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67th MORS Symposium (MORSS)

Final Program and Book of Abstracts

United States Military Academy
West Point, NY
22 - 24 June 1999

Keynote Speaker

LTG Randall L. Rigby

Deputy Commanding General,
United States Army Training & Doctrine Command

Theme:

Focusing Military Operations Research: From our Heritage to the Future

Military Operations Research Society(MORS)
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  BG **Fletcher M. Lamkin, Jr.**, Dean of the Academic Board

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  Mr. **Walter W. Hollis**, FS, Army Sponsor

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Special Session 1

Tuesday – 22 June – 1530 – 1700

Special Sessions Coordinators:

***Brian Engler**, Systems Planning and Analysis, Inc*
***Edward A. Smyth**, JHU/APL*

Tuesday, 1530 - 1700 .... **Thayer Hall, South Auditorium**

Theories of Combat

Session Chair: *Wayne P. Hughes, Jr., FS, Captain USN (Retired)*

Military operations research professionals have long recognized the need for a comprehensive, coherent theory to underpin models of combat and operations. This 90-minute session will include a statement of the problem, one effort to describe the phenomena of combat comprehensively, and a description of attempts to develop a theory of war in the old Soviet Union.

- **Introduction**: Wayne Hughes, Naval Postgraduate School

Wayne P. Hughes, Jr., FS, CAPT USN (Ret.)
Naval Postgraduate School
Department of OR (Code OR/HL)
Monterey, CA 93943
831-656-2484; FAX 831-656-2595
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- ***The Base of Sand Problem*** and associated research: Paul Davis, RAND

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- ***A Concise Theory of Combat*** published jointly by the Naval Postgraduate School and The Military Conflict Institute

Roger W. Mickelson
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The Military Conflict Institute, a public service corporation, seeks to develop a fundamental understanding of the nature of the nature of conflict, war, and combat; the publication of *A Concise Theory of Combat* by three TMCI members captures the results of several years of study of this complex and violent component of military conflict. The theories, philosophies, axioms, and principles described in this work are systematic, intellectual structures that explain and describe armed combat – "what everybody knows is true." *A Concise Theory of Combat* integrates many parts into a cohesive, unified whole in the scientific sense that art and practice must precede the codification into an organized body of knowledge. This presentation of "a theory" describes the spectrum of conflict, relationships of combat missions and outcomes, components of military combat, structure, and the dynamics of converting combat potential into actual combat power. Definitions and descriptors are provided to ensure that relevant terms are used consistently throughout the theory. This or any other theory is practical only to the extent that knowledge of any subject has practical value; it does not provide recipes for victory or recommendations for "fighting better." Rather, it provides a collective, integrated explanation of the most violent of human behaviors.

- ***The Evolution of Theory in the Soviet Union***: Allan Rehm, MITRE

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703-784-4055 (MCOTEA
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Tuesday, 1530 – 1700

Rist & Barchi Prize Awards/Prize Papers .... Thayer Hall, Room 144

Session Chair: *Maj Mark A. Gallagher, AFIT/ENS*

MORS will recognize and present the Barchi and Rist Prizes and the authors will brief their award-winning accomplishments during this dedicated Prize Session. These prizes are MORS' highest honors for recognizing outstanding technical achievements. The Barchi Prize is selected annually from among the papers derived from each working and composite groups' best presentation. Therefore, the Barchi Prize is often called "the Best of the Best." The Rist Prize is selected from among papers submitted in an annual call for papers. The winners for each prize will present their outstanding work. In addition, during the mixer, the prize winners along with the "Honorable Mentions" will have a display and copies of their papers available.

MORS 1999 RIST Prize Winner - *Signals from Space: The Next-Generation Global Positioning System*

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The Global Positioning System (GPS) is a constellation of satellites that provides precise navigation and timing information to military and civilian users worldwide. GPS signals from space guide cruise missiles and rental cars, and allow us to track the locations of railroad boxcars, golf carts, and soldiers in the field. As the provider of this national and international asset, the US has a vested interest in seeing that GPS remains the premier space-based navigation system, and has embarked on a GPS modernization program. Improvements in signal generation and processing technology now allow us to consider new signal structures, which will greatly improve the usefulness of GPS for military and civilian users. Choosing between these new signals, however, presents senior decision makers with a host of both technical and operational tradeoffs, many between competing military and civilian interests. The decision analysis presented here modeled the value of GPS to different user communities and quantified the tradeoffs. The results allowed the GPS Independent Review Team to recommend a new signal with superior military value that also meets all civilian technical performance requirements.

66th MORS Symposium Barchi Prize Winner

Upgrading Complex Systems of Systems: A CAIV Methodology for Warfare Area Requirements Allocation

Dr. Ronald R. Luman
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The engineering of complex systems of systems has received greatly increased attention in recent years. Although the characteristics and system engineering challenges associated with systems of systems are well understood, effective architecting approaches that enable cost/performance trades are still immature.

A systematic approach to considering how best to upgrade specific, complex systems of systems is postulated and demonstrated. Treating cost as the independent variable (CAIV), it seeks to find the "best" point design that may involve upgrading all component systems simultaneously, not just one at a time. The process has been demonstrated on a naval mine countermeasures system of systems representation of sufficient complexity to demonstrate feasibility of the approach. A constrained, nonlinear optimization problem is formulated whose objective function is a representation of the top-level measure of effectiveness (MOE), with constraints represented by functionalized Performance-Based Cost Models, secondary MOEs, and technology-driven bounds on system measures of performance (MOPs). Both closed-form and simulation-based optimization approaches have been demonstrated, including an efficient constrained stochastic optimization method necessitated by the use of simulation to generate MOEs.

This quantitative process for developing system of systems upgrade options for very complex situations can result in more effective and comprehensive systems acquisition and technology investment strategies.

Junior/Senior Analysts Session #1 .... Thayer Hall, Room 344

Session Chairs: *James L. Wilmeth III, SETA and William H. Dunn, AMSO*

The first session will accommodate those MORSians who, understandably want to meet with and discuss important issues with the more senior analysts known to most of us. This session will be held on Tuesday afternoon in an auditorium that will accommodate a relatively large number of participants. The session will be open to all to hear distinguished senior analysts discuss topics relating to this year's theme. After introductory remarks from each of the seniors, the balance of the period will feature a moderator-led Q&A session from the floor.

ARMY – Darrell Collier, US Army Space & Missile Defense Command
NAVAL – Dr. Al Brandstein, Marine Corps Combat Development Command
AIR FORCE – LTGEN Glenn Kent, USAF (Ret.)
INDUSTRY – Dr. Peter Cherry, Vector Research Inc.
OSD – Dr. Pat Sanders, OUSD (A&T) DTSE&E

Special Session 2

Wednesday – 23 June – 1530 – 1700

Wednesday, 1530 - 1700 .... **Thayer Hall, South Auditorium**

Heritage Session

Chair: **E. P. Visco, FS**

Dr. Paul H. Deitz
US Army Materiel Systems Analysis Activity
Attn: AMXSY-TD
392 Hopkins Road
APG, MD 21005-5071
410-278-6282; FAX 410-278-6584
Email: phd@arl.mil

Dr. Brian McCue
Center for Naval Analyses
4401 Ford Avenue
Alexandria, VA 22302

The papers in the heritage session were commissioned on the basis of military operational problems that have been plaguing us for many years. Ideally, we would be looking at problems that were of concern to the 'founders' and remain of concern as we move to the next millenium.

The papers that constitute the session deal with fundamental and continuing topics of concern to the military services. The Army paper, by Dr. Paul H. Deitz, Technical Director, US Army Materiel Systems Analysis Activity relates to the central issue of vulnerability. The foundation for vulnerability analysis of present day direct-fire weapons was established in the early 1960s when analysts at the US Army Ballistic Research Laboratory reviewed the results of Canadian trials involving large-caliber gun firings against M-47 and M-48 battle tanks. A new approach resulted, in which relationships were formed among field observations, outcomes inferred from the field observations, and inferred military utility. The resulting kill metrics provided the basis for loss-exchange rations which are a principal output of simulations today. In 1985, the Bradley Fighting Vehicle Live Fire test program once again brought the direct fire metrics into the limelight. Sharp debate ensued over the topics of observed vs. inferred metrics, tests vs. models, and population members vs. statistical ensembles. Today, as the future missions of the Army are predicted to bear little resemblance to the expected actions of the Cold-War and the use of legacy equipment in massed formations seems less likely, missions, goals, tactics, and technology application are changing radically. The Army is faced, again, with the issue of determining relevant mission utilities. The Army paper, then, examines a family of related military metrics, reviews the process by which the BRL developed the now familiar tank-kill measures, identifies perspectives gained during early Live-Fire programs, and provides suggestions as to how this history might affect future military operational research activities.

The Navy paper by Dr. Brian McCue, Center for Naval Analyses, focuses on anti-submarine operations. Data are available which show the occasions on which messages from or about U-boats, that is, German submarines, were intercepted by the Allies during phases of the World War II anti-submarine campaigns. A sub-set of the data, for May-September 1943, are used for the analysis. Three likelihood-based methods are shown by which wartime analysts could have attempted to estimate the total number of enemy submarines operating in the North Atlantic, from these data. The three methods take different views of the data, rest on different assumptions and give different answers. The degree to which the wartime data support the assumptions is assessed and the method whose assumptions are best supported by the data is the method whose answer is most closely borne out by postwar examination of German records. This work can be related to modern anti-submarine operations analysis.

An Air Force paper may round out the session.

Wednesday, 1530 - 1700 .... **Thayer Hall, Room 144**

Mini-Symposium Report: *Analyzing C4ISR for 2010*

Dr. Russell Richards
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In October 1998, MORS sponsored a workshop on Analyzing C4ISR for 2010. That workshop brought together members of the analytical community to look at the special problems of assessing the relative contribution of C4ISR to force effectiveness and to allocate investments between C4ISR and the other contributors to force effectiveness. The workshop divided into working groups covering the spectrum of military operations – major theater of war, smaller scale contingencies, operations other than war, infrastructure assurance, and overseas presence. It also included the synthesis working group and working groups on information architectures and analytical techniques and tools. Each working group was asked to characterize C4ISR within the focus area, to define the relative worth of C4ISR, to discuss and recommend measures of merit, to identify and describe tools, and to identify common issues and concerns. Each working group provided an assessment of the state of the practice with respect to each of the following areas: (1) problem structuring, (2) human factors and organization, (3) scenarios, (4) measures of merit, (5) tools and applications, (6) data, (7) risk and uncertainty, and (8) reporting.

This special session will provide an overview by the technical chair of the workshop summarizing the findings across the mission areas and it will provide reports by co-chairs from the two largest working groups – *Major Theater of War* and *Analytical Techniques and Tools.*

Major Theater of War:	Dr. Mark Youngren
Analytical Techniques and Tools:	Dr. Roy Rice
Synthesis Report on Analyzing C4ISR for 2010:	Dr. Russell Richards

Mini-Symposium and Workshop Report: *Joint Experimentation*

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The MORS Joint Experimentation Mini-Symposium and Workshop was held at the Armed Forces Staff College in Norfolk VA on 8-11 March 1999. It brought together a select group of military analysts and operators to examine how joint experiments can contribute to exploiting the Revolution in Military Affairs and advancing the implementation of Joint Vision 2010. It reviewed the US Atlantic Command's (ACOM) new role as the primary venue for joint experimentation, and examined how well designed and conducted experiments can point the way to the required organizational, doctrinal and cultural changes that best take advantage of the opportunities offered by advancing technologies. The goal of the mini-symposium and workshop was to contribute to planning, conduct, and exploitation of joint experiments by leveraging the experience and expertise of the analytical community. The meeting concentrated on assessing and improving the analytical community's ability to plan, conduct and analyze the results of concept-based experiments outlined in the Joint Experimentation Campaign Plan.

This paper reports on the workshop's progress and results.

Wednesday, 1530 – 1700

Junior/Senior Analysts Session #2

ARMY .... **Room 348**

Vern Bettencourt, FS, HQDA, DCSOPS
COL Ron Johnson, Office Secretary of the Army

NAVAL .... **Room 341**

Ted Smyth, Johns Hopkins University/APL
Bruce Powers, OCNO N816

AIR FORCE .... **Room 347**

Dr. Jacqueline Henningsen, FS, HQ USAF AXOC
Col Tom Allen, Air Force (Ret.), IDA

OSD .... **Room 369**

COL Gabe Rouquie, Army (Ret), Logicon
Dr. Lynda Jaques, US Pacific Command

Special Session 3

Thursday – 24 June – 1530 – 1700

Thursday, 1530 - 1700 .... **Room 144**

The Innovation Process: Warfighting Advantage or Achilles' Heel?

Panel Members:

COL Gary Anderson, USMC
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Marine Corps Warfighting Laboratory
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The United States relies, in part, on technology for warfighting advantage. The innovation process envisions the future, develops the new technology, transitions this technology to operations, and develops the warfighting doctrine and tactics needed to exploit the new technology. A critical issue is the optimal allocation of scarce resources among the competing technology programs. The process worked well during the Cold War. But, will it deliver the technology and warfighting concepts we will need to address the new and uncertain threats of the next decade and beyond? The interwar years of the 1920s and 1930s were also a period of rapid innovation in technology and warfighting concepts. Have the lessons of these years been applied to our present innovation process?

A panel of distinguished leaders in the innovation process will offer their insights into how the Department of Defense (DoD) and Department of Energy address these issues. From visions of technology to warfighting experiments, they will offer the latest thinking on the innovation process and the crucial role of operations research in it.

Thursday, 1530 - 1700 .... **Room 342**

SIMVAL Workshop Report: Making Verification, Validation, and Accreditation (VV&A) Effective and Affordable

Chair:
Priscilla A. Glasow
MITRE
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The latest in the series of MORS workshops on Simulation Validation, SIMVAL 99 was held in January to explore the use of tools and technologies to support verification, validation and accreditation of DoD models and simulations. This workshop was co-sponsored by the Society for Computer Simulation International (SCSI).

The workshop focused on three areas: (a) verification technologies, (b) validation methodologies and technologies, and (c) the impact of technology on VV&A costs. Technology vendors were invited to participate to elucidate the capabilities of existing tools. The participants of the workshop acquired a common foundational understanding of the state-of-the-art. Working group sessions were dedicated to identifying opportunities for tool and technology use, and examining concerns and issues resulting from that use.

This session will summarize the major findings and recommendations that emerged from the workshop.

SIMTECH 2007 Workshop Report

Chair:
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Email: starr@mitre.org

This session will summarize the major findings and recommendations that emerged from the workshop.

Thursday, 1530 - 1700 .... **Room 344**

Education Colloquium Panel Discussion

Coordinator: Maj **Willie McFadden**

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The DoD has adopted "Simulation Based Acquisition," supported by the Air Force's M&S Vision. As a result, there has been a great deal of emphasis on the use of M&S in all areas, including analysis, test and evaluation. While the concept is good, the implementation of that concept requires additional effort and additional funding. This talk will address some of the issues facing analysts and testers as we move more into the world of M&S.

PROF Richard E. Rosenthal
Naval Postgraduate School
Operations Research Department
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Thoughts on Advanced Distributed Learning in Technical Fields Like OR

The higher education community's embrace of asynchronous distance learning bears considerable resemblance to a gold rush. There are fundamental questions to be addressed concerning the efficacy of the technology in all fields. Before joining the stampede, we need to carefully consider how well it applies to advanced education in technical fields like operations research.

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Abstract unavailable at printing.

Tutorials

Monday, 1300 – 1700

Tuesday, Wednesday, Thursday - 1215 – 1315

Tutorial Coordinators:
MAJ **Jean McGinnis,** DAAR/PAE
MAJ **Willie McFadden.** Old Dominion University

Monday, 1300 - 1700..**Woodcliff Lake Hilton Auditorium**

Friendly Fire Shootdown Over Northern Iraq

LTC Scott A. Snook
USMA
West Point, NY 10996

The military is a complex organization operating in an even more complex world. When things run smoothly, it's easy to overlook the immense challenges of leading under such conditions. Sadly, it often takes a dramatic failure to remind us just how difficult a challenge this task really is. By examining a tragic case where both leading and organizing failed in a dramatic way, we will try to make some sense out of a tragedy that, on its surface, makes no sense at all. In the process, we will discuss a wide range of issues including: information flow, systems leadership, communications, high performance teams, culture, causality, accountability, and sense making – all tools of the trade for leaders of complex organizations.

Dramatic organizational failures and subsequent incident reviews open unique windows into the everyday lives of complex organizations. One such window opened on the 14th of April 1994, when two U.S. F-15 fighters accidentally shot down two U.S. Army Black Hawk helicopters in northern Iraq, killing all twenty-six people on board. This was our country's worst case of "friendly fire" since WWII. After almost two years of extensive investigation, with virtually unlimited resources, no compelling explanation emerged.

This tutorial places each member of the audience in the role of Air Force investigator. As participants in this experience, you will be charged with solving the following two puzzles:

1) How in the world could this tragedy ever happen? AND 2) Who would you hold accountable?

Short video clips tell the story, revealing evidence piece by piece in an attempt to slow down time and help us make sense of this seemingly senseless tragedy. In the process, we will all gain valuable insights into the challenging process of working and leading in complex organizations.

Tuesday, Wednesday, Thursday, 1215 - 1315..**Room 342**

Nonlinear Dynamics and Warfare Operations

Michael E. Crow
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We will review the major concepts of nonlinear dynamics (chaos theory, catastrophe theory and complexity theory) from an analytical perspective. The qualitative characteristics of chaotic, catastrophic and complex adaptive systems will be described, and their implications for analysis and warfare will be discussed. In addition, a qualitative description of the underlying mathematical basis of these theories will be presented.

Tuesday: On the first day an overview of the tutorial and nonlinear dynamics will be presented. The discussion will focus on a general description of each of the phenomena, some of the implications for analysis (e.g. non-predictability of chaotic systems), including some general topics that will be not be touched on again (e.g. discovering chaotic systems and the nature of randomness).

Wednesday: The second day will focus on cataloguing the different types of qualitative behavior that nonlinear systems can exhibit and offering suggestions for how to perform analysis on nonlinear systems. We will also identify the linearity assumptions used in traditional analysis and the implications of using this type of analysis on nonlinear systems.

Thursday: The third day will concentrate on the underlying mathematical basis of nonlinear phenomena that gives rise to the various types of dynamics. The discussion will remain on a qualitative and topological basis, rather than a detailed mathematical analysis.

Tuesday and Wednesday, 1215 - 1315.. **Room 344**

Neural Networks: Introduction and Applications *(Two Part Tutorial)*

LTC Jack Marin
USMA
Department of electrical Engineering & Computer Science
West Point NY 10996
914-938-4628; FAX 914-938-3807
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Neural networks, also known as artificial neural networks (ANN), parallel distributed processing systems, and connectionist models, are biologically inspired systems that attempt to "learn" patterns from sets of data.

Tuesday: The first part (Day 1) of this tutorial will concentrate on the basics of neural networks, to include, terminology, mathematical foundations, and a description of how a neural network works. Specific topics to be addressed include the perception learning algorithm, the back propagation, feed forward algorithm, competitive networks, and probabilistic neural networks.

Wednesday: Part 2 (Day 2) of this tutorial will describe how neural networks are applied in practice. Topics to be addressed include the application of neural networks to both prediction and pattern recognition problems, preprocessing of data, selection of learning algorithms, neural network topology selection, and the impact of various parameter settings. Software will be used to demonstrate the principals discussed in this tutorial, and a brief overview of neural networks and data mining will also be presented.

Tuesday and Wednesday, 1215 - 1315.. **Room 348**

Fuzzy Logic and Its Applications for Analysis

Maj Suzanne Beers, PhD
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Fuzzy logic and fuzzy set theory allow us to deal with gradual transitions between states, and to reason with words...aspects that make them ideal for many analysis tasks, especially those where drawing "lines in the sand" may be difficult, impossible, or meaningless. During this tutorial, the basics of fuzzy set theory and the mechanics of fuzzy logic will be presented, followed by applications of fuzzy logic to control, decision-making, and analysis tasks.

Wednesday, 1215 - 1315.. **Room 144**

Introduction to the High Level Architecture (HLA) for Simulations

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This tutorial provides an introductory overview to the US Defense Department High Level Architecture (HLA) for Simulations. It is designed primarily for those who are unfamiliar with the HLA, but may also be useful for those who desire a refresher on basic aspects of the HLA. The overview covers the motivations for HLA development including HLA goals, policy, and development process. It continues with descriptions of the latest versions of the three components of the HLA definition: the HLA Rules, the HLA Interface Specification and the HLA Object Model Template (OMT). The final segment of the overview takes a look at the nature and scope of the HLA services made available by DMSO, and being used internationally. The tutorial will conclude with a 22 minute video featuring US Defense Department personnel speaking to specific real-world problems being addressed by distributed simulation, and how HLA is being employed in helping solve those problems.

COMPOSITE GROUP A – Strategic & Defense

Working Groups 1, 2, 3, & 4

Chair: Michael O. Kierzewski, Optimetrics

Co-Chair: Ray Valek, USSTRATCOM

Tuesday, 1030 – 1200 Room 144

FREEDOM-TO-MIX: Integrating Strategic Offensive and Defensive Arms Control

Dr. Robert Batcher, Dr. Jerome Bracken, Dr. James Scouras
U.S. Arms Control and Disarmament Agency
320 21st Street, NW
Washington, DC 20451
Phone: 202-736-7396, Fax: 202-647-8743, Email: batchero@acda.gov

The United States and Russia appear to be on divergent paths with respect to the ABM Treaty. While both nations have formally affirmed their commitment to this treaty, the United States is developing technologies to support a deployment of national missile defenses within a rolling three-year timeframe. In addition there are strong voices in the Congress calling for moving as soon as possible beyond technology development to actual deployment. Meanwhile, Russia remains adamant that the ABM Treaty be preserved and has emphasized that progress in strategic arms reductions is conditioned on the continuation of the ABM Treaty.

This presentation explores an intriguing possibility for averting a situation where the United States is ultimately forced to choose between maintaining the ABM Treaty and deploying effective national missile defenses. Under the "freedom-to-mix" concept both the START and ABM treaties would be subsumed within a single new treaty. This freedom-to-mix treaty would have an overall limit on the total of strategic offensive plus defensive systems, with each nation having the freedom to decide its own separate subtotals of offensive and defensive systems.

The presumptive advantages of such a treaty are that it would allow the United States to deploy defenses beyond the limits of the ABM Treaty while allowing Russia to maintain a formal parity with the United States. This presentation critically examines the validity of these presumptions as well as other policy and technical issues associated with the freedom-to-mix concept.

Ground Effects Predictions for TMD Fire Control

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This presentation describes techniques used to estimate the benefits of ground effects predictions in tactical fire control decisions. These techniques were developed for the engagement of unitary chemical warheads in Theater Missile Defense. The objective was to establish if careful selection of interceptor launch sequences and intercept altitudes, under wind conditions known to the defense, could minimize civilian casualties and reduce interceptor expenditures while protecting the targeted asset.

The primary software tool used was the Post-Engagement Ground Effects Model (PEGEM) code. Simulated fire control decisions were based on user-supplied constraints and rules of engagement, examining a large number of different wind profiles.

The threat was a unitary chemical warhead aimed at the Pusan (Republic of Korea) port facility. Combinations of endoatmospheric single- or multi-shot engagements, possibly preceded by an exoatmospheric engagement were examined. The expected number of collateral urban civilian casualties and the probability of contaminating the targeted critical asset were computed as a function of engagement altitude.

Though the agent transport models continue to evolve, the study suggests that the use of timely ground effects predictions may provide significant benefits to the TMD. Compared to the best of fire control schemes not based on evaluation of the predicted ground effects, the use of these predictions may 1) reduce the expected number of civilian casualties, particularly by avoiding the large hazards which occasionally occur from intercept-induced releases, 2) reduce the likelihood that the defended asset would be contaminated, and 3) conserve interceptors.

COMPOSITE GROUP B – Space/C4ISR
Working Groups 5, 6, 7, 8, 9, 10, 11
Chair: Pete Shugart, US Army TRAC-WSMR
Tuesday, 1330 –1500 .... Thayer Hall, South Auditorium

Dr. Allan S. Rehm
Mitre Corporation
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McLean VA 22102-3481
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Email: arehm@mitre.org

Historical Lessons Learned for Modeling Campaigns Against Infrastructure: Targeting, Intelligence, and Measuring Effectiveness

Recently the idea of modelling infrastructure in increased levels of detail has been incorporated into a number of modelling efforts, both for targeting an enemy, and for modeling friendly infrasructure which has to be defended and reconstituted if damaged. For over 10 years the aurhor has been collecting examples of historical experience and data on which to base models of attacks on infrastructure. During that time, he was involved in several studies about these questions that raised some of the issues he became interested enough in to spend time on outside of any particular project. This talk summarizes some historical lessons learned for targeting, intelligence, and measuring effectivenss of campaigns aganst infrastructure. It also examines some of the types of models that have been considered or actually used for modeling these matters. This informal research was the basis for at least one prototype model of infrastructure as multiple interdependent networks.

COMPOSITE GROUP C – Joint Warfare
Working Groups 12, 13, 14, 15, 16, 17
Chair: Dr. Steve Pilnick, EDO Technology Services & Analysis
Wednesday, 0830 – 1000 .... Thayer Hall, South Auditorium

Evaluating Force Sufficiency in Operations Other Than War

Ms. Robbin Beall
Mr. Chuck Werchado
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The defense strategy described in the Report of the Quadrennial Defense Review (QDR) requires that joint forces be capable of responding to a series of contingencies of varying duration and scope. At the same time, forces must continue to address peacetime forward presence and other commitments that contribute to shaping the global environment. Following QDR, an effort was initiated to develop a rigorous analytical process to support these objectives. This process requires integration of analyses of three different types: (1) Tracking the global availability of forces and assessing U.S. ability to allocate forces to contingencies, constrained by maintenance availability, operational readiness, prior commitments to contingencies or presence requirements, and strategic lift capacity; (2) Assessing the adequacy of joint forces assigned to Major Theater Wars or Small Scale Contingencies; (3) Assessing the adequacy of force performance in a variety of Operations Other Than War.

At previous MORS symposiums, the SSC, MTW, and global force allocation components of this process were briefed. For the 67th MORSS, the remaining component, force performance in operations other than war will be briefed. The presentation will give an overview of three scenarios: (1) A hypothetical scenario that exercises multiple OOTW elements including reconnaissance support to counterinsurgency, strikes, raids, and noncombatant evacuation operations under evolving combat conditions; (2) Caribbean intervention; and, (3) Philippines disaster relief. The presentation will cover development of the scenario, measures of the capability of the force to provide the required level of support, modeling and simulation, and results of selected cases.

COMPOSITE GROUP D — Resources

Working Groups 18, 19, 20

Chair: Alan R. Cunningham, US Army TRADOC Analysis Center

Wednesday, 1030 – 1200 .... Room 144

Resources for Support and Infrastructure: Programmatic Challenges and Budget Realities

Christopher Jehn
Assistant Director for National Security
Congressional Budget Office

The apparent recent consensus for greater defense spending may diminish pressure to achieve economies in the support and infrastructure elements of the defense budget. That would be regrettable. Momentum for increasing defense spending may not last beyond FY 2001 (the start of a new administration). Moreover, no matter what size and structure the military may be, further economies in support and infrastructure are possible and desirable. This presentation will describe those possibilities and the budgetary context that makes them desirable, if not imperative.

COL Greg Parlier, Director, Program Analysis and Evaluation
HQ, USAREC, Ft. Knox, KY 40121
(502) 626-0321
Email: parlier@usarec.army.mil

Recruiting Environment Overview

This briefing will cover the implementation of the United States Army Recruiting Command's (USAREC) strategic approach toward manning the Army of the future. In addition to facing daunting short-term challenges in achieving the FY99 recruiting mission, we must also focus our intellectual energy on the human dimension of the Force XXI process to better understand future personnel and manpower requirements that are essential to manning the Army XXI and Army After Next. With the knowledge of these requirements, we can better assess how demographic, socioeconomic, and cultural trends will impact our ability to sustain future manpower accession goals. We will increasingly compete not only with our sister services but also with low unemployment, institutions of higher learning, and our own National Guard. This briefing will outline the solutions we are implementing in the short term, as well as our recently developed USAREC "Vision XXI" and supporting Transformation Strategy consistent with other appropriate Army strategic human resource planning goals. We are trying to "see" the future and better understand the evolving relationships between projected available resources, military manpower concepts, and future Army objectives.

COMPOSITE GROUP E – Readiness/Training

Working Groups 21, 22 & 23

Chair: LTC George Stone, JPO JSIMS

Wednesday, 1330 – 1500 .... Room 144

The Technology Roller Coaster Ride: How to Turn a Joy Ride into a Productive Venture

"When you're in the middle of it, it's very hard to tell where the technology [or roller coaster] is really taking you."[1]

As the Department of Defense prepares for the battlefields of the 21st century, there are serious considerations in how to conduct technology transition. Currently, there are many research and development efforts across DoD that do not coordinate, collaborate or synchronize. Also, the tools never to satisfy everyone in their race to maintain pace with technological advances.

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[1] Thursday, March 25, 1999, The New York Times, New York.

Transitioning technology research and production to consumption is a very rigorous and deliberate process. Besides the government and DoD, various commercial companies like Microsoft and Bell Labs face this issue. As indicated by the Vice President for Research at Bell Labs, new technologies do not transition easily into ongoing programs:

During this period Research re-discovered the AT&T Business Units, learned how to work with them to leverage technology, and learned how to reduce technology transfer cycles from decades to years. Although we were still slow in moving technology into the AT&T businesses, we were learning how to work together as a team. Slowly, but surely, there developed an undercurrent within Research to show relevance of the work (or some significant fraction of the work) to current and planned AT&T products and services.

Composite Group E, Readiness and Training, will host a four-member panel to address these issues from both the producer and consumer perspectives. Representatives from both industry and the military will be invited as panel speakers. The panel will highlight our past successes in this area with a focus on visualizing the future.

The challenge to those who participate in the Composite Group E panel discussion is to determine ways to enhance joint and service military readiness via insertion of visionary tools of the future. Analysis, training and planning tools should capitalize on historical experiences and well-defined transition plans in order to pave new frontiers for training forces that will operate in unknown, advanced technology environments.

Questions to be addressed include: What are the issues regarding transitioning technologies into models and simulations to increase the readiness and training of our forces? How does the corporation or organization muster enough commitment to succeed? What is the measure of success for technology transfer/insertion?

COMPOSITE GROUP F – Acquisition

Working Groups 24, 25, 26, 27, 28

Chair: COL Mike Lavine, OASA Acquisition, Logistics & Technology

Co-Chairs: John Ferguson, SAIC

Junior Analyst: Maj Chris Garrett, Air Force Test & Evaluation

Thursday, 0830 – 1000 .... Room 144

Integrating Cost and Performance Models to Enable CAIV-Based System Requirements Allocation

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The engineering of complex systems of systems has become increasingly problematic as warfare area architectures include a wider variety of inter-operating sensors and systems. Specifically, determination of the system requirements using cost as the independent variable (CAIV) is generally done through consideration of a small number of discrete options, without regard for cost and performance impact to the larger system of systems. A systematic approach to considering how best to architect affordable, complex systems has been developed and demonstrated. By integrating traditional performance models and innovative performance based cost models (PBCMs), the "best" system of systems point design can be determined as a function of total system of systems cost. The resulting series of point designs is expressed in terms of key performance parameters and is optimized by considering all component systems simultaneously, not just one at a time.

The process has been demonstrated on a naval mine countermeasure system of systems representation of sufficient complexity to demonstrate feasibility of the approach. A constrained, nonlinear optimization problem is formulated whose objective function is a representation of the top-level measure of effectiveness (MOE), with constraints represented by functionalized performance-Based Cost Models, secondary MOEs, and technology-driven bounds on system measures of performance (MOPs). Both closed-form and simulation-based optimization approaches have been demonstrated, including an efficient constrained stochastic optimization method necessitated by the use of simulation to generate MOEs in complex problems of interest. Examination of sensitivities to the PBCMs and especially technology-driven limitations on MOPs can also yield significant insights needed to focus a supporting warfare area technology investment strategy. The process is currently being applied to focus future S&T mine countermeasure investments for the Office of Naval Research, and is under consideration for a variety of other warfare area applications.

Designing the Optimal T&E Strategy Using Value-Focused Thinking and Fuzzy Logic

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The military test and evaluation (T&E) community, like the rest of the military, faces a complex, increasing workload and decreasing resources. As the fidelity and applicability of modeling and simulation (M&S) tools have improved, testers can now augment or possibly replace some traditional T&E events with models and simulations of the tested system and environment. However, choosing the optimal mix of T&E activities, including M&S options, is a complex and potentially risky problem. There are many ways testers can now gain information about the system under test, including preliminary analytical studies, digital models and simulations, hardware-in-the-loop simulations, developmental testing, and operational testing. These events should form a cogent T&E strategy that takes advantage of all the available information, and adapts to information gained as the system is developed and evaluated. Coupled with the cost of T&E and the often dramatic consequences of ineffective T&E, this situation gives rise to a series of constrained optimization problems if, given current information, the analyst can measure the relative value of each of these many T&E events for inclusion in the objective function and constraints.

This presentation will demonstrate how, using the Value Focused Thinking (VFT) approach from decision analysis, a hierarchical value model can illuminate an quantify the contribution of T&E events to the many levels of evaluation, from high-level mission accomplishment down to low-level measures of system performance. A fuzzy logic-based model will define the relationships between the measures of performance at the various levels of evaluation. This hierarchical structure will then provide the value od individual T&E events to the overall T&E strategy. These values will be the inputs to an optimization model, trading off the value versus cost of the various events, leading to an optimal test strategy for the system-under-test.

COMPOSITE GROUP G — Advances in Military Operations Research
Working Groups 29, 30, 31, 32
Chair: LTC Robert Kilmer, USA (Ret.), Walden University
Thursday, 1030 – 1200..........Room 144

A Panel Discussion of Future Advances in Military OR

The panel will open with a discussion of how emerging trends in modeling and simulation technology may impact the practice of Military OR. Material will be derived from the SIMTECH 2007 Special Meeting. The discussion will then proceed into the more general issues of evolving, emerging, and future technologies and methodologies relevant to Military OR. In addition to providing the audience with insights into likely Military OR futures, this discussion will serve as a means of identifying potential themes for CG G for the 68th MORSS.

Panelists:

Dr. Stuart Starr, MITRE, SIMTECH 2007 Overview
Mr. Denis Clements, GRC International, Emerging Technology Trends
Dr. Cy Staniec, Logicon, Emerging Methodology Trends

Mixer Session

Tuesday – MIXER – 1715 – 1900

Ballroom – Eisenhower Hall

Coordinators: LTC Jack Marriott, NIMA and Maj Suzanne Beers, Space Warfare Center

The Mixer Session for the 67th MORSS will have a 'Science Fair' atmosphere. The session will consist of video presentations, displays, interactive PC demonstrations, graphics boards and participation with the Barchi and Rist Prize winners and selected close competitors. Don't miss this opportunity to learn from the best of the best and have a great time doing it.

67th MORSS PRIZE PAPER FINALISTS

1. <u>Barchi Prize</u> –

   a. Winner – *Upgrading Complex System of Systems: A CAIV Methodology for Warfare Area Requirements Allocation* by Dr. Ronald Luman, the Johns Hopkins University
   Presented – Special Session #1, Tuesday 1530-1700, Thayer Hall Room 144

   b. Honorable Mention – *Effectiveness of Aircraft Alternatives for the Combat Search and Rescue (CSAR) Mission* by George E. Thompson, ANSER, Inc.
   Presented – WG Session #7, Thursday 1030-1200, WG 15, Thayer Hall Room 345

   c. Finalists –
   (1) *Depot-Level Maintenance Planning for Marine Corps Ground Equipment* by Capt C. A. Goodhart, USMA, DC/S Installations and Logistics (LX)
   Presented – WG Session #1, Tuesday 1030-1200, WG 19, Thayer Hall Room 312

   (2) *Improving Single Strike Effectiveness* by LCDR Philip S. Whiteman, USN, US Strategic Space Command/J533
   Presented – WG Session # 5, Wednesday 1330-1500, WG 7, Thayer Hall 339

2. <u>Rist Prize</u> –

   a. Winner – *Signals from Space: The Next-Generation Global Positioning System* by LtCol Lee J. Lehmkuhl, USAF, Capt David J. Lucia, USAF, and Col James K. Feldman, USAF, SWC/AEA
   Presented – Special Session #1, Tuesday 1530-1700, Thayer Hall Room 144

   b. Finalists –
   (1) *Army Enlisted Attrition Study, Phase I – Initial Entry Training, Volume 1 – Main Report* by Martin R. Walker, US Army TRAC-Lee
   Presented – WG Session #4, Wednesday 1030-1200, WG 22, Thayer Hall Room 323

   (2) *Forecasting and Allocating of US Army Recruiting Resources* by P.L. Brockett, J.J. Rousseau, L. Zhou, Center for Cybernetic Studies; B. Golany, Faculty of Industrial Engineering, Technion-Israel Institute of Technology; and D.A. Thomas, USMA, Department of Systems Engineering
   Presented – WG Session #4, Wednesday 1030-1200, WG 20, Thayer Hall Room 308

   (3) *Measures of Effectiveness for the Information-Age Army* by Richard Darilek, Jerome Bracken, John Gordon, Brett Lewis, Brian Nichiporuk and Walter Perry, RAND
   Presented – WG Session #5, Wednesday 1330-1500, WG 24, Thayer Hall Room 322

   (4) *Stochastic Analysis for Deployments and Excursions (SADE)* by LTC Patrick Dubois and MAJ Thomas M. Kastner, CAA
   Presented – WG Session #5, Wednesday 1330-1500, WG 18, Thayer Hall Room 314

Other Special Events

Tuesday, 0715 - 0815 .... **Room 144**
Working & Composite Group Warm-up
Coordinator: LTC(P) **Mike McGinnis**, USMA

Wednesday, 0700 - 0800 .... **Main Dining Room, West Point Club**
Town Hall Breakfast Meeting (WG & CG Chairs ONLY)

Wednesday, 0700 - 0800 .... **Benny Havens Lounge, West Point Club**
***PHALANX* Editors' Breakfast Meeting**
Coordinator: Dr. **Julian Palmore** , US Army CERL

Wednesday, 0700 - 0800 .... **Gray Room, West Point Club**
***Military Operations Research* Journal Editors' Breakfast Meeting**
Coordinator: Dr. **Gregory Parnell** , FS, Virginia Commonwealth University

Wednesday, 1030 - 1200 .... **Room 362**
M & S (SAG) Meeting
Coordinators: Dr. **Hank Dubin** and Ms. **Priscilla Glasow**

Thursday, 0700 - 0810 .... **Room 144**
Joint Senior Advisory Group (SAG) Meeting
Coordinator: Dr. **Jacqueline Henningsen** , FS, OSD (PA&E)

Thursday, 1530 - 1700 .... **Room 144**
Working Group Wrap-Up

Tuesday, 1330 – 1430, Wednesday, 1230 – 1330, Thursday, 1030 - 1200 .... **Room 368**
JWARS Demonstration – see flyer on page 17

Friday, 0730 .... **West Point Golf Course**
GOLF Scramble – see flyer on page 18

The JWARS Office invites all attendees to stop by and visit the JWARS Demo Room, Room # 368.

A formal JWARS Overview Briefing and Demonstration will be given each day in Room # 368:

Tuesday, 1330 - 1430 *Wednesday, 1230 - 1330* *Thursday, 1030 - 1200*

Personnel from the JWARS Office will be available at all other times to answer questions and discuss and demo the model.

Presentations about JWARS during MORSS

WG Session	Date / Time	WG	Room Number	Title
1st	Tues, 1030-1200	WG 11	# 327	*JWARS Synthetic Natural Environment*
3rd	Wed, 0830-1000	WG 6	# 340	*JWARS Communications Model Design*
3rd	Wed, 0830-1000	WG 19	# 312	*Intratheater Logistics Modeling in JWARS*
4th	Wed, 1030-1200	WG 23	# 325	*Behavioral Impacts on Battlefield Performance in JWARS*
5th	Wed, 1330-1500	WG 2	# 357	*Chemical Defense Representation in JWARS*
6th	Thur, 0830-1000	WG 6	# 340	*Sensor Representations in JWARS*
8th	Thur, 1330-1500	WG 13	# 317	*JWARS: Littoral Warfare*

If you don't get a chance to stop by the Demo Room, feel free to contact us with questions and comments at:

JWARS@osd.pentagon.mil

MILITARY OPERATIONS RESEARCH SOCIETY

Join Us for a Round of Golf!

When: Friday, 25 June @ 0730
(First Tee Time @ 0800)

Where: West Point Golf Course

Cost: $35 per person (Includes Lunch)

Format: Captain's Choice

Sign-up: Sign-up during regular MORSS registration, 22 June 1999

- ★ *Enter your team or sign up individually*
- ★ *Soft spikes required (available @ Pro Shop)*
- ★ *Rental Clubs - $10, Cart - $11 Pull-cart - $3*

Prizes:
- 1st, 2nd and 3rd place Teams
- Longest Drive
- Closest to Pin

General Information
67th MORSS Final Program

MORS Office

MORS office at USMA will be in **Thayer Hall, Room 376**. The office will be open on Thursday and Friday, 18-19 June, and Monday, 21 June, 0830-1700; on 22, 23, 24 June, 0700-1730.

The phone numbers for the MORS office at USMA are: 914-938-8082/83, Incoming FAX 914-938-8081.

USMA Support Office: 914-938-8086; FAX 914-938-8085

Attendee Support:

- **Computers** - There will be computer support in **Room 378.** Four computers will be set up for attendees to work on their presentations. This is primarily for those people who have presentations that are on the network (too large for a diskette). If presenters can fit their slides on a diskette, they can use the computers in the classrooms to modify them. A printer will also be available.

  Each classroom used for presentations will have a networked Pentium 90/100 PC running NT 4.0. The software loaded includes Microsoft Office 97. Unclassified presentations may be e-mailed to usmamors@usma.edu (POC: MAJ Stinson, 938-2073). Attendees may use the computers in the classrooms to make corrections to presentations.

- **Phone Rooms** – Phones with DSN lines and credit card capability will be available in **Room 374, Thayer Hall.** A commercial phone bank will be near the entry ways to Thayer Hall.

Government Quarters are not available.

Statements of Non-availability

The Joint Travel Regulations lists USMA as an installation that has no adequate TDY quarters. Specifically the regulations states: *The following installations (including USMA) have dining facilities but no adequate TDY quarters. Since travelers must reside in commercial facilities, SNA control numbers are not required for TDY quarters.*

Lost and Found

The Lost and Found will be in the MORS office at USMA during the Symposium. Lost and Found items not claimed at the end of the Symposium will be left with the host facility.

Mixer

There will be an informal mixer at the Cadet Activities Center, Eisenhower Hall on Tuesday evening, 22 June, from 1715-1900. There will be a cash bar.

Transportation will be provided back to the hotels before and after the mixer (see bus schedule p.21).

Barbecue at the Woodcliff Lake Hilton

On Wednesday evening, 23 June, there will be a fabulous Barbecue at the Woodcliff Lake Hilton. Tickets are only $40.00 per person. Volleyball, swimming and dancing (DJ for the evening will be **COL Lee Wyatt**) are some of the activities planned for an evening of fun. Attire is extremely casual!

Lunches will be available at:

- Cadet Restaurant in Eisenhower Hall
- Grant Hall
- West Point Club

Menus are available at registration and at the refreshment table.

Box lunches will be available for those attending tutorials on Tuesday, Wednesday and Thursday for $7.50 each day. Please order your lunches with your application form. Include payment with your registration fee. Lunch tickets may be available at the MORS Office.

Box Lunch Pick-Up will be in the Thayer Hall South Auditorium Lobby.

Coffee

Coffee and snacks will be provided without additional charge. Coffee will be served on Tuesday, Wednesday and Thursday at the following times in Thayer Hall Lobby:

0700-0830	**1000 – 1030**	**1500-1530**

Designated Smoking Areas

Smoking is NOT permitted in any building at USMA. The designated smoking areas are located outside each building.

Hotel Phone Numbers

Woodcliff Lake Hilton	201-391-3600
Holiday Inn, Montvale	201-391-7700
Holiday Inn, Suffern	914-357-4800
Wellesley Inn, Suffern	914-368-1900
Wellesley Inn, Ramsey	201-934-9250
Howard Johnson, Ramsey	201-327-6700
Ramada Inn, Newburgh	914-564-4500
Holiday Inn, Newburgh	914-564-9020
Super 8 Motel, Newburgh	914-564-5700
Hampton Inn, Newburgh	914-567-9100
Best Western Palisades Motel	914-446-9400
West Point Motel, Highland Falls	914-446-4180
Thayer Hotel	914-446-4731

Bus Schedule to 67th MORSS at USMA from Hotels
Tuesday – Thursday, 22-24 June 1999

Bus 1 & 2	Woodcliff Lake Hilton
Bus 3	Holiday Inn (Montvale)
Bus 4	Wellesley Inn and Howard Johnson (Ramsey)
Bus 5	Holiday Inn and Wellesley Inn (Suffern)
Bus 6	Ramada Inn and Holiday Inn (Newburgh)
Bus 7	Super 8 and Hampton Inn (Newburgh) Best Western and West Point Motel (Highland Falls)

- **All buses arriving at USMA from hotels will DROP-OFF and PICK-UP at Thayer Hall except after the Tuesday Mixer when the buses will depart from Eisenhower Hall.**
- **You MUST present bus passes issued by the MORS Office to ride the buses.**
- **Times will vary by approximately 5-15 minutes for buses with multiple hotel pick-ups.**

TUESDAY

Bus	Depart Hotel(s)	Arrive USMA
Buses 1-7	0630	0730

Tuesday Mixer (USMA) 1715-1900 Bus Schedule

	Depart USMA	Arrive Hotel(s)
Bus 1&2 – to Woodcliff Hilton and Holiday Inn (Montvale)	1715	1815
Bus 4 – to Wellesley Inn and Howard Johnson (Ramsey), Wellesley Inn and Holiday Inn (Suffern)	1715	1815
Bus 6 – to Best Western and West Point Motel (Highland Falls) Ramada Inn, Holiday Inn, Super 8 and Hampton Inn (Newburgh),	1715	1815
Bus 3 – to Woodcliff Lake Hilton and Holiday Inn (Montvale)	1900	2000
Bus 5 – to Wellesley Inn and Howard Johnson (Ramsey), Wellesley Inn and Holiday Inn (Suffern)	1900	2000
Bus 7 – to Best Western and West Point Motel (Highland Falls) Ramada Inn, Holiday Inn, Super 8 and Hampton Inn (Newburgh).	1900	2000

WEDNESDAY

Bus	Depart Hotel(s)	Arrive USMA
Buses 1-7	0630	0730

Wednesday Barbecue (Woodcliff Hilton) 1900-2200 Bus Schedule

	Depart USMA	Arrive Hotel(s)	Depart Hotel(s)	Arrive Barbecue	Depart BBQ to Hotels
Bus 1&2 – to Woodcliff Hilton and Holiday Inn (Montvale)	1715	1815			
Bus 3 – to Best Western and West Point Motel (Highland Falls)	1715				
Bus 3 – Pick-up at Thayer Hotel then to Highland Falls hotels			1800	1900	2200
Bus 4 – to Wellesley Inn and Howard Johnson (Ramsey).	1715	1815	1830	1900	2200
Bus 5 – to Wellesley Inn and Holiday Inn (Suffern)	1715	1815	1830	1900	2200
Bus 6 – to Ramada Inn and Holiday Inn, (Newburgh)	1715	1800	1815	1900	2200
Bus 7 – to Super 8 and Hampton Inn (Newburgh)	1715	1800	1815	1900	2200

THURSDAY

Bus	Depart Hotel(s)	Arrive USMA	Depart USMA	Arrive Hotel(s)
Buses 1-7	0630	0730	1515	1615
			1715	1815

Spouse/Guest Program Bus Schedule

Depart Grant Hall, USMA	Return to USMA	Tuesday Mixer Schedule	Depart Grant Hall, USMA	Return to USMA	Wednesday BBQ Schedule
Tuesday, 22 June 0930	1630	See above schedule	Wednesday, 23 June 0930	1630	See above schedule

Security Matters

All attendees and speakers are US Nationals. All have SECRET clearances and need-to-know certified by competent authority.

Attendees are reminded of the necessity for continuing attention to security precautions. While every effort will be made to provide a secure facility for the meeting and to insure that attendees are properly identified, cleared, and in possession of the required need-to-know, all are reminded that the responsibility for the unauthorized disclosure, particularly with regard to conversations, rests with the individual attendee. Attendees are requested to keep in mind the following important points:

1. Be careful WHERE you make classified disclosures. Do not extend classified discussion to hotels, restaurants, officers' clubs, or other places in which you are unable to positively identify all within hearing distance and be reassured of the nonexistence of eavesdropping devices.
2. Be careful TO WHOM you make classified disclosures. You should assure yourself that the people to whom you are talking are indeed registrants at the 67th MORSS. You are advised that a uniformed or civilian person located away from the restricted area of the meeting and not personally recognized as a registrant does not have authorized access to classified information, regardless of his possession of a MORS name badge.
3. The attention of non-government attendees is invited to the NISPOM, Chapter 5, Section 5, with regard to disclosure authorizations.
4. Attendees are advised that possession of photographic, audio recording or electronic transmitting devices is not authorized in the meeting spaces of the 67th MORSS.

Admission Policy

Admission to the secure area of the meeting is limited to holders of current printed invitations properly authenticated and issued by the MORS office to the named individual for his attendance at the 67th MORSS.

Persons who enter or attempt to enter the secure area of the meeting without proper invitation and persons who aid, encourage, or willfully permit improperly authorized persons to enter the secure area of the meeting are liable for citation for security violation.

Invitations

The only admissible invitation is the official 67th MORSS Invitation issued by the MORS Office. Other invitations, including official invitations for earlier MORSS, are inadmissible. There is no provision for one-session-only invitations and MORS has no obligation to issue invitations after the announced deadline or to work out invitations for persons who arrive uninvited at the meeting. ***Invitations must be brought to the meeting. They are required for registration.***

Restricted Meeting Areas

For the 67th MORSS, the designated restricted meeting area is the third floor of Thayer Hall inside the guard stations. All classified presentations and discussions in connection with the MORSS program are to be conducted inside this area. Classification signs must be posted in each room to designate the classification of any presentation or session Only the following persons are permitted access to MORS meeting areas:

- Officially invited 67th MORSS attendees with appropriate MORS-issued name badges and approved ID cards;
- MORS staff and service personnel with appropriate MORS-issued name badges and approved ID cards;
- Members of the 67th MORSS guard force;
- Officials representing the host command on official business.

Entry to the Meeting Areas

Entry to the restricted meeting areas will be regulated by the guard force and working group chairs and cochairs.

At each entry to the meeting area, each attendee will be required to stop long enough to show his properly validated 67th MORSS name badge and his identification and to be recognized by the guards. The name badge and ID card should be displayed at all times within the restricted meeting area. The guards or working group chairs and cochairs will check the following before admitting an attendee to the classified area:

- The validity of the ID card
- The validity of the name badge
- The correspondence of face and ID picture
- The correspondence of name on badge and ID card.

So that the ID check can be accomplished quickly, name badges and ID cards must be displayed together in the MORS name badge holder.

Guards will also check briefcases and purses to insure attendees are not carrying cameras, tape recorders or other portable electronic devices into the meeting areas.

Picture ID Cards

All attendees in the restricted meeting areas are required to display their ID cards in the MORS badge holders along with their name badges. Only three types of ID cards are permissible: the active duty military ID card ***(Please note:** You must be in uniform to use your active duty ID card)*, the ID card issued by MORS and USMA civilian ID cards. The MORS-issued ID cards will be delivered to the attendees when they register. Please return the MORS ID Card to MORS at the end of the symposium.

MORS Name Badges

A MORS name badge is issued to each properly registered attendee, along with a plastic pouch for its display. Attendees should take care that the badge is not lost or loaned during the meeting as these are avenues for improper entry and security violations. Badges should not be changed, corrected, or altered in any way. If necessary, a member of the MORS staff will issue a new badge at the MORS Office.

Note Taking

Classified presentations shall be delivered orally and/or visually. Classified documents shall not be distributed and classified note-taking and electronic recordings shall not be permitted by attendees during classified presentations.

Classified Matter -- Transmittal

Those desiring to send classified material in advance of their arrival should address it (for attendee pickup) in the following manner:

Classified Material Control
Superintendent USMA
Attn: MAIM-SC-A (George Couts)
West Point, NY 10996-5000
(408) 656-2450, DSN: 878-2450

The lower left corner of both the outer and inner envelopes should show the following information:

Hold for MORSS Attendee:
Your Name
Your Company or Organization

USMA will provide your package to the MORS Office at USMA where you may retrieve it when you arrive at the Symposium, after 1000 on Tuesday, 22 June 1998.

Please note: Capability to perform *major* reproduction of your materials once you arrive at USMA WILL NOT be provided.

When no longer needed for the Symposium, attendees may bring their classified material to the MORS office to be wrapped for hand carry or transmittal to their parent activity. ***The attendee is responsible for providing a letter of transmittal to be included in the package.*** The meeting security staff will be responsible for proper wrapping and marking of inner and outer envelopes in accordance with Navy security regulations. The address for classified mail shown on the attendee's personal security voucher will be used for mailing purposes. MORS will accept responsibility for mailing a properly wrapped and sealed package by registered mail and will provide the attendee with a receipt for the sealed package. Because of congestion, MORS staff will not be able to wrap packages during the breaks between sessions.

Classified Matter -- Overnight Storage

The MORS office will accept (until 15 minutes after the end of the last session) and safeguard (for the meeting duration) classified matter to the level of SECRET. Material will be accepted as a package rather than loose. Receipts must be presented on recovery of material by its holder. The MORS office staff is cleared to the SECRET level.

Classified Disclosure

Persons participating in the discussions at the 67th MORSS have been granted limited disclosure authorization via their personal security vouchers for the 67th MORSS. It is the individual responsibility of each participant to find out in advance, from his certifying official, the limits to his own classified disclosures and to stay within those limits at the symposium.

A written disclosure authorization is required for all papers and presentations (government and contractor). All disclosure authorizations must be forwarded to the MORS Security Manager on or before **14 May 1999**. Attach an unclassified abstract which has been stamped *Approved for Public Release; Distribution Unlimited* to the disclosure form. If the disclosure authorization is not received by MORS prior to the symposium, the presentation will be canceled. A disclosure form was provided in the Registration Packet. Request additional disclosure forms from the MORS office.

Applicable Distribution Statement

The *Applicable Distribution Statement* is frequently overlooked and the primary reason for returning a disclosure form to the author for completion. This section of the form MUST be completed and is found at the end of the MORS Disclosure Authorization Form. To find the most commonly used Disclosure Statements see page 10 of the Registration Packet.

MORS Purposes and Objectives

The purpose of the Military Operations Research Society is to enhance the quality and effectiveness of classified and unclassified military operations research. To accomplish this purpose, the Society provides media for professional exchange and peer criticism among students, theoreticians, practitioners, and users of military operations research. These media consist primarily of the traditional annual MORS symposia (classified), their published proceedings and abstracts, special mini-symposia, workshops, colloquia and special purpose monographs. The forum provided by these media is directed to display the state of the art, to encourage consistent professional quality, to stimulate communication and interaction between practitioners and users, and to foster the interest and development of students of operations research. In performing its function, the Military Operations Research Society does not make or advocate official policy nor does it attempt to influence the formulation of policy. Matters discussed or statements made during the course of its symposia or printed in its publications represent the positions of the individual participants and authors and not of the Society.

The Military Operations Research Society is governed by a Board of Directors consisting of 30 members, 28 of whom are elected by vote of the Board to serve a term of four years. The persons nominated for this election are normally individuals who have attained recognition and prominence in the field of military operations research and who have demonstrated an active interest in its programs and activities. The remaining two members of the Board of Directors are the immediate Past President who serves by right and the Executive Vice President who serves as a consequence of his position. A limited number of Advisory Directors are appointed from time to time, for a 1-year term, to perform some particular function. In addition to the members, the Society maintains a general distribution list of its clientele to whom announcements, newsletters, and information are routinely sent.

The MORS Board of Directors wants to make the meetings and other operations of the Society as responsive as possible, both to the needs of the times and the desires of the members. Consequently, attendees are invited to communicate their relevant ideas and thoughts to any Officer or other Director or to the Society in writing. Where practicable, your communications will be duplicated and furnished to the MORS Board Members and Program Chairs for guidance in respect to future plans and operations.

The following are particularly encouraged:

- Offers of help in future symposium programs and working groups.
- Proposals for establishing new working groups.
- Suggestions for future banquet speakers, keynote speakers, meeting themes, meeting sites, arrangement improvements.
- Constructive criticism of current operations or programs.

The Society will consider all comments, suggestions, and proposals.

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NOTES

67th MORSS Working Group / Classroom Match Up

Composite Group Number	Working Group Number	TIMES: Tuesday 0715-0820 Warm-up Session	Tuesday 0830-1000 Plenary Session	Tuesday 1030-1200 WG Session 1	Tuesday 1215-1315 Tutorials Session 1	Tuesday 1330-1500 WG Session 2	Tuesday 1530-1700 Special Session 1	Tuesday 1715-1900 Mixer	Wednesday 0830-1000 WG Session 3	Wednesday 1030-1200 WG Session 4	Wednesday 1215-1315 Tutorials Session 2
A	1			CG - A		Rm 359			Rm 359	Rm 359	
A	2					Rm 357			Rm 357	Rm 357	
A	3	C	P			Rm 355	S	M	Rm 359	Rm 355	
A	4A	G	L			Rm 344	P	I	Rm 344	Rm 344	
A	4B	/	E	Rm 144		----	E	X	Rm 353	Rm 353	
B	5	W	N	Rm 343			C	E	Rm 343	Rm 343	
B	6A	G	A	Rm 336	T	CG - B	I	R	Rm 336	Rm 336	T
B	6B		R	Rm 338	U		A		Rm 338	Rm 338	U
B	6C	W	Y	Rm 340	T	Thayer	L		Rm 340	Rm 340	T
B	7	A		Rm 339	O	Hall		P	Rm 339	Rm 339	O
B	8	R	S	Rm 341	R		S	R	Joint	Rm 341	R
B	9	M	E	Rm 337	I	South	E	E		Rm 337	I
B	10		S	Rm 329	A	Aud.	S	S	Rm 144	Rm 329	A
B	11	U	S	Rm 327	L		S	E	Rm 327	Rm 342	L
C	12	P	I	Rm 315		Rm 315	I	N	CG - C	Rm 315	
C	13		O	Rm 317		Joint	O	T	Thayer	Joint	
C	14	S	N	Rm 319		Rm 342	N	A	Hall	Rm 342	
C	15	E		Rm 345		Rm 345		T		Rm 345	
C	16	S		Rm 347		Rm 347		I	South	Rm 347	
C	17	S	T	Rm 348		Rm 348	SS1	O	Aud.	Rm 348	
D	18	I	H	Rm 314		Rm 314		N	Rm 314	CG - D	
D	19A	O	A	Rm 312	S	Rm 312	(2)	S	Rm 312		S
D	19B	N	Y	----	E	----			----		E
D	20		E	Rm 308	S	Rm 308			Rm 308	Rm 144	S
E	21	T	R	Rm 321	S	Rm 321			Rm 321	Rm 321	S
E	22	H		Rm 323	I	Rm 323			Rm 323	Rm 323	I
E	23	A	S	Rm 325	O	Rm 325			Rm 325	Rm 325	O
F	24	Y	O	Rm 322	N	Rm 322			Joint	Rm 322	N
F	25A	E	U	Rm 324		Rm 324				Rm 324	
F	25B	R	T	Rm 326	T1	Rm 326			Rm 144	Rm 326	T2
F	26		H	Rm 342		Rm 328			Rm 342	Rm 328	
F	27	R		Rm 330	(1)	Rm 330			Rm 330	Rm 330	(2)
F	28	M	A	Rm 332		Rm 332			Rm 332	Rm 332	
G	29	1	U	Rm 369	Rm 369	Rm 369			Rm 369	Rm 369	Rm 369
G	30	4	D	Rm 367		Rm 367			Rm 367	Rm 367	
G	31	4		Rm 365		Rm 365			Rm 365	Rm 365	
G	32			Rm 366		Rm 366			Rm 366	Rm 366	

All sessions in Thayer Hall

---- WG does not meet
1st WG in CG shaded gray

(1) T1 Schedule on Page 8-9
(2) SS1 Schedule on Page 2-3
(3) T2 Schedule on Page 8-9

67th MORSS Working Group / Classroom Match Up

Composite Group Number	Working Group Number	TIMES: Wednesday 1330-1500 WG Session 5	Wednesday 1530-1700 Special Session 2	Wednesday 1730-2100 Bar-B-Q	Thursday 0830-1000 WG Session 6	Thursday 1030-1200 WG Session 7	Thursday 1215-1315 Tutorials Session 3	Thursday 1330-1500 WG Session 8	Thursday 1530-1700 Wrap-up Session	Thursday 1530-1700 Special Session 3
A	1	Rm 359			Rm 359	Rm 359		----		
A	2	Rm 357			Rm 357	Rm 357		Rm 357		
A	3	Rm 355	S	H	Rm 355	Rm 355		Rm 355	C	S
A	4A	Rm 344	P	E	Rm 344	Rm 344		Rm 344	G	P
A	4B	Rm 353	E	A	----	----		----	/	E
B	5	Rm 343	C	D	Rm 342	Rm 343		Rm 343	W	C
B	6A	Rm 336	I	Q	Rm 336	Rm 336	T	Rm 336	G	I
B	6B	Rm 338	A	U	Rm 338	Rm 338	U	Rm 338		A
B	6C	Rm 340	L	A	Rm 340	Rm 340	T	Rm 340	W	L
B	7	Rm 339		R	Rm 339	Rm 339	O	Rm 339	R	
B	8	Rm 341	S	T	Rm 341	Rm 341	R	Rm 341	A	S
B	9	Rm 337	E	E	Rm 337	Rm 337	I	Rm 337	P	E
B	10	Rm 329	S	R	Rm 329	Rm 329	A	Rm 329		S
B	11	Rm 327	S	S	Rm 342	Rm 342	L	Rm 342	U	S
C	12	Rm 315	I		Rm 315	Rm 315		Rm 315	P	I
C	13	Rm 317	O	H	Rm 317	Joint		Rm 317		O
C	14	Rm 319	N	O	Rm 319	Rm 342		Rm 319	S	N
C	15	Rm 345		T	Rm 345	Rm 345		Rm 345	E	
C	16	Rm 347	SS2	E	Rm 347	Rm 347		Rm 347	S	SS3
C	17	Rm 348		L	Rm 348	Rm 348	Rm 348	Rm 348	S	
D	18	Rm 314	(4)		Rm 314	Rm 314		Rm 314	I	(6)
D	19A	Rm 312			Rm 312	Rm 312	S	Rm 312	O	
D	19B	Rm 310			Rm 310	Rm 310	E	Rm 310	N	
D	20	Rm 308			Rm 308	Rm 308	S	Rm 308		
E	21	CG E			Rm 321	Rm 321	S	----	T	
E	22	Thayer			Rm 323	Rm 323	I	Rm 323	H	
E	23	Rm 144			Rm 325	Rm 325	O	Rm 325	A	
F	24	Rm 322			CG F	Rm 322	N	Rm 322	Y	
F	25A	Rm 324				Rm 324		Rm 324	E	
F	25B	Rm 326			Thayer	Rm 326	T3	Rm 326	R	
F	26	Rm 328			Hall	Rm 328		Rm 328		
F	27	Rm 330				Rm 330	(5)	Rm 330	R	
F	28	Rm 332			Rm 144	Rm 332		Rm 332	M	
G	29	Rm 369			Rm 369	CG - G	Rm 369	Rm 342	1	
G	30	Rm 367			Rm 367	Thayer		----	4	
G	31	Rm 365			Rm 365	Hall		Rm 365	4	
G	32	Rm 366			Rm 366	Rm 144		Rm 366		

All sessions in Thayer Hall

---- WG does not meet
1st WG in CG shaded gray

(4) SS2 Schedule on Page 4-5
(5) T3 Schedule on Page 8-9
(6) SS3 Schedule on Page 6-7

Date: 5/21/99

67th MORSS SESSION SCHEDULE

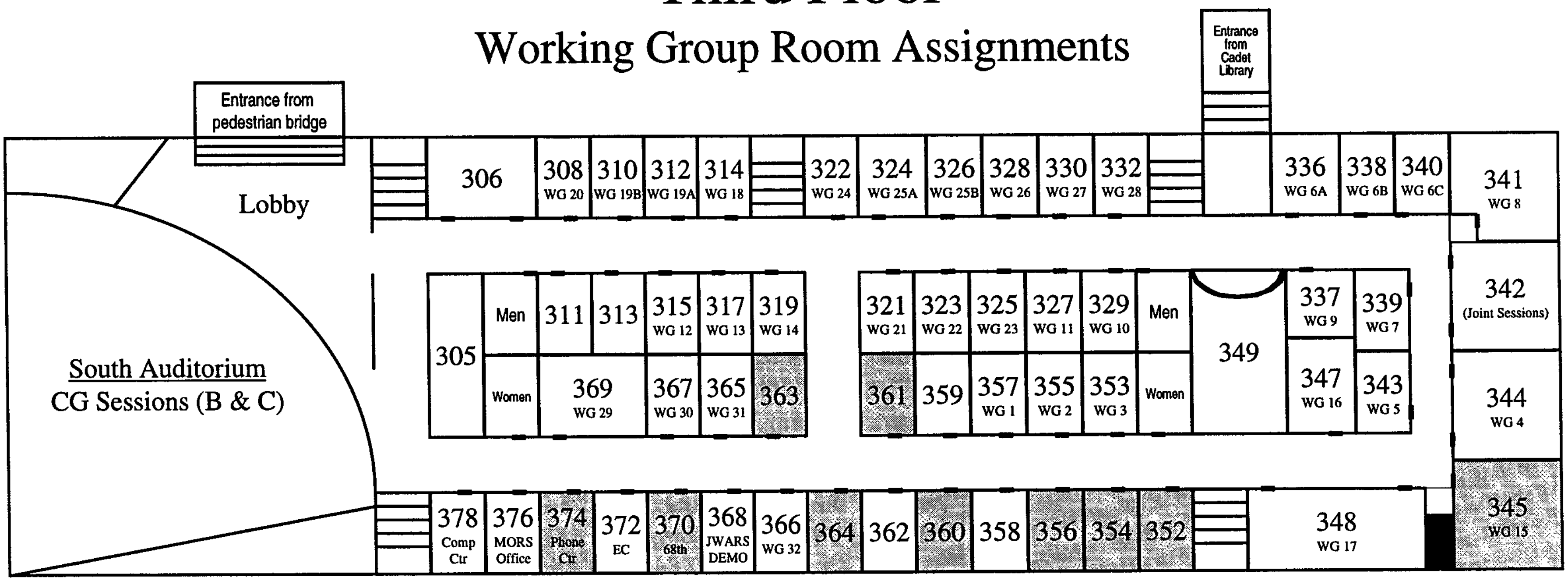
Special Sessions and Tutorials

Building / Room / Session	South Auditorium	Thayer Hall Room 144	Thayer Hall Room 342	Thayer Hall Room 344/347/341/369	Thayer Hall Room 348
Tuesday 22-Jun 1215 Tutorial	1300 Monday, June 21st at HQ Hotel Friendly Fire Shootdown Over Northern Iraq		Series Tutorial Nonlinear Dynamics & Warfare Operations #1	Series Tutorial (344) Neural Networks: Introduction and Applications #1	Fuzzy Logic and Its Applications for Analysis
Tuesday 22-Jun 1530 Spec Sess I	Theories of Combat Chair - Wayne Hughes, Jr., FS, Captain USN (ret) 1. Base of Sand Problem 2. Concise Theory of Combat 3. Evolution of Theory in the Soviet Union	Rist & Barchi Prize Awards **Barchi** - Upgrading Complex System of Systems: A CAIV Methodology **Rist** - Signals From Space: The Next Generation GPS System		Junior/Senior Analyst Session #1 (344) Panel Discussion with Dr. Darrell Collier (USA), Dr. Al Brandstein (N/MC), LTGEN Kent (USAF, Ret), Dr. Pat Sanders (OSD), and Dr. Peter Cherry (Commercial)	
Wednesday 23-Jun 1215 Tutorial		Introduction to the High Level Architecture (HLA) for Simulations	Series Tutorial Nonlinear Dynamics & Warfare Operations #2	Series Tutorial (344) Neural Networks: Introduction and Applications #2	Fuzzy Logic and Its Applications for Analysis
Wednesday 23-Jun 1530 Spec Sess II	Military OR Heritage Chair - Eugene Visco, FS	Mini-Symposium Reports 1. C4ISR in 2010 2. Joint Experimentation		Junior/Senior Analyst Session #2 Naval - Ted Smyth & Bruce Powers (341) AF - Jackie Henningsen & Tom Allen (347) OSD - Gabe Rouquie & Lynda Jaques (369)	Junior/Senior Analyst Session #2 Army Session with Vern Bettencourt & COL Ron Johnson
Thursday 24-Jun 0730 SAG					
Thursday 24-Jun 1215 Tutorial			Series Tutorial Nonlinear Dynamics & Warfare Operations #3		
Thursday 24-Jun Spec Sess III		The Innovation Process: Warfighting Advantage or Achilles' Heel	Mini-Symposium Reports 1. SIMVAL 99 2. SIMTECH 2007	Education Session (344) Panel Discussion	

Thayer Hall

Third Floor

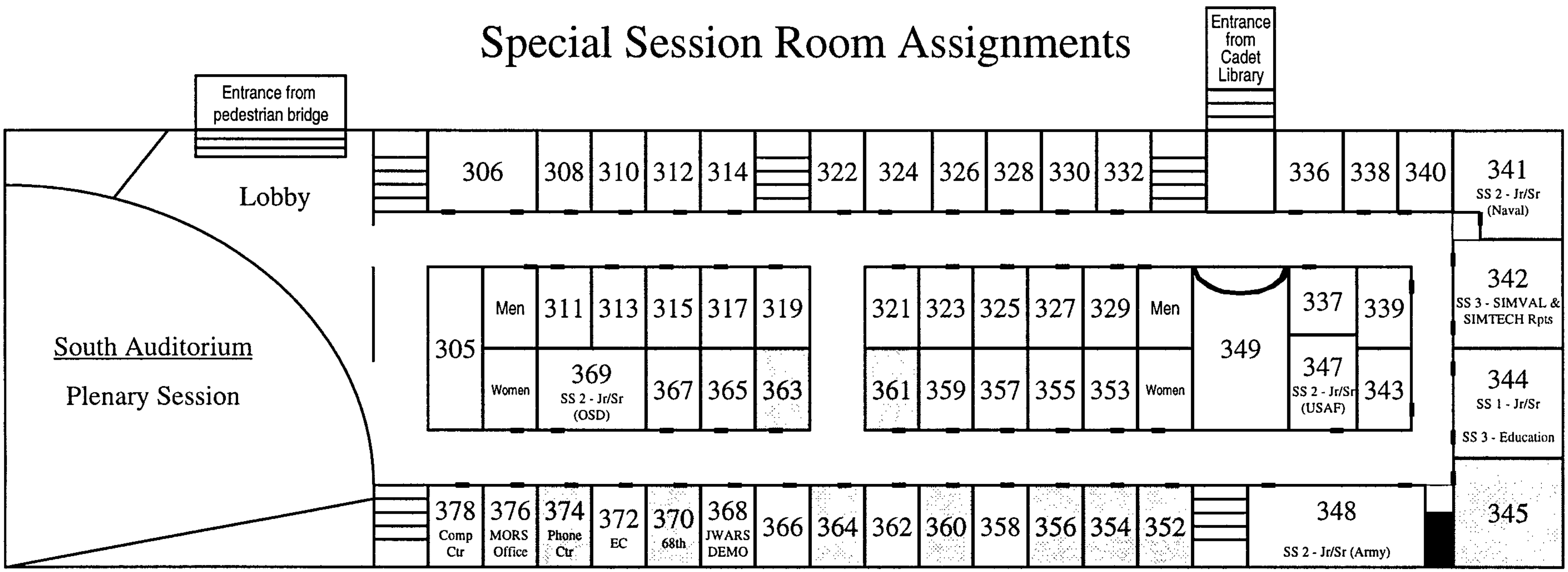
Working Group Room Assignments



NOTES

1 - Room 144 is on first floor (capacity 170), below rooms 342/344; all Composite Group Sessions will be in Room 144, except for CGs B & C which will meet in South Auditorium (too large for Room 144).
2 - All working groups within a composite group are located close to each other (except for CG C which are split 3 & 3).
3 - The Joint Panel Session for WGs 8 (IO/IW), 24 (MOE) & 25 (T&E) during WG Session #3 will be held in Room 144. Additional Joint Sessions will be in Room 342: Sess #2 (13/14), Sess #6 (5/11), Sess #7 (13/14) & Sess #8 (11/29).
4 - The larger classroom for WG 22 during WG Session #1 will be in Room 344 while WG 4 will be at their CG Session.
4 - Admin Rooms are: 378, 376, 374, 372 & 370. Shaded rooms are rooms required for the education center.
5 - Split Working Groups: WG 6 (336, 338 & 340), WG 19 (310 & 312) and WG 25 (324 & 326).
6 - JWARS Demo is set-up across the hall from WGs 29 & 31 (M&S and Computing Advances in OR).

Thayer Hall
Third Floor
Special Session Room Assignments



NOTES

1 - Room 144 is on first floor, below rooms 342/344 (capacity 170).

2 - SS 1: The first Junior/Senior Analyst Session (panel with Senior Analysts) will be held in Room 344; the Prize Paper Session in Room 144; and Theories of Combat in South Auditorium.

3 - SS 2: The second Junior/Senior Analyst Sessions will be in Rooms 348 (Army), 347 (USAF), 341 (Naval) & 369 (OSD); Military OR Heritage in South Auditorium; and the C4ISR & Joint Experimentation Mini-Symposium Reports in Room 144.

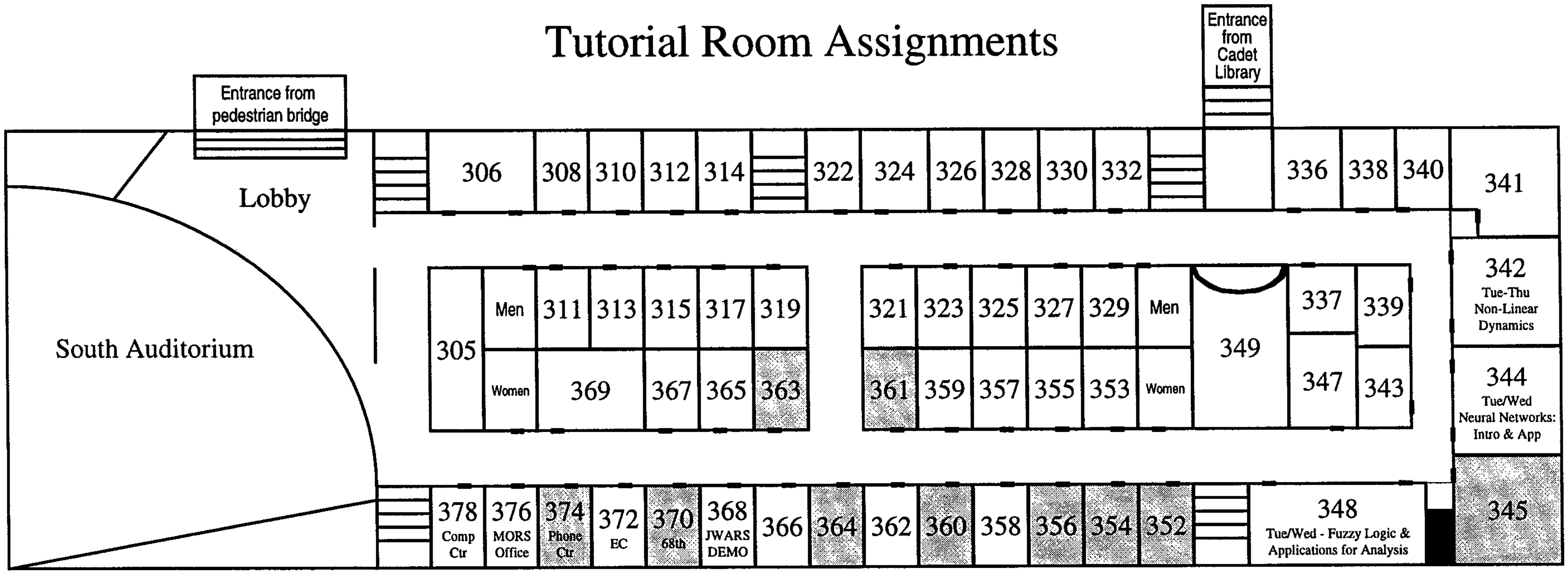
3 - SS 3: The Education Session (panel with Senior Education Analysts) will be held in Room 344; Innovation Process in Room 144; and the SIMVAL 99 & SIMTECH 2007 Mini-Symposium Reports in Room 342.

4 - The shaded classrooms are those required by the education center.

Thayer Hall

Third Floor

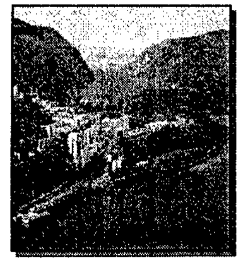
Tutorial Room Assignments

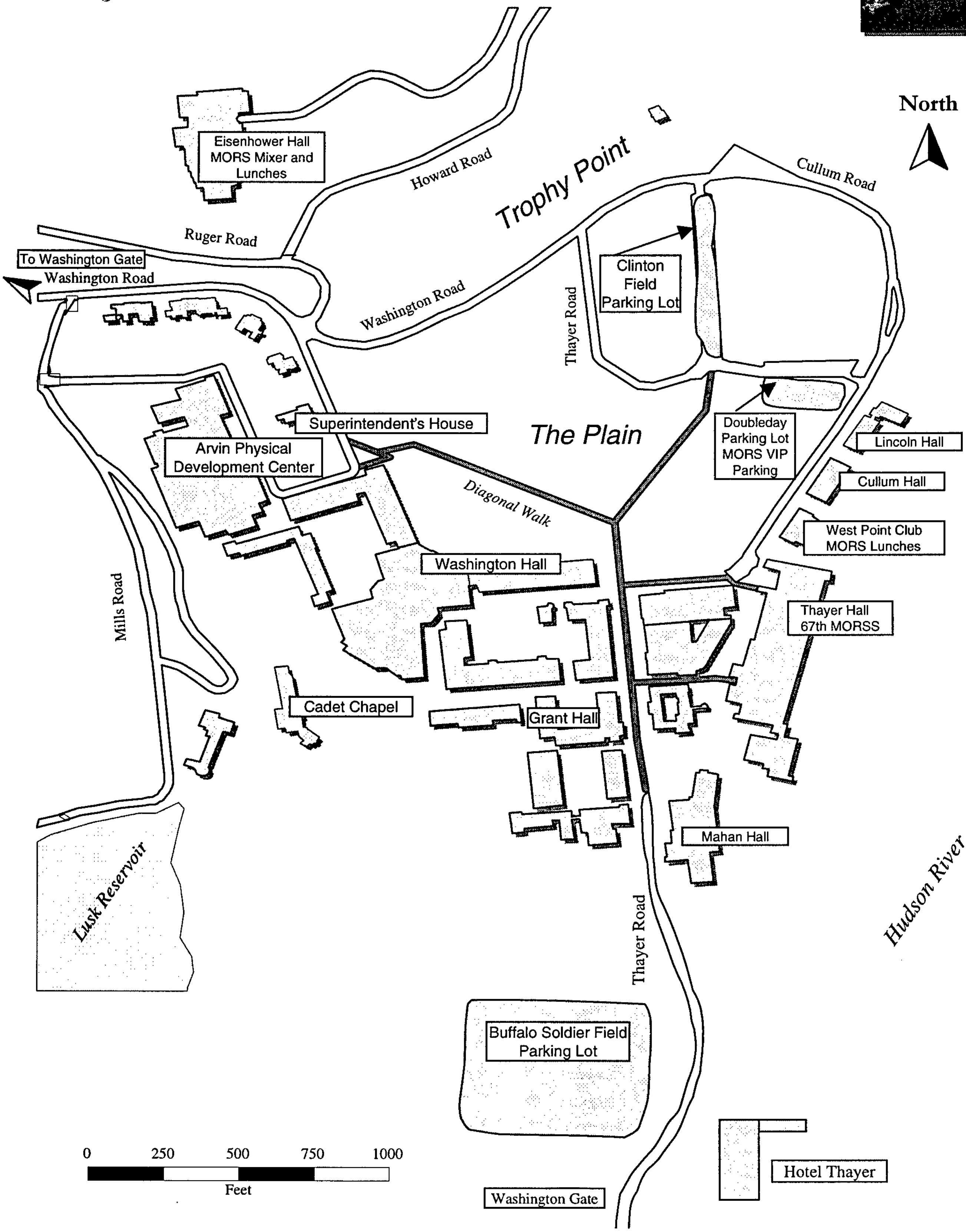


NOTES

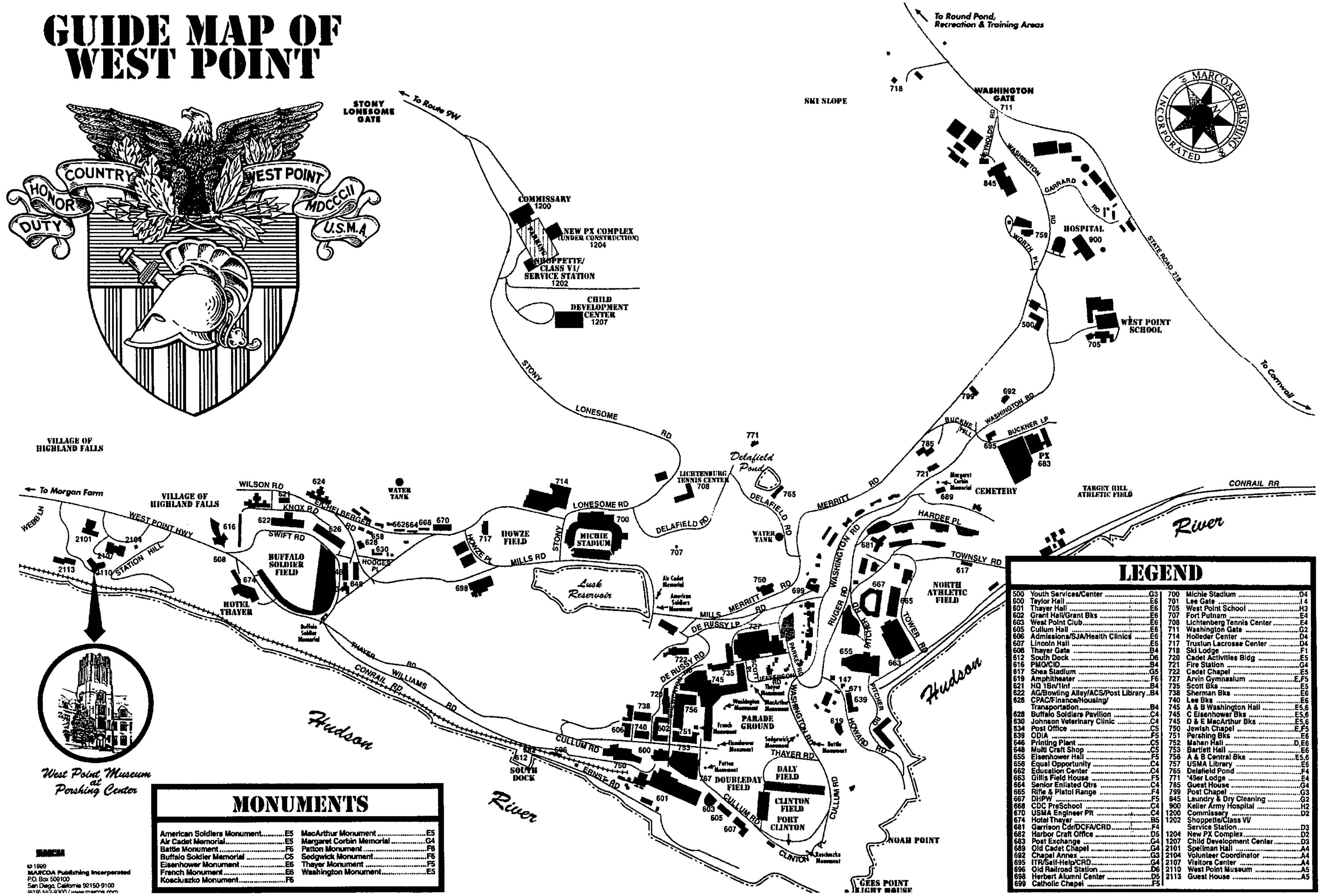
1 - HLA - Wednesday in Room 144.
2 - Neural Networks: Introduction and Applications - Tuesday & Wednesday in Room 344.
3 - Fuzzy Logic and its Applications for Analysis - Tuesday & Wednesday in Room 348.
4 - Nonlinear Dynamics and Warfare Operations - Tuesday through Thursday in Room 342.
5 - The shaded classrooms are those required by the education center.

67th MORS Symposium
United States Military Academy
West Point, New York





GUIDE MAP OF WEST POINT

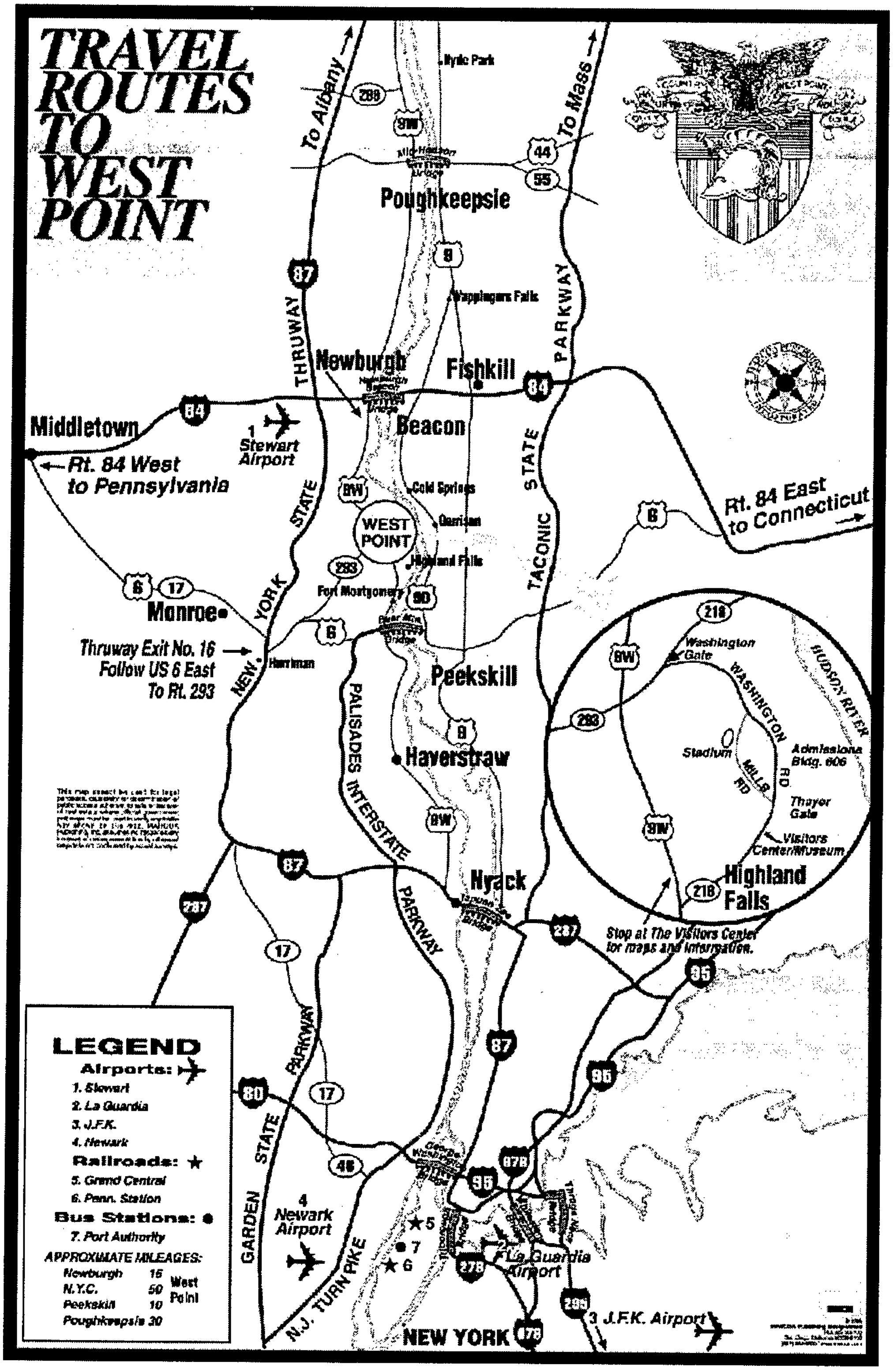


LEGEND

500	Youth Services/Center	G3
600	Taylor Hall	E6
601	Thayer Hall	E6
602	Grant Hall/Grant Bks	E6
603	West Point Club	E6
605	Cullum Hall	E6
606	Admissions/SJA/Health Clinics	E6
607	Lincoln Hall	E6
608	Thayer Gate	B4
612	South Dock	D6
616	PMO/CID	B4
617	Shea Stadium	G5
619	Amphitheater	F6
621	HQ 1Bn/1Inf	B4
622	AG/Bowling Alley/ACS/Post Library	B4
626	CPAC/Finance/Housing/ Transportation	B4
628	Buffalo Soldiers Pavilion	C4
630	Johnson Veterinary Clinic	C4
634	Post Office	C5
639	ODIA	F5
646	Printing Plant	C5
648	Multi Craft Shop	C5
655	Eisenhower Hall	F5
658	Equal Opportunity	C4
662	Education Center	C4
663	Gillis Field House	F5
664	Senior Enlisted Qtrs	C4
665	Rifle & Pistol Range	F4
667	DHPW	F5
668	CDC PreSchool	C4
670	USMA Engineer Plt	C4
674	Hotel Thayer	B5
681	Garrison Cdr/DCFA/CRD	F4
682	Harbor Craft Office	D6
683	Post Exchange	G4
689	Old Cadet Chapel	G4
692	Chapel Annex	G3
695	ITR/Self-Help/CRD	G4
696	Old Railroad Station	D6
698	Herbert Alumni Center	D5
699	Catholic Chapel	F5
700	Michie Stadium	D4
701	Lee Gate	I 4
705	West Point School	H3
707	Fort Putnam	E4
708	Lichtenberg Tennis Center	E4
711	Washington Gate	G2
714	Holleder Center	D4
717	Truxtun Lacrosse Center	D4
718	Ski Lodge	F1
720	Cadet Activities Bldg	E5
721	Fire Station	G4
722	Cadet Chapel	E5
727	Arvin Gymnasium	E,F5
735	Scott Bks	E5
738	Sherman Bks	E6
740	Lee Bks	E6
745	A & B Washington Hall	E5,6
745	C Eisenhower Bks	E5,6
745	D & E MacArthur Bks	E5,6
750	Jewish Chapel	E,F5
751	Pershing Bks	E6
752	Mahan Hall	D,E6
753	Bartlett Hall	E6
756	A & B Central Bks	E5,6
757	USMA Library	E6
765	Delafield Pond	F4
771	'49er Lodge	E4
785	Guest House	G4
799	Post Chapel	G3
845	Laundry & Dry Cleaning	G2
900	Keller Army Hospital	H2
1200	Commissary	D2
1202	Shoppette/Class VI/ Service Station	D3
1204	New PX Complex	D2
1207	Child Development Center	D3
2101	Spellman Hall	A4
2104	Volunteer Coordinator	A4
2107	Visitors Center	A4
2110	West Point Museum	A5
2113	Guest House	A5

MONUMENTS

American Soldiers Monument	E5
Air Cadet Memorial	E5
Battle Monument	F6
Buffalo Soldier Memorial	C5
Eisenhower Monument	E6
French Monument	E6
Kosciuszko Monument	F6
MacArthur Monument	E5
Margaret Corbin Memorial	G4
Patton Monument	F6
Sedgwick Monument	F6
Thayer Monument	F5
Washington Monument	E5


TRAVEL ROUTES TO WEST POINT
To Albany
To Mass
Poughkeepsie
Newburgh
Fishkill
Beacon
Middletown
Rt. 84 West to Pennsylvania
1 Stewart Airport
WEST POINT
Rt. 84 East to Connecticut
Monroe
Thruway Exit No. 16 Follow US 6 East To Rt. 293
Peekskill
Haverstraw
Nyack
Highland Falls
Washington Gate
Stadium
Admissions Bldg. 606
Thayer Gate
Visitors Center/Museum
HUDSON RIVER
Stop at The Visitors Center for maps and information.
NEW YORK STATE THRUWAY
TACONIC STATE PARKWAY
PALISADES INTERSTATE PARKWAY
GARDEN STATE PARKWAY
N.J. TURNPIKE
4 Newark Airport
La Guardia Airport
3 J.F.K. Airport
NEW YORK
LEGEND
Airports:
1. Stewart
2. La Guardia
3. J.F.K.
4. Newark
Railroads:
5. Grand Central
6. Penn. Station
Bus Stations:
7. Port Authority
APPROXIMATE MILEAGES:
Newburgh 16 West Point
N.Y.C. 50
Peekskill 10
Poughkeepsie 30

Directions to USMA

Current West Point Weather and Road Conditions

From JFK Airport:

VanWyck Parkway to Bronx-Whitestone Bridge. After crossing the bridge, look for the Cross Bronx Expressway. Follow the Cross Bronx Expressway to the Bronx River Parkway north. Take the Bronx River Parkway to left fork for the Sprain Brook Parkway. Follow Sprain Brook Parkway to Route 287, left exit to Tappan Zee Bridge and Interstate 87 (New York State Thruway). Over bridge, take exit 13N onto the Palisades Interstate Parkway heading north. Take the PIP north to its end (Bear Mountain traffic circle). Follow signs for Route 9W north (3d exit off traffic circle). Exit 9W via West Point exit, Stony Lonesome exit, or Route 293 exit.

From LaGuardia Airport:

Take the Whitestone Parkway to Bronx-Whitestone Bridge. After crossing the bridge, look for the Cross Bronx Expressway. Follow the Cross Bronx Expressway to the Bronx River Parkway north. Take the Bronx River Parkway to left fork for the Sprain Brook Parkway. Follow Sprain Brook Parkway to Route 287, left exit to Tappan Zee Bridge and Interstate 87 (New York State Thruway). Over bridge, take exit 13N onto the Palisades Interstate Parkway heading north. Take the PIP north to its end (Bear Mountain traffic circle). Follow signs for Route 9W north (3d exit off traffic circle). Exit 9W via West Point exit, Stony Lonesome exit, or Route 293 exit.

From Newark Airport:

Take Interstate 78 West to the Garden State Parkway. Take the GSP north to the end and follow signs for the New York State Thruway (I-87) east. Exit Thruway at exit 13N onto the Palisades Interstate Parkway heading north. Take the PIP north to its end (Bear Mountain traffic circle). Follow signs for Route 9W north (3d exit off traffic circle). Exit 9W via West Point exit, Stony Lonesome exit, or Route 293 exit.

From Stewart Airport:

Exit airport, make left turn onto New York State Route 207 to the New York State Route 300 interchange. Make left turn onto Route 300, cross New York State Route 17K to the Interstate 84 interchange. Take I-84 east to exit 10 (Route 9W). Make right turn onto 9W south. Exit 9W via Route 293 exit, Stony Lonesome exit, or West Point exit.

Use this form to submit your paper from the 67th MORSS to the Defense Technical Information Center (DTIC).

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Major **Mark Gallagher**
AFIT

Analysts can use DTIC both to research topics and to archive their work. DTIC provides a variety of means to search and order publications. Analysts can even make searches over the internet. Individuals may call DTIC at (800) 225-3842 for more information. In addition, Mr. Frank Scott from DTIC will be at USMA for this year's symposium to demonstrate extracting past studies from DTIC data bases and to discuss submitting documents to DTIC.

MORS encourages symposium presenters and other authors to submit their papers to DTIC. DTIC prefers papers, but they will accept annotated briefing. DTIC submissions may be unclassified or classified up to secret. Authors may submit unclassified papers both to DTIC and the MORS Journal. Each presenter's symposium package includes a simple DTIC submission form along with instructions. (For an electronic DTIC submission form, please contact me at mgallagh@afit.af.mil.) Corrina Ross, MORS Communications Manager, Christine Parnell, Communications Assistant and I will collect presenters' DTIC submissions at the symposium.

67th MORSS Participant Evaluation

1. Evaluation of 67th MORSS

The MORS Board of Directors and Symposium Staff want to improve MORS Symposia to better respond to your needs and to improve the quality of military operations research. Your evaluation is very important and your comments will be considered in planning future events. Please complete this questionnaire and return it to your Composite Group or Working Group Chair; the MORS Office in Room 376, Thayer Hall; or mail it to MORS, 101 S. Whiting Street, Suite 202, Alexandria, VA 22304-3416; or fax it to (703) 751-8171.

1. Background Information:

a. Name (optional) ______________________________

b. What is your affiliation?

Military: USA_____ USN_____ USAF_____ USMC_____ USCG_____

Civilian: USA _____ USN_____ USAF_____ USMC_____ USCG _____

Other DoD_____ FFRDC_____ Joint/Unified Staff/Command_____

Other Federal Government ____ Academic _____ Consultant ____

Professional Services Firm ____ Manufacturing Firm _____

Other ______________________________

c. Including this MORSS, how many MORS Symposia have you attended?_______

d. Please identify (Checkmark) membership in other professional organizations?

- ❑American Aeronautical Society (AAS)
- ❑American Society of Naval Engineers (ASNE)
- ❑Association of Old Crows (AOC)
- ❑American Institute for Aeronautics and Astronautics (AIAA)
- ❑Armed Forces Communications and Electronics Assoc (AFCEA)
- ❑Electronic Industries Association (EIA)
- ❑International Council on Systems Engineering (INCOSE)
- ❑International Test and Evaluation Association (ITEA)
- ❑National Defense Industrial Association (NDIA)
- ❑The Society of American Military Engineers (SAME)

Others? (Please List) ______________________________

____

____

e. **Do you plan on attending the 68th MORSS at the United States Air Force Academy in Colorado Springs, Colorado, June 20-22, 2000?**

Yes_____ Probably Yes______ 50/50 Chance_____ Probably No_____ No____

If no or probably no, why not? ______________________________

____

____

67th MORSS Participant Evaluation

2. Evaluation of 67th MORSS	Very Poor 1	Poor 2	Fair 3	Good 4	Excellent 5	Does Not Apply
a. **OVERALL**, how do you rate the 67th MORSS in meeting your needs?						
b. Please give your assessment of each **SPECIAL SESSION** (SS) you attend (print the session name in the blank) and then an overall assessment of the Special Sessions meeting your needs.						
(1) SS 1 ____________						
(2) SS 2 ____________						
(3) SS 3 ____________						
(4) Special Sessions overall						
(5) View of Prize Awards/Papers as a Special Session?						
(6) How can SS be improved?						
c. Please give your assessment of each **TUTORIAL SESSION** you attend (print the tutorial name in the blank) and then an overall assessment of Tutorials meeting your needs.						
(1) MON *"Frienfly Fire Shootdown Over Iraq"*						
(2) TUE ____________						
(3) WED ____________						
(4) THU ____________						
(5) Tutorials overall						
(6) How can Tutorials be improved?						
d. Please give your assessment of each **COMPOSITE GROUP** (CG) Session you attend and then an overall assessment of the Composite Groups meeting your needs.						
(1) CG A - Strategic & Defense						
(2) CG B - Space/C4ISR						
(3) CG C - Joint Warfare						
(4) CG D - Resources						
(5) CG E - Readiness/Training						
(6) CG F - Acquisition						
(7) CG G - Advances in MOR						
(8) Composite Groups overall						
(9) How can CGs be improved?						
e. Please give your assessment of each **WORKING GROUP** (WG) Session you attend and then an overall assessment of the Working Groups meeting your needs (Please *specify* the WG number in the blank).						
(1) 1st WG Session - WG# _____						
(2) 2nd WG Session - WG# _____						
(3) 3rd WG Session - WG# _____						
(4) 4th WG Session - WG# _____						
(5) 5th WG Session - WG# _____						
(6) 6th WG Session - WG# _____						
(7) 7th WG Session - WG# _____						
(8) 8th WG Session - WG# _____						
(9) Working Groups overall						
(10) How can WGs be improved?						
f. Please give your assessment of the following other events and provide suggestions for improvement.						
(1) Mixer						
(2) Mixer Presentations						
(3) Spouse/Guest Tour						
(4) Barbeque at the Hilton Hotel						
(5) Golf Tournament						
(6) Suggestions for improvement?						

67th MORSS Participant Evaluation

3. Evaluation of MORS Symposia

	Very Poor 1	Poor 2	Fair 3	Good 4	Excellent 5	Does Not Apply
How helpful to you are the MORS Symposia in the following areas?						
a. Receiving help on a current project						
b. Learning about new data sources						
c. Learning about models/techniques that you may use						
d. Meeting colleagues you can consult with in the future						
e. Becoming aware of new problems requiring analysis						
f. Broadening perspectives of military operations research						
g. Other ____________						
h. Overall, how can MORS Symposia be improved to meet your needs?						

4. Evaluation of MORS Activities

	Not Satisfied 1	2	Satisfied 3	4	Very Satisfied 5	No Opinion
a. How satisfied are you with the way MORS is being managed?						
b. How helpful are the following MORS publications/media for you or your organization?						
(1) Monographs						
(2) *Military Operations Research Journal*						
(3) *PHALANX*						
(4) *Miltary OR Analyst's Handbook*						
(5) MORS Web Page						
c. How helpful are the following MORS activities for you and your organization?						
(1) MORS Symposium						
(2) Mini-symposia						
(3) Workshops						
(4) Colloquia						

d. Suggestions for further activities:	Do Not Support		Support		Strongly Support	No Opinion
(1) Hold more joint meetings with other professional associations						
(2) Other (please specify)						
(3) Would you be willing to volunteer your time and effort to pursue any of these?	Yes	No	If so, which one(s)? (please list =>)			

5. Other Comments or Suggestions

Please feel free to continue writing on the back or attaching additional sheet(s).

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Military Operations Research Society

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Alexandria, VA 22304-3416

WG 1 – STRATEGIC OPERATIONS – AGENDA

Chair: Capt Greg Ehlers, US Strategic Command/J533
Co-Chairs: William Bearden, Jr., ANSER
Capt Jeff Weir, US Strategic Command
Room: 359

Tuesday, 1030-1200
COMPOSITE GROUP A SESSION .... **Room 144**

Tuesday, 1330-1500 - Force Structure Analysis
Capabilities Based Force Structure Methodology
Mr. Pat McKenna, USSTRATCOM /J533

Analysis of the Effectiveness of Navy Platforms as the Number of Assets Decreases
Dr. Philippe Loustaunau, Anne Milewich, Systems Planning and Analysis, Inc.

Wednesday, 0830-1000 - Stability Modeling
The Index of First Strike Stability
Nyland, Frederick S., Consultant, IVI/ITA

A New Multipolar Nuclear Exchange & Stability Model
Doug Anson, Myron Stein, Steve Upton, Military Systems Analysis & Simulations Group

Wednesday, 1030-1200 Stockpile Stewardship
Modeling the START III Stockpile with System Dynamics
Dr. William T. Hodson III, National Defense University

Nuclear Weapon System Safety Assessments
Mr. James Brackett
Defense Threat Reduction Agency (NSNS/DTRA)

Wednesday, 1330-1500 - Modeling in the Strategic World
Modeling Military Strategic Effects
Mark A. Gallagher, Major, USAF, Air Force Institute of Technology

Nuclear Weapon Assignment Model
Jeffery W. Weir, Captain, USAF, US Strategic Command (J533)

Thursday, 0830-1000 - Agent Defeat Weapons
Analysis of Agent Defeat Weapon Options in Major Theater Warfare: Collateral Effects an Impact on Operations
Dr Gene Schroeder, Los Alamos National Laboratory, US Strategic Command (J53)

Object Oriented Programming Approach to Planning Strikes Against WMD Targets
Dr Gene Schroeder, Los Alamos National Laboratory, US Strategic Command (J53)

Thursday, 1030-1200 - Strategic Space Operations
Space Operations Vehicle (SOV) Military Utility Analysis
Scott Fox, Major, USAF, AFSAA/SAAS

WG 1 – Strategic Operations – Abstracts

Tuesday, 1030-1200
COMPOSITE GROUP A SESSION .... Room 144

Tuesday, 1330-1500 - Force Structure Analysis
Capabilities Based Force Structure Methodology

Mr. Pat McKenna
USSTRATCOM /J533
901 SAC Blvd Suite 2E10
Offutt AFB, NE 68113-6500
(402)-294-1654/1652

Approved Abstract not available at printing

Analysis of the Effectiveness of Navy Platforms as the Number of Assets Decreases

Dr. Philippe Loustaunau and Anne Milewich
Systems Planning and Analysis, Inc.
2000 N. Beauregard St., Suite 400
Alexandria, Virginia 22311
Phone: (703) 578-6323, (703)578-5661; FAX: (703) 578-5690

A special challenge to analysts is the situation when there are only a small number of Navy platforms available to perform critical mission(s). As political and budget considerations bring the number of Navy inventory assets to record low levels, and as the geopolitical situation may demand a more complex commitment of those assets, it becomes vital for the analyst to rely less on steady-state models and expected values. Instead, one has to develop new approaches based on specific missions, operational issues, and detailed analysis of scheduling, which will accurately predict the effectiveness bounds of those platforms for the intended mission(s). This is particularly applicable to the Navy strategic force planning.

In this presentation, we will discuss the approach we developed for this problem. In our analysis, we incorporate mission, force size, and operational and maintenance constraints to develop an optimized designed schedule measured by percent time mission is met. This schedule allows us to provide a first set of measures, which we call Static Measures: how good the schedule is if executed exactly as specified. We then analyze how robust that schedule is in the face of random perturbations during execution. This provides a second set of measures, which we call Dynamic Measures. We consider two types of random perturbations: perturbations (e.g. collisions, machine failures, etc.), and smaller deviations (e.g. late departure from port, early arrivals, etc). Introducing stochastic parameters to the designed schedule allows us to associate the percent of time mission is met with the confidence of doing so.

When the number of platforms gives enough slack to the schedule, these perturbations may have little impact on the planned effectiveness of the force. But, when the number of platforms is small, these perturbations impact the planned effectiveness of the force in a significant way and jeopardize the execution of the intended mission(s) in a predictable way.

Wednesday, 0830-1000 - Stability Modeling
The Index of First Strike Stability

Nyland, Frederick S., Consultant, IVI/ITA
U.S. Arms Control & Disarmament Agency
320 21st Street, N.W.
Washington D.C. 20451
Phone: (303) 567-2163

The purpose of this paper is to define and provide explanatory comments concerning the index of first strike stability based on nuclear warheads impacting on the valued assets of two contenders in a potential nuclear exchange. The method of estimating the index of warhead first strike stability is outlined and illustrated for two different assumptions. The first assumption is that there are no strategic defenses. The second assumption is that strategic defenses are present on one or both sides. Strategic defenses are deployed to only defend valued assets, not strategic forces. A concluding overview section illustrates the essential elements of warhead first strike stability and its graphical interpretation, along with considerations as to its applicability as compared to an earlier elegant method of Kent and Thaler for estimating first strike stability.

A New Multipolar Nuclear Exchange & Stability Model

Doug Anson, Staff Member, Myron Stein, Staff Member, Steve Upton, Staff Member
Military Systems Analysis & Simulations Group, TSA-5
Los Alamos National Laboratory, PO Box 1663, MS F602
Los Alamos, NM 87545, (505) 667-0965; Fax:(505) 665-2017

Approved abstract unavailable at printing.

Wednesday, 1030-1200 Stockpile Stewardship
Modeling the START III Stockpile with System Dynamics

Dr. William T. Hodson III, National Defense University
Information Resources Management College
National Defense University, Ft. McNair
Washington, D.C. 20319
Phone: 202-685-3896 DSN: 325-3896; FAX: 202-685-3974
E-mail: hodsonw@ndu.edu

Having a comprehensive understanding of the issues involved in determining an appropriate size for the stockpile of strategic nuclear weapons under a START III agreement is extremely important prior to its negotiation. Too high an estimate will make a treaty difficult to obtain while too low an estimate could diminish U.S. strategic deterrence in the first half of the 21st century. The highly interdependent and time-varying relationship among the factors of initial stockpile size, rate of weapon failures over time, weapons testing protocols, and the capacity of refurbishment facilities suggested the use of a system dynamics simulation model to assist decision-makers in arriving at acceptable levels.

A computer model was developed using *ithink* system dynamics development environment. The model has been designed to be easy to use in conducting "what if" exercises and ad hoc sensitivity analyses, while at the same time faithfully modeling the essential elements of the process of weapon failure, testing and refurbishment. Taking advantage of the multimedia user-interface features of *ithink*, a "learning environment" for the user has been created which begins with an interactive tutorial on the essential issues involved in the process. It also allows the user to experiment by employing different sets of estimates of input parameters - initial stockpile size, failure rates, refurbishment facility capacity, etc. - to see the effect on weapons availability over periods of up to 30 years following treaty implementation.

Nuclear Weapon System Safety Assessments

Mr. James Brackett
Defense Threat Reduction Agency (NSNS/DTRA)
6801 Telegraph Road
Alexandria, VA 22310-3398
Phone: 703-325-2004 DSN: 221-2248 FAX: 703-325-4661
E-mail: jim.brackett@dtra.mil

Nuclear weapons in the U.S. stockpile must be safe. *The Report to the House Armed Services Committee* on Nuclear Weapons noted that "...nuclear weapon safety is concerned with the prevention of unintended nuclear detonations or the release of hazardous radioactive materials...due to accidents, fires or natural causes." Following a request by the Air Force Chief of Safety, the Defense Threat Reduction Agency (DTRA) completed an assessment of the Minuteman III. The final report was released in September 1998 and incorporated test results from warhead mating and de-mating operations. The Air Force subsequently requested similar assessments of the B-52, dual capable aircraft, and the B-2.

The presentation will describe an assessment methodology and techniques, adapted from quantifying safety of nuclear power plants, to perform a probabilistic risk assessment (PRA) of a complete nuclear weapon system, from warhead characteristics to operations, handling, transportation, and service operational and logistical constraints. The presentation will cover:

- the difference between a PRA and a traditional safety assessment
- six basic steps (understanding of peacetime logistical operations in the weapon system stockpile-to-target sequence; credible accident scenarios; abnormal environments; event sequences and fault trees; data handling and analysis; and calculation of the probabilities and uncertainties of plutonium dispersal)
- data handling, modeling, and simulation
- sample results, outputs, and recommendations
- status of the WSSA program in DTRA.

Wednesday, 1330-1500 - Modeling in the Strategic World
Modeling Military Strategic Effects

Mark A. Gallagher, Major, USAF
Air Force Institute of Technology
2950 P Street
Wright-Patterson AFB, OH 45433-7765
Phone: 937-255-6565 ext 4335; Fax: 937-656-4943
E-mail: mgallagh@afit.af.mil

Strategic effects are the cascading effects of attacking a set of targets. For example, severely degrading a communication network would most likely decrease the effectiveness of unattacked enemy ground forces. This presentation discusses how these effects can be estimated with a Leontief model. Leontief develop his macro-level economic model to determine how the capacity of one production sector supported other sectors. This mathematical framework may be applied to determine how the capacity in one military functional area may limit capability in other military functional areas. For example, many of the support services, such as communications or intelligence, could be related to air interdiction. This approach could be applied at the campaign or other large force engagement levels; it appears most appropriate to model "sectors" (functional areas) that support separate sectors. This Leontief modeling approach may be useful in determining enemy targets of high strategic impact, potential vulnerabilities in our military infrastructure, and quantify the warfighting value of new "support" capabilities. This presentation discusses the Leontief model, our planned modeling demonstration, and necessary data to estimate the model parameters.

Nuclear Weapon Assignment Model

Jeffery W. Weir, Captain, USAF
US Strategic Command (J533)
901 SAC Blvd Ste 2E9
Offutt AFB, NE 68113-6500
Phone: 402-294-1652; Fax: 402-294-6148
E-mail: weirj@stratcom.af.mil

We developed a nuclear weapon planning tool. This large-scale integer program assigns the best weapons against targets. Our approach preprocesses decision variables to account for three nonlinearities: damage compounding, bomber target tie-ups, and geographically targeting limitations of sea-launched and inter-continental ballistic. This presentation discusses the background, formulation, and solution technique.

Thursday, 0830-1000 - Agent Defeat Weapons
Analysis of Agent Defeat Weapon Options in Major Theater Warfare: Collateral Effects an Impact on Operations

Dr Gene Schroeder, Los Alamos National Laboratory, US Strategic Command (J53)
901 SAC Blvd Ste 2F7, Offutt AFB, NE 68113-6500
Phone: 402-294-7423; Fax: 402-294-6148; E-mail: schroedg@stratcom.af.mil

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Object Oriented Programming Approach to Planning Strikes Against WMD Targets

Dr Gene Schroeder, Los Alamos National Laboratory
US Strategic Command (J53)
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Offutt AFB, NE 68113-6500
Phone: 402-294-7423; Fax: 402-294-6148; E-mail: schroedg@stratcom.af.mil

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Thursday, 1030-1200 - Strategic Space Operations
Space Operations Vehicle (SOV) Military Utility Analysis

Scott Fox, Major, USAF
AFSAA/SAAS
1570 Air Force Pentagon
Washington, DC 20330-1570
Phone: (703) 588 8166; Fax: (703) 588-0220

Space has evolved into such a critical enabling element for our military force that "Joint Vision 2010" identifies space as the fourth medium of warfare. Our future space systems need to improve our ability to control space, meet launch-on-demand and operational responsiveness. The rapid response, quick turnaround and high maneuverability of the Space Operations Vehicle (SOV) system can answer these shortfalls by providing greater space asset protection and enabling US forces to achieve and maintain Space Superiority.

While this system has utility across the spectrum of space mission areas, this analysis looks at the contribution of the SOV system to Space Support and Space Force Applications missions. Specifically, we address the impact an SOV system, with aircraft-like turntimes and sortie rates, has supporting the time-critical spacelift requirements. The requirements are reflected in missions performed by the Space Maneuver Vehicle (SMV) as well as missions to replenish satellite constellations that provide key force enhancement in both peacetime and during a military campaign. We also assess the utility of the SOV system in its capacity to strike worldwide targets within minutes of launch using a Common Aero Vehicle (CAV). Finally, we look at the variations of basing strategies and force structures as they support all of the SOV missions.

WG 2 – NUCLEAR, BIOLOGICAL, AND CHEMICAL DEFENSE – AGENDA

Chair: Ms. Julia Klare, Institute for Defense Analyses
Co-Chair: LTC Victor Young, Joint Staff
Advisor: Mr. Doug Schultz, Institute for Defense Analyses
Room: 357

Tuesday, 1030-1200
COMPOSITE GROUP A SESSION .... Room 144

Tuesday, 1330-1500
The Terrorist NBC Threat: How Do We Assess the Threat?
Dave Gray, EAI Corporation

Weapons of Mass Destruction Terrorist Response Study
John Elliott, Center for Army Analysis

Wednesday, 0830-1000
Improving Community Response to Weapons of Mass Destruction
Elizabeth Lind, Vector Research, Inc.

A Proposed Template for BW Response
Chuck Crawford, US Army SBCCOM

Wednesday, 1030-1200
Chemical/Biological Equipment Certification Program to Support Domestic Preparedness for First Responders
LTC David Coker, West Desert Test Center, Dugway Proving Ground

Examination of Raid Team Alternatives Using CBASE
LTC Roger Pudwill, Center for Army Analysis

Wednesday, 1330-1500
The Consequences Assessment Tool Set (CATS) and the Joint Assessment for Catastrophic Events (JACE): Web-Based Disaster Simulation and Consequence Management
G. Robert Doenges, Jr., Science Applications International Corporation

Chemical Defense Representation in JWARS
LTC Dan Maxwell, OSD/PA&E

Total Army Analysis (TAA) 07 Tactical Ballistic Missile Evaluation
Trudy Ferguson, Center for Army Analysis

Thursday, 0830-1000
Droplet Size Effects on Lethality Calculations
Marty Richardson, MEVATEC

Knowledge Acquisition Matrix Instrument: Bioagent Casualty Modeling
Gillian Rickmeier, Pacific-Sierra Research Corporation

Thursday, 1030-1200
Monitoring and Detection of Low Levels of Chemical Agents: An Approach for Protection of Forces on the Battlefield and Fixed Sites
David Evans, ANSER, Inc.

Hybrid Virtual/Live Environment for Evaluation of Biological Sensors
John White, USA Edgewood Chemical and Biological Center

Thursday, 1330-1500
Modeling of Chemical Agent Liquid Aerosol Particles and Vapor Concentration Levels to Support Light Detection and Ranging (LIDAR) Chemical Detection System Field Testing
William Kilpatrick, Simulation Technologies, Inc.

Backup Presentation:

Need for Ground-based Ballistic Missile EWRs in the SBIRS Era
Capt. Dave Denhard, Air Force Studies and Analysis

WG 2 – NUCLEAR, BIOLOGICAL, AND CHEMICAL DEFENSE – Abstracts

Tuesday, 1030-1200
COMPOSITE GROUP A SESSION .... Room 144

Tuesday, 1330-1500
The Terrorist NBC Threat: How Do We Assess the Threat?

Dave Gray, Principle Analyst
EAI Corporation
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The terrorist use of weapons of mass destruction (WMD) is a new dimension for the military. The military is now challenged with protecting its forces against this real threat and assisting the civilian emergency responders in management of the consequences of NBC terrorism. To focus military operations research onto this grim aspect of force protection, we can apply current modeling tools and take advantage of emerging technologies to meet this challenge. First, we must broaden our views of the threat; second, identify the areas of vulnerability of military and civilian populations at home and abroad; third, decide on courses of action. This redefined terrorist threat and the vulnerability assessment for both military and civilian populations as presented are essential groundwork for further corrective actions. There are several approaches that the military community can take to reduce the risk to both military and civilian populations, and to prepare them for the terrorist use of WMD. We can modify current models to address several of the shortfalls in each of these areas. We can design training programs to be compatible with emergency response procedures. We can define materiel requirements to meet the new threat while reflecting the capabilities of emerging technologies. Some examples are provided in each area.

Weapons of Mass Destruction Terrorist Response Study

John Elliott
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This presentation highlights gaming results from the WMD-TRS Study conducted for the Director of Military Support (DOMS), Office of the Deputy Chief of Staff for Operations and Plans (ODCSOPS) HQ DA. The primary purpose of WMD-TRS was to provide the Deputy Director of Military Support (DOMS) with analysis to support decision making concerning the impacts of terrorist WMD use in the US and its territories. Political-Military Gaming was a key analytical methodology employed in this major CAA study.

The WMD-TRS Study employed a three phased gaming architecture. The three phases included a Mission Task Organized Forces (MTOFs) Issues Workshop (Jan 98), a WMD-TRS Integrated Response Issues Workshop (Mar 98), and the PHOENIX 98 Political-Military Game (Apr 98). The MTOF Issues Workshop identified MTOFs to respond to selected domestic terrorist incidents involving WMD. Options were developed to fill gaps in DoD support to interagency consequence management operations during the Integrated Response Issues Workshop. PHOENIX 98 evaluated capabilities of DoD's Rapid Assessment and Initial Detection (RAID) elements' preparedness and response to domestic terrorism involving WMD.

Application of CAA's political-military gaming methodology to develop, evaluate, and support resulting key insights generated by WMD-TRS, and planned follow-up analytical activities will be described and discussed with MORS participants.

Wednesday, 0830-1000

Improving Community Response to Weapons of Mass Destruction

Elizabeth Lind
Vector Research, Incorporated
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As the use of Weapons of Mass Destruction (WMD) becomes more probable in our current environment, initial efforts have been made toward improving our response capabilities within the first responder community. The situation is not one of a total lack of preparedness - fire departments and police departments respond every day to chemical spills and other hazardous materials calls - medics respond to disease and contamination every day. The WMD issue is a completely new magnitude of problem that requires coordination and planning beyond the scope of current response capabilities. This presentation will discuss our ideas on how to improve the first responder community response to WMD using analytical and problem solving skills.

A Proposed Template for BW Response

Chuck Crawford
US Army SBCCOM
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This presentation will describe a proposed plan of response, and its development process, to an act of domestic terrorism involving biological weapons.

Wednesday, 1030-1200

Chemical/Biological Equipment Certification Program to Support Domestic Preparedness for First Responders

LTC David Coker, Commander
West Desert Test Center, Dugway Proving Ground
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On 16 December 1998, Major General Andrews, TECOM Commander was briefed by Colonel Como, U.S. Army Dugway Proving Ground (DPG) Commander, and Lieutenant Colonel Coker, DPG West Desert Test Center (WDTC) Commander, on a proposed C/BEC program to support domestic preparedness for "first responders".

a. This initiative is in response to the proliferation of nuclear, chemical, and biological terrorist acts.
b. The C/BEC program will provide "one-stop" C/B protection, detection, and decontamination equipment certification through literature analyses, data reduction, and laboratory, chamber, and operational tests.
c. C/BEC will issue user-friendly, "Consumer Reports"-style publications and Web site information on a quarterly or annual basis.
d. DPG's C/BEC program will serve local, state, and government organizations and equipment developers and manufacturers.
e. DPG is best suited to support this certification program because: infrastructure and environmental permits are in place; leading-edge equipment and instrumentation is available; DPG provides an opportunity for independent evaluation; and DPG has resident experts in C/B testing and established partnerships with various agencies.

Examination of Raid Team Alternatives Using CBASE (ERTAG)

LTC Roger Pudwill,
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The ERTAG Quick Reaction Study (QRA) examined various alternatives provided by the Director of Military Support for augmenting the locations of the rapid assessment and initial detection (RAID) teams. Several alternatives were examined, with varying degrees of freedom in the location of the new teams. In the most restrictive case, a team was given a choice of only two potential stationing locations. Most of the other cases restricted the placement to a specified state, with the actual location being chosen to optimize the population coverage. Population coverage, maximum response distance, and availability of lift assets were the primary criteria used to develop the RAID team locations. Locations of the target population, asset dispersion and response coverage are all developed and used in finding optimal team locations through variations of the total cover problem.

Wednesday, 1330-1500

The Consequences Assessment Tool Set (CATS) and the Joint Assessment for Catastrophic Events (JACE): Web-Based Disaster Simulation and Consequence Management

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Approved abstract unavailable at printing.

Chemical Defense Representation in JWARS

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Approved abstract unavailable at printing.

Total Army Analysis (TAA) 07 Tactical Ballistic Missile Evaluation

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The TAA07 TBM Evaluation was conducted to support the Total Army Analysis 20076 process, which addresses the impact of Weapons of Mass Destruction (WMD) on force structure requirements. The specific objective of the analysis was to determine how many tactical ballistic missiles (TBMs) leak through an integrated theater missile defense (TMD). The analysis examined the impact of TBMs armed with both chemical and unitary high explosive warheads in two Major Theater Wars (MTW). Scenarios were based on the Defense Planning Guidance (DPG) draft Illustrative Planning Scenarios (IPS) 2000-2005. Measures of effectiveness included the number of TBMs impacting each critical asset for each day of the campaign, the number of TBMs with chemical warheads intercepted below altitude thresholds, TBM kills, and interceptor expenditure. The analysis used the Extended Air Defense Simulation (EADSIM). Analysis methodology is described and results are shown.

Thursday, 0830-1000

Droplet Size Effects on Lethality Calculations

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The goal of bulk chemical lethality predictions is to determine potential casualties from the dissemination of a chemical payload under both offensive laydown and defensive engagement scenarios. While these two scenarios can involve radically different initial conditions in terms of altitude of release, amount of agent ejected, and the shape and droplet distribution of the agent cloud, they both rely upon atmospheric transport codes to track the agent cloud to the ground. All atmospheric transport codes thus require a source term that consists of both a geometrical description of the agent cloud and a discrete droplet distribution. In order to keep track of agent reaching the ground, a gridded array is often employed. The amount of agent that lands within any particular grid cell is generally recorded as the sum of the droplet masses. Owing to this summation process, information regarding the numbers and locations of individual droplets is lost, and further calculations using deposition values rely on a uniformly smooth distribution of agent (within a given cell). This implicit smoothing function is valid as long as

the agent is deposited as a dense rain or mist such that individual droplet impacts make a negligible contribution to the over all amount of agent that gets deposited on a person. However, when the droplet distribution consists of larger, widely separated droplets, then the lethality calculations based upon a uniform distribution of agent can result in predictions that are inconsistent with a higher fidelity treatment of the actual distribution. For example, 10 large (LD90) VX drops that fall over a populated area have the chance to kill up to 9 out of 10 people. However, if the total mass of the 10 drops is uniformly distributed over a grid cell that is, say, 10 meters on a side, then the average deposition will be less than 1 mg/m^2 – a value that is below the casualty threshold – and no casualties will be reported.

To account for droplet distribution effects in lethality calculations, a discrete droplet lethality methodology is currently being implemented into the BMDO lethality model PEGEM. This presentation will discuss in greater detail the effects that discrete droplet sizes have on lethality calculations and the discrete droplet lethality methodology will be reviewed.

Knowledge Acquisition Matrix Instrument: Bioagent Casualty Modeling

Gillian Rickmeier
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The Knowledge Acquisition Matrix Instrument (KAMI) is a questionnaire for obtaining qualitative data to support modeling of human response to biological agent exposure. It is designed for bioagent-induced diseases that are wartime or terrorist threats but for which only limited human response data is available. The KAMI focuses on modeling parameters including infectivity, lethality, dose-dependent onset and duration, illness severity profiles, and time to death or recovery. In 1998, the KAMI was distributed to national and international subject matter experts to gather information on anthrax, plague, botulism, and VEE based on their experience from animal studies, epidemiology, vaccine development, accidental lab exposures and naturally occurring disease. Two expert panel meetings were held to review and reach a consensus on the KAMI data. This presentation describes the data gathering and analysis and how the results are used to generate casualty estimates for Volume II of *Allied Medical Publication 8: Medical Planning Guide for the Estimation of NBC Casualties (Biological).*

Thursday, 1030-1200

Monitoring and Detection of Low Levels of Chemical Agents: An Approach for Protection of Forces on the Battlefield and Fixed Sites

David Evans, Senior Analyst
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Several factors—including proliferation of chemical weapons technologies, the possible emergence of new or non-traditional chemical agents, and recent studies investigating the physiological and toxicological effects of chemical agent exposure—have drawn attention to the need to provide U.S. forces with adequate protection against exposure to low levels of chemical warfare agents. This paper examines current and planned chemical defense policy, doctrine, and operations for the detection and monitoring of acute and chronic exposure to low doses of chemical agents on the battlefield. While medical research on the effects of low doses will be addressed, this paper addresses (1) a definition of "low level", (2) likely scenarios in which U.S. forces would be exposed to low levels of chemical agents, (3) current and planned detection and monitoring technologies and systems, (4) current and planned non-medical protection technologies and systems (*e.g.*, suits, masks, and collective protection), and (5) a proposed strategy for developing technological and operational responses to identified challenges.

Hybrid Virtual/Live Environment for Evaluation of Biological Sensors

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The Integrated Biodetection Advanced Technology Demonstration (ATD) is demonstrating advanced biodetection technologies that may transition into a fielded bioaerosol detection system. The ATD will culminate with a Battle Lab Warfighting Experiment (BLWE) to demonstrate the military effectiveness of the system. This would traditionally be done utilizing technicians and soldiers at dedicated test facilities subject to the vagaries of weather and test range availability. The ATD and M&S Teams at SBBCOM have taken a new approach, integrating simulation into the process. This BLWE represents one of the first instances where a hybrid hardware/software system will be used to stimulate a biological agent sensor system, making the system behave as if under attack without the use of simulants or manual triggering of the sensors. Using existing DIS compliant NBC hazard prediction software and firmware decision logic modifications to the bio sensors, we have created a synthetic environment in which to exercise and test the system response to a variety of biological attack scenarios with the sensors operating under real-world environmental conditions. This presentation outlines the development and demonstration of the hybrid system, discusses lessons learned from the development process, and hypothesizes on further applications of the system beyond the BLWE, such as an embedded training capability.

Thursday, 1330-1500

Modeling of Chemical Agent Liquid Aerosol Particles and Vapor Concentration Levels to Support Light Detection and Ranging (LIDAR) Chemical Detection System Field Testing

William Kilpatrick
Simulation Technologies, Inc.
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A laser standoff chemical detector has been developed by the US Army Chemical and Biological Command, Edgewood Research Development and Evaluation Center (ERDEC). This chemical detector is a light detection and ranging (LIDAR) system called the Frequency Agile Laser (FAL) Sensor. The breadboard FAL Sensor was tested in September/October 1998 to assess its capabilities in detecting airborne chemical agent vapor and liquid aerosol (or rain) particles. Test support requirements included computer modeling to estimate the position of the chemical cloud; estimate the particle size distribution, location and count density; and to estimate chemical vapor levels from the resulting fallout. This paper describes an effort to develop computer models that use the Chemical/Biological Agent Vapor, Liquid, and Solid Tracking (VLSTRACK) Model's cloud property and challenge output data to characterize the aerosol particle phenomenology and vapor concentration levels for the test scenarios. Emphasis is placed on the aerosol particle modeling with application toward a field test using a liquid simulant Triethyl Phosphate (TEP) released from a XM11 simulator.

Backup Presentation:

Need for Ground-based Ballistic Missile EWRs in the SBIRS Era

Capt. Dave Denhard
Air Force Studies and Analysis, Space Superiority Branch (AFSAA/SAAS)
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The Space-Based Infrared System (SBIRS) is a global satellite system designed to meet infrared space surveillance requirements starting in the 2004+ time frame. The SBIRS, at its full operational capability (FOC), will provide (among other capabilities) post-boost tracking of ballistic missiles and other threats. These tracking capabilities, for North American air space, currently reside only with the ground based early warning radar (EWR) sites. This paper/presentation addresses the need and role for the ground based EWR sites (BMEWS, PAVE PAWS, PARCS) once SBIRS reaches FOC. In addition to missile warning, the EWR sites support other missions such as space surveillance and future missions such as National Missile Defense (NMD). The paper/presentation also addresses the impact to these missions if the EWR sites are removed. This effort is sponsored by HQ AFSPC.

WG 3 – ARMS CONTROL AND PROLIFERATION – AGENDA

Chair: Robert R. Tomes, ANSER
Cochair: John "Jed" Peters, RAND
Cochair: John Drye, Systems Planning and Analysis
Advisor: Dr. Bob Batcher, U.S. Department of State
Room: 355

Tuesday, 1030 -1200
COMPOSITE GROUP A SESSION .... Room 144

Tuesday, 1330-1500
Arms Control and Chinese Power Projection in the South China Sea: Desirable and Undesirable Outcomes.
Dr. John Garofano, U.S. Army War College

Potential Nuclear Arm Races in South Asia
Fredrick S. Nyland

Wednesday, 0830-1000 – **Joint Session with WG 1 Strategic Operations...Room 359**

Wednesday, 1030-1200
Patterns of War Initiation Among Status Quo Challengers and Defenders
Dr. Dan Geller, U.S. Department of State

Incentive Based Measures of Strategic Stability
Dr. Bob Batcher, U.S. Department of State

Wednesday, 1330-1500
Human-Centered Missile Defense System Development
Dr. Dan Tufano, Ridge National Laboratory and Dr. C.W. Glover, Oak Ridge National Laboratory

Evaluating the Effectiveness of National Missile Defenses
Dr. Bob Batcher, U.S. Department of State, Dr. Jerome Bracken, U.S. Department of State, Dr. James Scouras, U.S. Department of State

Thursday, 0830-1000
The National Military Strategy, Protecting Military Equities, and Conventional Arms Control Issues in Europe
Robert R. Tomes, ANSER

Conventional Arms Force in Europe (CFE): Treaty Elements, Adaptation and Analytical Questions
Dorn Crawford, US Department of State

Evaluating the Quality of Stability in Europe
Dr. John "Jed" Peters, RAND

Thursday, 1030-1200
Modeling First Strike Stability in a Multi-Player, Multi-Exchange Setting
Doug Anson, Los Alamos National Laboratory, Myron Stein, Los Alamos National Laboratory, and Steve Upton, LANL

Table-Top Exercises to Test the On-Site Inspection Provisions of the Comprehensive Nuclear Test Ban Treaty
Robert G. Gough, Sandia National Laboratories

Thursday, 1330-1500
The Treaty on Open Skies
Dr. Mark Gabriele

"Arms Control" for Information Warfare
Tamara Luzgin, U.S. Department of State

WG 3 – ARMS CONTROL AND PROLIFERATION – ABSTRACTS

Tuesday, 1030 -1200
COMPOSITE GROUP A SESSION .... **Room 144**

Tuesday, 1330-1500
Arms Control and Chinese Power Projection in the South China Sea: Desirable and Undesirable Outcomes.
Dr. John Garofano, U.S. Army War College

Approved abstract unavailable at printing.

Potential Nuclear Arm Races in South Asia
Fredrick S. Nyland

The purpose of this presentation is to illustrate a variety of potential nuclear arms races involving India, Pakistan, and other nations. One basis for this presentation lies in the assumed political motivations and policies of each country involved. The mathematical basis relies on arms race equations developed by Lewis F. Richardson. Simple arms races may be limited to two contenders. In this discussion, arms races involving two, three, and five contenders are considered. These races are hypothetical, but have been selected to illustrate some future possibilities ranging from a modest Indian policy of minimal deterrence to more aggressive national goals that could result in runaway arms races, particularly when more participants such as China, Russia, and the United States are considered.

Wednesday, 1030-1200
Patterns of War Initiation Among Status Quo Challengers and Defenders
Dr. Dan Geller, U.S. Department of State

The relationship between dyadic power balances and the onset (occurrence/initiation) of war is a principal element in realist theories of international politics. The possible influence of the status quo orientation of the belligerents has also been raised as a factor which may impact on the patterns of conflict. This study examines the question of the identity of war initiators as it relates to both power balances and status quo orientation for a set of nation-dyads that have formed long-term rivalries. The rivals identified here on the basis of time/density dispute criteria are conflict-prone and engage in a disproportionately large number of both militarized disputes and wars over extended periods of time. The results of the analysis indicate that: (1) status quo challengers rather than defenders are the most probable war initiators; (2) status quo challengers are equally likely to initiate wars whether they are superior or inferior in capabilities to their rivals; and (3) status quo defenders initiate wars almost solely under unstable military balances. This last pattern suggests that stable military balances of either preponderance or parity are generally interpreted by status quo defenders as supportive of deterrence, whereas unstable balances producing capability shifts or transitions are deemed dangerous enough to provoke preventive military action. The distribution is such that an unstable military balance approximates a necessary (although not sufficient) condition for war initiation by the status quo defender in an enduring rivalry.

Incentive Based Measures of Strategic Stability
Dr. Bob Batcher, U.S. Department of State

Measures of strategic stability are used in the strategic nuclear analysis community to assess the international balance of terror between nuclear weapons states. This paper takes a fresh look at the development of such measures within a framework of exploitation and preemption incentives to engage in nuclear war. Such incentives form the basis for defining indices of instability which measure the relative criticality of alternative bipolar force structures and force postures in encouraging nuclear war. In the process of development a set of measures are proposed as follows: exploitation incentive, first strike advantage, threat perception, preemption incentive, exploitation instability and preemption instability. This provides a rich construct that helps identify the sources of instabilities.

This work is exploratory and needs to be examined carefully. However, because it is based on a theory of interacting motivations, it promises to extend to multipolar measures free of some of the difficulties encountered in extending other bipolar measures to the multipolar context. This suggests that the multipolarization of strategic stability measures is more than a simple mathematical extension of bipolar measures; it requires a careful review of the security motivations of all parties toward each other.

Wednesday, 1330-1500

Human-Centered Missile Defense System Development

Dr. Dan Tufano, Ridge National Laboratory and Dr. C.W. Glover, Oak Ridge National Laboratory

Evaluating the Effectiveness of National Missile Defenses

Dr. Bob Batcher, U.S. Department of State, Dr. Jerome Bracken, U.S. Department of State, Dr. James Scouras, U.S. Department of State

Thursday, 0830-1000

The National Military Strategy, Protecting Military Equities, and Conventional Arms Control Issues in Europe

Robert R. Tomes, ANSER

Conventional Arms Force in Europe (CFE): Treaty Elements, Adaptation and Analytical Questions

Dorn Crawford, US Department of State

Evaluating the Quality of Stability in Europe

Dr. John "Jed" Peters, RAND

Thursday, 1030-1200

Modeling First Strike Stability in a Multi-Player, Multi-Exchange Setting

Doug Anson, Los Alamos National Laboratory, Myron Stein, Los Alamos National Laboratory, and Steve Upton, Los Alamos National Laboratory

Approved abstract unavailable at printing.

Table-Top Exercises to Test the On-Site Inspection Provisions of the Comprehensive Nuclear Test Ban Treaty

Robert G. Gough, Sandia National Laboratories

Approved abstract unavailable at printing.

Thursday, 1330-1500

The Treaty on Open Skies

Dr. Mark Gabriele

Approved abstract unavailable at printing.

"Arms Control" for Information Warfare

Tamara Luzgin, U.S. Department of State

The need for an arms control regime for Information Warfare is being discussed at the United Nations and other international fora. The goal of this paper is to explore what kind of arms control could be possible and to offer recommendations for implementation. Information Warfare is a uniquely different form of strategic warfare. Arms control for IW must be based on the same principles and methods as those employed for Information Warfare. This paper postulates a concept for IW arms control that is based on the information powershift paradigm for Information Warfare. The information powershift paradigm describes strategic Information Warfare as the precise employment of information power to alter information domains of interest and to compromise the ability of decision makers to make unencumbered decisions. The paper focuses on the Critical Information Infrastructures (CII) since information systems are more likely to be attacked. The paper proposes that effective arms control for IW must achieve two concurrent objectives.

- Provide a framework for evaluating the effectiveness of critical information infrastructure protection measures.
- Facilitate efforts to expand international cooperation in establishing standard and consistent critical information infrastructure protection regimes, measurement techniques and reporting criteria.

The goals of IW arms control should be to limit the vulnerability of CII systems and to dissuade cyber-brinkmanship through multilateral agreements that promote mutually assured information protection and that facilitate the open reporting of violations and noncompliance. The proposed approach is to monitor strategically significant features of the US critical information infrastructures and their interfaces to the global CII complex and to provide comprehensive assessments.

WORKING GROUP 4 – AIR & MISSILE DEFENSE – AGENDA

Chair: Tom Pendergast, Modern Technology Solutions, Inc (MTSI)
Co-Chairs: Sharon Noll, IDA/POET
Bob Strider, USASMDC-BI-ET
Mike Ellis, Quantum Research International
Paul Tabler, S3I
Paul Grim, SRS Technologies
Advisor: Dr. Daniel Willard, DUSA (OR)
Room: 344-Group A
Room: 353-Group B

COMPOSITE GROUP A SESSION .... Room 144

Tuesday, 1330-1500 .... **Room 344**
JTAMD Architecture (Lead: Paul Grim)

Nimble Shield 98
LTC James D. Renbarger, Joint Theater Air and Missile Defense Organization (JTAMDO)

Joint Mission Area Assessment--**Countering Air and Missile Threats in 2010 Timeframe**
LTC James D. Renbarger, Joint Theater Air and Missile Defense Organization (JTAMDO)

Probability of Negation for Cruise Missiles Using Least Defendable Routes
Dr. Nigel Siva, SPARTA, Inc.

Alternate: *Probability Distribution for Theater Missile Defense Attrition Effectiveness*
Dr. Nigel Siva, SPARTA, Inc.

Wednesday, 0830-1000 .... **Room 344**
BMC4I (Lead: Sharon Noll)

JCTN Applications to Missile Defense
MAJ Mike Steves and Mr. Steven Waugh, Ballistic Missile Defense Organization

Engagement Control for Joint Lower Layer Defense of TBM Attack
Mr. Ramey G. Maddox, AEgis Research Corporation

Two Deceptively Simple Criteria for the Scheduling of Engagements
Mr. Tom Tanner, Synetics Inc.

*Wednesday, 0830-1000 – **Group B*** .... **Room 353**
BMD Sensors (Lead: Paul Tabler)

Space Based Infrared System (SBIRS)
Mr Luther R. Briggs, NORAD-USSPACECOM/ANS, Dr David Finkleman, Director of Aerospace Analysis, LtCol James Bloise, USSPACECOM/J5R and Ms Cherie Gott, NORAD-USSPACECOM/ANS

Need for Ground Based Ballistic Missile EWRs in the SBIRS Era
Capt David Denhard, Air Force Studies and Analysis, Space Superiority Branch (AFSAA/SAAS)

Analysis of Russian Early Warning (EW) Radars for Shared EW Contributions
Ms. Cherie Gott, and Mr. Kevin Baumgardner, NORAD-USSPACECOM AN

Alternative

SBIRS Military Utility Evaluation
Mr. Damon Lum, SWC/AE

Wednesday, 1030-1200 .... **Room 344**

Attack Operations (Lead: Bob Strider)

Joint Theater Missile Defense Attack Operations Phase IV
COL John Carlile, Director, JTMD Attack Operations Task Force

Joint Attack Operations Investment Strategy
Michael W. Ellis, Quantum Research International

Wednesday, 1030-1200 – Group B .... **Room 353**

National Missile Defense (Lead: Paul Tabler)

Simulated Command Entities for Wargame 2000
Dr. Michael Lyons, The MITRE Corporation

Using ISAAC to Evaluate Relay Mirrors Constellations for SBL in NMD
Dr. Douglas Gettman, Schafer Corporation

National Missile Defense (NMD) System Operational Test and Evaluation
Dr. Ernest Montagne and Mr. Ric Harrison, TRW S&IT Group, Maj Phillip Baca, Joint Interoperability Test Command

Alternative: National Cruise Missile Defense
Mr. St. Clair Hultsman, (NORAD-USSPACECOM AN)

Wednesday, 1330-1500 .... **Room 344**

Boost Phase Intercept (BPI) (Lead: Michael Griffin)

Airborne Laser Counter-Salvo Requirement Analysis
Ms Karen E. Childers, System Simulation Solutions, Inc

A Methodology for Determining Defended Area for an ABL
Maj Garry L. Hall, Chief, Theater Missile Defense Analysis, Air Force Studies & Analyses Agency

The Role of Theater Ballistic Missile Defense in Global Engagement '98
Mr. Michael Griffin, Modern Technology Solutions Inc.

Wednesday, 1330-150 – Group B .... **Room 353**

TBMD Operational Effectiveness (Lead: Mike Ellis)

An Assessment of the Current TBM-Delivered CW Threat for Operations
John P. Lawrence, Assistant Vice President, Science Applications International Corporation

Total Army Analysis (TAA) 07 TBM Evaluation
Trudy A. Ferguson, Center for Army Analysis (CAA)

Thursday, 0830-1000 .... **Room 344**

TMD Threat (Lead: Mike Ellis)

Tactical Ballistic Missile Threat Trajectory Sensitivity Study
Robert L. Bowen and Charles V. Riley, USAMSAA

TBM Countermeasure Characterization
Dr. Matthew J. Vanderhill, M.I.T. Lincoln Laboratory

Feasibility of Third World Long Range Ballistic Missile Threat
Robert Woodside and Daniel Gadler, Boeing, Milton Gussow, JHU/APL

Alternate: ***Stochastic Threat-State Prediction***

Gordon W. Groves

Thursday, 1030-1200 .... **Room 344**
BMD Testing & Lethality (Lead: Paul Grim)

Bayesian Reliability Growth Models for Missile Testing
LTC David H. Olwell, Ph.D., Associate Professor of Operation Research, US Naval Postgraduate School (OR-OL)

Droplet Size Effects on Lethality Calculations
Dr. Martin B. Richardson, MEVATEC Corporation

Atmospheric Interceptor Technology Lethality Considerations
Mr. Jeff Elder, ITT Industries

Alternate: Warhead Effects on Cruise Missiles
Charles Garnett

Thursday, 1330-1500 .... **Room 344**
BMC4I (Lead: Sharon Noll)

The Role of Operator-in-the-Loop (OITL) as an Analytic Tool for Joint Theater Air and Missile Defense (JTAMD) Decisions
LCDR Ken Krogman, Ballistic Missile Defense Organization and Mr Andrew Melton, Computer Systems Center, Inc.

Maximizing System Performance by Maximizing Operator Performance Using Command and Control Displays
Dick Steinberg, Schafer Corporation, Steve Armstrong, STA Corporation, and Bobby Ford, THAAD Project Office

Battlelab Exercise and Training Capabilities
Robert Strider, U.S. Army Space and Missile Defense Battlelab

Working Group 4 – Air & Missile Defense – Abstracts

COMPOSITE GROUP A SESSION .... Room 144

Tuesday, 1330-1500 .... **Room 344**
JTAMD Architecture (Lead: Paul Grim)

Nimble Shield 98
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During September 1998, the Director for Force Structure, Resources and Assessment (J8) of the Joint Staff led a seminar wargame to gain Combatant Commanders' insights on Theater Ballistic Missile Defense (TBMD) concepts of operations. The wargame, named NIMBLE SHIELD, was designed and executed to achieve two principal objectives: development of insights into TBMD requirements, and assessment of TBMD operational concepts and their associated implications against common TBMD threat scenarios.

Participants included representatives from CENTCOM, USFK, PACOM, ACOM, and EUCOM. Prior to the beginning of the wargame, CINC staff planners were provided five alternative TBMD force structures consisting of various combinations of lower and upper tier active defense systems. In the wargame's first phase, planners from the respective staffs developed courses of action, based upon these alternative force structures, against TBMD threat scenarios derived from the FY2000-2005 Defense Planning Guidance. In the wargame's second phase, the courses of actions were refined and warfighting insights were developed.

This presentation will describe and summarize wargame planning and execution efforts. Insights gained about a number of issues related to TBMD systems architecture, deployment alternatives, political-military considerations, doctrine, and training will also be presented.

***Joint Mission Area Assessment*--Countering Air and Missile Threats in 2010 Timeframe**

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The FY2000-2005 Defense Planning Guidance (DPG) directed the Joint Theater Air and Missile Defense Organization (JTAMDO) and the Ballistic Missile Defense Organization (BMDO), in conjunction with OSD, the Services, combatant commands and relevant defense agencies, to develop and complete a Joint Mission Area Assessment (JMAA) of "the operational concepts, advanced technologies, organizational architectures, and doctrine for countering air and missile threats in the 2010 timeframe." Subsequent direction from the Defense Planning Advisory Group (DPAG) both restricted the focus of the JMAA to theater (vice national) air and missile threats and specified consideration of both theater air and missile defense (TAMD) attack operations and TAMD passive defense operations during the study. As directed in the DPG, the final JMAA report will be provided to the JTAMD executive committee by October 1, 1999.

The JMAA effort to date has centered around the execution of six JTAMD operational element study efforts: Single Integrated Air Picture (SIAP); Combat Identification (CID); Integrated Fire Control (IFC); Automated Battle Management Aids (ABMA); Attack Operations (AO); and Passive Defense (PD). This presentation will summarize these efforts, present emerging results (as available), and describe the overarching integrating analysis plan to be executed during the summer of 1999.

Probability of Negation for Cruise Missiles Using Least Defendable Routes

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Probability of Negation P_N of an enemy missile depends upon its *path* from its launch point to its intended asset (target). Since Ballistic Missile (BM) *trajectories* can be predicted uniquely, once the BM's trajectory is known, then its P_N can be calculated in terms of the probabilities of success in the *three major functions*: Sensor, BM/C^4I and Weapon. In contrast, the Cruise Missile (CM) *route* between its launch point and its intended asset is preplanned by the enemy, based upon his perception of the defense's performance and beddown, so that his CM will take the route of maximum *Probability of Survival* P_S (corresponding to minimum predicted P_N) while in transit. This particular route is called the *Least Defendable Route* (LDR). In our method, *Poisson density* is used to define a *risk function* (risk per unit route–length along source–type eight cardinal directions) in terms of *Probability of Detection, Engagement Volumes* (volumes of space where engagements are feasible) and *Engagement Lengths* (length between successive engagements for each engagement unit). The LDR between two points is found by directly maximizing P_S through minimizing the *cumulative risk* defined as the sum of risk along a route connecting those two points using the *D'Esopo–Pape Algorithm*. The resulting maximum P_S contour map represents the *offense's* perception of vulnerability. For the same LDR's, one can perform a model simulation, including additional details, and generate the *defense's* minimum P_N contour map. These two maps (P_S and P_N) provide *complementary* views for CM Defense.

Alternative: *Probability Distribution for Theater Missile Defense Attrition Effectiveness*

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Two effectiveness measures used for Theater Ballistic Missile (TBM) Defenses are the *Probability of Negation* of a TBM and TBM *Force Attrition.* The Probability of Negation is the probability that an enemy missile is destroyed or prevented from damaging the asset it was targeting; its value depends upon the qualities of the defense about that asset. Force Attrition is the sum of the number of TBM's destroyed at each defended asset and in total. Using the product of generating functions to determine the distribution of a sum of differently distributed independent binomial random variables, this paper rigorously derives the *complete and exact* probability distribution for the number of leakers (the complement of attrition) in the entire defended area. The probability density function of the total Force Attrition (i.e., the probability of *exactly k* number of TBM penetrators from a total of *m* attackers in the entire defended area) is determined from the total number of assets within the entire defended area, the number of TBM's targeting each asset and the Probability of Negation of a single TBM targeting each asset, assuming independent engagements. A useful approximation to this exact distribution is obtained in terms of a normal distribution. Examples are presented to elucidate the application of this approximation to distinguish the effectiveness of alternative defense architectures. This analytic technique would provide a top–level measure for Theater Air and Missile Defense planning tools to design defense beddowns against attacking laydowns.

Wednesday, 0830-1000 .... **Room 344**

BMC4I (Lead: Sharon Noll)

JCTN Applications to Missile Defense

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The Joint Composite Tracking Network (JCTN) concept was developed as a network of sensors that would enable substantial improvements in Air and Missile Defense operational capabilities for the Joint Forces Commander. The JCTN, along with the Joint Planing Network (JPN), and Joint Data Network (JDN) represent the JTAMD BMC4I network architecture concepts for achieving Joint Vision 2010.

The JCTN study showed that a Composite Tracking and Data Fusion Network could provide an accurate, resolved, consistent (operationally identical) real-time Air, Cruise Missile, and TBM picture because: (1) the same sensor data are processed virtually identically and simultaneously by all participants and (2) because joint composite tracking provides better track accuracy, track continuity, and common (correlated) track numbers. Viewing angle diversity and sharing of high-resolution sensor data also improves air picture resolution. JCTN is an enabler for Operational concepts like Single Integrated Air Picture (SIAP), Joint Engagement Zone (JEZ), Engage on Remote, Air Directed Surface to Air Missile (ADSAM). This presentation will outline the relationships of JPN, JDN, and JCTN, and will give examples of improved warfighting capabilities in a 2010 TAMD environment that would result from a JCTN deployment.

Engagement Control for Joint Lower Layer Defense of TBM Attack

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Approved abstract unavailable at printing.

Two Deceptively Simple Criteria for the Scheduling of Engagements

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The U.S. Navy's focus on littoral operations increases the vulnerability of its surface combatants because of the resulting compressed timeline for effective defense. To carry out its mission in the littoral environment, the surface combatant must be able to stand firm against an increasing number of credible arsenals, including the formidable land-based antiship cruise missiles. An effective defense requires the efficient allocation of each ship's limited number of engagements.

The exposure to land-based antiship cruise missiles can present the ship with a particularly formidable point defense problem. A scheduling strategy engineered to optimize every one of the limited number of engagement opportunities can serve as an effective force multiplier, greatly augmenting the advances in defensive weapons technology.

But how is "Optimum? Defined" The proposed answer is derived from the objective of minimizing the maximum risk of taking a hit. The article develops and illustrates an objective function defined as the ?effective kill probability of a sequence of engagements? as well as a gradient related to the individual contribution of each engagement. These criteria address two of the traditional challenges in scheduling. The first is to suppress the artificial biases introduced between dissimilar engagements. The second is to take full advantage of the significant differences induced by factors derived from the operational environment, tactical geometry, and interactions with other scheduled engagements.

Wednesday, 0830-1000.. **Room 353**

BMD Sensors (Lead: Paul Tabler)

Space Based Infrared System (SBIRS)

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SBIRS is the next generation of military infrared space programs to be implemented in a phased approach as follow-on to the Defense Support Program (DSP to counter the emerging threat.

The current DSP has been our strategic missile warning system for well over 20 years. While it remains a very capable system against ICBMs and SLBMs, its inherent design and 1970s technology is simply not suited for the growing number of diverse theater ballistic missiles. The main facet for this discussion will be SBIRS improvement to support theater missile defense efforts.

This paper describes the expected proliferation of missile types, increasing numbers of future theater ballistic missiles and the improvements which SBIRS will provide to counter these threats. These improvements include: smaller TBM launch point estimates and quicker reports to support Active Defense systems, and greatly reduced impact predictions to support Force Protection efforts. This paper also shows how the SBIRS satellites will augment in-theater radars as they support the theater warfighters.

Need for Ground Based Ballistic Missile EWRs in the SBIRS Era

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The Space-Based Infrared System (SBIRS) is a global satellite system designed to meet infrared space surveillance requirements starting in the 2004+ time frame. The SBIRS, at its full operational capability (FOC), will provide (among other capabilities) post-boost tracking of ballistic missiles and other threats. These tracking capabilities, for North American air space, currently reside only with the ground based early warning radar (EWR) sites. This paper/presentation addresses the need and role for the ground based EWR sites (BMEWS, PAVE PAWS, PARCS) once SBIRS reaches FOC. In addition to missile warning, the EWR sites support other missions such as space surveillance and future missions such as National Missile Defense (NMD). The paper/presentation also addresses the impact to these missions if the EWR sites are removed. This effort is sponsored by HQ AFSPC.

Analysis of Russian Early Warning (EW) Radars for Shared EW Contributions

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The U. S. Government is considering sharing ballistic missile warning information with Russia. We have therefore initiated a study to evaluate the quality and timeliness of Russian ballistic missile warning based on current and emergent Russian Early Warning Radar System (REWRS) capabilities. Russian ballistic missile warning has historically encompassed both a highly elliptical orbit satellite constellation, an early warning radar system, and a robust defense of Moscow. The first phase of this study examined the contributions of the ground-based early warning radars. The REWRS has degraded since the end of the Cold War. The Anti-Ballistic Missile (ABM) Treaty of 1972 (and agreed statements and understandings of 1974) required early warning radars to be on the periphery of the country and pointed outwards. However, the country at that time was the Soviet Union, and the western and southern peripheries are now in other independent republics. Without regard to agreements for continued operations in independent republics, we looked at the current configuration of operational early-warning radars to assess broad capabilities. Using intelligence estimates for anticipated radar coverages, we also looked at improvements expected from future capabilities.

Alternative

SBIRS Military Utility Evaluation

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HQ SWC/AE conducted this study of the Space Based Infrared System (SBIRS) at the request of HQ AFSPC/DRF/XPA and HQ USSPACECOM/J5R. The Defense Support Program (DSP) is being replaced by the SBIRS program as the answer to the evolving tactical ballistic missile threat and the need in future conflicts to perform the added missions of missile defense, technical intelligence, and battlespace characterization. The SBIRS program consists of two elements: SBIRS High and SBIRS Low. The SBIRS High element features a mix of geosynchronous earth orbit satellites, highly elliptical orbit satellites, and a new consolidated ground processing station. SBIRS High will incrementally replace the existing DSP infrastructure over the FY99-FY03 timeframe, with initial satellite launches in 2002. The SBIRS Low element consists of low earth orbit satellites and faces a deployment decision in 2000. Both SBIRS High and DSP detect and report strategic and tactical missile launches. This study focused on SBIRS High and DSP capabilities to assist in Theater Missile Defense. Computer simulation runs were made for SBIRS High and DSP using each system's performance data. The Air Force's legacy campaign model, THUNDER, generated 20 days of combat results for analysis. The resulting comparative analysis determined the relative military utility for SBIRS High versus DSP.

Wednesday, 1030-1200.. **Room 344**
Attack Operations (Lead: Bob Strider)

Joint Theater Missile Defense Attack Operations Phase IV

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Joint Attack Operations Investment Strategy

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The Joint Attack Operations Working Group (JAOWG) was organized in 1997, under the co-leadership of the Joint Staff (J-8) and the Ballistic Missile Defense Organization (BMDO). The charter of the JAOWG was to develop an assessment of U.S. Attack Operations capabilities and recommend an investment strategy to enhance U.S. capabilities to detect and defeat threat surface-to-surface tactical missile launch capabilities. In January 1998 the JAOWG's mission was transferred to the Joint Attack Operations Working-Level Integrated Product Team (WIPT), co-chaired by BMDO and the Joint Theater Air and Missile Defense Organization (JTAMDO), in order to integrate Attack Operations with other elements of the U.S. Theater Air and Missile Defense.

The JAOWG, drawing upon the lessons learned in exercises conducted by the Joint Theater Missile Defense-Attack Operations Joint Test Force, other DoD sponsored exercises, and with input from Service and industry subject matter experts, developed a functional description of critical Attack Operation's actions, identified shortfalls in current capabilities, and developed an investment strategy to improve Attack Operations performance through the FY 2003 timeframe. The Joint Attack Operations WIPT is continuing to refine the Attack Operations investment strategy, and extend its recommendations to the 2010 timeframe.

This paper will describe the key findings of the JAOWG and Joint Attack Operations WIPT, and current analysis plans to complete the Attack Operations investment strategy in support of the Joint TAMD process.

Wednesday, 1030-1200.. **Room 353**
National Missile Defense (Lead: Paul Tabler)

Simulated Command Entities for Wargame 2000

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Wargame 2000, under the sponsorship of the Ballistic Missile Defense Organization, is a real-time, interactive, discrete event, human-in-the-loop simulation for command and control in air and missile defense applications. The Wargame 2000 System provides a simulated combat environment in which warfighting commanders, their staffs, and the acquisition community can examine air and missile defense concepts of cperation, doctrine, tactics, techniques and procedures as an integral part of larger combat environments through the use of human-in-control experiments. WG2K is under development at the Joint National Test Facility with an initial demonstration of game capability for national missile defense in early 1999.

In national missile defense wargames, actual battle staff personnel from North American Aerospace Defense Command man positions in a command center which is an integral part of the Wargame 2000 composition. This man-in-the-loop activity is required to evaluate the accuracy and timeliness of decisions made by the battle managers and is a driver for the simulation to run in real-time. However, for the theater air and missile defense context, Wargame 2000 is also required to simulate the decision-making by the battle staff. Such computed generated

agents or command entities should model human behavior to provide realistic C2 decisions, based on adaptive and rational cognitive processes, and to compute these behaviors for scaleable combat performance. This paper addresses design considerations for command entities in Wargame 2000, using lessons from the Synthetic Theater of War and research results from behavior modeling through the application of control mechanisms for goal-driven actions.

Using ISAAC to Evaluate Relay Mirrors Constellations for SBL in NMD

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ISAAC (integrated strategic architecture analysis code) is a software suite developed by Schafer Corporation for analysis of ballistic missile defense architectures including space-based lasers (SBL) and airborne laser (ABL) assets. ISAAC has recently been upgraded to simulate constellations of relay mirrors for detailed analysis of more complicated missile defense architectures than architectures including only one type of platform. This presentation details comparative studies of the performance of SBL and SBL plus relay mirror constellations on a notional NMD scenario. Several design trades are also presented to illustrate the capabilities of ISAAC as a tool for rapid analysis of various NMD architectures.

National Missile Defense (NMD) System Operational Test and Evaluation

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The Joint Interoperability Test Command (JITC) is forging new ground as a member of the integrated Operational Test Agency (OTA) team for the National Missile Defense (NMD) System. The size and complexity of the NMD system, coupled with the unique acquisition strategy and the accelerated schedule, pose challenges for the operational test community. The JITC and the other members of the integrated OTA team, the Army Operational Test and Evaluation Command (OPTEC) and the Air Force Operational Test and Evaluation Center (AFOTEC), have developed a comprehensive strategy for operational test and evaluation (OT&E) of the NMD System. This strategy is designed to meet the unique challenges posed by the NMD system and provide timely information to acquisition decision makers.

The OT&E strategy comprises these three phases:

- Early Operational Assessment (EOA) to assess potential operational effectiveness, suitability, and interoperability
- Early User Test and Evaluation (EUT&E) to characterize NMD System performance and assess interoperability
- Initial OT&E to evaluate operational effectiveness and suitability and certify interoperability.

The JITC will rely on multiple data sources, including integrated flight tests, integrated ground tests, risk reduction flights, wargames, and models and simulations, to support the interoperability evaluation.

The JITC's NMD system interoperability evaluation focus areas are:

- Joint Technical Architecture Compliance
- Battle Management Command, Control, and Communications
- Cheyenne Mountain Air Station Integration
- NMD Message Set Development

To facilitate timely reporting, JITC uses the OTA Team-developed Continuous Evaluation Report Tracking System (CERTS), a database of T&E-related information to support formal reports and informal feedback to the entire NMD community: Office of Secretary of Defense, Services, and program management offices. CERTS concepts can be applied to other major programs.

This presentation will describe JITC's comprehensive interoperability evaluation strategy and participation in the NMD program evaluation.

Alternative

National Cruise Missile Defense

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This study addresses the cruise missile threat to North America and evaluates current and future capabilities for National Cruise Missile Defense. The Modernization Analyses Report from the most recent Quadrennial Defense Review, and the FY99-03 Defense Planning Guidance, generated an action for The National Defense Panel (NDP), to direct the Ballistic Missile Defense Organization (BMDO) to address National Cruise Missile Defense and report results to the Under Secretary of Defense for Acquisition and Technology (USD(A&T)). The resulting study was led jointly by the BMDO Chief Architect/Engineer and NORAD J5.

To carry out the study, three study panels were convened: threat, architecture, and operational concepts. The study focused on the most likely future threat - individual cruise missiles launched from ships or submarines. The Analysis Directorate (NORAD-USSPACECOM/AN) participated in overall study organization and on the architecture panel. A senior advisory group of retired Flag officers examined progress.

The study team conceived several technical alternatives for wide area surveillance. Potential approaches and architectures for defense against the cruise missile threat were formulated and evaluated. Several near term efforts were recommended, for example, exploiting maritime surveillance and monitoring capabilities. Potential synergisms between theater cruise missile defense and national cruise missile defense were considered. A briefing was presented to Gen Myers, USCINCSPACE and Lt Gen Lyles, BMDO Director, and a written summary of the study results was prepared for Dr Jacques Gansler, USD(A&T). Guidance is expected for follow-on work related to the ongoing review of the National Cruise Missile Defense (NCMD) study.

Currently, the analysis team, in conjunction with the NORAD staff, is continuing to seek out, postulate, and evaluate possible and affordable approaches for providing improved capabilities for national cruise missile defense for the near, intermediate and far term periods, respectively. For example, for the nearer term, we are considering defensive postures, including Joint, Multi-Command assets and operations, which might be formulated and employed for different specific threat scenarios, such as scenarios which include some degree of advance warning of the impending threat. For an intermediate time period, we are investigating the possibilities and costs of national cruise missile defensive force structures which include surveillance systems employing high altitude endurable (HAE) unmanned aerial vehicles (UAVs) carrying radar and possibly other surveillance sensors. We're evaluating the potential of passive and multi-static radar technology relative to cruise missile defense. We're participating in the development of the feasibility study for a PACAF-initiated Cruise Missile Defense Joint Test & Evaluation proposal. We are watching for indications of potential future capabilities for national cruise missile defense from space-based surveillance systems such as space-based radar.

Wednesday, 1330-1500.. **Room 344**
Boost Phase Intercept (BPI) (Lead: Michael Griffin)

Airborne Laser Counter-Salvo Requirement Analysis

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The Airborne Laser (ABL) program is currently going through iterations of updating their Operational Requirements Document (ORD). As more analysis is completed, more robust requirements are being developed. One such area is the requirement for counter-salvo capability.

A counter-salvo requirement is needed to ensure the ABL retains a robust capability against a large number of Theater Ballistic Missiles (TBMs) launched within a short window. The challenge of determining the salvo requirement is in defining the characteristics of the salvo or "raid set", as well as the required performance against the raid. The characteristics of the raid set include not only the number of missiles and launch window, but the type or types of missiles, location of launch point or points (range, azimuth), trajectory, and other factors. Defining capability requirements is also challenging, as it must be noted that the ABL is the first line-of-defense against the threat. Its area of responsibility can cover a large region, and it does not protect against TBMs by itself, but is part of a Family of Systems that together must negate the threat.

Intelligence assessments of likely threats were evaluated to determine likely salvo capabilities. Factors determining a threat's capability to salvo TBMs can include missile inventories and launchers, as well as training, doctrine, and command and control. Operational scenarios derived from the assessments were modeled in ISAAC, an engagement-level simulation that models the ABL and the TBM threat with high fidelity. Operationally representative scenarios that cover the scope of the threats were derived and modeled to evaluate the realistic expectations, and understand the sensitivity of the capability to various raid factors. From this, several raid sets were used to define the required capability. These sets were designed to ensure a robust capability against the various types of raids that may be encountered.

A Methodology for Determining Defended Area for an ABL

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The Role of Theater Ballistic Missile Defense in Global Engagement '98

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Last November, the Air Force held its Global Engagement 98 wargame. Focused on a operational level conflict with a regional adversary in 2008, the wargame, designed by the Air Force Wargaming Institute and RAND, sought to highlight the new Air Expeditionary Force (AEF) concept in a no-plan scenario. The wargame consisted of three simultaneous games with the same starting point, each with its own blue, red, and white panels. Each panel was staffed with the appropriate mix of retired Commanders in Chief (CINCs), current CINC staffs, professional assessors, country-specific experts, and modelers. Additionally, a game control cell provided overall management, a senior advisory panel struggled with National Command Authority decisions, and a request for information cell contained a host of system experts for reference. The conflict was waged on the ground, at sea, and in the air.

One of the key components of the threat was its large number of theater ballistic missiles. Employment these weapons was especially important within the context of the no-plan scenario as the threat often sought to keep US forces from deployment. Theater ballistic missile defenses (TBMD) played a decisive role in the outcome of each game. Most of the TBMD family of systems were presumed fielded to some extent, although none were deployed to the region at the outset of the wargame. Consequently, the impact of the TBMD systems on the AEF concept was substantial. This briefing touches on the overall game design, the specific role of theater ballistic missile defense, the pre-game analysis, the different challenges for TBMD and the resulting strategies, and the lessons learned both for the warfighter and the analytic community.

<u>*Wednesday, 1330-1500*</u>.. **Room 353**
<u>TBMD Operational Effectiveness</u> (Lead: Mike Ellis)

An Assessment of the Current TBM-Delivered CW Threat for Operations

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This paper takes a detailed look at the impacts of the current TBM-delivered chemical threat to US operations at airports of debarkation (APODS), seaports of debarkation (SPODS), and fighter bases on the Korean peninsula. This analysis attempts to determine a passive defense threshold for chemical TBMs leakers below which operational requirements can be met without unacceptable degradation. This provides a baseline against which the number of acceptable leakers can be quantified. Given the threat's overall missile launch capability both in individual raid size generation and number of likely reattacks, missile defense operational effectiveness can be determined such that the leakage rate can be managed below the identified passive defense threshold. Passive defense sensitivity to reattacks can also be determined providing a baseline against which attack operations effectiveness can be benchmarked. A significant element of these analyses was a detailed assessment of the nature of the chemically contaminated environment likely to be generated at these fixed facilities. This work has lead to live-agent testing on concrete surfaces conducted by Dugway Proving Grounds. A summary of the results of these tests will be included in the paper. This paper will be a synopsis of several studies sponsored by DTRA for USFK, the Air Staff and Joint Staff J4, completed over the past 18 months.

Total Army Analysis (TAA) 07 TBM Evaluation

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The TAA07 TBM Evaluation was conducted to support the Total Army Analysis 2007 process, which addresses the impact of Weapons of Mass Destruction (WMD) on force structure requirements. The specific objective of the analysis was to determine how many tactical ballistic missiles (TBMs) leak through an integrated theater missile defense (TMD). The analysis examined the impact of TBMs armed with both chemical and unitary high explosive warheads in two Major Theater Wars (MTW). Scenarios were based on the Defense Planning Guidance (DPG) draft Illustrative Planning Scenarios (IPS) 2000-2005. Measures of effectiveness included the number of TBMs impacting each critical asset for each day of the campaign, the number of TBMs with chemical warheads intercepted below altitude thresholds, TBM kills, and interceptor expenditure. The analysis used the Extended Air Defense Simulation (EADSIM). Analysis methodology is described and results are shown.

Thursday, June 24, 1999 0830-1000 .... **Room 344**

TMD Threat (Lead: Mike Ellis)

Tactical Ballistic Missile Threat Trajectory Sensitivity Study

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Performance estimates that are used in the evaluation of missile defense systems typically consist of "footprints" within which a desired level of intercept capability exists. These "footprints" are traditionally generated using "end-to-end" digital simulations in which a single "nominal trajectory" is modeled for each threat type. However, for each threat type, missile to missile variability will result in a distribution of trajectories that differ from the "nominal trajectory". To date, it has been presumed that the "nominal trajectory" is representative of this distribution. The purpose of this study is to determine the degree to which performance footprints based on the "nominal trajectory" are representative of system performance for the expected distribution of target trajectories. A family of possible target trajectories (including a "nominal trajectory) will be generated using a six degree of freedom simulation of a single threat tactical ballistic missile. The performance of a missile defense system will be characterized against each trajectory. This characterization will consist of decisions of whether or not a success probability exceeds a given threshold at various points in space. Analysis of simulation results will determine the degree to which performance decisions based upon the nominal trajectory differ from those based on the larger population. This presentation will discuss the methodology and, if available, the results of this study.

TBM Countermeasure Characterization

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As the proliferation of tactical ballistic missiles (TBMs) continues, adversary countries will develop countermeasures to enhance the effectiveness of their missiles. In response to the deployment of TBM defensive systems, reactive countermeasures could include such items as reduction of the radar cross section of re-entry vehicles, airborne and land-based stand-off jammers, jammers on the TBM itself, and fragmentation and segmentation of boosters and deployment modules. As part of a countermeasures vulnerability assessment study for the U.S. Navy, these countermeasures were characterized in detail. The RF and IR signatures and motions of the countermeasures selected were based on domestic experiments and foreign missile tests. This paper describes the countermeasure characterization portion of that study.

The effective radiated power (ERP) of several land and airborne stand off jammers was calculated based on commercially available RF hardware and on new work by the intelligence centers; this paper characterizes a landbased jammer assembled from commercially available components. Similarly, commercially available hardware was used to estimate the ERP of a jammer that could be carried in a TBM deployment module. Radar absorbing material is readily available on the open market. When this material is applied to re-entry vehicles, a reduction in radar cross section can be achieved. A summary of this analysis is presented for one TBM system. Another possible countermeasure is the intentional fragmentation or segmentation of booster tanks or deployment modules. An extensive analysis of all available RF and IR data on domestic and foreign tests was conducted. The descriptions of fragmentation and segmentation phenomena developed from this effort are summarized.

Feasibility of Third World Long Range Ballistic Missile Threat

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An industry study on the feasibility of a Third World country to acquire, develop, field, and launch an LRBM was requested in April 1997 by PEO TAD. The final report was prepared and distributed in October 1998 by the National Defense Industrial Association's (NDIA) Strike, Land Attack and Air Defense Committee.

The study examines the potential growth in ballistic missile range that could occur from the increasing proliferation of ballistic missile technology to Third World countries. The study focuses on the question of **feasibility**, using exclusively unclassified sources of information rather than traditional intelligence methods based primarily upon classified information and observed data. The report contains a succinct yet complete story of the Third World ballistic missile threat, beginning with the technology transfer of Germany's World War II V-2 rocket to the Soviet Union and the United States; describes the technical capabilities and ballistic missile inventory of Third World countries; estimates the time needed for them to develop and launch a longer rang ballistic missile (3,000 km to 10,000 km) based on configuring available boosters in stack or cluster form; and verifies these missile configurations' flight stability and performance characteristics by engineering analysis and simulations. By providing an independent assessment of this near-term LRBM capability, the report supports the findings of the Rumsfeld Commission which concluded that the BM, short or long range, poses a growing threat to the United States.

Alternatives

Stochastic Threat-State Prediction
Gordon W. Groves

Thursday, 1030-1200 .... **Room 344**
BMD Testing & Lethality (Lead: Paul Grim)

Bayesian Reliability Growth Models for Missile Testing

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Missile developmental and operational testing is very expensive. It requires estimating the probability that a missile exceeds a certain reliability level. Estimation is complicated by upgrades to the missile as failure modes are identified and removed, resulting in sequences of trials that are not identically distributed. Several models exist to describe this growth in reliability. The number of trials required to get precise estimates of the desired probability are large, and under a frequentist approach only result in approximate confidence intervals, not probability statements.

In this paper, we apply Bayesian methods to incorporate engineering knowledge and past experience into the statistical problem, using each of three reliability growth models. We use Markov Chain Monte Carlo methods to analyze the posterior distribution, and provide graphical and numerical predictions of the asymptotic reliability, and the likely number of redesigns and failure until we meet a desired reliability level. Additionally, pre-posterior analysis allows us to have insight into the number of missile trials necessary to achieve our analytical goals with the postulated prior knowledge, and the sensitivity of our analysis to those prior beliefs.

We illustrate with the THAAD program. Given five failures, what does the future hold? We compare traditional analysis methods (which produce very pessimistic forecasts) with our methods, which by explicitly drawing on engineering knowledge and prior historical norms can result in much more optimistic and realistic predictions. We highlight all the sensitivity of the analysis to the assumptions used, particularly comparing the Bayesian assumptions with the classical ones. We discuss safeguards against malevolent manipulation.

We discuss extensions and implications of the work. The methods have been implemented efficiently on a PC, and source code will be available.

Droplet Size Effects on Lethality Calculations

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The goal of bulk chemical lethality predictions is to determine potential casualties from the dissemination of a chemical payload under both offensive laydown and defensive engagement scenarios. While these two scenarios can involve radically different initial conditions in terms of altitude of release, amount of agent ejected, and the shape and droplet distribution of the agent cloud, they both rely upon atmospheric transport codes to track the agent cloud to the ground. All atmospheric transport codes thus require a source term that consists of both a geometrical description of the agent cloud and a discrete droplet distribution. In order to keep track of agent reaching the ground, a gridded array is often employed. The amount of agent that lands within any particular grid cell is generally recorded as the sum of the droplet masses. Owing to this summation process, information regarding the numbers and locations of individual droplets is lost, and further calculations using deposition values rely on a uniformly smooth distribution of agent (within a given cell). This implicit smoothing function is valid as long as the agent is deposited as a dense rain or mist such that individual droplet impacts make a negligible contribution to the over all amount of agent that gets deposited on a person. However, when the droplet distribution consists of larger, widely separated droplets, then the lethality calculations based upon a uniform distribution of agent can result in predictions that are inconsistent with a higher fidelity treatment of the actual distribution. For example, 10 large (LD90) VX drops that fall over a populated area have the chance to kill up to 9 out of 10 people. However, if the total mass of the 10 drops is uniformly distributed over a grid cell that is, say, 10 meters on a side, then the average deposition will be less than 1 mg/m^2 – a value that is below the casualty threshold – and no casualties will be reported.

To account for droplet distribution effects in lethality calculations, a discrete droplet lethality methodology is currently being implemented into the BMDO lethality model PEGEM. This presentation will discuss in greater detail the effects that discrete droplet sizes have on lethality calculations and the discrete droplet lethality methodology will be reviewed.

Atmospheric Interceptor Technology Lethality Considerations

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A study was recently completed which investigated trends in Kinetic Energy Weapon (KEW) lethality for the Atmospheric Interceptor Technology (AIT) Project Office. This study was conducted using the well established and accredited KEW lethality assessment code called PEELS, Parametric Endo/Exoatmospheric Lethality Simulation. The primary purpose of the study was to identify key trends in body-to-body interceptor lethality for two AIT concept kill vehicle designs against four threat representative tactical ballistic missile payloads. Results of this study yielded some interesting trends that are important for weapon systems analysts and engineers to understand about KEW lethality, such as miss distance requirements and aim-point sensitivity. This paper will discuss the purpose and scope of the study, background information about PEELS, trends using post-processing techniques specially designed for this study, and show results graphically.

Alternative

Warhead Effects on Cruise Missiles
Charles Garnett

Thursday, 1330-1500.. **Room 344**
BMC4I (Lead: Sharon Noll)

The Role of Operator-in-the-Loop (OITL) as an Analytic Tool for Joint Theater Air and Missile Defense (JTAMD) Decisions

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Joint Vision 2010 highlights the need to exploit the synergy of a Joint Family of Systems (FoS) as a cost saving alternative to traditional stove-piped Service systems. Within the Joint Theater Air and Missile Defense (JTAMD) arena, much work has been done to determine the FoS architecture. The challenge facing the JTAMD community is to decide what, and how much, Battle Management/Command, Control, Communications, Computers and Intelligence (BM/C4I) capability is required to make U.S. JTAMD forces more effective by making them more interoperable.

Constructive simulation in forms such as force-on-force models have been widely used to provide insight into the technological effectiveness of the various system architectures. This analytic methodology makes broad assumptions about the effectiveness of the BM/C4I architecture that binds these systems together. A significant challenge facing the community is the ability to test those BM/C4I assumptions.

OITL simulation has been successfully used in human factors test and evaluation (T&E) and operator training. This paper will present an analytic methodology that utilizes OITL as the tool for evaluating the BM/C4I assumptions and present some of the challenges facing the operational research community in ensuring that the results achieved in an OITL experiment provide useful insights to decision-makers.

Maximizing System Performance by Maximizing Operator Performance Using Command and Control Displays

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In emerging Missile Defense (MD) Command and Control (C2) systems and concepts, the user typically acts as a manager by exception while the majority of system activity is computer automated. While direct interaction of the user with the system is minimal, an inaccurate action by the user can have catastrophic consequences. Additionally, many of the decisions MD C2 commanders are required to make are based on uncertainty in measured track data and predicted future enemy course of actions. In each of these cases, critical decisions are being made based upon probabilistic or uncertain data. Depending on the degree of uncertainty, the action taken by a military commander is greatly affected. While a tremendous amount of money is being invested in government contracts to improve the precision of the data measured by sensors and the accuracy of intelligence data, this does not eliminate the problem. Research performed for the U.S. Army's Theater High Area Altitude Area Defense Interceptor (THAAD), the THAAD Radar, and the National Missile Defense have tested concepts with operators for displaying the ambiguity of data for real-time displays in a manner which minimizes operator perception errors.

As advances in information systems have made more information available to warfighters during real-time operations. Typical design interactions with C2 users have revealed an insatiable appetite for data on a display. However, this research for Missile Defense systems found that more information does not guarantee better user performance. It is essential to display information in a manner that will augment the battle commander's decision-making capability without information overload. Display designs must be based upon the need to satisfy the command and control purposes rather than a firehose of information which degrades operator performance. There is clearly a strong need for advanced Human Computer Interaction (HCI) methods to minimize risk of erroneous personnel actions. The THAAD BMC3, THAAD Radar, and NMD C2 display systems have been using empirical based testing to define critical data required by operators to optimize C2 display decision making. Empirical evidence for designing C2 displays based on a purpose centered rather than information driven design methodology was found.

Battlelab Exercise and Training Capabilities

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To enhance warfighter training and capabilities, the US Army Space and Missile Defense Battlelab (SMDBL) has developed several tools to support space and missile defense capabilities. The primary function to support the soldier has been the utilization of various computer simulations to stimulate tactical systems. This allows a soldier sitting at a tactical workstation (such as an Air Defense Systems Integrator (ADSI), an All Source Analysis System (ASAS), etc.) to be trained with messages and graphics on his display that are generated from simulations. This has created "virtual combat veterans", soldiers who have been trained on their systems and the data received is from a virtual source and not a wartime source.

To accomplish this, SMDBL created what is known as the Synthetic Battlefield Environment (SBE). The SBE uses Distributed Interactive Simulation (DIS) compliant models that can be tailored to meet the requirements of the simulated environment. SMDBL uses the Extended Air Defense Simulation (EADSIM) as well as models such as Modular Semi-automated Forces (MODSAF), the Target Acquisition Fire Support Model (TAFSM) and others to generate the appropriate environment. SMDBL has participated in exercises such as Roving Sands, Ulchi Focus Lens (UFL), Joint Project Optic Windmill (JPOW) and others to provide space and missile defense portrayal. All the pillars of Theater Missile Defense (TMD)- Active Defense, Attack Operations, Passive Defense, and the Battle Management-Command, Control, Communications, and Computers (BM/C4I)- are accurately portrayed.

Another part of the SBE is the interfaces used to link the simulations to the tactical workstations. For DIS simulations, the Tactical Simulation Interface Unit (TSIU) is utilized. The TSIU receives the Protocol Data Units (PDUs) from the DIS simulations and converts them into tactical message formats (TADIL B, USMTF, SCDL, etc.) that can be received at the tactical workstations for the soldiers to respond to. It is transparent to the soldier whether these are real or simulated messages and graphics.

The other interface is between two different models used in exercises. This tool is the Run Time Manager (RTM). This interface is between the Corps Battle Simulation (CBS) and EADSIM. This was developed to enhance the TMD portrayal in CBS using EADSIM. One-on-one missile defense engagements are simulated in EADSIM and the results are then put into CBS. This allows high fidelity TMD portrayal in a Corps level aggregate simulation.

To allow for transmission of data from one point to another, a system was developed called the Advanced Research Center Telecommunications Interface Console (ARCTIC). The ARCTIC is a multiplexer that allows the use of commercial phone lines to send and receive classified data. Cell phones can be utilized as well when a site is away from regular phone lines. The ARCTIC can provide VTC capability and includes data compression algorithms to pass data efficiently.

All of these tools were used when troops were deployed to Kuwait in April 1998. Soldiers from the US Army Air and Missile Defense Command (AAMDC) that were deployed to Kuwait received training at their workstations while the simulations were run from the SMDBL in Huntsville, Alabama.

WG 5 – OPERATIONAL CONTRIBUTION OF SPACE – AGENDA

Chair: Maj Dan Zalewski, OSD/PA&E
Co-Chair: Lt Michael Artelli, AFSAA/SAAS
Cochair: Maj Scott Fox, AFSAA/SAAS
Cochair: Mr Steve Friedman, Veridian, Veda Operations
Room: 343

Tuesday, 1030-1200
Space Operations Vehicle (SOV) Military Utility Analysis
Major Scott Fox, AFSAA/SAAS

Protecting the High Ground: Injecting Space Superiority into Modeling and Simulation
Capt James B. Clegern, USAF and Capt Jonathan W. Thompson, USAF, Space Warfare Center (SWC/AEWG)

ALTERNATE: Showing the Military Utility of a Space Maneuvering Vehicle in a Campaign Level Context
James R. Hunter, Capt, Charles Galbreath, Capt, Eric Frisco, Capt, SMC/XR, Systems Engineering & Integration Branch

Tuesday, 1330-1500
COMPOSITE GROUP B .... Thayer Hall, South Auditorium

Wednesday, 0830-1000
US Susceptibility to Foreign Weapons Aided by Satellite Navigation
Michael Artelli, 1Lt, AFSAA/SAAS

National Cruise Missile Defense
Mr. St. Clair Hultsman, NORAD-USSAPCECOM AN

Accurate and Adequate Representation of Space Systems in Modeling and Simulation
Mr Mark Fagan, Mr Robert Weber, Maj Eugene Yim, Capt Mark Powers, Lt Jawad Farooq, SMC/XR

ALTERNATE: Space Modeling and Simulation
Martin Solomon, AFSAA/SAAS

Wednesday, 1030-1200
Laser Clearinghouse
Lt Col David Vallado, Ms Cherie Gott, Mr Luther Briggs, NORAD-USSAPCECOM AN

A Multi-Command Integrated Investment Model
Capt Angela Giddings and Lt Heath Holtz, AFMC Office of Aerospace Studies (AFMC OAS/DRA)

Value Focused Thinking for Small Organizations
Allan R. Cassady, Maj, USAF, Air Force Space Battlelab

Wednesday, 1330-1500
Canadian Space Study
Mr. St. Clair Hultsman, Dr. Murray Dixson, NORAD-USSAPCECOM AN

Concept Design Center (CDC): Concurrent Concept Design and Analysis for Space
Captain Elizabeth Ward, USAF, Captain Allan Bartolome, USAF, Mr. Scott Gustafson, Aerospace Corp, Mr. Andrew Dawdy, Aerospace Corp, Dr. Lubo Jocic, Aerospace Corporation, SMC/XR

Quantifying the access of space assets to the tactical battlefield... An application of Pseudo-Optimal Scheduling Algorithms
Dr Urban H. D. Lynch, Boeing North American

ALTERNATE: The NORAD-USSPACECOM Communications System Simulation (NUCSS) Model of the Integrated Tactical Warning and Attack Assessment (ITW/AA) System
Dr Roy Mitchell, Dr David Finkleman, NORAD-USSAPCECOM AN

ALTERNATE: ATM/SONET Quality of Service Study for ITW/AA Mission Integrity
Dr Roy Mitchell, Dr David Finkleman, NORAD-USSAPCECOM AN

Thursday, 0830-1000
Joint Session with WG-11 .... Room 342

Thursday, 1030-1200
Space Based Infrared System (SBIRS)
Mr. Luther Briggs, Dr David Finkleman, Lt Col James Bloise, Ms Cherie Gott, NORAD-USSPACECOM AN

Need for Ground Based Ballistic Missile EWRs in the SBIRS Era
Capt David Denhard , Air Force Studies and Analysis, Space Superiority Branch (AFSAA/SAAS)

Analysis of Russian Early Warning Radars for Shared Early Warning Contributions
Ms Cherie Gott, Mr Kevin Baumgardner, NORAD-USSAPCECOM AN

Thursday, 1330-1500
Campaign Level Analysis of Space Based Laser Ancillary Missions
James R. Hunter, Capt, Charles Galbreath, Capt, SMC/XR, Systems Engineering & Integration Branch

An Acquisition and Launch Planning Method for Predicting the Functional Availability of Satellites to Meet User Requirements
Mr. William Justin Comstock, Welkin Associates, Ltd.

WG 5 – OPERATIONAL CONTRIBUTION OF SPACE – Abstracts

Tuesday, 1030-1200
Space Operations Vehicle (SOV) Military Utility Analysis

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Space has evolved into such a critical enabling element for our military force that "Joint Vision 2010" identifies space as the fourth medium of warfare. Our future space systems need to improve our ability to control space, meet launch-on-demand and operational responsiveness. The rapid response, quick turnaround and high maneuverability of the Space Operations Vehicle (SOV) system can answer these shortfalls by providing greater space asset protection and enabling US forces to achieve and maintain Space Superiority.

While this system has utility across the spectrum of space mission areas, this analysis looks at the contribution of the SOV system to Space Support and Space Force Applications missions. Specifically, we address the impact an SOV system, with aircraft-like turntimes and sortie rates, has supporting the time-critical spacelift requirements. The requirements are reflected in missions performed by the Space Maneuver Vehicle (SMV) as well as missions to replenish satellite constellations that provide key force enhancement in both peacetime and during a military campaign. We also assess the utility of the SOV system in its capacity to strike worldwide targets within minutes of launch using a Common Aero Vehicle (CAV). Finally, we look at the variations of basing strategies and force structures as they support all of the SOV missions.

Protecting the High Ground: Injecting Space Superiority into Modeling and Simulation

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Space superiority is a key feature of the Air Force Core Competencies. The proposed Space Operations Vehicle (SOV), Space Maneuvering Vehicle (SMV), and Common Aero Vehicle (CAV) are new systems requiring innovative methods to help achieve and keep Space superiority. This study explores some of the counter-space and space force projection implications of these systems using established wargame campaign models, simulations, and analysis (MS&A) tools. Our methodology will be to evaluate the SOV/SMV/CAV and build campaign model scenarios using current system characteristics, then compare campaign results with various numbers and types of weapons, plus various employment options.

The study will focus on two main areas:

1. The SOVs on-demand single-stage-to-orbit lift capability and orbital deployment, plus implications of the SOV/SMVs orbital maneuvering capability and specialized payloads.
2. Exploration of SOV/SMV/CAV employment options, vulnerabilities, and countermeasures for incorporation into current and New Vector Models and future wargame Space play.

As the Air Force evolves into a Space and Air Force, space will become the next battlefield to dominate and protect. By building highly accurate Space models and tactics today, we can smooth the entry of these systems into the future warfighting force.

ALTERNATE: Showing the Military Utility of a Space Maneuvering Vehicle in a Campaign Level Context

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Approved abstract unavailable at printing.

Tuesday, 1330-1500
COMPOSITE GROUP B .... Thayer Hall, South Auditorium

Wednesday, 0830-1000
US Susceptibility to Foreign Weapons Aided by Satellite Navigation

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Several countries are now producing satellite navigated weapons. This presentation identifies the impact of this emerging threat. The presentation focuses on Red capabilities against Blue targets, rather than the traditional Blue versus Red studies. These capabilities are based on the use of Global Positioning System (GPS) and Global Navigation Satellite System (GLONASS). We investigated the impact of removing GPS's Selective Availability (SA), as well as improving the signal through the use of differential processing.

We assessed the weapon capabilities against target classes, identified the targets at risk, and identified the effects of these targets at risk through theater-level modeling. Air-to-surface, cruise missiles, and theater ballistic missiles were investigated at various force mixtures to identify any synergistic effects when employed against US targets. Design of experiment techniques were used to vary the number and types of weapons available in the theater-level modeling.

National Cruise Missile Defense

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This study addresses the cruise missile threat to North America and evaluates current and future capabilities for National Cruise Missile Defense. The Modernization Analyses Report from the most recent Quadrennial Defense Review, and the FY99-03 Defense Planning Guidance, generated an action for the National Defense Panel (NDP), to direct the Ballistic Missile Defense Organization (BMDO) to address National Cruise Missile Defense and report results to the Under Secretary of Defense for Acquisition and Technology (USD(A&T)). The resulting study was led jointly by the BMDO Chief Architect/Engineer and NORAD J5.

To carry out the study, three panels were convened: threat, architecture, and operational concepts. The study focused on the most likely future threat – individual cruise missiles launched for ships or submarines. The Analyses Directorate (NORAD-USSPACECOM/AN) participated in overall study organization and on the architecture panel. A senior advisory group of retired Flag officers examined progress.

The study team conceived several technical alternatives for wide area surveillance. Potential approaches and architectures for defense against the cruise missile threat were formulated and evaluated. Several near term efforts were recommended, for example, exploiting maritime surveillance and monitoring capabilities. Potential synergisms between theater cruise missile defense and national cruise missile defense were considered. A briefing was presented to Gen Myers, USCINCSPACE and Lt Gen Lyles, BMDO Director, and a written summary of the study results was prepared for Dr Jacques Gansler, USD(A&T). Guidance is expected for follow-on work related to the ongoing review of the National Cruise Missile Defense (NCMD) study.

Currently, the analysis team, in conjunction with the NORAD staff, is continuing to seek out, postulate, and evaluate possible and affordable approaches for providing improved capabilities for national cruise missile defense for the near, intermediate and for term periods, respectively. For example, for the nearer term, we are considering defensive postures, including Joint, Multi-Command assets and operations, which might be formulated and employed for different specific threat scenarios, such as scenarios which include some degree of advanced warning on the impending threat. For an intermediate time period, we are investigating the possibilities and costs of national cruise missile defensive force structures which include surveillance systems employing high altitude endurable (HAE) unmanned aerial vehicles (UAVs) carrying radar and possibly other surveillance sensors. We're evaluating the potential of passive and multi-static radar technology relative to cruise missile defense. We're participating in the development of the feasibility study for a PACAF-initiated Cruise Missile Defense Joint Test & Evaluation proposal. We are watching for indications of potential future capabilities for national cruise missile defense form space-based surveillance systems such as space-based radar.

Accurate and Adequate Representation of Space Systems in Modeling and Simulation

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Proper representation of space systems and their effects in modeling and simulation is of great concern. As the DoD moves to simulation based acquisition, we must ensure that all systems are properly represented. This will allow decision makers to effectively perform trades between ground, sea, air, and space systems when determining future force structures.

Often in current models we find space is either misrepresented or not present at all. This leads to erroneous results such as insensitivity to space services or washing out the effects of ISR. Work is being done to add functionality with the hopes it will temporarily fix the problem until the next generation models come on line. There are, however, concerns about these models too. Thus it is difficult to quantify the utility of space systems and their diverse services.

We will first present what the contributions of space are to the warfighter. Next we discuss how space is represented today and how it will be in the future models under development to see how it matches up to the above contributions. Key areas of concern will be highlighted. Institutional problems and technical challenges that need to be resolved will be identified. We will finish with our recommendations and look forward to feedback from the audience.

ALTERNATE: Space Modeling and Simulation

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This briefing discusses the current capabilities and requirements of Space Modeling and Simulation (M&S). The M&S process is defined, and the benefits of M&S are explained. The Space M&S goal, challenges, current status, and roadmap are presented. The Air Force Studies and Analyses Agency's Space M&S mission, customers, uses, needs, measures and analyses are described. Space Integrated Product Team questions are enumerated.

<u>*Wednesday, 1030-1200*</u>
Laser Clearinghouse

Lt Col David Vallado, Ms Cherie Gott and Mr Luther Briggs
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This paper explores approaches to assure that high energy laser experiments do not damage satellites, to assist in implementing DoD instructions on high power laser illumination of satellites, and to contribute to forthcoming Tactical High Energy laser (THEL) tests. A Department of Defense Instruction (DODI) governing the use of terrestrial lasers that might illuminate the satellite background has been in coordination for over a year. The last draft partitioned responsibilities among laser owner/operators, satellite owner/operators, and USSPACECOM. Given satellite susceptibilities and laser characteristics USSPACECOM J3 and AM (this organization) are to determine intervals during which laser operations would not jeopardize satellites within the authority of the Command.

THEL tests establish many precedents. Existing Laser Clearinghouse (LCH) procedures and processes were developed for static irradiation. The combination of sky pointing against a moving object is a new experience. Analyses conducted with "static" LCH tools moved along potential target trajectories, including uncertainty in those trajectories, predicted few if any clear firing opportunities. The THEL project sought relief from USSPACECOM. In turn, this organization was commissioned to either confirm these predictions or to help develop alternative but confident analytical techniques that could recover reasonable firing opportunities. The problem also involves two aspects of testing: long-range planning, and actual test operation.

The convolution of target trajectory uncertainty, satellite state uncertainty which grows the farther in the future one predicts, and the characteristics of the laser beam leave few opportunities unless the analysis is conducted more insightfully.

During an actual test, the target will follow only one confined trajectory that will be known in near-real time. Individual satellite positions can be predicted very well during a short test interval. (Predicting what will happen a few minutes from now as opposed to weeks or months from now.) Therefore, the actual risk to any satellite system should intuitively be extremely small during a specific test.

We conducted several analyses. Using Satellite Toolkit (STK), we predicted how many satellites might be within the field of regard of the high energy laser at any given time. This number is a small fraction of the satellite sky. Using physically realistic target trajectories, AN studies showed there were frequent windows of opportunity sufficiently long for planned tests.

A Multi-Command Integrated Investment Model

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Both Air Combat Command (ACC) and Air Force Space Command (AFSPC) make decisions on which future weapons and support systems to purchase. Each command uses an analytical process with mathematical programming to recommend options by maximizing military utility subject to the command's projected yearly budgets. With today's reduced defense spending, ACC and AFSPC wish to merge this process across their commands. The AeroSpace Integrated Investment Study (ASIIS) proposes that mathematical programming can be utilized to appropriately reflect particular needs of both commands using integrated assessments for military utility, cost, and risk. We will highlight the issues of developing a mathematical programming approach for this large, complex problem.

Value Focused Thinking for Small Organizations

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The Air Force Space Battlelab experience proves rigorous decision analysis tools are practical for small organizations. Composed of less than 25 people with various operational experiences, the battlelab is effectively using Value Focused Thinking for improved decision making and resource allocation. The battlelab is dedicated to demonstrating the military utility of innovative ideas. These ideas are refined into low cost, rapid initiatives to demonstrate improvements to Air Force Competencies. The battlelab's legacy approach for decision-making lacked objectivity and traceability. The Air Force Space Battlelab adopted Value Focused Thinking to develop a decision support tool. To keep the model manageable for the battlelab, the model is simplified by combining core competency tasks with a bottom-up approach. This focuses the model on Air Force corporate values while maintaining ease of use. The scoring method also reduces complexity by comparing initiatives only to the mission area impacted. While limited to only twenty measures of merit, the model has effectively supported resource allocation and decision-making. Using the value model, two ongoing initiatives were eliminated and new initiatives are tailored to increase their value to the warfighter. Although the model is streamlined, scores remain consistent when initiatives are re-scored. The briefing includes a demonstration of an automated scoring system using an Access database. The methods used by the Space Battlelab can help other small organizations improve their decision-making.

Wednesday, 1330-1500
Canadian Space Study

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In January of 1996, the Center for Aerospace Analysis (NORAD/USSPACECOM AN) was asked by the Canadian Department of National Defence, Director General Operational Research (DGOR), through the Deputy Commander-in-Chief of North American Aerospace Defence Command (DCINC NORAD), to develop a quantitative assessment of the contribution to the Space Surveillance mission of hypothetical Canadian locations where state-of-the-art radar, optical, or other technological devices might be placed. We focused on radar and optical sensors. The study concluded that the best option, in all cases considered, is placement of two radars; one near the Canadian east coast and one near the Canadian west coast. With this configuration, all of Canadian space is under 24 hour surveillance. Another major conclusion was that ground-based optical sensors would be less desirable, mainly because weather conditions in Canada are not usually favorable.

Since the completion of this study, other options have arisen requiring analysis. In particular, the original study did not include any space-based sensor options. Those were originally thought to be too costly for Canada to consider but the cost has dropped by almost an order of magnitude. Also, small optical telescopes continue to generate interest because of their low cost, robust capabilities and easy availability. Because of their low cost, an extensive and fully automated network of telescopes is possible, and it is just such a network which, if distributed widely over Canada, would not only provide observations of great interest to the Space Surveillance Network (SSN), but could also overcome weather difficulties. The probabilities would be that at least some of the sensors would be available at any given time.

A follow-on study has therefore been initiated. A variety of possible options for a Canadian role in space surveillance will be considered, and U.S.-Canadian discussions are planned to identify the areas where a Canadian contribution would be most valuable. Planning for conducting the study commenced in November of 1998. The study will focus on the benefit of using optical sensors on space-based platforms and on the use of small optical telescopes to augment the SSN. The Space Based Visible payload on the Mid-Course Experiment Satellite (MSX) will be used as the model for a possible Canadian optical sensor. Relevant information will also be taken from the proposed Microvariability and Oscillations of Stars (MOST) satellite program, a Canadian science mission sponsored by the Canadian Space Agency. A complementary Canadian study of the RAVEN telescope is expected to accomplish most of the analysis goals for the small optical augmentation telescopes option, but other relevant analyses will be carried out using data from a variety of sources including U.S. Space Command personnel who have extensive experience in operating fully autonomous small telescopes for space surveillance purposes.

A draft outline of the study has been written, and an addition to the outline has also been is being written covering is the benefit to space surveillance of radars based in Western Canada. These specific sensors were not directly addressed in the original study. In parallel, further information is being collected on other possible uses for small optical telescopes, such as satellite imaging and astrometry. Further data is also being gathered on the capabilities of the Western Canada based radio telescopes in order to eventually assess their utility in a space surveillance mode.

Concept Design Center (CDC): Concurrent Concept Design and Analysis for Space

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The Space and Missile Center's Developmental Planning Directorate is charged with the daunting mission of influencing decisions governing space and planning the Air Force's future space systems. As such, we accomplish this mission by concentrating our efforts on key areas such as the integration of multiple space missions, air and space assets, and classified and unclassified programs. Ultimately, our mission is to analyze and evaluate current and proposed space systems and develop future space concepts addressing the Warfighter's needs.

We rely heavily on the CDC for concept design and analysis. The CDC consists of the synergistic interaction of team, process, and facility. The CDC employs a team of experts in fields such as utility, availability, cost, thermal, power, structure, propulsion, ground segment, software, and payload. These experts develop and bring their models to a facility equipped for concurrent engineering. In the presence of the customer, the CDC conducts rapid generation of consistent point designs in as short as three days. The real-time interaction between the customer and the experts allow for clearer communication and understanding which contributes to a better product. Furthermore, the reduction of the length of time to conduct a study has dramatically reduced costs.

The Integrated Navigation and Mobile Communication Architecture Study serves as a perfect example of how we develop concepts through the CDC. Dr. Lubo Jocic developed the NavComm concept as part of the Air Force's Modernization Process. In order to further define the concept, the CDC conducted a system-of-systems architecture study baselining 12 architectures to address the Air Force's projected communication and navigation needs. The results showed potential cost savings in the merger of the two missions but more importantly, it influenced the decision to proceed with GPS III. As a testament to our impact, GPS III is now called Global Multi-mission Service Platform (GMSP)

Quantifying the access of space assets to the tactical battelfield... An application of Pseudo-Optimal Scheduling Aalgorithms

Dr Urban H. D. Lynch, Boeing North American, SDC, Bldg-90, MS-SY-05, 2800 Westminster Blvd., Seal Beach, CA 90740
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The presence of tactical satellites (TACSATs) to the battlefield coupled with in-theater control by the theater CINC can provide the situational awareness to multiply tactical force effectiveness. How does one timely quantify the presence of a TACSAT constellation to the battlefield and the frequency with which tactical surveillance missions can be accomplished? This working group presentation provides an overview of two integrated models: Satellite Image Mission Scheduler (SIMS) and Communication Relay Scheduler (CRS). SIMS schedules TACSAT sensors to target areas of interest to meet specific mission surveillance needs. CRS schedules the communications links to get the collected data to ground. SIMS and CRS are hosted on personal computers and use pseudo-optimal scheduling algorithms to provide timely results for trade studies. Study results for a generic sample 24-satellite TACSAT constellation with a wide-area-search MTI sensor is presented as an example. Several tactical surveillance missions are analyzed along with sensitivity of results to satellite maneuver agility, sensor performance and single-many satellite CONOPS.

ALTERNATE: The NORAD-USSPACECOM Communications System Simulation (NUCSS) Model of the Intetrated Tactical Warning and Attack Assessment (ITW/AA) System

Dr Roy Mitchell and Dr David Finkleman, NORAD-USSAPCECOM AN, 250 South Peterson Blvd, # 116, Peterson AFB, CO 80914-3180
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The NORAD -USSPACECOM Analysis (NORAD-USSPACECOM/AN) group has, over the past few years, embarked on a modeling and simulation (M&S) strategy in order to provide timely input to the commands on current and future issues concerning the Integrated Tactical Warning and Attack Assessment (ITW/AA) network.

The NORAD-USSPAC8COM Communications System Simulation (NUCSS) is a high fidelity model of the current ITW/AA ballistic missile warning communications network. It can model the network under a variety of stress events such as link/node outages and degradation of the communication links. NUCSS, used in conjunction with other existing models that are maintained by other organizations, currently give NORAD/AN the capability to address a host of ITW/AA related problems. The simulation is mature enough to address these issues in the context of mission effectiveness.

This paper will discuss the results of the successful model validation efforts where the model results were compared to the results of three ITW/AA Technical Performance Evaluation (TPE) End-to-End tests for both the low and high threat message load scenarios. The utility of NUCSS will then be demonstrated by presenting a recently completed study. It investigates the effects of a commercial high speed media outage on the message traffic during these End-to-End test scenarios. Finally, the use of NUCSS in conjunction with other models, to address ITW/AA issues in the context of mission effectiveness, will be discussed. The discussion will include a presentation of the results of a comparison of the operators' perception of an attack to the ground truth of the threat scenario for the attack.

ALTERNATE: ATM/SONET Quality of Service Study for ITW/AA Mission Integrity

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The Defense Information Systems Agency (DISA) is changing the network long haul Defense Information Systems Network (DISN) to an ATM/SONET network. This raises the issue of how this change will affect the functioning of the ITW/AA network. Currently, the ITW/AA network relies on dedicated communication channels. Under the new plan, the dedicated, secure and jam resistant DSCS and MILSTAR back up circuits will remain unaffected. It is the Commercial High Speed (CHS) media component of the communications network that will be switched to ATM/SONET.

ATW/SONET allows efficient use of network resources. It can handle telephone services, video connections, imagery, data files, and messages. Data is transferred over virtual circuits (VC) in a fixed message size of 53 byte cells. This allows Time Division Multiplexing (TDM) which greatly simplifies message handling. Cell streams in different VC connections may be treated unequally in order to provide different Quality of Service (QoS) to the user. This service is defined by QoS parameters which determine message loss rate, the delay of data transfer, data security, and data reliability.Information transfer latency and loss are the major measures of ITWAA effectiveness.Critical ITWAA information must be passed reliably securely under all conditions.

In an ATM/SONET network, the service provider and the user enter a contract. The network guarantees a QoS and is responsible to verify that the traffic obeys its descriptors. The user assures that the traffic will obey specific bounds and is responsible for verifying that the QoS is acceptable. Unfortunately, due to the nature of ATM/SONET, time sensitive and mission critical ITW/AA messages will be competing for network resources with all other message traffic on the commercial network. It is therefore critical for NORAD/USSPACECOM to develop a strategy that will allow it, as a smart consumer of network resources, to specify the correct QoS parameters and pass these requirements to DISA prior to ATW/SONET service implementation.

This paper will describe the results of a collaborative effort between NORAD/USSPACECOM and DISA to determine QoS parameters that will ensure that the integrity of the ITW/AA communication network, the NORAD-USSPACECOM Communications System Simulation (NUCSS), and a DISA model of the ATM/SONET service.

NUCSS is a high fidelity model of the ITW/AA, ballistic missile warning communication network. It can model the network under a variety of stress events, such as link/node outages and degradation of the communication links under realistic threat scenario message traffic. Currently, the model supports the message traffic of the High and Low load threat scenarios of the Technical Performance Evaluation End-to End Test. NUCSS captures the Advanced Data Communication Control Procedure (ADCCP) protocol of the ITW/AA network. It is the only current and validated model of the ITW/AA communication network. The simulation is mature enough to be used with other models to address ITW/AA issues in the context of mission effectiveness.

DISA currently models the ATM/SONET using NETMAKER, which allows the rapid prototyping of a communications network using predefined commercially available components of ATM and SONET. In conjunction with NUCSS, the resolution of the issues surrounding the migration of the ITW/AA media to an ATM/SONET network can be addressed in order to ensure the integrity of the ITW/AA mission.

<u>*Thursday, 0830-1000*</u>
Joint Session with WG-11 .... Room 342

<u>*Thursday, 1030-1200*</u>
Space Based Infrared System (SBIRS)

Mr. Luther Briggs, Dr David Finkleman, Lt Col James Bloise and Ms Cherie Gott
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SBIRS is the next generation of military infrared space programs to be implemented in a phased approach as follow-on to the Defense Support Program (DSP) to counter the emerging threat.

The current DSP has been our strategic missile warning system for well over 20 years. While it remains a very capable system against ICBMs and SLBMs, its inherent design and 1970s technology is simply not suited for the growing numbers of diverse theater ballistic missiles. The main facet for this discussion will be SBIRS improvement to support theater missile defense efforts.

This paper describes the expected proliferation of missile types, increasing numbers of future theater ballistic missiles and the improvements which SBIRS will provide to counter these threats. These improvements include: smaller TBM launch point estimates and quicker reports to support Attack Operations, improved in-flight state-vector calculations to cue Active Defense systems, and greatly reduced impact predictions to support Force Protection efforts. This paper also shows how the SBIRS satellites will augment in-theater Radars as they support the theater warfighters.

Need for Ground Based Ballistic Missile EWRs in the SBIRS Era

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The Space-Based Infrared System (SBIRS) is a global satellite system designed to meet infrared space surveillance requirements starting in the 2004+ time frame. The SBIRS, at its full operational capability (FOC), will provide (among other capabilities) post-boost tracking of ballistic missiles and other threats. These tracking capabilities, for North American air space, currently reside only with the ground based early warning radar (EWR) sites. This paper/presentation addresses the need and role for the ground based EWR sites (BMEWS, PAVE PAWS, PARCS) once SBIRS reaches FOC. In addition to missile warning, the EWR sites support other missions such as space surveillance and future missions such as National Missile Defense (NMD). The paper/presentation also addresses the impact to these missions if the EWR sites are removed. This effort is sponsored by HQ AFSPC.

Analysis of Russian Early Warning Radars for Shared Early Warning Contributions

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The U.S. Government is considering sharing ballistic missile warning information with Russia. We have therefore initiated a study to evaluate the quality and timeliness of Russian ballistic missile warning based on current and emergent Russian Early Warning Radar System (REWRS) capabilities. Russian ballistic missile warning has historically encompassed both a highly elliptical orbit satellite constellation, an early warning radar system, and a robust defense of Moscow. The first phase of this study examined the contributions of the ground-based early warning radars. The REWRS has degraded since the end of the Cold War. The Anti-Ballistic Missile (ABM) Treaty of 1972 (and agreed statements and understandings of 1974) required early warning radars to be on the periphery of the country and pointed outwards. However, the country at that time was the Soviet Union, and the western and southern peripheries are now in other republics. Without regard to agreements for continued operations in independent republics, we looked at the current configuration of operational early-warning radars to assess broad capabilities. Using intelligence estimates for anticipated radar coverages, we also looked at improvements expected from future capabilities.

Thursday, 1330-1500
Campaign Level Analysis of Space Based Laser Ancillary Missions

James R. Hunter, Capt and Charles Galbreath, Capt
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Approved abstract unavailable at printing.

An Acquisition and Launch Planning Method for Predicting the Functional Availability of Satellites to Meet User Requirements

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In 1997 a panel convened by the Director of Central Intelligence to investigate satellite acquisition planning reported that Mean Mission Duration is not a sufficient estimator on which to base future satellite acquisitions and launches. The National Reconnaissance office was subsequently directed to develop new methods which 1) are based on intelligence value, 2) incorporate improved methods of estimating the useful life of satellites, and 3) are applied consistently across NRO programs.

The method presented herein models the expected useful life of a satellite as the product of its survivor function R(t), its duty cycle as a function of time, and its payload collection capability adjusted for the weighted value of user requirements. Time series of individual satellite functional availability scores are then rolled up into a composite constellation score that is used as the basis of future satellite acquisitions and launches.

WG 6 – C4ISR – Agenda

Chair: LTC Patrick Vye, Joint Staff J6, Technology and Architecture Division
Co-Chairs: Mr. Chris Chartier, OASD(C3I) Joint C4ISR Decision Support Center
LtCol Stephen Lisi, Joint Staff J6
Mr. Jon Grossman, RAND Corporation
Mr. John Furman, Mitre Corporation
Advisor: Mr. Dennis Mensh, Litton/PRC
Room: 336-Group A
Room: 338-Group B
Room: 340-Group C

Tuesday, 1030-1200
WORKING GROUP SESSION 1A .... **Room 336**

MTI/IMINT Fusion Study
Charles Taylor, OASD (C3I) Joint C4ISR Decision Support Center

Intelligence Collection Capability Analysis
Lt. Mike Rosenbaum, USAF ESC/DIS, Steve Topper, Teledyne Brown Engineering

Processing, Exploitation and Dissemination System (PEDS) Study
Major Bruce Bishop, Air Force Studies and Analyses Agency, AFSAA/SAAI

Tuesday, 1030-1200
WORKING GROUP SESSION 1B .... **Room 338**

Information Assurance for the Joint Theater Distribution System
Virginia Wiggins, OASD (C3I) Joint C4ISR Decision Support Center

Recommendations for Promoting the Interoperability Among C4ISR Architecture Databases (Subtitle: C4ISR Core Architecture Data Model Version 2.0)
Dr. Robert P. Walker, Institute for Defense Analyses

Quantifying the Military Worth of Information Operations (IO) Using THUNDER
Diane Neely, Capt USAF, Air Force Studies and Analysis Agency, AFSAA/SAAI

Tuesday, 1030-1200
WORKING GROUP SESSION 1C .... **Room 340**

US/UK Sensor-to-Shooter C4 Coalition Interoperability Study
LtCol Stephen Lisi, USAF, Joint Staff J6, Technology and Architecture Division

Modeling Alternative Coalition C4ISR Architectures
MAJ Ross Snare, Mr. Tim Bailey, TRADOC Analysis Center

Using Military Worth Analysis To Assess C4ISR Impacts On JV2010
Ollie Cathey, Joseph L. Spenneberg, SPARTA, Inc.

Tuesday, 1330-1500
COMPOSITE GROUP B .... **Thayer Hall, South Auditorium**

Wednesday, 830-1030
WORKING GROUP SESSION 3A .... **Room 336**

Sensor-to-Shooter (MOUT Communications) Study
LTC Patrick Vye, USA, Joint Staff J6, Technology and Architecture Division

GPS Joint Operational Battlefield Environment (JOBE) Joint Feasibility Study
George T. Cherolis, Dennis L. Lester, AFOTEC

ATM/SONET Quality of Service Study for ITW/AA Mission Integrity
Dr. Roy Mitchell, Dr. David Finkleman NORAD-USSPACECOM Directorate of Analysis

Wednesday, 830-1030
WORKING GROUP SESSION 3B .... **Room 338**

Strategic Effects of Airpower and Complex Adaptive Agents: An Initial Investigation
Maj. Thomas R. Tighe, USAF, Maj. Raymond Hill, USAF AFIT/ENS

A Better Way to Model Warfare for Analysis of Command and Control:Agent-based Modeling of War as a Complex Adaptive System (CAS)
Geoffrey Maron, Capt USAF, Air Force Studies and Analyses Agency

An Entropy Based Warfare Dynamic Model of Attrition and Command and Control
Dr. Ed Splitt, Mark Herman, Bill Thoet, Booz•Allen & Hamilton

Wednesday, 830-1030
WORKING GROUP SESSION 3C .... **Room 340**

The NORAD-USSPACECOM Communications System Simulation (NUCSS) Model of the Integrated Tactical Warning and Attack Assessment (ITW/AA) System
Dr. Roy Mitchell, Dr. David Finkleman, Mr. St. Clair Hultsman,, USSPACECOM, Mr. Craig Baer, BCSI Corporation

JWARS Communication Model Design
Greg Hawk (GRCI), James W. Jones, (CACI)

An Analysis of Command Decision Time Delays
Dr. Ralph S. Klingbeil, Naval Undersea Warfare Center Division Newport

Wednesday, 1030-1200
WORKING GROUP SESSION 4A .... **Room 336**

Sensor-to-Shooter (Battle Management) Study
Chris Chartier, Joint C4ISR Decision Support Center), LTC Patrick Vye, LtCol Stephen Lisi, Joint Staff, J6I

Concept Evaluation
Capt Wid D. Hall, Space and Systems Center, Los Angeles AFB

A Markov Modeling Approach for Situation Awareness
Bill Thoet, Booz•Allen & Hamilton

Wednesday, 1030-1200
WORKING GROUP SESSION 4B .... **Room 338**

Military Worth of ISR Methodology
Jim Barnes, Major USAF, Air Force Studies and Analyses Agency, AFSAA/SAAI

Multi-Intelligence Metrics for C4ISR Architecture Assessments
Arthur Dougas, SAIC

Multi-Int Assessment Methodology
Dave Gordon, Bill Thoet, Booz•Allen & Hamilton, LtCol Shehan, Joint Staff

Wednesday, 1030-1200
WORKING GROUP SESSION 4C .... **Room 340**

Reengineering the Process to Improve C4ISR Interoperability
Harold Powell, OASD (C3I) Joint C4ISR Decision Support Center

Interoperability Assessment Through Simulation
Ray Shellman

Go To War
James D. McMullin, Major, Department of the Army, Center for Army Analysis

Wednesday, 1330-1600
WORKING GROUP SESSION 5A .... **Room 336**

Participant/Experts' Interpretation of Experiment in Command and Control: The Use of After Action Reviews
Susan G. Hutchins, Susan Page Hocevar, William G. Kemple, Naval Postgraduate School

Technology-to-Tactics for Sensor-to-Shooter Networks: A Strategy-to-Tasks Approach
Gregory G. Hildebrandt, Naval Postgraduate School, Raymond E. Franck, Jr., Air Force Academy, Clifford R. Krieger, DRC

Alternative Architectures for Command and Control: Performance on Anticipated and Unanticipated Tasks
Susan Page Hocevar, William G. Kemple, David Kleinman, Gary Porter, Naval Postgraduate School

Wednesday, 1330-1600
WORKING GROUP SESSION 5B .... **Room 338**

Reengineering Battle Command for the Mounted Task Force
2LT Mark Allen, 2LT Brian Bagley, 2LT John Garcia, 2LT Alan Hammons, 2LT Marc Titler, 2LT Elliot Zimmer
United States Military Academy Department of Systems Engineering

Air-to-Ground Combat Identification Requirements Study Phase 1
Thomas Donohue and Paul Hylton, AFRL/SNZT

GLobal Architecture Combat Identification Effectiveness Tool
Thomas Donohue and Jon Wollam, AFRL/SNZT

Wednesday, 1330-1600
WORKING GROUP SESSION 5C .... **Room 340**

Speech Recognition
Eben A. Hughes, Major, USAF Command and Control Battlelab

Warfighter Gateway
Richard M. Nehls, Major, USAF Command and Control Battlelab

Collaborative Tools For The Joint Air Operations Center
Douglas L. Clark, Major, USAF Command and Control Battlelab

Thursday, 830-1030
WORKING GROUP SESSION 6A .... **Room 336**

Model and Simulation of Time Critical Targets with HLA Federations
Lt Michael Rosenbaum, USAF Electronic Systems Center, Elaine Baker, MITRE Corp, Steve Topper, Teledyne Brown Engineering

Stimulating the Army's C4ISR Networks with the Run Time Manager
William G. Tomlinson, Boozž Allen & Hamilton, 1525 Perimeter Pkwy, Suite 250

An Army Command and Control (C2) Federation Prototype
LTC Don Timian, Mike Hieb Ph.D., Jonathan Glass, and MAJ Mike Staver, Army Model and Simulation Office

Thursday, 830-1030
WORKING GROUP SESSION 6B .... **Room 338**

Behavioral Validation of Information-driven Combat Models
Mr Dorian Buitrago, Mr Robert Weber, The Aerospace Corporation

SIGINT Modeling: Quantifying Coverage Capability in a LP
Kenneth Cogan, George Teas, Adroit Systems Inc.

Target Characteristics in Collection Modeling
James F. Sculerati, MRJ Technology Solutions

<u>*Thursday, 830-1030*</u>
WORKING GROUP SESSION 6C .... Room 340

NETWARS
LTC Patrick Vye, USA, Joint Staff J6I

Accurate and Adequate Representation of Space Systems in Modeling and Simulation
Mr Mark Fagan, Mr Robert Weber, Maj Eugene Yim, Capt Mark Powers,, Lt Jawad Farooq, Capt Mark Powers, SMC/XR, LA AFB

An Overview of Sensor Representations in the Joint Warfare System (JWARS)
Dr. Mark Youngren, MITRE

<u>*Thursday, 1030-1200*</u>
WORKING GROUP SESSION 7A .... Room 336

A Focused Logistics C4ISR Operational Architectures Assessment Methodology.
Dr. Fairly Vanover, TRADOC Analysis Center (TRAC) Fort Lee

Advanced Planning for C4I Support to Warfighters
Keith Dean, OASD (C3I) Joint C4ISR Decision Support Center

Databases to Support C4ISR Analysis
Deborah Kelly, OASD(C3I) Joint C4ISR Decision Support Center

<u>*Thursday, 1030-1200*</u>
WORKING GROUP SESSION 7B .... Room 338

A High Level Model of Target Location, Movement, and Engagement
Dr. Richard Tepel, Mitre Corp.

Ground Target Tracking Modeling and Analysis
Keith Catanzano, Gerald Boxer, Bill Thoet, Booz•Allen & Hamilton

Measuring Network-Centric Warfare
Patrick Gorman, Randy Hayes, Booz•Allen & Hamilton

<u>*Thursday, 1030-1200*</u>
WORKING GROUP SESSION 7C .... Room 340

Supporting Task-Based Operational T&E through Commercial Software Tools
D. McGowen, S. Brown, R. Brunson, J. Thurston, AFOTEC, D. Mitta, A. Mykityshyn, Georgia Tech Research Institute

Strategies for Year 2000 (Y2K) Operational Evaluation of Command and Control Systems
Ms. Janet Forbes, Joint Interoperability Test Command, Ms. Kathleen Wigton, Dr. Ernest Montagne, TRW S&IT Group

Cause-And-Effect Experiments in Warfare Modeling and Simulation: C4ISR Impacts
C. Christopher Reed, Robert H. Weber, Dorian Buitrago, David Goldstein, Don Dichmann, and Patrick Lahey, The Aerospace Corporation

<u>*Thursday, 1330-1400*</u>
WORKING GROUP SESSION 8A .... Room 336

The Treatment of Time in Simulations
Dennis Mensh, PRC/Litton

Time as an Element in Distributed Simulations
Michael J. Leite, PRC/Litton

Common Threat Representations in Simulation, Analysis, and Testing of Integrated Ship Defense
Richard Reading, PRC/Litton

Thursday, 1330-1400
WORKING GROUP SESSION 8B .... **Room 338**

Analysis To Support NASA Consolidation
Christopher Thomas, Greg Roszyk, Booz•Allen & Hamilton

Using MTWS as a C2 Experimental Simulator
LT Joan M. Wollenbecker, Susan Hocevar, William Kemple, David Kleinman, Gary Porter, Naval Postgraduate School

Digitization in Campaign Modeling
Kurt A. Bodford

Thursday, 1330-1400
WORKING GROUP SESSION 8C .... **Room 340**

The Unit Order of Battle (UOB) Data Access Tool (DAT)
Mike Hopkins DMSO

Authoritative Data Sources (ADS)
Mike Hopkins DMSO

The Virtual Reality Command, Control, and Communications Network Battle Management Tool
John H. Brand, Ph.D., Army Research Laboratory
Kriss Preston, Ph.D., Mike Thurber, Rick Coleman, Ph.D., Quality Research, Inc

ALTERNATES

Analysis of Russian Early Warning Radars for Shared Early Warning Contributions
Ms. Cherie Gott, Mr. Kevin Baumgardner, NORAD-USSPACECOM

National Cruise Missile Defense
Mr. St. Clair Hultsman, NORAD-USSPACECOM

Laser Clearinghouse
Lt. Col. David Vallado, Ms. Cherie Gott, Mr. Luther Briggs, NORAD-USSPACECOM/ANS

Utility Curve Development
Capt Wid D. Hall, Space and Systems Center, Los Angeles AFB

JWARS Development Process
James Relyea, Fran Dougherty, Arthur Long, GRCI

WG 6 – C4ISR – ABSTRACTS

Tuesday, 1030-1200
WORKING GROUP SESSION 1A .... Thayer Hall, Room 336
MTI/IMINT Fusion Study

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The House Permanent Subcommittee on Intelligence (HPSCI) FY99 Authorization Bill tasked ASD (C3I) to conduct a study that reviews the impact of fused Moving Target Indicator (MTI) and Imagery Intelligence (IMINT). The hypothesis of the Committee is that such fusion will allow a decrease in the requirements for revisit by IMINT systems and at the same time improve overall situational awareness and battlefield effectiveness. This study addresses key issues that include:

- Does the planned investment program as characterized by the FY99 President's Budget adequately consider the synergies between Moving Target Indicator (MTI) Radar and Electro-Optical (EO)/Synthetic Aperture Radar (SAR) imaging systems?
- Would properly integrated MTI and imaging systems produce a more capable fielded system at a lower cost?
- Can investments in fusion and or exploitation reduce the requirement for IMINT?

This presentation will discuss a parametric analysis of the impact of fusion on IMINT revisit rate requirements and battle outcome metrics and provide a review of fusion technologies that are likely to be available in the near term.

Intelligence Collection Capability Analysis

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The Modeling, Simulation and Training Product Area Directorate (MST PAD) at the USAF Electronic Systems Center (ESC), Hanscom AFB, MA has conducted studies designed to influence decisions on requirements for Intelligence, Surveillance and Reconnaissance (ISR) technologies. Efforts have been coordinated through the ISR Technical Program Integrated Product Team (TPIPT), an organization with representatives from most major USAF acquisition and operational commands. This year's effort focused on developing analytical methodologies and employing those methodologies to examine Intelligence Collection Technologies supporting the ISR requirements generation process.

- Both the Surveillance and Reconnaissance Mission Area Plan (MAP) and the Space-based Force Enhancement MAP identified signal and imagery intelligence collection capability (i.e. SIGINT and IMINT) as an area where coverage is insufficient to meet the needs of Operational Forces and the National Command Authority. The MST PAD has developed methods to evaluate the operational value of high-payoff R&D technologies, promising SIGINT/IMINT concepts, and synergistic combinations of solutions.

The ISR study team at ESC developed an approach to determine SIGINT/IMINT collection requirements centered on development of an "ISR Object." Methods used include:

- Different object classes to account for diverse target types upon which SIGINT/IMINT collectors can gather information.
- Object Attributes to define the ability of an SIGINT/IMINT collectors to detect, locate, classify and identify a target.
- Object Attributes of ISR collectors to determine quality and coverage of a given system.

Missions are modeled in a generic scenario designed to provide realistic environmental, target location, and target densities. Using post-processing techniques, combinations of platforms and their attributes are assessed to determine which technologies provide optimum coverage. Results are presented to assist senior AF leaders make resource decisions and to solicit additional guidance for further "what if" analysis.

Processing, Exploitation and Dissemination System (PEDS) Study

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By themselves, most ISR sensors have little military worth. The true military worth is realized only after the data collected by a sensor is processed, exploited and disseminated to the decision makers when they need it.

Both the Air Force Surveillance and Reconnaissance Mission Area Plan and the HQ USAF Reconnaissance Roadmap recognize as a top priority the need to improve the Air Forcefs ability to process, exploit and disseminate intelligence. The AFSAA PEDS study is intended to provide analysis to help senior Air Force leadership decide how to make such improvements.

This MORSS briefing will present the modeling approach and findings of Phase I of that study, and describe the ongoing Phase II. Phase I used a commercial discrete event simulator called Extend to build a queuing model based on emphirical observations of how PEDS works today, and then ran various excursions to identify high payoff areas for PEDS improvements. The scope of that phase is today U-2 imagery collection and the associated ground PEDS support. The model uses an observed relationship between exploitation time and factors such as target complexity, analyst familiarity with the target, and analyst experience. Other independent variables included imagery arrival rates, number of workstations, procedures, and personnel policy. Phase II of the study will expand the scope to include all ground systems of Air Combat Commandfs Distributed Common Ground System.

Tuesday, 1030-1200
WORKING GROUP SESSION 1B .... Thayer Hall, Room 338

Information Assurance for the Joint Theater Distribution System

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The Joint Theater Distribution System relies on the unimpeded flow of information to ensure focused logistic support for US forces. As evidenced in numerous Government reports and FFRDC studies, today's combat support AIS are only marginally capable of supporting these requirements. Error rates of 30 to 40 percent in the information available to Joint Force Commanders are common. In addition, the timelines of information are questionable. Various studies have shown that logistics and combat support information, which typically are moved by low precedence procedures, are likely to be delayed or blocked under wartime surge conditions. The information infrastructure which supports the deployment of "CONUS based" forces is largely focused in the commercial segment and vulnerable to attack.

Focused logistics, Just In Time Delivery and Targeted Personnel mobilization are increasingly critical capabilities. The following issues require assessment from the viewpoint of a potential adversary.

- What are the key elements of the information infrastructure supporting the Joint Theater Distribution System?
- Will the system have the network capacity available for support?
- Which of these elements are most vulnerable to disruption or denial of information flow?
- What is the impact on combat operations if the Theater Distribution System is disrupted by information warfare?

Recommendations for Promoting the Interoperability Among C4ISR Architecture Databases (Subtitle: C4ISR Core Architecture Data Model Version 2.0)

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Based on data requirements from the DoD C4ISR Architecture Framework Version 2.0 and from numerous architecture initiatives of the Military Commands, Services, and Agencies derived from the Framework, the C4ISR Core Architecture Data Model (CADM) provides a specification of architecture data expected to be common among two or more DoD architecture developers. The CADM fully supports all the architecture products specified in Framework 2, including all of Appendix A of the Framework. The CADM supports additional architecture data requirements arising from Command, Service, and Agency architecture databases and data models. Part of the CADM has been extended to form the basis of a new Army Systems Architecture Database.

The CADM 2.0 promotes interoperability among C4ISR architecture databases as it is used for: (a) assisting in gaining consensus on and consistency of data used to express an architecture; (b) migrating existing architecture databases for integration, reuse, and data sharing when practical; (c) reviewing and comparing architectures; (d) assessing completeness of data underlying an architecture; (e) beginning data standardization for architecture data; and (f) providing a starting point for future architecture development.

Examples for the use of CADM 2.0 for the next (FY99) Army Systems Architecture Database will be presented, and electronic copies of the OSD report will be made available.

Quantifying the Military Worth of Information Operations (IO) Using THUNDER

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Military worth can be defined as the quantifiable effects of a system or its components on a military objective. Traditional uses of THUNDER have focused more on the simulationís target based (attrition) model to determine campaign outcomes and less on the effect of a system to influence military objectives. In this study we present an approach to move away from the traditional THUNDER attrition model (counting dead targets) and more towards meeting objectives through the application of Information Operations (IO) and determining their effects on a campaign. The first step in this process was to build a strategy to task hierarchy which defines national, military, and component objectives and traces them through tasks and targets. The second step was to model IO systems at the mission level. Results of mission level runs were than scripted into THUNDER to change the Red Commanderís awareness over time and the ability of his assets to communicate over time. The effect of these changes can be quantified and linked back to the objectives outlined in the strategy to task hierarchy thereby closing the military worth loop.

Tuesday, 1030-1200
WORKING GROUP SESSION 1C............ Thayer Hall, Room 340

US/UK Sensor-to-Shooter C4 Coalition Interoperability Study

LtCol Stephen Lisi, USAF
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This study began in September 1998 and will be completed in August 1999. The US Joint Staff Director for C4 Systems (J-6) and the UK Ministry of Defence Director General of Information and Communication Services agreed to conduct a collaborative study to examine C4 interoperability to support US/UK military operations. The study objectives are to share operations research methodology and to develop high pay-off C4 improvements to combined warfighting. The study is examining multinational fire support, maneuver, and interdiction.

Existing operational architectures and information exchange requirements have been captured for baseline comparison. Alternative development is being narrowed through application of several interoperability models, a queuing model and a business process model. Baseline and alternative architectures will be examined in several types of models (entity and campaign) in the US and the UK. Briefing will review method of developing C4ISR analysis of probable coalition operations at a JV 2010 operations tempo. Results will be briefed to senior UK and US decision-makers.

Modeling Alternative Coalition C4ISR Architectures

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TRAC (TRADOC Analysis Center) is conducting a US & UK Multinational C4 Systems Interoperability Study which involves modeling coalition C4ISR architectures. This coalition battle management study examines the effects, at a campaign level, of coalition C4ISR improvements. The coalition battle management system includes the hardware, software, personnel, and facilities used to coordinate, deconflict, and synchronize rapid targeting and attacks when multiple components have the capability to locate, identify, track, attack, and evaluate targets in overlapping areas of responsibility.

A Southwest Asia scenario is used in the simulation. The scenario enables modeling a deep battle with its associated sensors, shooters and targets. The scenario is joint and coalition in that it contains US Air Force, Army, Navy, and Marine elements and UK Royal Air Force, Army, and Navy elements.

The study examined joint battle management architectures. This presentation will discuss coalition and joint C4ISR modeling and simulation techniques and measures used and how the analysis supported decision makers.

Using Military Worth Analysis To Assess C4ISR Impacts On JV2010

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SPARTA, Inc.'s Military Worth Analysis (MWA) technique will enable the Joint C4ISR Decision Support Center (DSC) to determine the impact of C4ISR on JV2010, specifically, focused logistics. The MWA technique examines the impact of dissimilar systems at theater/JTF levels and determines the payoff of changes in theater warfighting concepts and systems in terms of MOPs/ MOEs and/or opportunity costs. The changes examined can be conceptual modifications of operating procedures for existing systems, technological improvements, and/or new systems, or new capabilities such as Total Asset Visibility. The underlying concept is that military operations cost money, take time, and result in friendly and enemy casualties. Systems or capabilities competing for resources are evaluated in terms of how these parameters are affected. For example, a proposed system may be more cost-effective than other similar systems, but if its utility, aggregated at a theater or JTF level, is low, (as measured in terms of how it impacts cost, duration, and casualties), it may increase the cost and duration of a conflict due to the opportunity costs associated with its in-theater deployment. MWA can be used to provide insights into the warfighting return on investment for proposed functions, capabilities, concepts, systems, or modifications. MWA's strength is in the ability to gain such insights rapidly and provide transparency to results and justification for any resulting recommendations, while avoiding unnecessary expenditures of time and money on more detailed analysis of ideas that, even if viable, do not render an economically or militarily feasible payoff to the warfighter.

Tuesday, 1330-1500
COMPOSITE GROUP B .... Thayer Hall, South Auditorium

Wednesday, 830-1030
WORKING GROUP SESSION 3A .... Thayer Hall, Room 336

Sensor-to-Shooter (MOUT Communications) Study

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This study was commissioned by the Joint Staff J6 and the ASD (C3I) Decision Support Center to support the Joint Staff J-8 Land and Littoral JWCA Team. REALCOM MOUT assessed current joint C4 capabilities and recommended C4 improvements to aid the joint warfighter in the complex, C4 stressing, urban environment. The 1997 Joint Warfighting Science and Technology Plan cites MOUT as one of the Joint Chiefs of Staff top ten Joint Warfighting Capability Objectives.

This presentation will discuss the methodology, (including a "proof of concept" for integrated communications modeling (OPNET) and conflict simulation(Joint Tactical Simulation)), and the results of the analysis. Included will be a discussion of the issue analysis, development of MOE's and MOP's, use of vignettes in the scenario, and the use of the models to capture warfighting benefits of alternative joint C4 architectures. Results are presented on the material alternatives that were considered and the final recommended improvements.

GPS Joint Operational Battlefield Environment (JOBE) Joint Feasibility Study

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The GPS JOBE JFS was directed by OSD Director, Test, Systems Engineering, and Evaluation (DTSE&E) to determine the necessity and feasibility of conducting the GPS JOBE JT&E. The fundamental purpose of the GPS JOBE JT&E is to shed light on effects of hostile GPS EW on Joint warfighter operations and identify ways to minimize mission impacts. Throughout the nomination and JFS phases, the Joint community expressed three major concerns that provided a basis for the problem statement and JT&E issues. Their expressed concerns were:

- What happens to warfighters and their support activities when GPS is denied or degraded?
- What can warfighters do to minimize operational risks in a GPS- denied/degraded environment?
- How can DOD reduce GPS EW vulnerabilities in future acquisition and integration efforts?

The GPS JOBE JFS problem statement is: Electronic Warfare vulnerabilities are the major shortfall of military GPS, the extent and impact of these vulnerabilities on joint operations are not known nor are the opportunities for mitigation well understood. The JT&E issues are:
Issue 1: To what extent are joint operations vulnerable to GPS EW with and without mitigation techniques?
Issue 2: How well do current and enhanced T&E processes identify GPS vulnerabilities.

The JT&E currently plans a set of three tests centered on the reconnaissance and interdiction missions. The test structure will progress from a relatively simple Test 1 to the more complex Test 3 over a three-year period. Parts of these tests will be field tests and others will use a combination of M&S and live systems.

This presentation will cover the background on the GPS JOBE JFS; the test design; and MOEs developed to evaluate the issues shown above.

ATM/SONET Quality of Service Study for ITW/AA Mission Integrity

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The Defense Information Systems Agency (DISA) is changing the network long haul Defense Information Systems Network (DISN) to an ATM/SONET network. This raises the issue of how this change will affect the functioning of the ITW/AA network. Currently, the ITW/AA network relies on dedicated communication channels. Under the new plan, the dedicated, secure and jam resistant DSCS and MILSTAR back up circuits will remain unaffected. It is the Commercial High Speed (CHS) media component of the communications network that will be switched to ATM/SONET.

ATM/SONET allows efficient use of network resources. It can handle telephone services, video connections, imagery, data files, and messages. Data is transferred over virtual circuits (VC) in a fixed message size of 53 byte cells. This allows Time Division Multiplexing (TDM) which greatly simplifies message handling. Cell streams in different VC connections may be treated unequally in order to provide different Quality of Service (QoS) to the user. This service is defined by QoS parameters which determine message loss rate, the delay of data transfer, data security, and data reliability. Information transfer latency and loss are the major measures of ITWAA effectiveness. Critical ITW/AA information must be passed reliably and securely under all conditions.

In an ATM/SONET network, the service provider and the user enter a contract. The network guarantees a QoS and is responsible to verify that the traffic obeys its descriptors. The user assures that the traffic will obey specific bounds and is responsible for verifying that the QoS is acceptable. Unfortunately, due to the nature of ATM/SONET, time sensitive and mission critical ITW/AA messages will be competing for network resources with all other message traffic on the commercial network. It is therefore critical for NORAD/USSPACECOM to develop a strategy that will allow it, as a smart consumer of network resources, to specify the correct QoS parameters and pass these requirements to DISA prior to ATM/SONET service implementation.

This paper will describe the results of a collaborative effort between NORAD/USSPACECOM and DISA to determine QoS parameters that will ensure that the integrity of the ITW/AA mission is preserved. This will involve an effort to federate an existing model of the ITW/AA communication network, the NORAD-USSPACECOM Communications System Simulation (NUCSS), and a DISA model of the ATM/SONET service.

NUCSS is a high fidelity model of the ITW/AA ballistic missile warning communication network. It can model the network under a variety of stress events such as link/node outages and degradation of the communication links under realistic threat scenario message traffic. Currently, the model supports the message traffic of the High and Low load threat scenarios of the Technical Performance Evaluation End-to-End Test. NUCSS captures the Advanced Data Communication Control Procedure (ADCCP) protocol of the ITW/AA network. It is the only current and validated model of the ITW/AA communications network. The simulation is mature enough to be used with other models to address ITW/AA issues in the context of mission effectiveness.

DISA currently models the ATM/SONET using NETMAKER, which allows the rapid prototyping of a communications network using predefined commercially available components of ATM and SONET. In conjunction with NUCSS, the resolution of the issues surrounding the migration of the ITW/AA CHS media to an ATM/SONET network can be addressed in order to ensure the integrity of the ITW/AA mission.

Wednesday, 830-1030
WORKING GROUP SESSION 3B.. Thayer Hall, Room 338

Strategic Effects of Airpower and Complex Adaptive Agents: An Initial Investigation

Maj. Thomas R. Tighe, USAF, Maj. Raymond Hill, USAF AFIT/ENS

US airpower theory and doctrine depend on the concept that the destruction of a few key targets or centers of gravity can unravel the enemy's physical ability to wage war or break his will to prosecute the war. This synergistic decimation of the enemy's effectiveness and resistance to our political will is known as Strategic Effects. These strategic effects are very difficult to quantify and are not directly accounted for in current DoD computer models. Since these computer models are used to aid with decisions about force structure and budget priorities, many believe that the Air Force's greatest potential contribution to modern joint warfare is going unrecognized and under financed.

This thesis explores military theory and current doctrine to define a method quantifying strategic effects. This method is based upon the Observe-Orient-Decide-Act (OODA) decision cycle. Next, current modeling techniques, and specifically the campaign level model, THUNDER, are examined for applicability to model strategic effects as defined. Finally, a proof of concept model is developed to study the advantage associated with OODA loop exploitation. This simple model uses Java-based, multi-threaded, autonomous, complex adaptive agents to demonstrate the non-linear (synergistic) results of OODA loop exploitation. These results are similar to the anticipated effects of strategic attack and provide a solid foothold from which the study and modeling of strategic effects can begin.

A Better Way to Model Warfare for Analysis of Command and Control:Agent-based Modeling of War as a Complex Adaptive System (CAS)

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Current combat models are inadequate for modeling strategic and non-linear effects. Most current models were constructed in a reductionist manner based on linear equations. This approach yielded attrition oriented models that do not capture the complexity inherent in warfare. While effects of many methods of warfare are inaccurately represented in attrition based models, methods dependent on non-linear effects suffer the greatest misrepresentation. The inaccurate representation of Marine forces prompted the Marine Corp into a pursuit of CAS modeling techniques for maneuver warfare. A recognized weakness in current campaign level models is the inability to represent the non-linear and strategic effects air power can have when applied to enemy centers of gravity. Air power brings more to a campaign that just the killing power of its' munitions, but with current models, air power is played as a weapon delivery system only.

The New Sciencesî of Complexity and Chaos provide a new framework with which to analyze systems. We propose to model war as a complex adaptive system with an agent-based model and investigate the force multiplying effects of C2. Agent-based models are intended to capture the complexity inherent in a system by capitalizing on simple primitives of the system. The primitives of a system are those system properties, components, and interactions that drive system behavior. Oftentimes, a relatively complicated system can be accurately represented with a collection of simple primitives. An accurate representation of war will allow the examination of non-linear and strategic effects. Agent-based models may increase our ability to analyze the effects of air power, information war, terrorism, C2 warfare, space power, nuclear weapons, and psychological operations (to name a few).

An Entropy Based Warfare Dynamic Model of Attrition and Command and Control,

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Approved abstract unavailable at printing.

Wednesday, 830-1030
WORKING GROUP SESSION 3C.. Thayer Hall, Room 340

The NORAD-USSPACECOM Communications System Simulation (NUCSS) Model of the Integrated Tactical Warning and Attack Assessment (ITW/AA) System

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The NORAD-USSPACECOM Analysis (NORAD-USSPACECOM /AN) group has, over the past few years, embarked on a modeling and simulation (M&S) strategy in order to provide timely input to the commands on current and future issues concerning the Integrated Tactical Warning and Attack Assessment (ITW/AA) network.

The NORAD-USSPACECOM Communications System Simulation (NUCSS) is a high fidelity model of the current ITW/AA ballistic missile warning communications network. It can model the network under a variety of stress events such as link/node outages and degradation of the communication links. NUCSS, used in conjunction with other existing models that are maintained by other organizations, currently give NORAD/AN the capability to address a host of ITW/AA related problems. The simulation is mature enough to address these issues in the context of mission effectiveness.

This paper will discuss the results of the successful model validation efforts where the model results were compared to the results of three ITW/AA Technical Performance Evaluation (TPE) End-to-End tests for both the low and high threat message load scenarios. The utility of NUCSS will then be demonstrated by presenting a recently completed study. It investigates the effects of a commercial high speed media outage on the message traffic during these End-to-End test scenarios. Finally, the use of NUCSS in conjunction with other models, to address ITW/AA issues in the context of mission effectiveness, will be discussed. The discussion will include a presentation of the results of a comparison of the operators' perception of an attack to the ground truth of the threat scenario for the attack.

JWARS Communication Model Design

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JWARS is a closed-form (no operator intervention) analytic simulation of join theater warfare that will eventually replace such models as TACWAR and MIDAS. Since JWARS potentially will be used will into the twenty-first century, it needs to allow the representation of yet unknown systems and capabilities. A flexible, data-driven communications modeling approach was devised to provide a framework to realistically model virtually any kind of communications system of the future. It supports any number of networks, any connectivity, and each network has its own performance characteristics. JWARS is interested in the effects such as time delay and non-delivery on critical messages. It allows the user to define the background message traffic load for each network, and the load varies with activity phases of the war.

JWARS is being developed using Object-Oriented Design (OOD) and programming techniques. Rumbaugh OOD methodology was used to define a JWARS communications model for implementation. Three model views were developed: 1) object, 2) functional, and 3) dynamic. Object view provides summary of communications model static entities and their relationships. Functional view provides overall process summary, with accompanying data and control flow interaction. Dynamic view provides temporal summary of object entity interaction, using processes defined in object API protocols.

Primary communications model entities (objects) include: 1) Battle Space Entity (BSE), 2) communications manager, 3) communications message, 4) communications architecture, 5) communications networks, and 6) communications annex. BSE is the basic JWARS representation entity. Each BSE incorporates a communications manager that interfaces with the JWARS communications architecture. The architecture manages one or more communications networks. The communications annex provides data to create communications entities, define activation profiles, and define communication relationships.

An Analysis of Command Decision Time Delays

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Time delay in making command decisions is an important aspect of combat operations and should be accounted for in operations analysis and modeling. Exercise data on decision time delays by Anti-Submarine Warfare Commanders (ASWC) were analyzed in order to estimate time delay statistics. The types of decisions appear to be categorizable into two groups: (1) recognitional and (2) analytical. The probability density functions of the time delays were analyzed and could be reasonably fit by a number of statistical distributions. Theoretical arguments are presented that suggest that the underlying decision making process can be described by an inverse gaussian distribution.

Wednesday, 1030-1200
WORKING GROUP SESSION 4A........ Thayer Hall, Room 336

Sensor-to-Shooter (Battle Management) Study

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The Sensor-to-Shooter (Battle Management) Study is the latest in a series of studies conducted by the Joint Staff (J6I) and OASD/C3I Joint C4ISR Decision Support Center (DSC) to help define the 2010 Joint C4 Architecture. This study evaluated potential C4 solutions to selected CINC joint battle management problems against time sensitive ground targets. Recommendations include the implementation of: (1) a correlated single source of near real time enemy target location and other track-oriented information for C2 nodes and shooters; (2) a timely Joint Task Force (JTF) common tactical picture disseminated down to brigade-level; and (3) joint automated weapon-target pairing capability for JTF and service battle management systems.

When compared with the currently programmed C4 architecture in joint vignettes, modeling results show that these recommendations increase joint speed of command, decrease the time latency of data associated with targets passed across service boundaries, and increase joint probability of hit in important cases. Modeling results in a Southwest Asia campaign show significant improvements in the efficiency of joint fires, the commonality and completeness of the tactical pictures shared by the services, and loss exchange ratio.

Since a significant portion of the study was discussed at last year's MORS Symposium, this presentation will address progress since then and highlight study recommendations in the broader context of the evolving 2010 C4 architecture.

Concept Evaluation

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Concepts are future weapons and supporting systems. The multi-mission model Systems Effectiveness Analysis Simulation (SEAS) was used to determine the impact of concepts in the halt phase of two scenarios set in the year 2016 – a SWA-N scenario and a scenario based on the Global Engagement 97 wargame. The impact of each concept was assessed by playing the concept plus baseline forces in the simulation and comparing attrition outputs such as allied aircraft lost, allied vehicles lost, enemy aircraft destroyed, and enemy vehicles destroyed to corresponding attrition outputs from the baseline. The baseline consisted of current and programmed systems in the US inventory. Combinations of concepts (concept architectures) were not evaluated. The concepts selected for evaluation were from the five Air Force Space Command (AFSPC) Technical Product Integrated Planning Teams that are currently active (Counterspace, Space Surveillance, Surveillance & Threat Warning, Satellite Operations, and Military Satellite Communications) and from the Space Force Applications mission area. All concepts from these six areas that were suitable for a combat model were evaluated. The results of the concept evaluation assisted AFSPC in prioritizing concepts and determining which mixture of concepts will have the greatest impact in combat.

A Markov Modeling Approach for Situation Awareness

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As the intelligence and operations community moves towards Joint Vision 2010, previous metrics for evaluating intelligence support must move from user satisfaction to battle space awareness. This paper will describe one such measure and an analytical model based on a finite state Markov model used to implement it. The Markov model implementation provides a multi-INT (SIGINT, IMINT, and MTI) computation that addresses target behavior, sensor performance, system latencies and cross cueing to estimate situation awareness accuracy and completeness metrics.

Wednesday, 1030-1200
WORKING GROUP SESSION 4B........ Thayer Hall, Room 338

Military Worth of ISR Methodology

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Senior civilian and military leadership must constantly make force structure acquisition decisions involving intelligence, surveillance, and reconnaissance systems. In the past these decisions were made based on coverage statistics such as points or area covered per day. The goal of this methodology is to demonstrate the military worth of intelligence, surveillance, and reconnaissance (ISR) information to the warfighter in terms of campaign outcomes rather than the traditional QQT measures.

Thus far the methodology has dealt with only one scenario in 2010 - SWA along with a redundant approach for campaign/mission analysis to lower risk: CFAM/EADSIM/Thunder. Coverage statistics from NAPA were fed into the above three models. NAPA is the NROís model for computing collection statistics. CFAM is a weapons optimizer that is used to help generate the ATO for EADSIM runs. Thunder is the campaign model that will be used to generate campaign measures of effect. The initial outputs of EADSIM are mission-level MOEs that can be use to show traceability from ISR to military MOEs. Then EADSIM will be used to refine a special type of probabilities of kill (Pk) to feed Thunder runs. This Pk is a conglomerate of probabilities to include weather, target acquisition, timeliness. This approach will provide the robustness of a campaign model, as well as traceability. That is, we'll have the ability to trace military worth effects back to ISR inputs so we can determine what a pound of ISR is worth to the warfighter.

Additionally, and potentially more exciting, this methodology can be used to reverse engineer ISR capabilities or architectures. Instead of starting with ISR collection and feeding the military worth model, we can determine a desired military effect and have the methodology back-in the ISR. The advantage of this approach is that the appropriate questions can now be answered. Relevant questions may include, What improvement(s) in ISR capability is(are) required to increase our ability to (some type of military worth outcomes)?î

Multi-Intelligence Metrics for C4ISR Architecture Assessments

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As Modeling and Simulation of complex C4ISR architectures progresses at breakneck speed, one aspect that is sometimes an afterthought is how to measure the utility of the elements being represented. This utility measurement is necessary for C4ISR systems to support development and exploration of better overall architectures but also to help the decision makers lead the C4ISR community into the 21st century.

While extensive work has been performed in hundreds of studies defining the measurement of utility of single intelligence sources, a well defined measurement of the value of multi-intelligence architectures has received limited attention. The desired condition of any future C4ISR study is to represent and examine a cohesive architecture, which includes the benefits from all sources of intelligence including IMINT, SIGINT, MASINT, and HUMINT. By 2010, all of these sources are necessary to maintain battlespace awareness and reflect the JV2010 desired goal of information superiority.

The intent of this presentation will be to provide some analytically based techniques for combining different sources of intelligence and measuring the utility against stated or objective military capabilities. Some areas that will be discussed include the measurement of Dominant Battlespace Awareness (DBA) and its meaning in a multi-INT environment, and the measurement of the value of all source fusion and relating capabilities to the real requirements of the warfighter. Finally, some proposed multi-INT Measures of Effectiveness (MOE's), Measures of Performance (MOP's) and challenges involved with using these metrics in an analysis will be discussed.

Multi-Int Assessment Methodology

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Past and current assessments of ISR end-to-end architectures have often been almost entirely focused on stovepipe metrics. In addition, many analysis efforts only address the ability of ISR systems to respond to specific tasking and not the overall satisfaction of the requester. With declining budgets and the need to evaluate system of system architectures, there is a growing requirement for multi-int assessments and corresponding metrics. This presentation will focus on evolving efforts in the intelligence community to address the multi-int challenge as well as a proposed methodology for use by the community. This methodology is based on understanding, evaluating, and allocating the community's essential elements of information (EEIs) to ISR sensors and then determining an architecture's ability to address these requirements. The resulting metrics, that can be traced back to the EEIs, measure a level of situation awareness in terms of accuracy, completeness and timeliness. This methodology will not only enable multi-int assessments, but also provide for meaningful analysis that measures the satisfaction of intelligence needs

Wednesday, 1030-1200
WORKING GROUP SESSION 4C.. Thayer Hall, Room 340

Reengineering the Process to Improve C4ISR Interoperability

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The Joint C4ISR Decision Support Center (DSC) 1998 Study Task 4 (DSC 98-4), "Reengineering the Process to Improve C4ISR Interoperability" was approved by the DSC Senior Steering Group - USD(A&T), VCJCS, and ASD(C3I) - on 27 Oct 97. This study had a twofold purpose: 1) to determine process flows and enforcement mechanisms that best ensure that interoperability considerations are substantively addressed early in the C4ISR systems requirements cycle, and 2) to provide ASD(C3I) and the Joint Staff recommended changes to current instructions and oversight processes to better achieve the attainment of Department of Defense interoperability goals.

To gain insight into the DoD interoperability processes, a case study of land warfare systems was conducted. A summary of the systems case study finds that the interoperability of current land warfare systems is degraded by incompatibilities in radio equipment, message formats and data elements. These systems shortfalls trace back to requirements and acquisition processes. The most critical process shortfall, which ripples throughout many other interoperability processes, is the lack of defined joint interoperability requirements. Impacts of this shortfall include lack of clearly defined interoperability evaluation criteria for program reviews and lack of outcome-based standards for interoperability certification testing.

The study is currently being briefed out to senior management and has produced the following draft recommendations: Develop and use Joint Information Exchange Requirements (JIERs) as measurable, enforceable, outcome-based interoperability requirements; USACOM, JBC, and Joint Staff establish JIER-based Joint interoperability requirements and Key Performance Parameters (in CRDs and ORDs (starting with MS 1); Include JIER compliance as part of interoperability exit criteria for program reviews; Direct DISA JITC to perform JIER-based interoperability configuration management; Designate ACOM, Joint Staff , and OSD offices in charge of interoperability; Revise appropriate Joint Staff and OSD documents to require use of JIERs and interoperability-associated Key Performance Parameters.

Interoperability Assessment Through Simulation

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With advancing technology and the proliferation of sophisticated threats, Theater Defense has become less the purview of large, monolithic forces, and more the responsibility of joint multi-national forces. A high degree of coordination of these forces is necessary for effective defense, but the cost/benefit of the various levels of interoperability both for joint forces and for multi-national forces must be determined before new systems are build or existing systems are retrofitted. A simulation tool that has been built to provide detailed analysis of interoperability is the Extended Air Defense Testbed (EADTB). This simulation models the physical behavior of sensors, threats, weapons, communications, and the environment in great detail. The operational behavior of systems is controlled through user-written rulesets that specify the BM/C2 from higher echelon down to shooter and sensor. Messages between systems are modeled in detail. The rules are written such that "sending' rulesets populate the contents of messages while the "receiving" rulests interpret the received messages and respond appropriately. The messages and response to messages, along with the rules for tactics and system control, define the BM/C2 that is to be modeled. EADTB is currently being used to analyze Joint Data Network (JDN) requirements. Preliminary analysis has resulted in recommended modifications to MilStd-6016 regarding the JDN messages for TBM defense. This paper describes how the architecture of EADTB supports interoperability analysis. It includes examples of rulesets and data available for detailed assessment of system performance. Demonstration and results of a notional scenario with interoperability excursions will be provided.

Go To War

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The Go To War study addresses the question of what happens when digital and analog forces are required to fight together in a campaign. The study was used to assist in determining what courses of action to consider during the fielding of the digital force in regard to prepositioned equipment and war fighting. The War Plans Division, Office of the Deputy Chief of Staff for Operations and Plans sponsored the study.

Specific issues the study considered were: (1) how preposition equipment plans should change to accommodate the digitized force; (2) what changes in war plans are required; and, (3) at what point in the campaign should a digitized corps fight together. The study considered the capability of the force with different numbers of digitally enhanced divisions. Force effectiveness was evaluated using analog divisions, digital divisions, and a mix of analog and digital divisions.

The Concepts Evaluation Model (CEM) was used to analyze the contribution of "Digitizing" the force. CEM was modified to allow modeling digital capabilities at the individual Division, Corps, or Army level. The capability to model information dominance and improved logistic capabilities were refined in CEM.

Wednesday, 1330-1600
WORKING GROUP SESSION 5A.......... Thayer Hall, Room 336

Participant/Experts' Interpretation of Experiment in Command and Control: The Use of After Action Reviews

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Adaptive Architectures for Command and Control (A2C2) is a multi-disciplinary, multi-year research effort designed to advance our understanding of the characteristics of effective organizations in the context of joint and coalition mission environments. One of the important features of the A2C2 research strategy is the aspect of "human-in-the-loop." This refers to the component of the research where predictions generated by pre-experimental models are tested in the laboratory simulation with human subjects. One of the benefits of the human-in-the-loop are the insights that participant/experts (junior military officers) contribute to the interpretation of model assumptions, extrapolating the organization designs and laboratory simulation to a "real" war-fighting environment, and offering constructive feedback to improve future simulation experiments. To obtain insights into how the experimental participants viewed the model-derived architectures, from a warfighter-user perspective, after action reviews (AARs) were conducted. Questions included topics such as difficulties encountered in completing the mission, successful versus unsuccessful strategies, adjustments or changes made during the scenario, adjustments or changes that should have been made during the scenario, the effect of the command structure on the team's ability to perform tasks, etc. The primary benefit of the analysis of these data is to capture the participant/experts' subjective evaluation of alternative organizational designs as well as their own individual and group performance. These findings enhance our understanding of the factors that contribute to effective outcomes and identify variables to be refined or added to future models.

Technology-to-Tactics for Sensor-to-Shooter Networks: A Strategy-to-Tasks Approach

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This analysis considers the relationship between a Joint Reconnaissance Strike Complex (JRUK) and constituent sensor-to-shooter networks that address specified Operational Situations (OPSITS). The strategy-to-task framework is used to understand how the technology of a sensor-to-shooter network is related to the tactical concept. Operational templates are developed for Precision Strike and Operational Maneuver from the Sea. Using the Joint Unified Task List (JUTL) and the Naval Tactical Task List (NTTL), these templates link mission, objectives, tasks and performance standards. There is a demonstration of how multiattribute utility function analysis can be used to evaluate mission success through the achievement of performance standards by force elements.

Alternative Architectures for Command and Control: Performance on Anticipated and Unanticipated Tasks

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This presentation will highlight some of the results of the most recent simulation experiment conducted by the Adaptive Architectures for Command and Control (A2C2) research team. It clarifies findings from previous experiments and further examines the role of coordination in performance. The experimental design involved ten teams in the execution of a simulated joint mission. Each team performed the simulation using two of three different command structures. The first research question posed is to evaluate the role of training and workload on performance. Analyses to address this use data generated by the Distributed Dynamic Decisionmaking III (DDD-III) software that runs the JTF simulation. The second focus of this study is on the role of coordination capability in adapting to uncertainty. The specific research question posed to address this issue is: When faced with the need to respond to an unanticipated, complex, task, does a structure that requires some inter-unit coordination provide a performance advantage over a structure that minimizes coordination by using a task-based design? Specifically, the effectiveness of the two organizational structures will be compared for specific simulation tasks that were not part of the defined mission (e.g., responding to "surprise" missile sites). Performance measures on these tasks will be analyzed to compare how effectively these two structures were able to adapt to unanticipated events.

Wednesday, 1330-1600
WORKING GROUP SESSION 5B .... Thayer Hall, Room 338

Reengineering Battle Command for the Mounted Task Force

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Abstract: Battle Command is the art of battle decision-making, leading and motivating soldiers and their organizations into action to accomplish missions at least cost to soldiers and to the nation. The dynamics of Battle Command are leadership, decision-making, information assimilation, visualization, conceptualization, and communication. Within this, an alternative battle command system uses digitization to improve the decision cycle in order to minimize the time from ìobserve to actî thus maximizing the lethality, survivability, and tempo of mounted operations. Under the alternative system, technologies such as teleconferencing, computer networking, automated databases, COA analysis tools and synchronization tools allow the task force to conduct preparatory activities more quickly and in parallel. The quality of the proposed system is equal to or greater than the current process, while time savings range from 6 to 13 hours. Finally, through Janus simulation, time savings of 6 to 13 hours provided improved lethality, survivability, and tempo for friendly forces. The models used to estimate these improvements can be updated and changed with the evolution of alternative battle command systems in order to predict both time savings and mission success.

Air-to-Ground Combat Identification Requirements Study Phase 1

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The Air Force Combat Identification Integration Management Team (CID†IMT) and HQ ACC/DRAI are sponsoring the Air to Ground (A/G) CID Requirements Study. Using a systematic approach, AFRL/SNZT will identify promising Air-to-Ground Combat Identification Architectures and their associated CID performance characteristics. These architectures wiil be both within and across mission areas. Key A/G CID issues will be studied in trade off analyses aimed at defining requirements for the CID Operational Requirements Document (ORD).

AFRL/SNZT will provide the study sponsors with analytical evidence of the relative ability of the selected SOS architectures to increase mission effectiveness. Key parameters will include ID System Characteristics, Fusion of Multiple ID Sources, Targeting, Aircraft Survival, Weapons Effects, Correlation of Off-Board Sources, Communication Networks, Operational Impacts, Environmental Factors, and Camouflage, Concealment and Deception (CCD). Current architectures being considered for study include:

- Enhancements to the Forward Air Controller (FAC)
- Onboard Interrogation and Reply (aka IFF)
- Onboard Non Cooperative Target Identification (NCTI).
- Offboard sources of ID
- Own ID broadcast systems

The Team will model these architectures all the A/G mission areas [Close Air Support (CAS), Suppression of Enemy Air Defenses (SEAD), Theater Missile Defense/Attack Operations (TMD/AO) and Battlefield Air Interdiction (BAI)] in a threat environment [e.g., Integrated Air Defense - Surface To Air Missiles (SAM), Anti-Aircraft Artillery (AAA), etc.]. Both friendly and hostile maneuvers, the effect of noncombatants on the battlefield, signal phenomena, environmental, and other significant parameters will be integrated into the scenarios.

GLobal Architecture Combat Identification Effectiveness Requirements (GLACIER) Tool

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The constructive and deterministic GLobal Architecture Combat Identification Effectiveness Requirements (GLACIER) tool V1.0 was created to support the AFRL Air to Ground (A/G) CID Requirements Study being sponsored by The Air Force Combat Identification Integration Management Team (CID†IMT) and HQ ACC/DRAI. GLACIER determines operational effectiveness of a sensor system-of-systems within the mission areas of Suppression of Enemy Air Defense (SEAD), Attack Operations (AO), Close Air Support (CAS) and Interdiction. It determines the expected number of desired and undesired (friend or foe) target kills based upon probability of target identification, sensor fusion, and probability of destruction. Sensor characteristics, operational doctrine and rules of engagement, architecture features, and mission area features are considerations accounted for in the tool.

A GLACIER run consists of a fixed-wing delivery aircraft loaded with air-to-ground weapons and an accompanying sensor suite flying a scripted route toward a fixed target set. The sensor suites may consist of visual, procedural, interrogation and reply (IFF), Non-Cooperative Target Identification (NCTI), or target identification broadcast. His on-board sensors are fused with information from off-board nodes such as a forward air controller (FAC), a Rivet-Joint surveillance aircraft, an unmanned airborne vehicle (UAV), a ground station which receives information from any of the above or from a spaceborne system, or any other target identification source. Correlation is considered perfect at this time. The weapon's circular error probable (CEP) at target is then determined from the relative targeting accuracy (RTA) of these combined sensors. The probability of target destruction is found via a Joint Munitions Effectiveness Manual (JMEM) look-up. Fixed-wing attrition is also input and used in determining the probability aircraft reaching its weapon release point.

Wednesday, 1330-1600
WORKING GROUP SESSION 5C.. Thayer Hall, Room 340

Speech Recognition

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The United States Air Force has been interested in speech recognition technology since the early eighties. This interest was spurred by the steady escalation of aircraft cockpit complexity and increased demand on the pilot to stay ìheads-up and ìeyes out.î The capability to enter data and commands verbally to the aircraft computers promised considerable manual workload reduction.

Since the early eighties, rapid improvement in microcomputer technology has enhanced recognition algorithms and hardware. The added robustness of the resulting recognition systems indicate that the technology has matured sufficiently to consider not only aircraft applications, but also applications in other highly task oriented and complex environments, such as the Joint Air Operations Center (JAOC).

Speech recognition technology may be effective in supporting JAOC planning and execution tasks. Speech recognition technologies can allow the warfighter to complete his tasking to develop the Air Tasking Order (ATO) faster, more intuitively and naturally, and with fewer constraints. With speech recognition capabilities the user could navigate through menus quicker, and fill-in data fields by speaking to the computer with or without the use of a mouse, keyboard, or light pen. Benefits will result through reduced operator workload and training.

Warfighter Gateway

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The United States Air Force will arrive at the 21st Century as an Expeditionary Aerospace Force (EAF) embracing the Air Expeditionary Force (AEF) concept as its vehicle for presentation of forces to a theater Commander-in-Chief (CINC). AEF assets will require a reliable C2 gateway to maintain connectivity with the Joint Force Air Component Commander (JFACC) command elements for dissemination of common situational awareness, threat information, and updated guidance while enroute to their theater of operations. Airborne AEF connectivity and reach back capabilities are presently either extremely limited or in most cases non-existent for the initial forces arriving in theater. Furthermore, existing fighter aircraft datalinks are limited to Line Of Sight (LOS) transmission while actual operations often require access to Beyond Line Of Sight (BLOS) information. No gateway link presently exists between SATCOM broadcast information (Tactical Related Application (TRAP)/Tactical Data Dissemination System (TDDS), Tactical Information Broadcast System (TIBS), and Global Broadcast System (GBS)) and fighter aircraft and ground force datalinks (Link 16, Improved Data Modem (IDM), and Situational Awareness Data Link (SADL). The planned divestiture of the Airborne Battlefield Command and Control Center (ABCCC) aircraft further complicates the C2 issue by creating an interim deficiency in BLOS communications relay for aircraft in direct support of ground forces. The purpose of this combined Initiative is to determine the operational utility of an airborne gateway capable of disseminating both retargeting and situational awareness information directly to cockpit displays of Link 16, IDM, or SADL equipped AEF aircraft.

Collaborative Tools For The Joint Air Operations Center

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The United States Air Force (USAF) has embraced the concept of a reduced forward presence during contingencies through distributed operations and the expeditionary air force concept. The USAF Command and Control Battlelab (C2B) has identified collaborative tools (CT) in the Joint Air Operations Center (JAOC) as an innovation that will enhance the efficiency and effectiveness of JAOC processes

To effectively meet the study goals the C2B conducted research to identify available collaborative tool capabilities. Once identified, CT capabilities were demonstrated to warfighter subject matter experts from Numbered Air Forces, Air Operations Groups, Army, Navy, and Marines to determine what collaborative tools and capabilities are required. The CT concept was assessed by warfighters during Expeditionary Force Experiment 1998 in a distributed JAOC environment.

In general terms warfighters require a collaborative capability that is powerful, fast, easy to use, and intuitive to learn. Several basic collaborative capabilities/tools were identified as essential. The standard computer embedded collaborative tools suite needed to support the JAOC warfighter include: video, audio, chat, whiteboard, video/audio broadcast, scrolling bulletins, shared applications, web tools, and virtual environments. Study revealed the keystone for implementation of collaborative tools is robust, redundant, and reliable communications connectivity with adequate bandwidth for rapid data exchange.

Collaborative tools must be fully DII COE compliant and interoperable with command and control systems architecture from the GCCS level down. While no single product meets all warfighter collaborative needs, the most capable GOTS/COTS product (or combination thereof) providing the closest approximation of warfighter requirements should be implemented.

Thursday, 830-1030

WORKING GROUP SESSION 6A .... Thayer Hall, Room 336

Model and Simulation of Time Critical Targets with HLA Federations

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The Model, Simulation and Training Product Area Directorate of the USAF Electronic Systems Center participated in the first *analytic* High Level Architecture (HLA) model confederation to examine sensor-to-shooter operations during prosecution of time critical targets. The Trailblazer Federation is a collection of Service-based simulations interoperating via HLA. The goal of this project was to provide experience and lessons learned applying HLA to simulation-based analysis of information superiority concepts. The federation was developed to experiment with the *future* execution of the Joint Suppression of Enemy Air Defenses (JSEAD) mission area.

Initial efforts focused on determining which federates would model specific JSEAD mission processes. Quickly, it became apparent that integration issues such as aggregate representation of model entities, doctrinal issues such as allocation of operational fires, and tactical issues such as process architecture and weaponeering/ targeteering, had to be resolved to build the federation and conduct useful analysis. By following a structured federation development (FEDEP) process, we created an environment where both federation development and military worth analysis of command and control doctrine/architectures provides useful insight to the acquisition and operational warfighting professions.

Simulation outcomes are dependent on both federation mechanization and the range of behaviors that can occur between hostile and friendly forces. Experimental results provide a clear view of how to model sensor-to-shooter processes against time critical targets. In addition, metrics needed to evaluate macro and micro-level command and control system requirements and their relationship to combat outcomes become apparent. This briefing will outline the development processes and address model results.

Stimulating the Army's C4ISR Networks with the Run Time Manager

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The current Run Time Manager (RTM) concept focuses on linking a simulated C4ISR network with a live C4ISR network instead of stimulating individual systems. The RTM was utilized during the III Corps and embedded 4ID Warfigher Exercise at Fort Hood, Texas in December 1998 using the Corps Battle Simulation (CBS) Version 1.5.4.1. The RTM C4ISR effort is being developed and funded by the National Simulation Center at Fort Leavenworth, Kansas with the cooperation of the Space & Missile Defense Battle Lab (SMDBL) in Huntsville, Alabama for the continued development of the Air and Missile Defense functionality.

This briefing begins with a brief history of the RTM followed by an introduction to the Army Battle Command System touching on the requirement for stimulation and introducing simulations as an integral piece of this effort. Next a C4ISR stimulation conceptual approach will be discussed followed by the Run Time Manager (RTM) initial concepts and technical approach for fielding. During the III Corps WFX the C4ISR network was the Armyís Tactical Command and Control System (ATCCS) tactical network. The RTM stimulated the Maneuver Control System (MCS), the All Source Analysis System (ASAS), the Field Artillery Tactical Data Systems (FATDS) which included the AFATDS, IFSAS and FDS systems, Combat Service Support Combat Systems (CSSCS), the Air and Missile Defense Workstation (AMDWS), Air Defense System Integrator (ADSI) and Forward Area Air Defense Command, Control and Intelligence (FAADC2I) systems.

The remainder of the briefing will address the implementation of the RTM during the III Corps WFX followed by a discussion of future efforts. Initially the RTM began as the Run Time Gatewayís one way interface with the Corps Battle Simulation which was introduced during Prairie Warrior í96 to provide a more realistic representation of TMD operations for both Army and Joint training and mission planning and rehearsals. Later it evolved into a two-way linkage called the Run Time Manager. When the Run Time Manager was linked with the Corps Battle Simulation version 1.5.4.1 and the Extended Air Defense Simulation, the entire simulation is referred to as the Corps Battle Simulation Air and Missile Defense Version 1.5.4.1. As part of the Corps Battle Simulation the Air and Missile Defense functionality simulates the firing, attrition and adjudication of all high altitude and medium altitude radar aimed Air Defense Artillery against fixed wing aircraft, cruise missiles, and tactical ballistic missiles with a two-way link to the Corps Battle Simulation. When the RTM effort was expanded to focus on linking a simulated C4ISR network with a live C4ISR network, the RTM performing the Air and Missile Defense was renamed the Air and Missile Defense Interface (AMDI) to avoid confusion with the RTM being developed to do the C4ISR stimulation.

An Army Command and Control (C2) Federation Prototype

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Over the last six years a "cottage industry" has grown-up around the Army's need for Modeling and Simulation (M&S) Command, Control, Communications, Computers, and Intelligence (C4I) interfaces to link "Live" C4I systems to simulations. As one would expect, almost all of these interfaces have been developed as "add-ons" to link specific legacy simulations to specific C4I systems and typically handle a small subset of the messages or data necessary for interoperability.

With the development the High Level Architecture (HLA) for all Department of Defense (DoD) simulations, the mandate that all DoD C4I systems be Defense Information Infrastructure (DII) Common Operating Environment (COE) compliant, and the requirement that the Warfighter Simulation (WARSIM) 2000, One Semi-Automated Forces (OneSAF), and the Close Combat Tactical Trainer (CCTT) be capable of interfacing to Army Battle Command Systems, the Army has a unique opportunity to build and define - using both the HLA and select DII COE components - a common M&S C4I interface standard.

This paper will describe 1) an M&S C4I interface Technical Reference Model (TRM) and 2) a pair of prototype HLA/DII COE compliant C4I interfaces that Project Manager (PM), WARSIM and the National Simulation Center (NSC)/Training and Doctrine Command Analysis Center (TRAC), together with the Defense Modeling and Simulation Office (DMSO), the U.S. Army Office of the Director of Information Systems for Command, Control, Communications, and Computers (ODISC4), and the Army Model and Simulation Office (AMSO), are developing.

Thursday, 830-1030
WORKING GROUP SESSION 6B.. Thayer Hall, Room 338

Behavioral Validation of Information-driven Combat Models

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The validation question takes on a different focus for combat models used to explore relative utility of various weapons, sensors, information networks and tactics for the 2010 planning horizon. Reference to empirical data from test ranges or live combat simulation is not meaningful for future combat scenarios involving weapons and sensors which have not yet been developed and tactical doctrine which is still hypothetical. Comparison to other models or intelligence sources is likewise infeasible given that the state of research of combat phenomena from an information perspective is in its infancy and DoD models have just begun to address C4ISR variables.

This study follows a bottom-up theoretical approach based on C.J. Ancker's two axioms of combat presented in "A Proposed Foundation for a Theory of Combat" in the MORS "Warfare Modeling" handbook and other published work on salvo fire engagement. We use a Markov process approach to compare the results for engagements of both homogeneous and heterogeneous units of sensors and shooters with the outcomes of the same engagements as simulated by a time step, object-oriented Monte Carlo combat model which explicitly plays the effects of C4ISR.

SIGINT Modeling: Quantifying Coverage Capability in a LP

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The Sensor Platform Allocation Model (SPAM) is a MIP that optimizes platform/sensor allocation to target coverage requirement goals. This approach was been used successfully in defining IMINT capability in several AF studies. As a phenomenology, SIGINT is difficult to quantify both from a requirement and a sensor capability perspective. This presentation builds upon the MTI methodology added to SPAM and presented at last years MORSS. The methodology looks at the ISR issue from: 1) a sensor availability and the effect of multi-mode/multi-INT sensor/platforms, and 2) the temporal aspect where the probability of detection is proportionate to the access of a given area. Complicating the issue is varying concepts of operation for the sensor/receiver as well as modeling target behavior. The mathematical construct presented in this paper was developed to facilitate explicit modeling of SIGINT sensors and requirements from an ISR perspective, and provide a framework for discussion about relevant MOEs for SIGINT coverage.

Key to this approach was decoupling the sensor coverage capability from the actual detections (a function of target and receiver behavior). This produces a sensor coverage factor. The sensor coverage factor then represents an upper bound on the probability of detection, i.e., the sensor must be available to have an opportunity to detect SIGINT targets. The sensor coverage factor accounts for not only the area coverage per unit time, but also the frequency coverage capability.

Starting with engineering measures of performance between receiver and transmitter, platform-specific measures of effectiveness were developed for each SIGINT sensor modeled. Obtaining quantifiable SIGINT requirements has proven much more vexing. Several approaches to implementing SIGINT requirements have been applied using the modeling construct presented here.

Target Characteristics in Collection Modeling

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ISR modeling has logically tended to focus on reproducing the collection process to determine collection architecture performance. However, most of these methods treat collection as the end event, either assuming automatic success against all targets within the collection footprint, or treating success as a probabilistic event based on collector characteristics only, ignoring target characteristics and behavior.

An approach combining collection and target characteristics promises to better integrate ISR collection into airpower modeling. Algorithms describe target deployment, movement and emissions for target classes consisting of battlespace entities with similar characteristics. Applied to collection results from the Sensor-Platform Allocation Model (SPAM), this methodology shows target behavior has a considerable effect on collection success. By mapping these target classes to object types within the Conventional Forces Analysis Model (CFAM), we may also realistically assess the contribution of imagery collection to targeting and application of airpower. Future efforts will include capturing the effects of area imagery collection and integration of SIGINT and MASINT characteristics in conjunction with development of these capabilities in SPAM.

Thursday, 830-1030
WORKING GROUP SESSION 6C.. Thayer Hall, Room 340

NETWARS

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This presentation will discuss the development and capabilities of a Joint network-modeling tool called the Network Warfare Simulation or NETWARS. NETWARS was originally conceived as a Joint communications modeling tool, but the scope expanded to meet Service communications modeling requirements. A Joint and Service technical working group has been meeting weekly since March 1997. A Joint Mission Needs Statement (MNS) was written and signed by the VDJS in July 1997 in conjunction with the Services and OSD. The first production version of this model will be available in late fall, 1999.

NETWARS is a communications model that consists of a front-end tool set designed to reduce the time needed to conduct communications analyses. The front-end tool set will prepare input to the simulation engine and process the results of the analysis. The back-end tool set consists of commercial off-the-shelf (COTS) simulation engine called OPNET (Optimized Network Engineering Tools) used to process the scenario data input via the front end.

The Military Communications Electronics Board (MCEB) endorsed: NETWARS as a Joint and Service communications modeling tool; level-of-effort to build Service/DISA specific communications modules and IERs; Services and DISA long-term commitment to NETWARS.

Accurate and Adequate Representation of Space Systems in Modeling and Simulation

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Proper representation of space systems and their effects in modeling and simulation is of great concern. As the DoD moves to simulation based acquisition, we must ensure that all systems are properly represented. This will allow decision makers to effectively perform trades between ground, sea, air, and space systems when determining future force structures.

Often in current models we find space is either misrepresented or not present at all. This leads to erroneous results such as insensitivity to space services or washing out the effects of ISR. Work is being done to add functionality with the hopes it will temporarily fix the problem until the next generation models come on line. There are, however, concerns about these models too. Thus it is difficult to quantify the utility of space systems and their diverse services.

We will first present what the contributions of space are to the warfighter. Next we discuss how space is represented today and how it will be in the future models under development to see how it matches up to the above contributions. Key areas of concern will be highlighted. Institutional problems and technical challenges that need to be resolved will be identified. We will finish with our recommendations and look forward to feedback from the audience.

An Overview of Sensor Representations in the Joint Warfare System (JWARS)

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The Joint Warfare System has developed a canonical set of sensor representations that simulate the activities of all types of sensors that operate as part of a comprehensive C4ISR architecture. The design of these abstractions is intended to ensure that analysts can achieve insight into the contributions that different types and quantities of sensors have to the outcome of military campaigns. This presentation provides an overview of the JWARS sensor design concepts. The current status of the implementation is discussed.

Thursday, 1030-1200
WORKING GROUP SESSION 7A.. Thayer Hall, Room 336

A Focused Logistics C4ISR Operational Architectures Assessment Methodology.

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This presentation offers a methodology for assessing the adequacy of Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) Operational Architectures for supporting the Joint Vision 2010 Focused Logistics Operational Concept. The methodology will: 1) synthesize literature to define the six tenets of Focused Logistics; 2) describe the Focused Logistics C4ISR Operational Architectures that support the tenets; 3) identify major problem related to each tenet; 4) compare the interrelationship among these problem; 5) determine the frequency of the interrelationships; 6) quantify the relative importance of these problems; 7) identify the most important problem areas; 8) stratify the problems in terms of related missions and functions; 9) define and weight potential problem solutions; and 10) evaluate and rank the value of the solutions. The six tenets of Focused Logistics are: Joint Deployment/Rapid Distribution; Multinational Logistics; Information Fusion; Agile Infrastructure; Joint Logistics Command and Control; and Joint Health Services Support. The solutions will be in terms of doctrine, organization, training, materiel, leadership, and people. Problems will be identified from literature and Subject Matter Experts. The Excel Spreadsheet and Statistical Package for Social Sciences (SPSS) will be used for a statistical Analysis. The Expert Choice Decision Support System will be used for evaluating and ranking alternative solutions. The results are expected to show the solutions which provide the most value per capital investment.

Advanced Planning for C4I Support to Warfighters

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In order to achieve the goals set forth in Joint Vision 2010, military systems will be more dependent than ever on each other to achieve information superiority in the systems-of-systems environment. In order to achieve this mode of operation, programs must articulate C4I support requirements, dependencies and shortfalls early-on in the acquisition process. Once stated, C4I support requirements can be planned for and used to assess impacts and resolve issues before systems are designed, built, tested and fielded.

This paper focuses on how C4I support plans are used to achieve information superiority. The paper will discuss cross-program analysis, interoperability certification, bandwidth sufficiency determination, intelligence supportability, as well as issue identification and resolution. The paper will also propose metrics by which to track the benefit of the C4I support plan initiative throughout the department.

Databases to Support C4ISR Analysis

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In order to meet its tasking from the USD(A&T), ASD(C3I), and VCJCS to improve the quality of C4ISR analysis and reduce redundancy, the Joint C4ISR Decision Support Center has developed a set of linked databases with detailed records on planned, on-going, and completed C4ISR-related studies and assessments, modeling and simulation tools, and points of contact. This capability is now mature. It contains records on nearly 200 studies and assessments and over 100 M&S tools. While the registered user community is quite broad, MORSS is an excellent opportunity to acquaint more analysts and decision makers with this useful capability.

It is proposed to make a presentation on this capability to WG 6 (C4ISR) and to any others that might be interested. Depending upon time and facilities, a quick demonstration of the databases could be integrated into this presentation. We also propose to set up a demonstration of the databases in the vicinity of meeting rooms for these working groups. This would require a table, about a 6x8 foot space, and the audio-visual requirements noted above.

Thursday, 1030-1200

WORKING GROUP SESSION 7B .... Thayer Hall, Room 338

A High Level Model of Target Location, Movement, and Engagement

Dr. Richard Tepel

Abstract unavailable at time of printing.

Ground Target Tracking Modeling and Analysis

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Maintaining a continuous track on a moving ground target creates incredible demands on intelligence resources. This analysis explores improvements to ground movement target tracking efficiency which would alleviate some demands on the intelligence system. Modeling tracking based on intelligent awareness of target movement characteristics, terrain constraints and the background "confuser" density provides an analytical basis for minimizing the uncertainty associated with end-to-end tracking.

The core of the analysis is a state transition model, which characterizes target transition within a Markov chain. The target states are Tracked-In the Open, Tracked-In the Shadows, and Confused. The tracked states are indexed by the last time the target was detected. The Markov models provide stop-start detentions, which fused with IMINT preplanned and cued looks, maintain a probabilistic end-to-end track analysis. As the time since the last detection grows the number of confuser-targets within the uncertainty area also grows. The accuracy and completeness of the track require a minimal uncertainty associated with each revisit. Characterizing vehicle behavior on highways, rural roads, mountain roads and off-road provides insight into minimizing uncertainty associated with the vehicle's probabilistic location. The analysis incorporates travel characteristics such as variable velocity, potential highway exits, traffic delays, stop signs at intersections, and expanding travel paths on a road grid to challenge the end-to-end tracking ability. Analyzing ground target tracking with intelligent awareness of the target behavior illustrates the potential to improve significantly the tracking efficiency by reducing uncertainty.

Measuring Network-Centric Warfare

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Network-centric warfare suggests that by fighting as a network, we can dramatically increase our combat effectiveness beyond that level obtained by fighting as a collection of individual platforms. An inter-woven system of sensors, information, and engagement grids will enable concepts like "speed of command," and "self-synchronization" and dramatically alter the way in which we conduct warfare. The key for measuring Network-Centric Warfare with the family of modeling tools that are available today lies in capturing the effects of space and time. Analysis must focus on information commonality and velocity, and measuring the resulting operational impact through system effects. To do this, business process re-engineering models must be used to quantify activities with associated latencies. Every step in the end-to-end combat process (e.g., precision engagements, maneuver executions) must be de-composed into human decision-making events, information processing events, computer operator time, message building and transmit time, and network loading queues based upon throughput and bandwidth availability. In addition, we use OPNET to measure the impact of radio wave propagation and network architectures on information completeness, timeliness and accuracy. Whenever information is passed around the battlespace for command and control, battle management, or engagement, electromagnetic propagation is involved at some level. OPNET enables a detailed analysis of wave propagation, multi-path fading, multiplexing techniques, wave attenuation, free-space loss, etc.

Thursday, 1030-1200
WORKING GROUP SESSION 7C........ Thayer Hall, Room 340

Supporting Task-Based Operational T&E through Commercial Software Tools

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A task-based operational test and evaluation (OT&E) process currently being implemented by the Air Force Operational Test and Evaluation Center (AFOTEC) requires a focus on the tasks performed by users of the system under test. In evaluating the system's operational effectiveness, testers will assess the contribution of that system to mission accomplishment. One means of understanding how the system might impact mission accomplishment is to establish the relationships between tasks and mission. The primary objective of this presentation is to describe how task-based OT&E6as it is implemented on C4I systems6might be supported by commercially available software tools. This work identified a set of tools to support task-based OT&E. In order to identify a meaningful set of tools, we derived a set of tool requirements. These requirements, derived from data reflecting how task-based OT&E had been applied across a sample of nine C4I systems, encompassed general ("visionary") needs of operational testers, as well as their more immediate (short-term) needs. A total of 80 tool requirements (14 general requirements and 66 short-term requirements) were derived. The 66 short-term requirements were further categorized according to six functional areas: Communication, Guidance and Training, Reference Documentation, Planning, Analysis, and Test Reporting. Results of our analysis identified commercially available tools that could address planning and analysis requirements. Tools supporting requirements engineering and management activities, the collection of task analysis data, and visual modeling and simulation activities were identified. Tool evaluations determined the extent to which this tool set satisfied general, planning, and analysis requirements derived from our review of C4I systems. The results of such evaluations allowed us to distinguish between tools and provide recommendations for tool selection.

Strategies for Year 2000 (Y2K) Operational Evaluation of Command and Control Systems

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The Joint Interoperability Test Command (JITC) is the operational test agency for the Global Command and Control System (GCCS). We have developed a unique methodology for applying DoD Y2K Management Plan guidance in an operational evaluation.

GCCS is the DoD command and control system of record and is operational at over 600 sites worldwide. The size, complexity, and sensitive nature of this system present significant challenges to the Y2K tester. To meet these challenges, we are conducting a comprehensive test program composed of these building blocks:

- Application testing
- System testing in the laboratory
- Field testing with test scripts
- Field testing with operational scenarios.

The advantage of this building block approach is to start small and apply lessons learned in subsequent tests.

Our methodology for each building block encompasses these features:

Baseline tests. Determine performance in the current time frame.
Y2K tests. Determine performance across selected Y2K critical dates (e.g., Jan 1, 2000, and Feb 29, 2000).

The test program addresses these critical GCCS functional areas:

Situational awareness (common operational picture, missile warning, etc.) Force planning (deliberate and crises action planning)
Office automation and messaging (word processing, email, etc.).

In keeping with the operational nature of the field tests, we decomposed each functional area into activities, functions, and mission tasks. The principal measure of performance is mission task success, which supported two critical operational issues: performance and interoperability.

This paper will discuss our unique test methodology and lessons learned that apply to other Y2K testing efforts.

Cause-And-Effect Experiments in Warfare Modeling and Simulation: C4ISR Impacts

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Two of the major challenges in assessing the sensitivity of combat outcomes to space system performance are (a) capturing sufficient cause-and-effect fidelity, and (b) making the cause-and-effect linkage between inputs and outputs understandable and believable. The purpose of the present work is the development of an experimental testbed for warfare modeling that will drive the necessary cause-and-effect insights needed for campaign simulation upgrades. This is a quick-reaction, rapid prototyping capability that allows modelers to test and experiment with various methods of modeling fundamental cause-and-effect mechanisms needed for warfare modeling. Some of the main features of this experimental capability are:

(1) The primary segments of the cause-and-effect chain, i.e., (a) Scenario, Environment; (b) Surveillance Architecture; (c) Communications; (d) Data Processing, Fusion, and Exploitation; (e) Strategy, Tactics, Doctrine; (f) Concept of Operations; (g) Combat Attrition; (h) Logistics:

(2) Representation of decision processes by means of autonomous agent technology;

(3) Simultaneous propagation of both continuous activities (e.g., motion through space and time) and discrete events (such as sensor updates, report arrivals, or target engagement/disengagement);

(4) Stochastic, nonlinear models as appropriate;

(5) An underlying conceptual structure that facilitates clarity and simplicity in modeling;

(6) Ease of experimentation and model changes.

As part of this activity, we are investigating ways of modeling the decision processes involved in strategy and tactics. Our current emphasis is on the principles of preemption, dislocation, and disruption identified in Leonhard's "The Art of Maneuver", together with methods of approximate reasoning (i.e., fuzzy logic). Results from on-going experiments will be presented.

Thursday, 1330-1400

WORKING GROUP SESSION 8A .... Thayer Hall, Room 336

The Treatment of Time in Simulations

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As BMC4I Models and Simulations (M&S) become more and more complex in their representation of System Operational and Functional requirements, the modelers and analysts need to examine system behavior as a function of time. To be effective, M&S programming languages must handle the following timing functions with minimum effort:

- Time: a timing mechanism must be provided for the modeler to introduce time delays into the model and to record simulated time.
- Events: the model will deal with continuous time of a real system, but for the sake of the economy of instructions the model timing will change only when there is a significant change in the state of the system.

Most models and simulations operate with event time being a multiple of clock time. Also, in a Distributed Interactive Simulation (DIS) environment, it becomes necessary to model and simulate real-time, near real-time, and non-real time BMC4I event processes simultaneously. This paper examines the:

- timing requirements for BMC4I simulation programs;
- ensures that the BMC4I event processes are completed in ht correct order;
- the results of the BMC4I system performance measurements reflect the BMC4I operational/functional system performance requirements expected in the field.

Time as an Element in Distributed Simulations

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This paper discusses the impact of facility separation, data rates, data protocols and computer processing criteria upon simulation performance as a function of time. As participating units in simulations becocme geographically separated at distances greater than those bounding the real (physical) operating area, time becomes a limiting factor in the prosecution of the test events. This is further exacerbated by increased data rates and the use of "real-time" data processing algorithms. The relationships between clock time and event/exercise time are examined. Alternatives for mitigating data senescence, transmission delays and protocol limitations are proposed.

Common Threat Representations in Simulation, Analysis, and Testing of Integrated Ship Defense

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The Navy's Program Executive Office, Theater Surface Combatants has applied the High Level Architecture to create an engineering-level simulation Federation for Integrated Ship Defense (ISD). The Federation includes both tactical combat system code-in-the-loop and high fidelity physics-based models, in a network-distributed environment. For the first time, it achieves full fidelity detect-to-engage ISD simulation integrating both hardkill and electronic warfare (EW) elements.

A crucial component of the ISD Federation is the use of threat anti-ship cruise missile representations seen commonly by all ISD elements. Threat behavior is reactive to the operational environment imposed by the set of all the ISD simulations. This establishes a single, continuous battle timeline and is the lynchpin of integrated hardkill/EW engagement. For example, during defensive missile fly-out, the missile sees the trajectory changes caused by ship signature fluctuations or electronic countermeasures. The ability to quantify the synergistic impact of multiple ship defense elements grants new access to problem domains (e.g., performance assessment, tactics development) and complex scenarios that were previously unattainable. Interactions with battle group and joint theater operational simulations (e.g. EADSIM) are more tenable.

Use of common threat representation permists efficient scenario reconfiguration, to allow insertion of any: full fidelity threat models, conceptual threat models, test target models, or direct playback of test data. Thus, a direct interchange can be made between operational and test scenarios, and live fire test data can be interwoven with engineering simulation. This closes the loop around the design/development, operational testing, and training communities, and builds in the ability to perform effective validation of ISD simulation results.

Thursday, 1330-1400
WORKING GROUP SESSION 8B .... Thayer Hall, Room 338

Analysis To Support Nasa Consolidation

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Approved abstract unavailable at printing.

Using MTWS as a C2 Experimental Simulator

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The Adaptive Architectures for Command and Control (A2C2) project uses a "design-model-test-model" framework that includes three-tiers of "human-in-the-loop" experiments at the Naval Postgraduate School (NPS), associated with different levels of research.
Four tier 1 experiments have been conducted to date, all employing the DDD-III, a highly abstract simulator, well suited to basic research, that offers excellent experimental control and on-line data collection. But, the research is also branching into the more applied arena, which involves tier 2 experiments. The Marine Corps' MTWS has been installed in the NPS Systems Technology Battle Lab as the tier 2 simulator.
To aid transition to MTWS, the fifth experiment, conducted during February and March 1999, reexamined the research of experiment four, which focused on the willingness of JTF decision-makers to change organizational structure. Experiment five examined whether the DDD-III results could be replicated on MTWS, the similarities and differences in experimental control possible and the feasibility of collecting the same or similar measures. It also examined factors that should be considered when selecting the experimental driver when the research question does not clearly favor one over another. To facilitate comparison, MTWS was played as abstractly as it reasonably could be. Experiment five also examined the effects of trained operators between the decision-makers and the simulator and whether increased "jointness" at lower levels in a JTF allows fewer C2 nodes without adversely affecting performance.

Digitization in Campaign Modeling

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Over the past several years, analysts at the Center for Army Analysis (CAA)O have worked to analyze the force enablers of "Digitizing" the force. The analysts have enhanced the suite of campaign models available to replicate the enablers of digitization. The Combat Sample Generator (COSAGE), Concepts Evaluation Model (CEM), and TACWAR are used to evalute combat capabilities.

Modeling digitization has evolved through several studies: Campaign XXI, Breaking the Phalanx. Division Redesign, and Go To War. Information dominance, and the related logistic enhancement are the key capabilities modeled in COASAGE and CEM. `he functions replicated allowed the modeling of digital capabilities at the individual Division, Corps, or Army level.

The enhancements added to CAA modeling have provided useful insights about the capabilities of digital forces, and the capabilities of a mix of analog and digital forces.

Thursday, 1330-1400
WORKING GROUP SESSION 8C .... Thayer Hall, Room 340

The Unit Order of Battle (UOB) Data Access Tool (DAT)

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The Unit Order of Battle (UOB) Data Access Tool (DAT) project is sponsored by the DMSO Data Engineering program. UOB DAT provides simulation developers with consistent and authoritative order of battle information.

UOB DAT consists of three main components, a data interchange format (UOB-DIF), a library of UOB data sources, and a data extraction tool (UOB-DAT). The interchange format presents unit order of battle information from all library sources in a single understandable format based on standards in the DDDS. The data access tool features a graphical interface that allows users to browse order of battle data and select individual units. Selected units form a task force that can be used to start a simulation exercise. The tool supports organizing the reporting hierarchy of the task force, including adding specific or generic units. Further, users can "roll up" subordinate units into a parent unit, which is important for simulations that operate at aggregation levels above the basic unit.

Authoritative Data Sources (ADS)

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The Authoritative Data Source (ADS) Project sponsored by the Defense Modeling and Simulation Office (DMSO) directly supports the Department of Defense (DoD) Modeling & Simulation (M&S) Master Plan (DoDD 5000.59P). The project specifically supports the M&S Master Plan goal to provide authoritative representations of the environment, systems, and human behavior in a shared/reusable format. The objective of the ADS project is to catalog all of the data sources within DoD that can be used to support Modeling and Simulation. The intent is to use the catalog to expedite the search process that occurs with each M&S development and/or implementation event. DMSO established an Authoritative Data Source Working Group in 1994. The working group defined the terminology commonly associated with the project and developed a taxonomy of 13 top level and 373 sub-categories by which to catalog the sources. The effort to identify, catalog and designate M&S began in April 1996 and has to date collected a standard set of metadata for each of 1061 sources. The metadata, intended to expedite the knowledge acquisition phase of either model development or application, is available today on the Modeling and Simulation Resource Repository (MSRR) **http://ads.msrr.dmso.mil/.** The library supports a very robust key word or category search capability and a number of reports can be obtained from the database. DMSO is coordinating with DoD Data Administration Office at the Defense Information Systems Agency (DISA) to expand the ADS catalog across DoD, not just M&S.

The Virtual Reality Command, Control, and Communications Network Battle Management Tool

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The ARL has developed, under a Phase II Small Business Innovative Research (SBIR) program, a virtual reality software tool that enhances the situational awareness of a combat network battle manager. The tool, nicknamed Situation Awareness Virtual Environment for C3 (SAVEC3), allows a network manager to respond to battle conditions and physical and electronic attacks on the net, as well as enhancing the ability to plan signal operations by representing the results of simulations of network traffic and enemy actions. The tool is modular in construction, and allows generation and/or display of information from several sources simultaneously. In its present form the tool shows the information gathered by the Integrated System Control (ISYSCON) from the operations of a Mobile Subscriber Equipment (MSE) Packet Network, superimposed on a three-dimensional terrain background, along with signal and supported unit locations and combat overlays (battle maps). In this way real battle signal events are reported in the context of the total battle. Operators can respond in context and signal planners can use the network simulation capability provided by the GTE Multi-Switch Simulation to plan connectivity and quality of service as the battle develops, signal assets are destroyed, enemy responses occur, and supported units move.

The software has been developed using the MSE as the development environment, but is not limited in application to legacy networks. The SAVEC3 package has been demonstrated linked to an MSE network through the ISYSCON and the GTE Multi-Switch Simulation. The package has also been demonstrated as a server for C3 network information for the ARL very high resolution VR software, the Virtual Geographic Information System (VGIS). The SAVEC3 package will be demonstrated during Prairie Warrior 99, as an adjunct to the ISYSCON. During the exercise the terrain visualization capability will be used by signal planners and by the ISYSCON operator to conduct and to plan signal operations.

The SAVEC3 tool gives the operator or planner the capability to monitor the events in a net in a global sense as well as, simultaneously, examine specific areas of the net such as the functioning of an individual node. This "drill down" capability is being extended into the operation of individual machines. That is, the goal is to allow the operator to visualize in three dimensions, in real time, the file space and process space of a machine that may have been penetrated or compromised with malicious code. A statistical analysis package has also been developed which can be invoked to monitor network events quantitatively.

ALTERNATES

Analysis of Russian Early Warning Radars for Shared Early Warning Contributions

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The U. S. Government is considering sharing ballistic missile warning information with Russia. We have therefore initiated a study to evaluate the quality and timeliness of Russian ballistic missile warning based on current and emergent Russian Early Warning Radar System (REWRS) capabilities. Russian ballistic missile warning has historically encompassed both a highly elliptical orbit satellite constellation, an early warning radar system, and a robust defense of Moscow. The first phase of this study examined the contributions of the ground-based early warning radars. The REWRS has degraded since the end of the Cold War. The Anti-Ballistic Missile (ABM) Treaty of 1972 (and agreed statements and understandings of 1974) required early warning radars to be on the periphery of the country and pointed outwards. However, the country at that time was the Soviet Union, and the western and southern peripheries are now in other independent republics. Without regard to agreements for continued operations in independent republics, we looked at the current configuration of operational early-warning radars to assess broad capabilities. Using intelligence estimates for anticipated radar coverages, we also looked at improvements expected from future capabilities.

National Cruise Missile Defense

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This study addresses the cruise missile threat to North America and evaluates current and future capabilities for National Cruise Missile Defense. The Modernization Analyses Report from the most recent Quadrennial Defense Review, and the FY99-03 Defense Planning Guidance, generated an action for The National Defense Panel (NDP), to direct the Ballistic Missile Defense Organization (BMDO) to address National Cruise Missile Defense and report results to the Under Secretary of Defense for Acquisition and Technology (USD(A&T)). The resulting study was led jointly by the BMDO Chief Architect/Engineer and NORAD J5.

To carry out the study, three study panels were convened: threat, architecture, and operational concepts. The study focused on the most likely future threat - individual cruise missiles launched from ships or submarines. The Analysis Directorate (NORAD-USSPACECOM/AN) participated in overall study organization and on the architecture panel. A senior advisory group of retired Flag officers examined progress.

The study team conceived several technical alternatives for wide area surveillance. Potential approaches and architectures for defense against the cruise missile threat were formulated and evaluated. Several near term efforts were recommended, for example, exploiting maritime surveillance and monitoring capabilities. Potential synergisms between theater cruise missile defense and national cruise missile defense were considered. A briefing was presented to Gen Myers, USCINCSPACE and Lt Gen Lyles, BMDO Director, and a written summary of the study results was prepared for Dr Jacques Gansler, USD(A&T). Guidance is expected for follow-on work related to the ongoing review of the National Cruise Missile Defense (NCMD) study.

Currently, the analysis team, in conjunction with the NORAD staff, is continuing to seek out, postulate, and evaluate possible and affordable approaches for providing improved capabilities for national cruise missile defense for the near, intermediate and far term periods, respectively. For example, for the nearer term, we are considering defensive postures, including Joint, Multi-Command assets and operations, which might be formulated and employed for different specific threat scenarios, such as scenarios which include some degree of advance warning of the impending threat. For an intermediate time period, we are investigating the possibilities and costs of national cruise missile defensive force structures which include surveillance systems employing high altitude endurable (HAE) unmanned aerial vehicles (UAVs) carrying radar and possibly other surveillance sensors. We're evaluating the potential of passive and multi-static radar technology relative to cruise missile defense. We're participating in the development of the feasibility study for a PACAF-initiated Cruise Missile Defense Joint Test & Evaluation proposal. We are watching for indications of potential future capabilities for national cruise missile defense from space-based surveillance systems such as space-based radar.

Laser Clearinghouse

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This paper explores approaches to assure that high energy laser experiments do not damage satellites, to assist in implementing DoD instructions on high power laser illumination of satellites, and to contribute to forthcoming Tactical High Energy Laser (THEL) tests. A Department of Defense Instruction (DODI) governing the use of terrestrial lasers that might illuminate the satellite background has been in coordination for over a year. The last draft partitioned responsibilities among laser owner/operators, satellite owner/operators, and USSPACECOM. Given satellite susceptibilities and laser characteristics USSPACECOM J3 and AN (this organization) are to determine intervals during which laser operations would not jeopardize satellites within the authority of the Command.

THEL tests establish many precedents. Existing Laser Clearinghouse (LCH) procedures and processes were developed for static irradiation. The combination of sky pointing against a moving object is a new experience. Analyses conducted with "static" LCH tools moved along potential target trajectories, including uncertainty in those trajectories, predicted few if any clear firing opportunities. The THEL project sought relief from USSPACECOM. In turn, this organization was commissioned to either confirm these predictions or to help develop alternative but confident analytical techniques that could recover reasonable firing opportunities. The problem also involves two aspects of testing: long-range planning, and actual test operation.

The convolution of target trajectory uncertainty, satellite state uncertainty which grows the farther in the future one predicts, and the characteristics of the laser beam leave few opportunities unless the analysis is conducted more insightfully.

During an actual test, the target will follow only one confined trajectory that will be known in near-real time. Individual satellite positions can be predicted very well during a short test interval. (Predicting what will happen a few minutes from now as opposed to weeks or months from now.) Therefore, the actual risk to any satellite system should intuitively be extremely small during a specific test.

We conducted several analyses. Using Satellite Toolkit (STK©), we predicted how many satellites might be within the field of regard of the high energy laser at any given time. This number is a small fraction of the satellite sky. Using physically realistic target trajectories, AN studies showed there were frequent windows of opportunity sufficiently long for planned tests.

Utility Curve Development

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Military utility is the impact that a weapons system (or supporting system) has in combat and is commonly expressed in attrition outputs relative to a base case. The multi-mission model Systems Effectiveness Analysis Simulation (SEAS) was used to determine the impact of providing allied forces with an additional capability to accomplish four selected Air Force Space Command (AFSPOC) tasks: Suppression of Adversary Air Defenses, Neutralize Air & Cruise Missile Capability, Neutralize WMD Targets, and Neutralize Non-WMD Targets. The additional capability could represent a conventional ballistic missile, a military space plane delivering reentry vehicles, a space based laser, a well-positioned aircraft carrier, or any other weapons system capable of striking targets rapidly upon the outbreak of hostilities. The impact of this capability was measured by comparing attrition outputs such as allied aircraft lost, enemy aircraft destroyed, and enemy vehicles destroyed to corresponding attrition outputs from a base case where additional capability was not introduced. The base case consisted of current and programmed systems in the US inventory. The impact of the additional capability was measured in a scenario based on the Global Engagement 97 wargame set in the year 2016. Only the halt phase of this campaign was examined. Three sets of runs were accomplished for each of the four AFSPC tasks. In the first set of urns, targets were destroyed at a rate of one per minute beginning immediately upon commencement of the hostilities. Attrition outputs from the runs were compared to assess the impact of varying the percentage of targets destroyed by the additional capability. In the second set of runs the percentage of targets destroyed was fixed and the rate at which the targets were destroyed was varied parametrically. Attrition outputs from the runs were compared to assess the impact of varying the rate at which targets were destroyed by the additional capability. In the third set of runs, a time delay was imposed on the use of the additional capability. Attrition outputs from the runs were compared to assess the impact of the delay. Utility curves (input variation plotted against an attrition output) were created for all cases to graphically depict the impact (military utility) of the additional capability. The utility curves assisted AFSPC in prioritizing operational tasks and mission needs.

JWARS Development Process

James Relyea, Fran Dougherty, Arthur Long
GRCI
JSTARS Program Office

Approved abstract unavailable at printing.

WG 7 – OPERATIONS RESEARCH AND INTELLIGENCE ANALYSIS – AGENDA

Chair: Miss Linda L. Weber, MITRE Corporation
Co-Chairs: Mr. Raymond Ennis, CIA
Mr. Lester W. Grau, Foreign Military Studies Office
LTC David Olwell, NPGS
Advisor: Dr. Allan S. Rehm, MITRE Corporation
Room: 339

Tuesday, 1030 – 1200:
Introductions, Admin
Miss Linda Weber, Chair; Mr. Ray Ennis, Mr. Les Grau and LTC Dave Olwell, Cochairs; Dr. Allan Rehm, Advisor

Suggestions on Conversion of Evaluations of Foreign Ground Force Human Factors to Modeling Inputs
Mr. Gerald Halbert and Mr. John R. Lynch, National Ground Intelligence Center

Tuesday, 1330-1500
COMPOSITE GROUP B .... Thayer Hall, South Auditorium

Wednesday, 0830-1000:
Target Characteristics in Collection Modeling
Mr. James F. Sculerati, MRJ Technology Solutions

An Acquisition and Launch Planning Method for Predicting the Functional Availability of Satellites to Meet User Requirements
Mr. Justin Comstock, Welkin Associates, Ltd.

Wednesday, 1030-1200:
Reverse Engineering of Foreign Missiles via Genetic Algorithm
Mr. Jon Wollam, Veridian Corporation, LtCol Stuart Kramer, Air Force Institute of Technology and Mr. Skip Campbell, NAIC/TANW

Showing the Military Utility of a Space Maneuvering Vehicle in a Campaign Level Context
Capt James Hunter, Capt Charles Galbreath, and Capt Eric Frisco, SMC/XR

Wednesday, 1330-1500:
A Study Guide to a Textbook on Tank Combat Effectiveness
Mr. Peter Shugart, TRAC/WSMR

BARCHI PRIZE FINALIST – Improving Single Strike Effectiveness
LCDR Philip S. Whiteman, USSTRATCOM/J533

Thursday, 0830-1000:
A Bayesian Belief Network Approach to Analyzing Indicators and Warning Data
Mr. Marty Krizan, National Security Agency, Mr. Dennis M. Buede, Decision Logistics and Mr. Terry A. Bresnick, Innovative Decision Analysis

Quantifying the Military Worth of Information Operations (IO) Using THUNDER
Capt. Diane Neely, Air Force Studies and Analysis Agency (Presenter: Capt Sonja Leach)

Thursday, 1030-1200: - **JOINT Session with WG 8..Room 341**
Part I: National Intelligence Estimate on Information Warfare and the Memo for Holders
Mr. Steve Stigall, Office of Transnational Issues

Part II: Foreign Modeling of IW
Mr. Steve Stigall, Office of Transnational Issues

Thursday, 1330-1500:
Recent Advances and Applications in Tactical Hydrology Support
Dr. William D. Martin and Dr. Mark Jourdan, USA Engineer Waterways Experiment Station

Geospatial Information Process Simulation (GIPS)
LTC Melissa M. Buckmaster, NIMA

Alternates

Non-Combatant Evacuation Operation (NEO) Simulation (NEOSIM)
LTC Patrick J. DuBois, Center for Army Analysis

The Changing Face of Analysis for Joint Experimentation
Miss Linda Weber, USACOM J97M / MITRE

WG 7 – Operations Research and Intelligence Analysis - Abstracts

Tuesday, 1030 – 1200:

Introductions / Admin (15-20 minutes)
Miss Linda Weber, WG7 Chair
Mr. Ray Ennis, Mr. Les Grau and LTC Dave Olwell, Cochairs
Dr. Allan Rehm, Advisor

Suggestions on Conversion of Foreign Ground Force Human Factors to Modeling Inputs

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This presentation discusses conversions of evaluations of foreign ground force human factors to inputs usable by the modeling and simulation (M&S) community. These human factors include leadership, moral and cohesion and unit training. The NGIC foreign ground forces evaluation criteria describes the expected level of performance of a foreign ground force. Normally one ground force will be rated lower than another and this rating is meaningful in describing differences in potential performance. The rating number by itself is not usable to the M&S community. After rating a country's ground forces, a look up table is utilized to determine what comparative differences in performance can be expected between ground forces rated at different levels.

The look up table describes the ability of units to perform operations such as reconnaissance, delivery of fire, and ability to maneuver. Ground forces that are not as proficient as other ground forces cannot execute operations at the same level of accuracy, timeliness, or effectiveness as those rated at a higher level.

This proposed methodology is not complete, has not been verified, but is an attempt to describe the differences in the ability to conduct combat operations. This methodology has relevance during stability and support operations, periods of maneuver or defense, and has implications for information warfare.

Tuesday, 1330-1500
COMPOSITE GROUP B .... Thayer Hall, South Auditorium

Wednesday, 0830-1000:

Target Characteristics in Collection Modeling

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ISR modeling has logically tended to focus on reproducing the collection process to determine collection architecture performance. However, most of these methods treat collection as the end event, either assuming automatic success against all targets within the collection footprint, or treating success as a probabilistic event based on collector characteristics only, ignoring target characteristics and behavior.

An approach combining collection and target characteristics promises to better integrate ISR collection into airpower modeling. Algorithms describe target deployment, movement and emissions for target classes consisting of battlespace entities with similar characteristics. Applied to collection results from the Sensor-Platform Allocation Model (SPAM), this methodology shows target behavior has a considerable effect on collection success. By mapping these target classes to object types within the Conventional Forces Analysis Model (CFAM), we may also realistically assess the contribution of imagery collection to targeting and application of airpower. Future efforts will include capturing the effects of area imagery collection and integration of SIGINT and MASINT characteristics in conjunction with development of these capabilities in SPAM.

An Acquisition and Launch Planning Method for Predicting the Functional Availability of Satellites to Meet User Requirements

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In 1997 a panel convened by the Director of Central Intelligence to investigate satellite acquisition planning reported that Mean Mission Duration is not a sufficient estimator on which to base future satellite acquisitions and launches. The National Reconnaissance office was subsequently directed to develop new methods which 1) are based on intelligence value, 2) incorporate improved methods of estimating the useful life of satellites, and 3) are applied consistently across NRO programs.

The method presented herein models the expected useful life of a satellite as the product of its survivor function R(t), its duty cycle as a function of time, and its payload collection capability adjusted for the weighted value of user requirements. Time series of individual satellite functional availability scores are then rolled up into a composite constellation score that is used as the basis of future satellite acquisitions and launches.

Wednesday, 1030-1200:

Reverse Engineering of Foreign Missiles via Genetic Algorithm

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One mission of the National Air Intelligence Center (NAIC) is the reverse engineering of foreign missile weapon systems from incomplete observational data. In the past, intuition and repeated runs of a missile performance model were required to converge to a solution compatible with observed flight characteristics. This approach can be cumbersome and time-consuming, as well as being subject to undesirable influences from the analyst's preconceptions and biases. An alternative approach has been created to apply genetic algorithm techniques to allow automation of the process, wider exploration of the design space, and more optimal solutions matching the observational data.

The genetic algorithm (GA) is a probabilistic search method that copies the natural selection and reproduction processes found in nature. A population of missiles is interpreted as individuals which are given different characteristics representing solutions in the design space. These individuals compete against each other for resources and survival. Over time, through breeding and mutations, the population adapts to gain competitive advantages within the environment. The individuals with a high fitness tend to do well and pass on their genetic legacy, while others of lesser fitness perish.

For this analysis, a GA was modified to allow fitness function evaluations through the Lockheed Martin Missile Integrated Design Analysis System (MIDAS). Missile design variables such as diameter, length, and mass were defined and implemented into a genetic chromosomal representation. MIDAS then attempted to fly the missile along a scripted trajectory matching the observed flight characteristics. A fitness objective function was then developed which measured the accuracy of matching the observational data. This briefing will cover the methodology developed through this process, and demonstrate its effectiveness on a representative test case.

Showing the Military Utility of a Space Maneuvering Vehicle in a Campaign Level Context

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The Space Maneuvering Vehicle (SMV) has the potential for revolutionizing military affairs as we know it. It is a multi-mission support platform all four space mission areas: Space Support, Space Force Application, Space Force Enhancement, and Space Control. But before the acquisition decision is made, how do we prove that an SMV provides any additional worth to the war fighter on top of the forecasted space capability as a quantitative check to the US taxpayer? As directed by Air Force Space Command, SMCXR has undergone a rigorous qualitative analysis of the what makes an SMV unique and how it might support the campaign as well as operations other than war. Using a four pronged approach of qualitative analysis, quantitative analysis, cost effectiveness analysis, and technical risk assessment, we attempt to show what worth an SMV is to campaign level outcomes and cost requirements to achieve those outcomes. Using aggregated measures of effectiveness on the campaign we back out SMV architectures necessary to achieve the required level of effectiveness and associated cost and technology risks. The methodologies and results to date will be presented.

Wednesday, 1330-1500:
A Study Guide to a Textbook on Tank Combat Effectiveness

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Recently, a foreign book on Tank Combat Effectiveness has been published. Some of the information in the book is new to Western analysts; some has relevance to other material that is/has been available in the West, but these relationships may not be apparent to readers who do not have an appropriate background. This presentation, extracted from a study guide, will discuss some of the interesting sections of the book. For those sections that have implications beyond the obvious, the related material will be identified so that the connections may be exploited further.

BARCHI PRIZE FINALIST – Improving Single Strike Effectiveness

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USSTRATCOM's Network Interdiction Tool (NIT) has been developed to provide man-in-the-loop analysis for the interdiction of complex systems having a network architecture. The objective of the NIT program is to leverage operations research techniques to advance critical elements of strategic planning and consequences of execution evaluation into the 21st century.

NIT's graphical user interface accepts assumptions, requirements, and objectives from the targeteer. Data is displayed through GOTS spatial data display software. To minimize intelligence data requirements, NIT utilizes a simple capacitated flow network model of systems. Target selection analysis under deterministic assumptions is aided by integer programming formulations solved by COTS software. Risk assessment and prioritization of weapon assignment is performed by Monte Carlo runs integrated with basic linear program formulations.

Thursday, 0830-1000:
A Bayesian Belief Network Approach to Analyzing Indicators and Warning Data

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This paper describes the results of a project to explore multi-dimensional statistical analysis tools for the purpose of data mining. Our ability to sift large volumes of data and quickly arrive at an actionable conclusion is increasingly challenged by an ever-decreasing work force both in terms of numbers and experience. State-of-the-art statistical analysis tools can offer some relief.

The project focused on the use of Bayesian belief networks to find patterns in data. The project explored the use of two COTS computer software applications: "Netica" from Norsys, and "Belief Network Power Constructor" (BNPC) which is freeware available from the Internet. The Bayesian approach yields a probabilistic network wherein each node/variable contains a conditional probability distribution relative to other nodes/variables.

Our findings are that belief networks can contribute substantially to the discovery of patterns in data and to the formulation of hypotheses that are the basis for actions, in our case, the redirection of assets. The software reviewed for this task provided good visualization through the use of "belief bars" that automatically adjust with changes in conditional probability. Netica's belief bars provide the user with immediate feedback on the posterior probability of a variable in response to changes in other variables. The combination of the belief network derived from Bayesian theory and the multi-dimensional visualization provided by Netica combined to form a powerful analytic tool set that can assist decision makers.

Quantifying the Military Worth of Information Operations (IO) Using THUNDER

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Military worth can be defined as the quantifiable effects of a system or its components on a military objective. Traditional uses of THUNDER have focused more on the simulation's target based (attrition) model to determine campaign outcomes and less on the effect of a system to influence military objectives. In this study, we present an approach to move away from the traditional THUNDER attrition model (counting dead targets) and more towards meeting objectives through the application of Information Operations (IO) and determine their effects on a campaign. The first step in this process was to build a strategy to task hierarchy which defines national, military and component objectives and traces them through tasks and targets. The second step was to model IO systems at the mission level. Results of mission level runs were then scripted into THUNDER to change the Red Commander's awareness over time and the ability of his assets to communicate over time. The effect of these changes can be quantified and linked back to the objectives outlined in the strategy to task hierarchy thereby closing the military worth loop.

Thursday, 1030-1200:
Part I: National Intelligence Estimate on Information Warfare and the Memo for Holders

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Part II: Foreign Modeling of IW

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Approved abstract not available at printing.

Thursday, 1330-1500:
Recent Advances and Applications in Tactical Hydrology Support

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Approved abstract unavailable at printing.

Geospatial Information Process Simulation (GIPS)

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A discrete event simulation model of the geospatial information production process employed by the National Imagery and Mapping Agency (NIMA) has been developed for the first time. This simulation model allows new ways of measuring personnel and equipment utilization and availability for the multiple product lines produced by NIMA. Examples of these product lines include hardcopy and softcopy products such as maps and nautical charts; high-resolution information and products for urban warfare and mission rehearsal; and precision targeting data. The system analysis is based on standard queuing assessments, which greatly impact the introduction of new product lines to the production process. This is critical for developing the future imagery architecture and its supporting requirements.

This methodology was developed to provide managers with a relatively simple, high level tool set to help them gain insight into current production processes, and to improve productivity while achieving efficiencies and economies. Standard simulation analysis is critical in projecting future capabilities in order to identify the impact of personnel and equipment changes on workloads; estimate production costs; estimate the impact of new technologies on future workloads; and estimate future capacity plans and costs of the manufacturing processes.

Alternates

Non-Combatant Evacuation Operation (NEO) Simulation (NEOSIM)

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The fall of the Berlin Wall indicating the end of the Cold War dramatically changed the number, type and nature of events to which the United States (US) commits military resources. Rather than focusing on conflict with the Warsaw Pact in Central Europe, the US now militarily plans for Major Theater Wars (MTW) and commits to Small Scale Contingencies (SSC). This change in focus is commonly referred to as the revolution in military affairs. As a result of this revolution, there have been calls for complimentary revolution in analytical analysis. Specifically, there are numerous requests for a theater simulation model to model SSC to compliment the existing theater campaign simulation models readily available. Attempts to create a SSC theater simulation model has not been made due to the inability to define SSC success or Measures of Effectiveness (MOE).

This paper discusses the Center for Army Analysis' initial effort to model SSC. The SSC type selected is the Non-Combatant Evacuation Operation (NEO), which is widely considered the most structured and easy to define success or establish MOE. The approach combines the modeling expertise of CAA with the expert knowledge of the Southern European Task Force (SETAF) to produce a model first for specific planned NEO and then broadened to produce a generic model for future NEO. The methodology is described and results shown.

The Changing Face of Analysis for Joint Experimentation

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Approved abstract not available at printing.

WG 8 – INFORMATION OPERATIONS/INFORMATION WARFARE (IO/IW) – AGENDA

Chair: Ms. Jean Kopala, ANSER Corporation
Cochair: Dr. Dick Deckro, Air Force Institute of Technology (AFIT)
Cochair: Capt Ken Haertling, Air Force Information Warfare Center (AFIWC)
Advisor: Mr. Steve Mahoney,
Room: 341

Tuesday, 1030 – 1200
Introductions, Admin
Ms. Jean Kopala, Chair; Dr. Dick Deckro and Capt Ken Haertling, Cochairs; Mr. Steve Mahoney, Advisor

Quantifying the Military Worth of Information Operations (IO) Using THUNDER
Capt Diana Neely, Air Force Studies and Analysis Agency (AFSAA) (Presenter: Capt Sonia Leach)

A Methodology for the Development of IO Measures of Effectiveness (MOEs) within the framework of the Joint Munitions Effectiveness Manual (JMEMs)
Capt Wayne Zorn, Air Force Information Warfare Center (AFIWC)

Tuesday, 1330-1500
COMPOSITE GROUP B .... Thayer Hall, South Auditorium

Wednesday, 0830-1000
JOINT SESSION with WG 9, 10, 24 and 25 .... Room 144

How to Test a System of Systems, Focusing on Lessons Learned
Dr. Pat Sanders, DTSE&E
Dr. Bob Bell, Scientific Advisor, MCOTEA
Dr. Hank Dubin, Technical Director, OPTEC
Col Mark Smith, Director, JADS JTF
Dr. Marion Williams, Technical Director, AFOTEC

Wednesday, 1030-1200
The Virtual Reality Command, Control, and Communications Network Battle Management Tool
Dr. John H. Brand, Army Research Laboratory (ARL), Dr. Kriss Preston, Dr. Mike Thurber, and Dr. Rick Coleman, Quality Research, Inc., Dr. Douglas Meyer, Envisage, Inc., Mr. Devlin, GTE

Strategic Cyber Defense
Ms. Jarrellann Filsinger, TIS Labs at Network Associates, Mr. Walt Tirenin, Air Force Research Laboratory (AFRL) and Mr. Don Faatz, MITRE

C2 Analysis and Targeting Tool (CATT)
Capt James Leinart, Air Force Information Warfare Center (AFIWC)

Wednesday, 1330-1500
The Air Force's Common Unified Battle Environment (CUBE) Testing Facility
Lt Todd Virgil, Electronic Systems Center (ESC)

What Makes a Man?: Modeling Considerations for Individual Behavior
Capt Robert Renfro, Air Force Institute of Technology (AFIT)

Modeling PSYOP: A VFT Approach
1Lt Philip Kerchner, Air Force Institute of Technology (AFIT)

Thursday, 0830-1000
Realistic Operational Communications
Maj Paul Cole, Marine Corp Operational Test and Evaluation Activity (MCOTEA)

"Arms Control" for Information Warfare
Ms. Tamara Luzgin

Forecasting International Conflict Through System Stability: Framing the International System as a General System
Mr. Michael Haxton, Joint Warfare Analysis Center (JWAC)

<u>*Thursday, 1030-1200*</u>
Joint Session with WG7..........Room 341

Part I: National Intelligence Estimate on Information Warfare and the Memo for Holders
Mr. Steve Stigall, Office of Transnational Issues

Part II: Foreign Modeling of IW
Mr. Steve Stigall, Office of Transnational Issues

<u>*Thursday, 1330-1500*</u>
Improving the Performance of Telecommunication Networks: Reliability, Throughput & Information Security
Professor Yupo Chan, Air Force Institute of Technology (AFIT)

Selection and Announcement of Best Presentation, Wrap-Up
Ms. Jean Kopala, Chair; Dr. Dick Deckro and Capt Ken Haertling, Cochairs; Mr. Steve Mahoney, Advisor

WG 8 – Information Operations/Information Warfare (IO/IW) - Abstracts

<u>***Tuesday, 1030 – 1200:***</u>
Quantifying the Military Worth of Information Operations (IO) Using THUNDER

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Military worth can be defined as the quantifiable effects of a system or its components on a military objective. Traditional uses of THUNDER have focused more on the simulation's target based (attrition) model to determine campaign outcomes and less on the effect of a system to influence military objectives. In this study we present an approach to move away from the traditional THUNDER attrition model (counting dead targets) and more towards meeting objectives through the application of Information Operations (IO) and determining their effects on a campaign. The first step in this process was to build a strategy to task hierarchy which defines national, military, and component objectives and traces them through tasks and targets. The second step was to model IO systems at the mission level. Results of mission level runs were then scripted into THUNDER to change the Red Commander's awareness over time and the ability of his assets to communicate over time. The effect of these changes can be quantified and linked back to the objectives outlined in the strategy to task hierarchy thereby closing the military worth loop.

A Methodology for the Development of IO MOEs within the Framework of the Joint Munitions Effectiveness Manuals (JMEM)

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Current conventional warplanning cycles do not adequately address information operations (IO). In addition, the targeting process was developed for and is tailored to support conventional operations. The Joint Munitions Effectiveness Manuals (JMEM) provide the analytical structure for the development of conventional weapon effectiveness. The weapon effectiveness data generated using the JMEM methodology supports weapon allocation modeling and simulation as well as targeting and weaponeering solutions. In order to effectively integrate IO in the conventional warplanning environment, supportable data for IO weapon effectiveness must be generated.

Initial research in the subject area resulted in a solution methodology based upon decision analysis theory. A decomposition technique capturing the base elements of both the target and the weapon provides a robust and supportable data development environment. JMEM methodology takes advantage of the decomposition techniques used as the heart of decision analysis theory. In addition, JMEM is a proven method used to generate weapon effectiveness data for joint munitions for over 30 years.

A methodology for the development of IO measures of effectiveness within the framework of JMEM is proposed. The intent is to provide a logical and supportable methodology that will allow the development of IO weapon effectiveness data. This data can then be used in weapon allocation models and simulations and with the targeting process to raise awareness and improve planning for IO capabilities as part of a conventional conflict. The proposed methodology is presented as a step by step comparison to the JMEM approach. In addition to the complete methodology, several examples of weapon effectiveness data development are provided for illustration. Appendices provide step by step data development for electronic attack weapons to include radar jamming operations against point to point and broadcast communications. Also, directed energy weapon effectiveness data development is compared to existing conventional munition effectiveness data.

Tuesday, 1330-1500
COMPOSITE GROUP B .... **Thayer Hall, South Auditorium**

Wednesday, 0830-1000:
JOINT SESSION with WG 9, 10, 24 and 25 .... **Room 144**

How to Test a System of Systems, Focusing on Lessons Learned

Dr. Pat Sanders, DTSE&E
Dr. Bob Bell, Scientific Advisor, MCOTEA
Dr. Hank Dubin, Technical Director, OPTEC
Col Mark Smith, Director JADS JTF
Dr. Marion Williams, Technical Director, AFOTEC

Wednesday, 1030-1200:

The Virtual Reality Command, Control, and Communications Network Battle Management Tool

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The ARI has developed, under a Phase II Small Business Innovative Research (SBIR) program, a virtual reality software tool that enhances the situation awareness of a combat network battle manager. The tool, nicknamed Situation Awareness Virtual Environment for C3 (SAVEC3) Nets, allows a network manager to respond to battle conditions and physical and electronic attacks on the net, as well as enhancing the ability to plan signal operations by representing the results of simulations of network traffic and enemy actions. The tool is modular in construction, and allows generation and/or display of information from several sources simultaneously. In its present form the tool shows the information gathered by the ISYSCON from the operations of an MSE Packet Network, superimposed on a three-dimensional terrain background, along with signal and supported unit locations and combat overlays (battle maps). In this way real battle signal events are reported in the context of the total battle. Operators can respond in context and signal planners can use the network simulation capability provided by the GTE Multi-Switch Simulation to plan connectivity and quality of service as the battle develops, signal assets are destroyed, enemy responses occur, and supported units move.

The software has been developed using the Mobile Subscriber Equipment (MSE) as the development environment, but is not limited in application to legacy networks. The SAVEC3 Net package has been demonstrated linked to an MSE network through the Integrated System Control (ISYSCON) and the GTE Multi-Switch Simulation. The package has also been demonstrated as a server for C3 network information for the ARL very high resolution VR software, the Virtual Geographic Information System (VGIS). The SAVEC3 package will be demonstrated during Prairie Warrior 99, as an adjunct to the ISYSCON. During the exercise the terrain visualization capability will be used by signal planners and by the ISYSCON operator to conduct and to plan signal operations.

The SAVEC3 tool gives the operator or planner the capability to monitor the events in a net in a global sense as well as, simultaneously, examine specific areas of the net such as the functioning of an individual node. This "drill down" capability is being extended into the operation of individual machines. That is, the goal is to allow the operator to visualize in three dimensions, in real time, the file space and process space of a machine which may have been penetrated or compromised with malicious code. A statistical analysis package has also been developed which can be invoked to monitor network events quantitatively.

Strategic Cyber Defense

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This presentation describes the DARPA Information Assurance (IA) program's conceptual framework for defensive strategies in the "cyber" realm. Our focus in the IA program is on cyber defense techniques for threats with the greatest potential impact at the strategic level of conflict. We will briefly summarize a definition of strategic-level conflict, what we mean by "cyber defense" in the IA program, and the reason for our specific focus on strategic-level cyber defense. A preliminary taxonomy of strategies will be presented for discussion and consideration. The DARPA IA program's focus is on the *defensive* aspects of conflict in the "cyber" realm. Thus, although offensive cyber operations are clearly essential for an effective overall military strategy, the program's charter does not currently support such activities.

Our objective is to identify potential strategies for defense, and to the extent possible, evaluate their effectiveness through modeling and simulation (M&S) and experimental methods. Since experimentation on a strategic scale can be very difficult, expensive, and time-consuming, an effective modeling-based approach would be very profitable for rapid assessment of strategies. We have initiated an exploratory investigation of the efficacy of M&S techniques in our domain of interest. However, we seek the expertise of the MORS community for suggestions in this challenging endeavor.

C2W Analysis and Targeting Tool (CATT)

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The Air Force Information Warfare Center is developing the CATT. Various outputs are derived from simulation runs and must be narrowed down via meaningful metrics. Subsequent data analysis on the pertinent output will be used to gain insight into particular military operations.

Wednesday, 1330-1500:
What Makes a Man?: Modeling Considerations for Individual Behavior

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Individual motivations can be defined in terms of needs common to all people, those resulting from cultural biases, and those distinct to personal characteristics. This paper discusses a possible framework for modeling these motivations. At certain times and in various environments, one or more of these motivations may dominate. It is clear, however, that within each of these broad categories a hierarchy exists. It is possible to estimate what influences a person's decision making process most strongly at any given time by understanding what motivations are dominant for a particular scenario.

Modeling PSYOP: A Value Focused Thinking (VFT) Approach

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"Soft Targeting" in information operations is becoming increasingly import. Psychological operations (PSYOP) are one of the classic approaches to targeting an opposition's "wetware" or human element. While a long-standing military practice, there are no fixed measures of merit for evaluating PSYOP options during the planning phase. This study reports on an initial look at using Value Focused Thinking to develop first cut measures of PSYOP actions. The value hierarchy, based on doctrine and expert opinion, is reviewed. The process for its use is illustrated via the analysis of a notional example with associated notional courses of action.

Thursday, 0830-1000:

Realistic Operational Communications Scenarios (ROCS)

Major Paul L. Cole
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The Marine Corps must be able to take network performance (Bits and Bytes) and turn that into a useful measure that the Commander in the field can use. The Commander in the field does not see Bits and Bytes; he knows messages and tasks. The speed and reliability of those messages and tasks are what he uses to evaluate the usefulness of the communications network.

Future C4I architecture modernization efforts will result in increased messaging, data trafficking, and sensor fusion requirements to optimize response times to enemy actions. To overcome this impediment requires the capability to create high fidelity virtual test environments capable of simulating the data and messaging traffic generated in varying combat environments. Additionally, the evaluation needs to be performed as the test is being conducted to demonstrate the network's capabilities. Consequently, the Realistic Operational Communications

Scenarios (ROCS) system was derived. ROCS is a simulation and instrumentation tool designed to aid in testing the Marine Corps Tactical Data Network and other C4I systems such as EPLRS via the creation of realistic virtual test environments played over real systems.

ROCS aids the Operational Tester in evaluating the C4I network in terms that translate to observables that concern the Commander. ROCS provides a realistic scenario in type and size of messages and injects them into a real network at different levels of command and then tacks those messages as they transit the network. ROCS provides a history of that message as it transits the network and an overall history of how the network performed. ROCS reduces the amount of equipment and personnel required to test a specific piece of equipment. Additional uses for ROCS could be in training or in testing doctrine.

"Arms Control" for Information Warfare

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The need for an arms control regime for Information Warfare is being discussed at the United Nations and other international fora. The goal of this paper is to explore what kind of "arms control" could be possible and to offer recommendations for implementation.

The premise of this paper is that Information Warfare is a uniquely different form of strategic warfare and that arms control for IW must be based on the same principles and methods as those employed for Information Warfare. This paper postulates a concept for IW arms control that is based on the information powershift paradigm for Information Warfare. The information powershift paradigm describes strategic Information Warfare as the precise employment of information power to alter information domains of interest and to compromise the ability of decisionmakers to make unencumbered decisions. The paper focuses on the Critical Information Infrastructures (CII) since information systems are more likely to be attacked. The paper proposes that effective arms control for IW must achieve two concurrent objectives:

- Provide a framework for evaluating the effectiveness of critical information infrastructure protection measures.
- Facilitate efforts to expand international cooperation in establishing standard and consistent critical information infrastructure protection regimes, measurement techniques and reporting criteria.

The goals of IW arms control should be to limit the vulnerability of CII systems and to dissuade cyber-brinkmanship through multilateral agreements that promote mutually assured information protection and that facilitate the open reporting of violations and noncompliance. The proposed approach is to monitor strategically significant features of the US critical information infrastructures and their interfaces to the global CII complex and to provide comprehensive assessments.

Forecasting International Conflict Through System Stability: Framing the International System as a General System

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In this study, we build on three areas of research: Expected Utility models of conflict, General Systems Theory, and Social Network representations of organizational networks. This study has three primary goals: The first is to show the value of representing international systems of organizations as thermodynamic systems. The second is to determine whether the framework of using expected utility calculations to gauge system stability provides a valid means of modeling the onset and progress of conflict in a dynamic setting. And the third is to determine whether the Social Network Analysis concept of flow and connectedness provides a meaningful indication of the ability of organizations to resolve differences nonviolently. The results suggest this approach is indeed valid; the dissimilarity of response patterns to other actors in the system provides a good measure of policy orientation and preference orderings; and finally, the social network analysis metrics can provide valuable input to help estimate the prospects for peaceful, nonviolent conflict resolution. The results provide clear indication that the framework of modeling the international system in terms of system stability theory provides strong predictive accuracies, accounting for as high as 75% of militarized disputes and 69% of the non-disputes from 1988 to 1992. These accuracies are achieved despite using data with obvious and considerable holes, and an incomplete specification of the models involved.

<u>Thursday, 1030-1200:</u>
Part I: National Intelligence Estimate on Information Warfare and the Memo for Holders

Mr. Steve Stigall
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Approved abstract not available at printing.

Part II: Foreign Modeling of IW

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Approved abstract not available at printing.

Thursday, 1330-1500:
Improving the Performance of Telecommunication Networks: Reliability, Throughput & Information Security

Professor Yupo Chan
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A stochastic network is defined here in this presentation as a network whose components are subject to failure. We examine the reliability of large-scale stochastic-networks. For any realistic communication networks, the analysis is by no means easy, since the reliability expression can be extremely nonlinear and complex. We suggest a practical way to approximate network reliability, which is shown to be computationally feasible. We then develop a reliability-improvement model in the absence of an analytical reliability-expression. This is handled by a linear, heuristic improvement-model. Finally, we examine the tradeoff between maximizing expected-throughput and reliability. This is accomplished by generating the non-inferior solutions using multi-criteria optimization. Thus expected throughput and reliability can now be measured practically and subsequent improvements made, providing important insights into the operations of stochastic networks. Extensive computational experiences have been gained through experiments with three large-scale networks. Results are in part validated against Monte-Carlo simulation. Recent research concentrates on network games, in which information transmission is not only made reliable, but also protected against external tampering. Our model suggests that a stable equilibrium can be induced by judicious hardening and improvement strategies. Most important, the value of information-assurance can be imputed from the unit costs of improvement. This forms a basis for budgetary decisions in planning future communication networks.

WG 9 – ELECTRONIC WARFARE AND COUNTERMEASURES -- AGENDA

Chair: Mr. Thomas H. Plank, Sverdrup Technology, Inc.
Co-Chairs: Major Darren Durkee, Air Force Studies and Analysis Agency
Mr. Daniel R. McGauley, Nichols Research Corporation
Captain Thomas J. Timmerman, Air Force Studies and Analysis Agency
Mr. Patrick Walker, Air Force Information Warfare Center
Advisor: Michael F. Gauble, Lockheed Martin Government Electronic Systems
Room: 337

Tuesday, 1030-1200
WG 9 Introduction – Mr. Thomas H. Plank, WG-9 Chair

Miniature Air Launched Decoy (MALD) Military Worth Study
Major Darren P. Durkee and Captain Michael L. Fredley, Air Force Studies and Analyses Agency

Common Threat Representation in Simulation, Analysis, and Testing of Integrated Ship Defense
Mr. Richard Reading, Litton PRC

Tuesday, 1330-1500
COMPOSITE GROUP B .... Thayer Hall, South Auditorium

Wednesday, 0830-1000
JOINT SESSION with WG 8, 9, 10, 24 and 25 .... Room 144

Panel on *How to Test a System of Systems*
Panelists: Leaders in the Test and Evaluation Community

Wednesday, 1030-1200
Electronic Combat System Testing and Simulation: Preliminary Results and Measures from JECSIM Program
Major James Przybysz and Dr. Frank Gray, Air Force Operational Test and Evaluation Center, Office of Chief Scientist

Extended Analysis Methodology for Quantifying the Credibility of Models and Simulations
Mr. James Kirkland and Mr. Matthew Newsome, Nichols Research

Wednesday, 1330-1500
A Real-Time Clutter Algorithm
Captain Tri Pham and Mr. Patrick Walker, Air Force Information Warfare Center, Capabilities Analysis Division

Tactics Against a Semi-Active Missile
Captain Jon Fitton and Mr. Ted Trakas, Air Force Information Warfare Center, Capabilities Analysis Division

Thursday, 0830-1000
A Structured Approach to Sample Size Selection for ECM Effectiveness Testing
Mr. Marc Evans, 412 Test Wing, EWR

Task-based Operational Test and Evaluation
Mr. D. McGowen, Mr. R. Brunson, and Ms. J. Thurston, AFOTEC and Mr. J. Gibbons, Georgia Tech Research Institute

Thursday, 1030-1200
Global Positioning System (GPS) Joint Operational Battlefield Environment (JOBE) Joint Feasibility Study
Mr. George T. Cherolis and Mr. Dennis L. Lester, GPS JOBE Joint Feasibility Study

WG 9 Round Table Discussion – *The Future of Electronic Warfare*
Chair, Co-Chairs, Advisor, and attendees
Facilitators: Mr. Thomas H. Plank and Mr. Michael F. Gauble

Thursday, 1330-1500
WG 9 Wrap-up
Chair, Co-Chair, and Advisor

WG 9 – ELECTRONIC WARFARE AND COUNTERMEASURES – ABSTRACTS

Tuesday, 1030-1200
WG 9 Introduction
Mr. Thomas H. Plank, WG-9 Chair

Miniature Air Launched Decoy (MALD) Military Worth Study
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The MALD is a low-cost, expendable decoy designed to increase the enemy's fog of war through stimulation, saturation, and deception of the adversary's integrated air defense system (IADS). The Air Force Studies and Analyses Agency (AFSAA), under the sponsorship of the Defense Advanced Research Projects Agency (DARPA), is conducting a study to examine the military worth of MALD in a Major Theater of War (MTW). The study objectives include determining the effects of MALD employment on friendly mission effectiveness and on enemy IADS effectiveness.

The study investigates the military worth of employing various numbers of MALD in a futuristic MTW. Key suppression measures such as standoff weapons, standoff jamming, and high-speed antiradiation missiles (HARM) will be incrementally introduced to the scenario to examine the synergistic effects while working in conjunction with MALD. A futuristic Air Tasking Order (ATO), developed in coordination with theater planning staffs, was mission planned by qualified aircrews to formulate mission routes, targets, and tactics. The entire D-Day ATO will be modeled within the SUPPRESSOR mission-level model. The main measure of outcome is successful execution of the mission within specified attrition constraints.

Common Threat Representation in Simulation, Analysis, and Testing of Integrated Ship Defense

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The Navy's Program Executive Office, Theater Surface Combatants has applied the High Level Architecture to create an engineering-level simulation Federation for Integrated Ship Defense (ISD). The Federation includes both tactical combat system code-in-the-loop and high fidelity physics-based models, in a network-distributed environment. For the first time, it achieves full fidelity detect-to-engage ISD simulation integrating both hardkill and electronic warfare (EW) elements.

A crucial component of the ISD Federation is the use of threat anti-ship cruise missile representations seen commonly by all ISD elements. Threat behavior is reactive to the operational environment imposed by the set of all the ISD simulations. This establishes a single, continuous battle timeline and is the lynchpin of integrated hardkill/EW engagement. For example, during defensive missile fly-out, the missile sees threat trajectory changes caused by ship signature fluctuations or electronic countermeasures. The ability to quantify the synergistic impact of multiple ship defense elements grants new access to problem domains (e.g., performance assessment, tactics development) and complex scenarios that were previously unattainable. Interactions with battle group and joint theater operational simulations (e.g., EADSIM) are more tenable.

Use of common threat representation permits efficient scenario reconfiguration, to allow insertion of any: full fidelity threat models, conceptual threat models, test target models, or direct playback of test data. Thus, a direct interchange can be made between operational and test scenarios, and live fire test data can be interwoven with engineering simulation. This closes the loop around the design/development, operational testing, and training communities, and builds in the ability to perform effective validation of ISD simulation results.

Tuesday, 1330-1500
COMPOSITE GROUP B .... Thayer Hall, South Auditorium

Wednesday, 0830-1000
JOINT SESSION with WG 8, 24 and 25 .... Room 144

Panel on *How to Test a System of Systems*
Panelists: Leaders in the Test and Evaluation Community

<u>Wednesday, 1030-1200</u>

Electronic Combat System Testing and Simulation: Preliminary Results and Measures from JECSIM Program

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The Joint Electronic Combat test using SIMulation (JECSIM) program was chartered to define which parts of EC testing can be accomplished with constructive simulations and which parts must be done with live or virtual simulations. This presentation shows some initial results. Live and virtual simulations of a semi-active surface-to-air missile against on-board and off-board EC techniques are compared to constructive simulations of the same events. All constructive simulations were run in the Joint Modeling and Simulation System (JMASS) environment. Time series comparisons include missile seeker boresight errors, gimbal angles, track Doppler, and acceleration commands. Discrete signal comparisons include target track, noise track, guidance enable, anti-EC activation, and relative velocity vectors at intercept. We demonstrate how these comparisons can be used as subjective and objective validation data to support accreditation decisions for different applications. We also demonstrate how detailed simulation performance data can be used to estimate how well the simulations would perform for engagements where no other data is available. The latter uses straight-forward linear regression techniques and leads naturally to new *measures of credibility (MOCs)*. MOCs provide a quantitative link from operational measure-of-effectiveness requirements to constructive simulation performance criteria.

Extended Analysis Methodology for Quantifying the Credibility of Models and Simulations

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The purpose of this paper is to describe a methodology for quantifying the credibility of modeling and simulation (M&S) for use in test planning, analysis, and interpolation/extrapolation of test results in Test and Evaluation (T&E). The methodology is being developed as part of the Joint Electronic Combat Simulation (JECSIM) Joint Test and Evaluation (JT&E). JECSIM was chartered to investigate the utility of digital models and simulations in the developmental and operational T&E of threat semi-active missile systems against friendly forces' fighter, bomber, and helicopter aircraft with and without electronic countermeasures (ECM). The JECSIM Joint Task Force defined two issues to guide the project and ensure coverage of the charter objectives. The first issue, related to capability, credibility, and usability assessments of M&S, is focused on comparisons between test measurements and M&S predictions. The second addresses the sensitivity of endgame parameters to the ultimate measure of ECM effectiveness, probability of kill (Pk).

<u>Wednesday, 1330-1500</u>

A Real-Time Clutter Algorithm

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The Capabilities Analysis Division of the Air Force Information Warfare Center (AFIWC/SMC) recently developed a clutter algorithm for use in real-time simulations. We use basic statistical concepts to limit clutter properties to those most pertinent to detection of low-flying, conventional aircraft by land-based radars. We dynamically process Digital Terrain Elevation Data (DTED) for terrain masking and clutter. Simulations indicate results from our algorithm are comparable to those from more complicated models. Our algorithm was incorporated into the Distributed Mission Training (DMT) system in January 1999, and will be incorporated into AFIWC's Improved Many-on-Many (IMOM) mission-planning tool, Version 6.0, this summer.

Tactics Against a Semi-Active Missile

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Capabilities Analysis Division of the Air Force Information Warfare Center (AFIWC/SMC) recently completed an effectiveness assessment of tactics by a large aircraft against a semi-active surface-to-air missile (SAM) threat. We use Enhanced SAM Simulation (ESAMS), Version 2.8, to score Level II (Engagement) results. We in turn relate these engagement results to Level I (System Performance) properties of the threat. Analysis shows an interesting interplay of Level I characteristics and Level II results.

Thursday, 0830-1000

A Structured Approach to Sample Size Selection for ECM Effectiveness Testing

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Electronic countermeasures (ECM) effectiveness measurement objectives are formulated in terms of both one-tailed and two-tailed hypothesis tests applied to the Reduction-in-Lethality (RIL) figure of merit. The probability density function for the RIL is derived and applied to determine the required sample sizes necessary to achieve these objectives. The optimal ratio of dry (ECM off) to wet (ECM on) runs (flight profile repeats) is determined so that test objectives can be met at minimum cost. Methodology leads to simple nomographic approach to ECM test series design.

Task-based Operational Test and Evaluation

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The April 1997 Four-Star Command and Control summit declared that "The Air Force must commit to a fundamentally different way to evolve requirements, develop, test, field, and sustain C2 systems." In response to this direction, the C2 General Officers Steering Group (GOSG) leading the Command and Control Test Integrated Product Team (C2IPT), tasked HQ AFOTEC/TK to propose an alternative to the current approach of requirements-based operational test and evaluation. The alternative developed by AFOTEC is task-based operational test and evaluation.

Task-based operational test and evaluation is a fundamentally different approach than requirements-based operational test and evaluation. Whereas the focus of requirements-based operational test and evaluation is determining operational effectiveness and suitability based on system performance as compared to requirements, the focus of task-based operational test and evaluation is determining operational effectiveness and suitability based on task accomplishment.

The foundation for task-based operational test and evaluation is operational task analysis. Operational task analysis is a process that examines a targeted mission. This process decomposes the mission into tasks that must be accomplished in order to satisfactorily complete the mission. These tasks are then related to the system functionality that supports the task accomplishment. These relationships form a traceability matrix that allows system functionality to be associated with task and ultimately mission outcomes. Operational task analysis is most beneficial when it is done early and continuously in program development. It is an iterative process involving the user, contractor, product center, responsible test organization, and operational test agency. Operational task analysis provides the structure for early operational test agency participation in program development by furnishing operational insight to the program office and acquisition decision maker. Evaluation of test data collected during any part of program development can be made at the mission level using the operational task analysis.

In summary, task-based operational test and evaluation supports the GOSG C2IPT direction by providing an alternative to requirements-based operational test and evaluation. This alternative allows the operational test agency to better determine whether systems are operationally effective and suitable for the intended use by representative users before production or deployment. This concept also provides the opportunity for meaningful early operational test agency participation during program development.

Thursday, 1030-1200

Global Positioning System (GPS) Joint Operational Battlefield Environment (JOBE) Joint Feasibility Study

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The GPS JOBE JFS was directed by the Director, Test, Systems Engineering, and Evaluation (DTSE&E) to determine the necessity and feasibility of conducting an Office of the Secretary of Defense (OSD)-sponsored Joint Test and Evaluation (JT&E). The fundamental purpose of the GPS JOBE JT&E will be to shed light on effects of hostile GPS Electronic Warfare (EW) on Joint operations and identify ways to minimize mission impacts. Throughout the JT&E nomination and JFS phase, the Joint community expressed three major concerns that provided a basis for the GPS JOBE problem statement and JT&E issues:

- What happens to warfighters and their support activities when GPS is denied or degraded?
- What can warfighters do to minimize risks in a GPS-denied/degraded environment?
- How can DOD reduce GPS EW vulnerabilities in future acquisition and integration efforts?

The GPS JOBE problem statement derived from these questions is as follows: Electronic Warfare vulnerabilities are a major shortfall of military GPS, the extent and impact of these vulnerabilities on joint operations are not known nor are the opportunities for mitigation well understood. The related issues that stem from this problem statement are as follows:

- To what extent are joint operations vulnerable to GPS EW with and without mitigation techniques?
- How well do current and enhanced T&E processes identify GPS vulnerabilities?

If chartered, the GPS JOBE JT&E will consist of a series of mini-tests and field tests that concentrate on performance and effectiveness of Joint reconnaissance and interdiction missions. It is envisioned these tests will be conducted on live test and training ranges and be augmented by virtual and constructive simulations. These tests will become increasingly complex as the focus shifts from small unit ground operations to larger scale operations that extend from the Joint Task Force (JTF) level down to tactical land, sea, and air elements.

This presentation will cover the background on the GPS JOBE JFS; proposed test architecture and approach; and expected benefits and products from the JT&E.

WG 9 Round Table Discussion – *The Future of Electronic Warfare*
Chair, Co-Chairs, Advisor, and attendees
Facilitators: Mr. Thomas H. Plank and Mr. Michael F. Gauble

Thursday, 1330-1500
WG 9 Wrap-up
Chair, Co-Chair, and Advisor

WG 10 - UNMANNED SYSTEMS - AGENDA

Chair: Ms. Mary L. Ray, US Army TRADOC Analysis Center
Cochair: Dr. Maryanne Fields, US Army Research Laboratory
Room: 329

<u>*Tuesday, 1030 - 1200*</u>
Effects of Unmanned Aerial Vehicles (UAV) on Information Gain for Army After Next (AAN)
Cadets Armour Craig, Dan Thompson, Joseph Hays, Ethan Dial, Craig Blow, and Nate Garaas, LTC Gene Paulo, US Army Military Academy-Department of Systems Engineering

Unmanned Aerial Vehicle Engagement-Level Simulation
Capt Jennifer Walston, USAF, LTC T. Glenn Bailey, MAJ Ray Hill, US Air Force Institute of Technology

Military Worth of Intelligence, Surveillance, and Reconnaissance (ISR) Methodology
MAJ James Barnes, Air Force Studies and Analyses Agency

<u>*Tuesday, 1330-1500*</u>
COMPOSITE GROUP B .... Thayer Hall, South Auditorium

<u>*Wednesday, 0830-1000*</u>
JOINT SESSION with WG 8, 9, 10, 24 and 25 .... Room 144

Testing a System of Systems
Dr. Marion Williams, AFOTEC; Dr. Hank Dubin, US Army OPTEC; COL Mark Smith; Dr. Pat Sanders, DTSE&E; and Dr. Bob Bell, MCOTEA *(scheduled)*

<u>*Wednesday, 1030 - 1200*</u>
Predator Unmanned Aerial Vehicle Operational Testing
Capt Chris Dusseault, USAir Force Operational Test and Evaluation Command

SIGINT Modeling: Quantifying Coverage Capability in a LP
Mr. Kenneth Cogan, Adroit Systems, Inc.; Mr. George Teas, Adroit Systems, Inc.; and Mr. Kurt Willstatter, Teledyne Brown Engineering

Dynamic Routing of Unmanned Aerial Vehicles Using Reactive Tabu Search
Capt Kevin O'Rourke, LTC T. Glenn Bailey, MAJ Ray Hill, LTC William B. Carlton (USA), US Air Force Institute of Technology

<u>*Wednesday, 1330-1500*</u>
Unmanned Ground Vehicles, Demo III
US Army Research Laboratory

Engr UGV

Armor UGV

<u>*Thursday, 0830-1000*</u>
Space Operations Vehicle (SOV) Military Utility Analysis
MAJ Scott Fox, US Air Force Studies and Analysis Agency

Raptor Employment Analysis
Mr. Jeffrey Kramer, USA TRADOC Analysis Center-White Sands Missile Range

<u>*Thursday, 1030-1200*</u>
System Design of On-Orbit Servicing Architectures
Capt Gregg Leisman, Lt Adam Wallen, LTC Stuart Kramer, and MAJ William Murdock, Air Force Institute of Technology

A Sensor Pointing Terrain Interaction Model and Reconnaissance Analysis Methodology Applied to Two Operations Other Than War Scenarios
Dr. Ephraim Martin IV, Lockheed Martin Electronics & Missiles

<u>*Thursday, 1330-1500*</u>
Army Force XXI UAV Requirements Study
Ms. Mary L. Ray, TRADOC Analysis Center-Ft. Leavenworth

WG 10 - UNMANNED SYSTEMS - ABSTRACTS

Tuesday, 1030 - 1200

Effects of Unmanned Aerial Vehicles (UAV) on Information Gain for Army After Next (AAN)

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This research is a Janus-based simulation effort that studies the Army After Next (AAN) and its utilization of Unmanned Aerial Vehicles (UAV). In support of the spring 1999 AAN wargame conducted by TRADOC Future Battle Directorate, we are examining an element of the 8T Air Assault Force in a defense mission against an attacking heavy division. Design of Experiments is used to study the effect of varying certain UAV capabilities and tactics, as well as to determine the overall benefits of UAV utilization to the friendly fighting force. Of the numerous possible missions of UAVs (to include battle damage assessment, target acquisition, and target designation, among others), this effort focuses on reconnaissance. More specifically, reconnaissance results are quantified and used to predict enemy intent, based on a methodology developed in a graduate thesis by a U.S. Army officer with extensive cavalry experience. Enemy intent serves as a Measure of Effectiveness (MOE) for the UAV, while a more traditional MOE (Loss Exchange Ratio) serves as a supplemental and complementary means of determining the level of UAV contribution to mission success. Additional insight should include capabilities and limitations of Janus in portraying AAN weapon systems, as well as future focus for analysis of UAVs in the Army After Next.

Unmanned Aerial Vehicle Engagement-Level Simulation

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In this paper, we present an approach for evaluating performance parameter changes for the Predator unmanned aerial vehicle (UAV) using object-oriented simulation. Our discrete-event simulation of the UAV flight environment invokes an algorithm that provides real-time near-optimal routing changes that captures the dynamic target re-tasking typical of UAV missions. We present results of an analysis that evaluates the operational effects of improved speed capability of the Predator using target detection as the measure of effectiveness.

Military Worth of Intelligence, Surveillance, and Reconnaissance (ISR) Methodology

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Senior civiian and military leadership must constantly make force strure acquisition decision involving ISR systems. In the past, these decision were made based on coverage statistics such as point targets or area coverage per day. The goal of this methodology is to demonstrate the military worth of ISR information to the warfighter in terms of campaign outcomes rather thatn the traditional quality, quantity, and timeliness (QQT) measures. As the result of this study, we will have the ability to trace military worth effects back to ISR inputs so we can determine what a "pound of ISR" is worht to the warfighter. Addtionally, and ptentially more exciting, this methodology can be used to "reverse engineer" ISR capabilities or architectures. Instead of starting with ISR collection and feeding the military worth model, we can determine a desired military effect and have the methodology "back-in" the ISR. The advantage of this approach is that the appropriate questions can now be answered. Relevant questions may include "What improvements iSR capability are required to increase our ability to produce some type of military worth outcome?"

Tuesday, 1330-1500

COMPOSITE GROUP B .... Thayer Hall, South Auditorium

Wednesday, 0830-1000

JOINT SESSION with WG 8, 10, 24 and 25 .... Room 144

Wednesday, 1030 - 1200

Predator Unmanned Aerial Vehicle Operational Testing

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Abstract unavailable at printing.

SIGINT Modeling: Quantifying Coverage Capability in a LP

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Abstract unavailable at printing.

Dynamic Routing of Unmanned Aerial Vehicles Using Reactive Tabu Search

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In this paper, we consider the dynamic routing of unmanned aerial vehicles (UAVs) currently in operational use with the US Air Force. Dynamic vehicle routing problems (VRP) have always been challenging, and the airborne version of the VRP adds dimensions and difficulties not present in the typical ground-based applications. Previous UAV routing work has focused on primarily static, pre-planned situations, but scheduling for military operations (which may be ad hoc) drives the need for a dynamic solver that can respond to rapidly evolving problem constraints. With these considerations in mind, we examine the use of a Java-coded metaheuristic to solve these dynamic routing problems, explore its operation with several general problem classes, and look at the advantages it provides in sample UAV routing problems.

Wednesday, 1330-1500

Abstracts for this session unavailable at time of publication.

Thursday, 0830-1000

Space Operations Vehicle (SOV) Military Utility Analysis

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Space has evolved into such a critical enabling element for our military force that "Joint Vision 2010" identifies space as the fourth medium of warfare. Our future space systems need to improve our ability to control space, meet launch-on-demand and operational responsiveness. The rapid response, quick turnaround and high maneuverability of the Space Operations Vehicle (SOV) system can answer these shortfalls by providing greater space asset protection and enabling US forces to achieve and maintain Space Superiority. While this system has utility across the spectrum of space mission areas, this analysis looks at the contribution of the SOV system to Space Support and Space Force Applications missions. Specifically, we address the impact an SOV system, with aircraft-like turn times and sortie rates, has supporting the time-critical spacelift requirements. The requirements are reflected in missions performed by the Space Maneuver Vehicle (SMV) as well as missions to replenish satellite constellations that provide key force enhancement in both peacetime and during a military campaign. We also assess the utility of the SOV system in its capacity to strike worldwide targets within minutes of launch using a Common Aero Vehicle (CAV). Finally, we look at the variations of basing strategies and force structures as they support all of the SOV missions.

Raptor Employment Analysis

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Raptor is a suite of anti-armor mines, sensors, communications, and controls which result in a minefield that is more flexible in tactical usage, more lethal to the enemy, and safer to friendly forces and non-combatants than conventional minefields. The Raptor improves the commander's ability to dominate the battlespace through the employment of unmanned and unobserved obstacles capable of detecting, reporting, and selectively engaging enemy vehicles. An operational effectiveness (OE) analysis conducted during the summer of 1997, the Raptor Milestone I Analysis of Alternatives (AoA), showed the positive contribution Raptor could make to the battlefield. However, Raptor is a new system which has neither fielded equivalent, nor previous field performance history from which to compare its performance. ARDEC, the materiel developer, proposed a closer look at the OE conducted for the AoA, to assess additional system parameters, Raptor employments, and potential threat reactions not captured in the original AoA, which would reinforce the findings that Raptor is a valuable asset for the maneuver commander. The Raptor employment analysis was performed in three phases: Phase I used a SWA scenario from the original AoA to examine mine placement, threat reactions, and Raptor performance parameters. Phases II and III simulated Raptor in a European environment. This paper presents a brief overview of the Raptor employment, followed by the analytical description and results.

Thursday, 1030-1200
System Design of On-Orbit Servicing Architectures

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Abstract unavailable at printing.

A Sensor Pointing Terrain Interaction Model and Reconnaissance Analysis Methodology Applied to Two Operations Other Than War Scenarios

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The dynamic interaction of sensors with terrain and tactical targets deserves special attention to help sort out the relative value of high cost sensor package options. A phenomena of particular interest when considering a reconnaissance mission is the time related terrain coverage provided by a given sensor package when used with a given tactical employment logic. How much area can be covered in a given time using a given search pattern with a given set of sensors? What difference does one search logic provide compared to another? What difference does one sensor field of view provide when compared to alternatives? The methodology used in the most high fidelity combat simulations assigns a field of regard (FOR) and within that FOR a field of view (FOV). Each FOV is viewed in a set or random period of time. The search pattern within the FOR may be systematic or random depending on the sensor and the search logic. A model was developed which uses defense map agency (DMA) terrain to graphically portray terrain surveyed by the sensor suite. The sensor suite is moved on or over the terrain. A specified sensor employment logic and search methodology are employed and the terrain is painted by the model to show which area is directly observed by which sensor or sensors. The Johnson methodology is linked to the model by Monte Carlo simulation to compute which targets on the terrain are acquired. An analysis of two scenarios is presented using this model which examines the performance of several air sensor packages in a reconnaissance mode. Both scenarios are Operations Other Than War. The first is a coastal infiltration operation set in Australia. The second scenario is a central European operation set in Bosnia. Both are oriented towards air reconnaissance in a sparse target environment where both target detection and target identification are of primary importance and target engagement is a lesser priority for the sensor platform. The results are extremely revealing and instructive and are not available from most other sensor modeling and analysis methodologies.

Thursday, 1330-1500
Army Force XXI Unmanned Aerial Vehicle (UAV) Requirements Study

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In the late 1980s and early 1990s, the U.S. Army developed requirements for a family of three UAV systems aimed at satisfying ground commanders' AirLand Battle (ALB) intelligence needs. The three UAV systems were the Close Range (Brigade), Short Range (division and corps), and Endurance (Echelon Above Corps (EAC)) systems. The Operational Requirements Documents (ORD) for the family of Army UAVs reflect requirements under ALB doctrine, a doctrine that will be replaced by Force XXI. The doctrinal differences between Force XXI and ALB, the increasing joint nature of military operations, and the rapid advance in key information, sensor, weapons guidance, and signature management technologies will have a significant impact on future UAV missions, payloads, and UAV system characteristics and capabilities. Collectively, these will lead to new requirements for conducting traditional reconnaissance, surveillance and target acquisition missions as well as new UAV missions in support of land forces. TRADOC initiated a study of Army UAV requirements in the summer of 1996. The objectives of the study were to identify Force XXI ground commanders' baseline UAV mission requirements; to assess current UAV programs in light of Force XXI requirements in order to identify any shortcomings and to offer potential solutions; and to assess the implications to the U.S. Army of expanding beyond conventional UAV missions and payloads. This presentation will discuss UAV modeling and simulation techniques and measures used in the study to develop ground commanders' requirements for Force XXI UAVs and discuss how this analysis has been used to revise UAV system requirements.

WG 11 – MILITARY ENVIRONMENTAL FACTORS – AGENDA

Chair: Dr. Theodore Bennett, Jr., Naval Oceanographic Office
Co-Chairs: Niki Deliman, U.S. Army Engineers Waterways Experiment Station
Phillip Doiron, Applied Research Associates, Inc.
John Elrick, Air Force Operational Test and Evaluation Center
Kimberley Davis-Lunde, Naval Meteorology and Oceanography Command
Advisor: Eleanor Schroeder, Naval Oceanographic Office
Room: 327

Tuesday, 1030-1200:
Environment in Modeling & Simulation and Wargaming .... Room 327

Providing Physically Consistent Environmental Data in Support of DoD Modeling and Simulation
Mr. Gary B. McWilliams, DoD Modeling and Simulation Executive Agent for the Air and Space Natural Environment

JWARS Synthetic Natural Environment
Mr. Gerald DePasquale, JWARS (CACI)

Movement Representation in Army M&S: Ongoing Standardization Activities for MOVE
Dr. Niki C. Deliman, U.S. Army Engineers Waterways Experiment Station

Tuesday, 1330-1500:
COMPOSITE GROUP B SESSION .... Thayer Hall, South Auditorium

Wednesday, 0830-1000:
Modeling Systems .... Room 327

Numerical Weather Prediction Models for Battlespace Environment Simulation
Dr. Joel B. Mozer, Air Force Research Laboratory

Validation of Short-Term Battlespace Forecast Model Forecasts With Profiler and Upper Air Data Collected Over Oklahoma
Dr. Patrick A. Haines, Dr. Teizi Henmi, Mr. Robert E. Dumais and Mr. David I. Knapp,
Army Research Laboratory AMSRL-IS-EA

Advanced Hydroenvironmental Modeling and Simulation Systems
Dr. Jeffery P. Holland, U.S. Army Engineers Waterways Experiment Station

A River Stage Forecasting System for Military Applications Using Artificial Neural Networks
Dr. Bernard B. Hsieh, Dr. William D. Martin, CAPT Charles L. Bartos, USA and Ms Peggy Wright,
U.S. Army Waterways Experiment Station

Wednesday, 1030-1200: SESSION A
Joint WG 11, WG 13 and WG 14 Session .... Room 342

Anti-Submarine Warfare in the Littoral
CDR Larry Gordon, CNO OPNAV N84

Future Submarines Mission Study
Dr. Matthew J. Vanderhill, Lincoln Laboratory, Massachusetts Institute of Technology

Wednesday, 1030-1200: SESSION B
Environmental Effects on Individual Warfighters and Systems .... Room 327

Modeling Weather Effects on the Grizzly Performance on a SAF Environment
Dr. George L. Mason and Mr. Richard B. Ahlvin, U.S. Army Engineers Waterways Experiment Station

Mission Specific Data Sets Requirements for Wheeled and Tracked Vehicle Mobility Modeling
Mr. John G. Green, Mr. Richard B. Ahlvin and Ms Stephanie J. Price
U.S. Army Waterways Experiment Station

Heat Stress Potential for Naval Aircraft Refueling Operations While Wearing Chemical & Biological Protective Equipment
Mr. Robert Auer, U.S. Army Soldier & Biological Chemical Command

Wednesday, 1330-1500:
Modeling Interfaces..Room 327

Environment Model Interfaces in War Games
Dr. Steven M. Kovel, Army Research Laboratory AMSRL-IS-EP

Analysis of the Factors That Determine Effective Logistics-Over-The-Shore (LOTS) Sites
Mr. Phillip L. Doiron, Applied Research Associates, Inc.

SWIM-Web Based Scenario Editor Bringing Weather to the Synthetic Battlefield
Mr. Paul D. West and Mr. John Melendez, United States Military Academy
Mr. Richard Palmer, U.S. Army Cold Regions Research and Engineering Laboratory

Environmental Effects on the Mine Impact Burial Model
Dr. Peter C. Chu, LT Vickey Taber, USN and Mr. Steven D. Haeger, Naval Postgraduate School

Thursday, 0830-1000:
Space Systems and the Environment
Joint WG 5 and WG 11 Session...Room 342

Cost and Operational Benefit Analyses for Space-Based Environmental Satellite Systems: An Overview
Mr. Alan Goldberg, Ms Elaine Goyette and Ms Josephine Sterling, The MITRE Corporation

Modeling Atmospheric Effects on Missile Warning in the Missile Defense Space Tool
CAPT F. Anthony Eckel, USAF, Space Warfare Center (SWC/AEWG)

Thursday, 1030-1200:
Joint WG 11, WG 13 and WG 14 Session..Room 342

Ocean Optics: Impacts on Threat Detection, Vulnerability Assessment, and LIDAR System Performance in Littoral Warfare
LCDR Kimberley Davis-Lunde and Mr. Ed Chaika, Naval Meteorology and Oceanography Command;
CAPT David Martin, Deputy Undersecretary of Defense for Science and Technology;
Dr. Alan D. Weidemann, Naval Research Laboratory;
Dr. Gary D. Gilbert, Space and Naval Warfare Systems Center;
Ms Laurie A. Jugan and Dr. Walton E. McBride, Planning Systems Incorporated

Using a Mine-Hunting Sonar for Real-Time Environmental Characterization
Mr. Stephan C. Lingsch and Mr. William C. Lingsch, Naval Oceanographic Office

A Modeling and Simulation Approach for Exploring Ship to Objective Maneuver (STOM) Concepts
Mr. Joe Manzo. The MITRE Corporation

Thursday, 1300-1530:
The Environment in Modeling & Simulation and Wargaming
Joint WG 11 and WG 29...Room 342

Toward a Common Synthetic Natural Environment
Mr. Clark D. Stevens, STRICOM

Atmospheric Effects and Impacts for High- and Low-Resolution Warfare Models
Dr. Richard Shirkey, Army Research Laboratory

Putting Weather into Combat Simulation
Lt Col Frank A. Zawada,USAF, and Lt Mike J. Currie, USAF, AFRL/VSSW

The Effects of Vegetation on Dismounted Infantry Operations
Mr. Danny C. Champion, USA TRAC-WSMR

WG 11 – MILITARY ENVIRONMENTAL FACTORS – ABSTRACTS

Tuesday, 1030-1200:
Environment in Modeling & Simulation and Wargaming ....Room 327

Providing Physically Consistent Environmental Data In Support of DoD Modeling and Simulation

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The results from a series of modeling and simulation (M&S) experiments conducted in the summer and fall of 1998 to develop reference procedures for creating physically consistent natural environmental data sets will be presented. Physically consistent data sets are required for the realistic representation of the natural environment in computer simulations. These newly defined procedures use many of the new M&S capabilities developed by the three DoD Modeling and Simulation Executive Agents for the Natural Environment. Three examples of these new resources are the Environmental Scenario Generator, Dynamic Terrain Modeling, and Integrated Ocean Model. Data ensuing from the experiments were obtained from three simulation participants: Two DoD acquisition programs (the U.S. Army's Grizzly Breaching Vehicle and the U.S. Marine Corps' Advanced Amphibious Assault Vehicle (AAAV)), and the Naval War College's seminar-based Global '98 War Game. The capability to simulate a physically consistent natural environment allows the Grizzly project to improve the design of field engineering experiments and reduce the cost of operational test and evaluation assessments. Similarly, the AAAV project uses this capability to facilitate engineering design assessment, reduce the cost of operational testing and evaluation assessment, and create a more realistic training simulator. The Naval War College is adapting these new reference procedures and M&S resources to improve its ability to readily generate integrated Meteorological and Oceanographic (METOC) information needed by operational-level decision makers in war games. These experiments were conducted under the auspices of a partnership formed by fifteen DoD organizations and contractors. The Defense Modeling and Simulation Office provided funding support.

JWARS Synthetic Environment

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This presentation describes how JWARS has leveraged several technologies and software to meet Synthetic Natural Environment requirements. The JWARS Coordinate System is an object-oriented encapsulation of the Global Coordinate System (GCS). JWARS Terrain is simulated using a set of reusable Compact Terrain Data Bases (CTDBs) and software libraries. The JWARS Movement Infrastructure is generated from CTDBs and algorithms contained in the NATO Reference Mobility Model (NRMM). JWARS Weather Scenarios are generated using a reusable Weather Scenario Generator (WSG). [WSG draws environmental information from the Master Environment Library (MEL), a virtual warehouse of Atmosphere, Ocean, and Space models and data.] JWARS solar & lunar phenomena and ephemeristic calculations are simulated using an adaptation of Solar Lunar Almanac Core (SLAC) system. JWARS is currently considering reuse of the Integrated Weather Effects Decision Aid (IWEDA) to generate weather effects on systems from JWARS Weather Scenarios. The JWARS SNE is a classic example of technology transfer and software reuse.

Movement Representation in Army M&S: Ongoing Standardization Activities for MOVE

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The U.S. Army Model & Simulations Office (AMSO) is charged with promoting standards development and promulgating standards for Army modeling and simulation (M&S). To accomplish this objective, standards categories have been identified and coordinators selected to assist in the process of nominating and developing standards for algorithms, procedures, data, and other forms of representation within their respective standards areas. The MOVE Standards Category is concerned with movement representation within the battlespace (air, land, and sea). Algorithms for ground vehicle movement, fixed and rotary wing aircraft movement, engineer activities, vehicle/unit route selection, and logistical network representation are among the current activities supported by the MOVE Standards Category. The purpose of this presentation is to discuss the focus and objectives of MOVE, current activities, standards development, and future directions. This presentation will also serve as a forum to collect ideas and perspectives from participants regarding movement issues in the battlespace.

Tuesday, 1330-1500
COMPOSITE GROUP B SESSION..........South Auditorium

Wednesday, 0830-1000:
Modeling Systems..........Room 327

Numerical Weather Prediction Models for Battlespace Environment Simulation

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Advances in the state-of-the-science of theater-scale Numerical Weather prediction (NWP) modeling, as well as modern computer capabilities have unveiled new possibilities for military environmental simulation and specification. Traditional weather forecasts based on NWP model output have long been used as a decision tool for military operations. This use historically involves the interpretation of classical weather parameters (e.g. winds, temperature, and humidity) by trained meteorologists to predict the specific impacts of the weather on a particular mission or operation (e.g. flight ceilings and weapon lock-on-ranges). In a simulation where meteorological expertise may not readily be available, NWP data can be interpreted objectively and autonomously to determine these impacts. A particular benefit of this approach is that appropriately tailored NWP products provide physically consistent and realistic weather effects over a battlespace.

AFRL has developed methods to generate and utilize tailored NWP data for a broad range of simulation activities. Environmental methods to generate data derived from the Air Force's operational mesoscale NWP model, MM5, as well as the Navy's COAMPS model have formed the core environment to support high-fidelity force-level simulations, aggregate campaign simulations, and analyses for acquisition. These techniques have also been applied to operational mission planning and mission rehearsal activities where weather impacts are needed. Additionally, we have developed techniques to augment NWP-based simulation data with other sources of data such as meteorological observations, satellite data, and high-fidelity cloud models. An overview of AFRL's NWP data utilization techniques is presented here as well as examples derived from several simulation activities.

Validation of Short-Term Battlespace Forecast Model Forecasts With Profiler and Upper Air Data Collected Over Oklahoma

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The Battlescale Forecast Model (BFM) consists of 3-Dimensional Objective Analysis, Initialization, and Mesoscale Numerical Weather Prediction components. One use of the BFM is to provide more accurate and timely meteorological information for use in artillery targeting; validation of this capability is the object of this study

The BFM is initialized from an objective analysis including synoptic 12 GMT upper air observations in and around Oklahoma, NOGAPS model data, and, if available, the Ft. Sill Oklahoma 12 GMT RAOB. Short term forecasts were generated for a 400 km by 400 km model grid covering the western and central parts of Oklahoma; the model's horizontal resolution used is 10 km. In the vertical, 32 grid points are used beginning at 2 m above ground level and extending to the model top set here at 11 km above sea level. Forecasts have been made for April, May, and October 1998; additional forecasts for other months are in progress.

We made a number of comparisons of BFM forecasts with hourly upper air winds observed by the wind profiler network (there are 4 wind profilers located within the model grid). The results show the BFM forecasts are better than a contemporaneous observation for a typical spatial separation of 20-25 km. In addition, 2 and 4 hour BFM wind forecasts are better than and much better than respectively 2 hour old and 4 hour old data.

Advanced Hydroenvironmental Modeling and Simulation Systems

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The USAE Waterways Experiment Station (WES) is the Department of Defense (DoD) computational technology area leader for the development of advanced hydroenvironmental modeling and simulation systems, each of which has significant dual-use capabilities for supporting U.S. Forces in tactical situations. For example, the same computational system developed for installation land management/watershed management has provided DoD with the computational tools and predictive models needed to forecast river stages on the Sava River in Bosnia in support of U.S. peacekeepers. This paper will present an overview of hydro-environmental systems whose fundamental capabilities (due to their first-principles, physics-based computational models which are integrated with data assimilation, visualization, and animation) provide DoD with state-of-the-art hydrologic, hydrodynamic, and transport predictive capabilities in support of military operations. Features of three hydroenvironmental systems, the Groundwater Modeling System, the Surface Water Modeling System, and the Watershed Modeling System, will be presented. Enhancements to the systems' computational models for implementation on scalable computing architectures are highlighted. The conceptual design of a new modeling system, the web-based Land Management System being developed in support of military installation training and readiness issues, will also be presented as a paradigm of future systems developments.

A River Stage Forecasting System for Military Applications Using Artificial Neural Networks

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Forecasting of a river stage constitutes major input information in water resources planning and management. It provides a warning of impending flood stages during the times of floods and assists in regulating reservoir outflows during river low flows. The accurate determination of river stage and flow will be very useful in military to improve the understanding and safety of military scenarios.

The river flow forecasting system is believed to be highly nonlinear, time-varying, spatially distributed, and not easily described by simple models. The conceptual modeling and system theoretic modeling are two major approaches for modeling the rainfall-runoff or prediction of river flow that have been explored in literature. Recently, significant progress in the fields of nonlinear pattern recognition and system control theory have been made possible through advances in a branch of nonlinear system theoretic modeling called artificial neural networks (ANN). It is treated as a simple computing system made up of numerous, highly interconnected processing elements.

Wednesday, 1030-1200: SESSION A

Joint WG 11, WG 13 and WG 14 Session...Room 342

Anti-Submarine Warfare in the Littoral

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"Anti-Submarine Warfare is a core and enduring naval competency that will be a vital mission in the 21st century." This quote by the Chief of Naval Operations, Admiral J.L. Johnson, reflects renewed focus by the U.S. Navy on Anti-Submarine Warfare (ASW). The understanding of the role of the environment on our ASW weapons and sensor effectiveness is critical. This talk examines the mission of Naval Oceanography in assisting the operational navy in this understanding. The critical environmental factors in the littoral on ASW as well as possible strategies to deal with this dynamic ocean environment will be discussed.

Future Submarine Mission Study

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In the second quarter of the next century adversary countries will pose a greater threat to U.S. surface forces, logistic choke points, and rear area bases primarily through advances in targeting and precision guided weapons, and it will become more difficult to insert our land and surface forces into the initial phases of regional conflicts. Submarines with their characteristics of stealth, endurance, and agility, thus have the potential to play an increased role in littoral conflicts by taking on new missions.

A short study was conducted to quantitatively evaluate future submarine missions to determine required payloads and to direct the development of new technology programs. This paper briefly summarizes that activity. The study began by trying to characterize the world in 2030 and then derived some implications for submarine operations in that time frame. Naval missions were reviewed, and a preliminary assessment was made whether the mission was a current, future, or inappropriate activity for submarines. For many of the power projection missions quantitative estimates of the numbers of weapons needed for subs to conduct the mission were developed. These payload estimates were compared to the capacity of current and future surface combatants and submarines. A particularly interesting case study of the 1986 raid on Libya highlighted that one or two appropriately equipped subs could carry the firepower of the entire raid with significantly simplified logistics requirements, force structure, and risks. Marine Corps fire support requirements were used to estimate the firepower required from submarines. Small Unit operations supported by subs and drawing on new DARPA concepts, such as the Advanced Fire Support System and dispersed missile Container/Launcher Units, were a potentially an attractive new mission. Submarine launched UAVs could also be used to support a variety of missions. The successful execution of these new missions, however, requires the maintenance of current U.S. submarine advantages, especially in the area of stealth.

Wednesday, 1030-1200: SESSION B

Environmental Effects on Individual Warfighters and Systems..........Room 327

Modeling Weather Effects on the Grizzly Performance on a SAF Environment

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Engineers often perform mine plowing operations in inclement weather. A computer program has been developed to predict mobility performance of a tracked mine plow (Grizzly) to include varying weather conditions and terrain parameters. Various time intervals of one minute to one hour are available for use by the SAF environment. As part of this research the short term operation forecasts of trafficability (SOFT) model is created. Terrain data are dynamically changed in the SAF terrain data base such that the soil strengths are modified continuously with time. The SOFT model outputs soil strength changes from the surface to 18 inches as a function of the permeability, runoff, and evaporation rate expected for a given soil class. As the moisture content of the soil changes the required plowing force and available vehicle traction is predicted by a mobility performance prediction model. This study illustrates how weather changes and plowing performance can be simulated in the SAF environment.

Mission Specific Data Sets Requirements for Wheeled and Tracked Vehicle Mobility Modeling

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Realistic mobility predictions for any area of the world require certain essential terrain data, some of which will require generation from statistical climatic variations. The stochastic mobility modeling methodology is used as a tool in assessing the effect of less-than-complete input terrain data sets on mobility predictions for wheeled and tracked vehicles in various climatic zones. The Mission Specific Data Sets (MSDS) required to make an accurate mobility prediction using NRMM are determined by making multiple mobility predictions using terrain feature distributions for specific climatic zones along with known terrain data for a specific area within the same climatic zone. Speed map comparisons are presented which graphically convey the importance of selected terrain features within an area. The results of this investigation are terrain data requirements for wheeled and tracked vehicles in various climatic zones and measures of confidence on mobility speed predictions for varying levels of MSDS.

Heat Stress Potential for Naval Aircraft Refueling Operations While Wearing Chemical & Biological Protective Equipment

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This paper describes a limited investigation to evaluate the potential for heat stress to affect personnel conducting refueling operations aboard United States Navy aircraft carriers while wearing chemical/biological protective gear. This analysis was performed at the United States Army Soldier and Biological Chemical Command (SBCCOM), Natick Soldier Systems Center (Natick) for Battelle Laboratories.

Natick used SBCCOM's Integrated Unit Simulation System (IUSS) to simulate individuals performing aircraft refueling tasks under various environmental conditions. IUSS input data approximated energy expenditures to represent refueling operations. Physiological data pertaining to body temperatures, fluid levels, blood flow, and other measures were collected as thesimulations ran and key results were output and compared.

This paper discusses results, key assumptions, and details of the physiological representation used. It concludes with a discussion of potential follow-on efforts to provide more definitive analysis and conclusions.

Wednesday, 1330-1500:
Modeling Interfaces..........Room 327

Environment Model Interfaces in War Games

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Atmospheric and environmental phenomenology have been portrayed in most military war games. In ModSAF, for example, models and representations can be found for the change of illumination levels on objects due to solar and lunar motion, weather influences (such as rain, sleet and snow), and the obscuration impacts of smoke, dust and haze. Newer models have been developed that more accurately portray turbulence and radiative transfer within those phenomenology. However, these models are frequently not capable of being directly substituted into the war games, either because the data interfaces are wrong or the model may adversely affect the performance of the war game model itself.

This paper documents a study (begun in 1997) that was initiated to examine a number of war games, beginning with JANUS, ModSAF, JSIMS, and JMASS, to determine how environment is currently played in these games. Our focus has been on the specific environmental sub-models that are part of the EOSAEL and WAVES modeling packages. In this study it has been found that these atmospheric models are not used as originally developed and have been modified to accommodate the requirements of the war games. Other mechanisms for the interface between the models are discussed. An alternate, promising approach for an interface has been introduced with the development of the TAOS software. However, there are still limitations to the efficacy of the interfaces.

Analysis of the Factors That Determine Effective Logistics-Over-The-Shore (LOTS) Sites

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This research involved the development of a methodology for the selection of effective LOTS sites. In order to accomplish this objective, doctrine of the US military was reviewed to determine the various factors that affect LOTS site selection. Based on the information obtained in this doctrine review, data factors were identified for two areas of concentration. These two areas were the hinterland, where transportation activities for clearing the beach would take place, and the shoreline, where the cargo would be landed from ships offshore.

The methodology developed consisted of creating overlays of all of the ranked critical factors and analyzing them to delineate the best sites within the two areas of concentration. Once the analysis of these two areas was completed, they were combined into a product that depicted the most effective LOTS sites.

In order to validate the methodology, locations of actual preplanned LOTS sites in Korea were compared with the output of the LOTS site selection methodology. Seventy five percent of the preplanned sites were in agreement with the results of our analysis.

In conclusion, the LOTS site methodology is effective and should be incorporated into a software package to support planners for contingency operations.

SWIM-Web Based Scenario Editor Bringing Weather to the Synthetic Battlefield

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Weather is often more difficult to capture in simulation than it is to predict in real life. Nearly infinite combinations of scenario location, time, and season preclude the establishment of a comprehensive library of ready-made, simulation-specific datasets. Yet scenario developers need accurate and timely weather data that is easy and quick to integrate.

The Simulation-Weather Integration Module (SWIM) fills that need for users of Janus, a major Army constructive combat simulation. SWIM is a web-based scenario editing tool, written in Java, that typically brings users 20 to 40 years of historical data from 2511 weather reporting stations worldwide. Source data is extracted from the International Station Meteorology Climate Survey compiled by the Navy, Air Force, and Department of Commerce. Scenario developers compare existing scenario weather data with SWIM's suggestions and can select or enter specific parameters for customized studies.

Developed for the Army's Cold Regions Research and Engineering Laboratory (CRREL) to study cold weather effects in simulation, SWIM extends its utility for all climates and regions of the world. It allows rapid baseline and what-if weather scenarios critical for trainers and analysts. Environmental effects on detection, mobility, people and equipment can be studied with confidence in the data source. SWIM suggests "typical" conditions based on the scenario location, month, and time of day. While currently aimed at a predominantly Army ground simulation, SWIM design techniques can be applied to Joint and future Joint (OneSAF) simulations to provide an accurate environment for a broad range of simulations.

Environmental Effects on the Mine Impact Burial Model

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The Navy's Impact Burial Prediction Model creates a two-dimensional time history of a bottom mine as it falls through air, water, and sediment. The output of the model is the predicted burial depth of the mine in the sediment in meters, as well as height, area and volume protruding. Model input consists of environmental parameters and mine characteristics, as well as parameters describing the mine's release. Thus, investigation of burial becomes urgent. First, we show that the meteorological and oceanographic (METOC) data collected through surveys must have a resolution commensurate with both the degree of natural variability and the effect. Second, we show how to design METOC survey network to support the mine warfare community. Third, we performed a series of sensitivity tests on the Mine Impact Burial Model. It was found that the model data ingestion could be greatly simplified without sacrificing accuracy too much. However, several parameters including sediment shear strength were found to have a large effect on the model and were investigated further.

Thursday, 0830-1000:
Space Systems and the Environment
Joint WG 5 and WG 11 Session..Room 342

Cost and Operational Benefit Analyses for Space-Based Environmental Satellite Systems: An Overview

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The National Polar-Orbiting Operational Environmental Satellite System (NPOESS) is the system which will converge the currently separate NOAA Polar-Orbiting Operational Environmental Satellite (POES) System and DoD Defense Meteorological Satellite Program (DMSP). The NPOESS Integrated Program Office (IPO) is currently involved in the acquisition of the system to support a 2008 launch date. The NPOESS program has been encouraged by DoD and civil agency management to periodically reevaluate various sensor capabilities in the interest of cost savings, and to demonstrate the potential impact to users' missions as a consequence of these options.

There are two major analytical tasks in identifying operational benefits from improved environmental sensing. The first is the problem of quantifying improved environmental understanding which can be attributed to improved sensor system performance characteristics. The improved environmental understanding may include better resolution, accuracy, or coverage of current conditions. These improvements, when incorporated into numerical weather prediction models, can result in better future predictions. The second task is to convert better environmental understanding (current and forecast) into economic or other benefits ("social" benefits for the civil community, "tactical decision" benefits for national security). Both tasks are intrinsically complex and multifaceted. This presentation will describe the structure and complexity of the problem, some methodologies used and the data needed for understanding and quantifying impacts to both DoD and civilian communities.

Modeling Atmospheric Effects on Missile Warning in the Missile Defense Space Tool

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The atmosphere can absorb and scatter infrared (IR) energy emitted by a missile thus reducing the effectiveness of space based IR sensors. This paper presents the details of how atmospheric effects on missile warning are modeled in the Missile Defense Space Tool (MDST). The MDST is a medium fidelity model that simulates the ability of the DSP and SBIRS systems to detect enemy missile launches. It is the primary missile warning tool currently used at joint and USAF exercises such as Blue Flag, Roving Sands and Ulchi Focus Lens. To make MDST a realistic representation of missile warning, it is critical that it contains pragmatic atmospheric effects algorithms. This realism leads to more effective training for the warfighter.

To emulate the atmospheric effects on missile warning, two distinctly separate algorithms are applied in conjunction. This strategy is based on the fact that the principal influence on a sensor's inability to detect a missile is the interference of clouds. Therefore, the primary algorithm stochastically determines whether or not a cloud free line of site exists between a sensor and a missile based on a time varying cloud field. The secondary routine handles clear sky atmospheric transmissivity with the use of look-up tables built from the Moderate Resolution Transmissivity Model (MODTRAN) using fixed atmospheric profiles.

Thursday, 1030-1200:

Joint WG 11, WG 13 and WG 14 Session............Room 342

Ocean Optics: Impacts on Threat Detection, Vulnerability Assessment, and LIDAR System Performance in Littoral Warfare

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Underwater optics can be a critical factor in mission planning and execution because of its effects on human vision as well as the performance of electro-optical (EO) surveillance and reconnaissance systems. Unfortunately, the performance of passive (e.g., hyperspectral) sensors and active Laser Imaging, Detection, and Ranging (LIDAR) EO systems is highly dependent on water clarity. Likewise, while the combat swimmer continues to play a vital role in modern regional warfare, his performance is also subject to the optical environment. SEALS may be particularly vulnerable at key points in infiltration: clear water may allow detection by harbor sentries or fisherman; very turbid water may impact visibility range or viewing of navigational aids or the SDV control panel. Therefore, foreknowledge of the optical "battlespace" can be critical to mission and route planning. To meet this requirement, efforts by the Meteorology and Oceanography (METOC) community to characterize the littoral optical environment have gained increased momentum in recent years. However, coastal optics presents a formidable challenge because of the high spatial and temporal variability exhibited there: winds, tides and currents, river plumes, and human influences can, within hours, cause operationally significant changes.

We will describe the importance of underwater and marine boundary layer optics to Naval and Joint operations in the littoral and overview its impacts on EO and human systems. We will include applications to ASW and submarine vulnerability, mine countermeasures, and Naval Special Warfare. Satellite-based ocean color sensors for remote determination of the optical environment in denied-access areas will be discussed, including the hyperspectral Naval EarthMap Observer (NEMO).

Emerging tools and capabilities to predict the optical environment and its effects on the warfighter will be described, including the Littoral Optical Geospatial Integrated Climatology (LOGIC) and the Generic LIDAR Model (GLM). These tools will allow a number of products to be generated, including range of diver visibility, EO system performance estimates, laser bathymetry penetration depth, and asset vulnerability to EO detection. Such products will enhance the safety and tactical advantages of the warfighter.

Using a Mine-Hunting Sonar for Real-Time Environmental Characterization

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The Naval Oceanographic Office (NAVOCEANO) provides environmental support to Mine Warfare (MIW) in digital form for characterizing the environment. These data include bathymetry, sediments, mine burial probability, and climatology for currents, temperature, and salinity prior to an exercise or operation. In most cases, high-resolution data bases needed by MIW are on the order of centimeter resolution, much higher than available data bases. The mine-hunting phase of the operation using AN/AQS-14 mine-hunting side-scan sonar provides this information. Data are processed using the UNIfied Sonar Image Processing System (UNISIPS) for the processing and data-basing of the AN/AQS-14 sonar imagery. The Comprehensive Environmental Assessment System (CEAS), a Geographic Information System (GIS), is used for the integration of historical and in-situ environmental data. The AN/AQS-14 sonar imagery is processed in near-real-time (12 hours), providing the Mine Countermeasures (MCM) Commander with the current environmental picture, which is used for tactical planning. The MCM Commander can direct his assets, which include side-scan sonar, forward-looking search sonar, and Explosive Ordnance Demolition (EOD) divers efficiently, or avoid areas, which are not huntable.

The AN/AQS-14 side-scan sonar data are georeferenced, allowing for bottom characterization and identification of provinces in accordance with current MIW doctrine. In addition to bottom characterization, georeferencing can show sonar system artifacts not apparent in the standard waterfall display. Change detection is also performed, with historical or data collected during the operation.

In addition to sonar imagery, environmental data from the EOD divers (e.g., temperature, bottom grabs, and visibility), temperature and salinity collected using Expendable Bathythermographs (XBTs), and contact information are all entered into CEAS for comparison with climatology.

Presented are the GIS and image processing software, data-basing, and techniques used for MIW environmental support. Results will be presented from MIW exercises from the past two years.

A Modeling and Simulation Approach for Exploring Ship to Objective Maneuver (STOM) Concepts

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Abstract unavailable at printing.

Thursday, 1300-1530:
The Environment in Modeling & Simulation and Wargaming
Joint WG 11 and WG 29..........Room 342

Toward a Common Synthetic Natural Environment

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Currently, vast resources are expended for each simulation in the development of highly specialized Synthetic Natural Environments (SNE). The result is a duplication of capabilities in similar but disparate representations complicating the correlation problem. A correlated SNE capable of representing a broad range of effects models and environmental content at varying levels resolution is needed.

Simulations such as Modular Semi-Automated Forces (ModSAF), Close Combat Tactical Trainer (CCTT), Warfighter Simulation (WARSIM) and Joint Simulation System (JSIMS) will be required to interoperate with each other and with C4I systems in the Digital Capstone Exercise and subsequent training exercises. At STRICOM, the WARSIM/JSIMS Synthetic Natural Environment (SNE) team is working closely with the Synthetic Theatre of War (STOW) program to provide a single, seamlessly integrated representation of the land, sea, air, and space, designed for reuse in other simulations and with consideration to interoperability with other systems. Related efforts supporting the goals of reuse include: DARPA's Advanced Simulation Technology Thrust (ASTT), JSIMS Terrain Generation Process, and Synthetic Environment Data Representation and Interchange Specification (SEDRIS. These efforts would extend the JSIMS Common Data Model (JCDM), the cornerstone of this process, to include the representation required in CCTT and OneSAF. This will in turn facilitate the development of correlated multi-resolution terrain databases, reducing cost and facilitating interoperability between simulations and with C4I systems.

Other factors facilitating development of a common SNE to be addressed include; technological advances in computing resources and open systems architectures, advancements in Software Engineering methodologies, acquisition reform and associated Integrated Design Teams (IDT), and advances in the quality and correlated coverage of NIMA source data. This presentation will discuss STRICOM's development of a common database generation process under Technology Base funding and development of a strategy for a multi-resolution representation of terrain and environmental effects models and services under the DARPA ASTT program.

Atmospheric Effects and Impacts for High- and Low-Resolution Warfare Models

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The natural environment is an important factor in determining the outcome of real battles. However determining weather effects and impacts in warfare models frequently imposes a large computational cost. Low-resolution warfare models cannot afford to include physics-based calculations that are computationally burdensome for individual platforms and systems; while some high-resolution warfare models do include such computations, it is usually on a limited basis. This paper discusses proposed Atmospheric Standards being put forth under the auspices of the Army Modeling and Simulation Office that are useful for high and low-resolution modeling. The proposed Standards models include: a smoke obscuration model (COMBIC) currently used in CASTFOREM and elsewhere, an atmospheric sensor "noise" (path radiance) model (SGR), an attenuation model for haze, fog, rain and snow (XSCALE), and a climatological model (CLIMAT). Also, for low-resolution modeling, a completely new approach is presented that includes weather at an appropriate level of fidelity. This approach is based on the use of the doctrine-based Integrated Weather Effects Decision Aid model (IWEDA) tied with ACQUIRE, a range performance model for target acquisition systems. Thus, for given sensors, target and background types, probabilities of acquisition under various weather conditions can be tied directly to doctrine-based results resulting in weather penalties that are not computationally burdensome. The viability of this methodology is being examined using a beta version of AWARS.

Putting Weather into Combat Simulation

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Progress has been made in putting weather and effects into warming and simulations. However many of the models that are currently used in wargames and for assessing military effectiveness either account for weather poorly or not at all. Previous work by Air Force Research Laboratory (AFRL) achieved success in putting realistic weather and weather effects into a aircraft-weapon allocation model used to support campaign analysis. Results were used to demonstrate military utility for the joint departmental National Polar Orbiting Environmental Satellite System (NPOESS). Since then AFRL has taken the knowledge learned and is currently attempting to put realistic weather and weather effects into the Air Warfare Simulation (AWSIM) which is part of the CINC's ALSP Training Confederation. This will be a report the approach taken to integrate weather to effect air-to-ground sorties in AWSIM and how it was demonstrated in Blue Flag Exercises, one of the AF's premier training efforts.

The Effects of Vegetation on Dismounted Infantry Operations

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Prediction of realistic Line-of-Sight (LOS) conditions has always been an essential aspect of combat simulations. The representation of LOS in areas with surface features (vegetation) has never been extensively examined. However, recent advances in weapons systems, combat simulators, and the evolving mission requirements of the modern Army have demonstrated the need for a more precise understanding of how vegetation impacts LOS prediction. TRAC-WSMR and TEC recognize this problem and have developed a study to: (1) identify geotypical feature density zones; (2) document typical LOS within each with a field collection effort and; (3) predict future LOS performance. The study will: (1) facilitate the selection of a standard algorithm for LOS which performs effectively in varied feature densities and (2) provide recommendations on how to improve the play of surface features in combat models.

WG 12 LAND & EXPEDITIONARY WARFARE - AGENDA

Chair: MAJ Dennis Boykin IV, TRADOC Analysis Center
Co-Chairs: Larry Cantwell, TRADOC Analysis Center
Capt Doug Dudgeon, MCCDC; Thomas J. Iten, Raytheon E-Systems;
Bob Kourey, Raytheon; Timothy McIlhenny, Raytheon
Advisor: Dr Ephraim Martin IV, Lockheed Martin Electronics & Missiles
Room: 315

Tuesday, 1030-1200
Digital Leaders Reaction Course
Michael J. Tavares, TRADOC Analysis Center

Requirements Study and Design of a Possible Fire Control System for the Objective Crew Served Weapon
2LT Susan Castorina, 2LT Timothy Cook, 2LT Joseph Stanyer, & MAJ Greg Brouillette, Instructor, USMA

Tuesday, 1330-1500
Applying Operational Synthesis to Maneuver Warfare Questions
Dr. Gary E. Horne and Capt Brian L. Widdowson, Marine Corps Combat Development Command

The German Approach to the Future: Incorporating the US Future into the German Past to Plan for the 21st Century
David P. Harding, US Army National Ground Intelligence Center

Automated exploration of Future Urban Concepts using Agent-based Simulations
Joe V. Holland, Randy E. Michelsen, Dennis R. Powell, Steven C. Upton, David R. Thompson, Los Alamos National Laboratory

Wednesday, 0830-1000
COMPOSITE GROUP C .... Thayer Hall, South Auditorium

Wednesday, 1030-1200
Operations Analysis Support for a Joint Task Force,
Mr. Samuel R. Frost, CPT Eric J. Niksch, HQ, US Army Europe

The Army After Next: How Will We Test
Mr. James W. Fasig, Technical Director, Aberdeen Test Center

Wednesday, 1330-1500
Rapid Estimation of Battlefield Attrition in a Real-Time Maneuver Course Of Action Analysis Decision Support System
Alexander Kott, Ph.D. & Larry Ground, Logica Carnegie Group; John Langston, EER Systems, Inc.

Dynamic Force Capability Analysis (DFCA)
CPT(P) Todd M. Gesling, TRADOC Analysis Center

Evaluating the Military Utility of a Non-Lethal Weapon System using Battle Simulations
Shawn A. Miller, 1st LT, USAF, Chief, Modeling and Simulation Branch, Brooks AFB

Thursday, 0830-1000
A Sensor Pointing Terrain Interaction Model and Analysis Methodology Applied to Two Operations Other Than War Scenarios
Dr Ephraim Martin IV, Lockheed Martin Electronics & Missiles

SUO SAS (Small Unit Operations Situation Awareness System) Utility Study
Dr. Carol Jacoby, Greg McNeill, Nancy Rantowich , Dr. Emilia Webster, Raytheon Systems Company

Thursday, 1030-1200
Development of an Operations Research Software Package for Army Divisions
CPT(P) Blane C. Wilson, TRADOC Analysis Center

Broadening the Lens of an Advanced Warfighting Experiment With Agent-Based Modeling
Maj Michael West and Capt Mary Leonardi, Marine Corps Combat Development Command

The Unit Order of Battle (UOB) Data Access Tool (DAT)
Mike Hopkins, Defense Modeling & Simulation Office

Thursday, 1330-1500

Winner of the 1999 Hollis Award - ***Developing a Potential Light Infantry Force Structure for the Fielding of the Objective Crew Served Weapon (OCSW)***

Frank D. Sturek, CPT(P); David Ritter, 2LT, Student; Kingsley Fink Jr., 2LT, Student; USMA

Indirect Fire System Requirements for Army After Next

Cadets Reed Burggrabe, Michael Fransen, Aaron Tolson, Suresh Ramgopal, and Scott Greco; Directed by MAJ Barry C. Ezell, USMA

WG 12 – LAND & EXPEDITIONARY WARFARE – ABSTRACTS

Tuesday, 1030-1200

Digital Leaders Reaction Course Experiment

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Key ingredients in this experiment were the significant advances in hardware/software technologies dealing with Advanced Distributed Simulations successfully using High Level Architecture (HLA) and Distributed Interactive Simulations (DIS) concurrently. In short, the Eagle simulation was used to populate the Army Battle Command System (ABCS) databases and drive an interactive Digital Leaders Reaction Course (DLRC). The ABCS systems included the Maneuver Control System (MCS), the All Source Analysis System (ASAS), the Army Field Artillery Tactical Data System (AFATDS), and a UAV feed.

The TRADOC Analysis Center (TRAC) and The MITRE Corporation provided scenario, simulation, and other technical support for the Army Experiment 5 (AE5) Digital Training Experiment (DTE) and a DLRC exercise with the 1st Brigade 4th Infantry Division TAC CP at Fort Leavenworth, Kansas, during the period March through September 1998.

The mission of the TRAC/MITRE team was to develop and provide scenarios, simulations, and simulation-to-ABCS software interfaces sufficient to drive a proof of principle demonstration. The principle of using automated interfaces and simulations with automated command and control features in a prototype DLRC was proven and demonstrated in July 1998 and implemented with the the 1st Brigade 4th Infantry Division TAC CP in September 1998.

The TRAC/MITRE team participated in pre–DTE preparatory activities, training and preparing the MCS and AFATDS users in the use of the interfaces and applications, and conducting multiple iterations of the vignettes to enhance their tactical decision making skills. Specific activities included scenario development, simulation support, simulation to ABCS interface support, after action review system support, and hardware/software support.

If the facilities are sufficient we will also demonstrate these capabilities at the end of the presentation.

Requirements Study and Design of a Possible Fire Control System for the Objective Crew Served Weapon

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The Joint Service Small Arms Program (JSSAP) Office is researching and developing a next generation crew served weapon to replace the current family of crew served weapons at the light infantry BN and below (the M240G, M2, and the Mk 19). The Objective Crew Served Weapon (OCSW) is an automatic grenade launcher which use air burst technology to detonate its 25mm high explosive rounds over head. Thus eliminating or drastically reducing the enemy's ability to effectively seek and find cover. The JSSAP Office tasked a USMA Cadet and faculty team to design a possible Fire Control System for the OCSW which optimizes the gunners ability to complete all the tasks of the crew served weapons it will replace. The Cadet / Faculty design team conducted a requirements study, identify the critical objectives, performance parameters, developed criterion, measure of effectiveness, and alternatives, and modeled the alternatives. The design team will present the recommended alternative, simulation results, and other results and conclusions of our Systems Engineering Design Process.

Tuesday, 1330-1500

Applying Operational Synthesis to Maneuver Warfare Questions

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To begin to get at answers to maneuver warfare questions we are focused on explorations involving distillations of the essence of combat, visualization of the appropriate data, and understanding combat evolutions. This process of "Operational Synthesis" is a complement to traditional Operations Analysis—it supports the study of asymmetries, risks, and potentials through the use, *inter alia*, of agent-based distillations.

We are using agent-based models in particular for three reasons. One, they can assess the impact of often immeasurably small differences in initial conditions and intermediate interactions. Second, because tactics and doctrine need not be hard-wired into agent-based models, they exhibit emergent behavior such as discovering "tactics" and "asymmetries." They also hint at the risks and potentials associated with scenarios. Thirdly, if simulations are to be used to understand the complex nature of warfare it is essential that they be run many times—the Spartan nature of distillations enables this understanding.

In our presentation we will discuss results from millions of simulation runs obtained via supercomputing power. We will present the application of our Data Farming meta-technique in the context of questions related to maneuver warfare. In particular, we have developed a family of scenarios referred to as an Attrition Maneuver Yardstick because it serves as a tool to use in the process of beginning to understand how we might explore these questions.

The German Approach to the Future: Incorporating the US Future into the German Past to Plan for the 21st Century

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The German Federal Armed Forces (Bundeswehr) currently find themselves in a state of transition unprecedented in their post-war history. Germany's emergence as the preeminent economic and political power in Europe, increased social pressure for change, and the evolving international security environment requiring a broader spectrum of force capabilities are all forcing German civilian and military leaders to relook the way they approach security and structure the armed forces. As the Bundeswehr looks to the future, what is it using as its paradigm for the planning the future force? This paper will explore how the German Armed Forces Staff is studying likely future threats to European security, drawing on its past experiences, and studying the US vision of the future, most notably Force XXI, JV 2010, and AV 2010, to devise a uniquely German force to handle what it considers its most likely potential conflicts in the coming years. These studies, currently under way and informing the Structural Review Commission which the new Social Democratic government is launching this month, will determine the development of the Bundeswehr for the next century.

The implications for NATO and the US are significant since the Bundeswehr represents potentially the most capable European military force in post-communist Europe. Expanding global US commitments will likely require greater assistance from our allies. The Germans recognize that their future defense budgets will remain flat, but at the same time, they have far to go to modernize to attain the types of standards implicit in FORCE XXI. Can they do it? Do they want to do it? If not, in what areas will they fall short and what changes will they adopt to compensate ? What will the future Bundeswehr look like and how will it mesh with US forces in a multinational deployment? The answers to these questions have implications for US and Alliance interoperability. I intend to map out a likely course for future Bundeswehr development based on the models they are currently studying and derive some general conclusions of interest to US force developers.

Automated exploration of Future Urban Concepts using Agent-based Simulations

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As part of a Marine Corps sponsored project, we are developing a new agent-based simulation technique for automatically generating concepts we call 'generative analysis'. Generative analysis seeks to develop a new class of simulation environments that take advantage of the maturing area of complex systems science and intelligent agent research. Instead of comparing urban warfare concept alternatives developed by the analyst and imposed as input to drive the simulation, generative analysis techniques produce alternatives that the analyst might never have conceived. In essence, the approach is to construct an ecology of simple interacting agents (an agent is a simulation entity) and the environment within which they exist. We rely on using the power of the computer to create these ecologies of agents and imbue them with the ability to self organize, adapt, learn, communicate, and evolve over many thousands of trials in order to produce the ecology that is best capable of achieving the goals and objectives given to it by the analyst. We are first exploring this new methodology in the context of tactical questions in urban settings.

Wednesday, 0830-100

Wednesday, 1030-1200 Working Group 12, Session 4

Operations Analysis Support for a Joint Task Force

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Rather than focusing on traditional conflicts the US now plans for Major Theater Wars (MTW) and supports Small Scale Contingencies (SSC). This change in focus has resulted in calls for the operations research community to re-look analytical support provided to the operational and tactical levels of command. The US European Command (EUCOM) took steps in this revolution by providing Operation Analysis (OA) Teams to Joint Task Forces (JTF) in the European Theater starting in 1997. This capability is now official and is part of the EUCOM Directive 55-11. This document ensures that each JTF has the required analytical resources to plan for and execute its mission successfully.

This paper focuses on the capabilities and products that the OA team brings to the fight. The platform to demonstrate the utility of the team is a series of AGILE LION exercises featuring a Southern European Task Force (SETAF) led JTF deploying into Africa for a SSC. The authors will demonstrate products already developed and their impact on the success of the mission. Additionally, they will also offer their experiences and propose suggestions about how the OA team can integrate themselves as a key part of the JTF staff.

The Army After Next: How Will We Test

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The future of military warfighting is dictated by technology developments and the realization of new threats riddling world peace. Technology advances in energy sources, material properties, command, control, communication and intelligence, along with atypical threats challenge the Department of Defense traditional mission. The symbiotic relationship between the warfighter, the material developer and the training/doctrine community is imperative and shapes the true solution for acquisition reform.

The Army After Next is a perpetual objective and is complicated with the requirement to align it with other Service resource objectives to develop unified applications for a more lethal and efficient war machine. Mobility platforms, weapon systems and information transfer mechanisms are the common denominators supporting all Services' objectives. Reciprocal elements of variable battlefields, modular applications, self-sustaining hardware and force multipliers are the challenge. The capacity, vulnerabilities, efficiencies and management of energy sources; the "lighter than light", chameleon effects, and self-healing requirements and abilities of exotic materials through applications such as plastic muscles and memory metal; and the battlefield awareness realized through shared resources/exchange/integration of information and their control systems will drive the DoD to worldwide knowledge-based warfare.

Man as the machine complicates all of these challenges. Engineering experiments focused on stimulus and response will transition into computer analysis procedures. Today's combined test and training initiative is only the first step toward integrated knowledge-based applications. Aberdeen Test Center with its programmatic solutions for joint warfighting is an example for future acquisition platforms.

Wednesday, 1330-1500 Working Group 12, Session 5

Rapid Estimation of Battlefield Attrition in a Real-Time Maneuver Course Of Action Analysis Decision Support System

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It is the ultimate meeting point for military arts and science. When the orange force meets the blue force on the field of battle, which will prevail? How long will the conflict last? How many casualties will each side suffer? More importantly, what actions might a commander take to alter the outcome and improve his chances of success.

The estimation of attrition is fundamental to any effort to predict the outcome of an armed conflict. Tremendous amounts of time and energy have been spent in an attempt to develop predictive models for the future. The result is generally a complex, data intense framework which lends itself to deliberate planning but requires too much time to set up and employ than the commander has available when "the bullets are flying."

The authors propose a methodology for estimating combat attrition in a very rapid manner which closely approximates the rules of thumb currently employed by trained, experienced military planners. The presentation will map the factors in our methodology to those used by skilled planners, examine the relationships and address the causality of variances and their impact on the usefulness of the approach.

We believe this methodology provides a practical approach that gives the commander a useful and consistent starting point in predicting the outcome of an engagement. It is sufficiently simple and computationally fast so that when integrated into the Course Of Action Detail and Evaluation Tool (CADET), it gives the commander a means for re-planning a feasible response to disruptions in the tactical course of action, without losing the offensive momentum.

Dynamic Force Capability Analysis (DFCA)

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Approved abstract unavailable at printing..

Evaluating the Military Utility of a Non-Lethal Weapon System using Battle Simulations

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In the unstable political climate of the current age, Military Operations Other Than War (MOOTW) have become a more important mission for the United States military. In these types of missions, commanders need an option other than lethal firepower. Recently, the focus has been to implement non-lethal weapons into the force structure for these types of operations. By including these weapons into the military's arsenal, many questions are raised: how should these weapons be employed, how are the Rules of Engagement changed, and what weapon systems are effective in certain mission areas?

In an attempt to answer these and other questions, the Studies and Analysis Division of the Air Force's 311th Human Systems Wing has been performing military utility studies for the past two years to assess the effectiveness of non-lethal weapon technologies being developed by the Air Force Research Laboratory. In conducting these studies, computer simulation exercises were used to obtain outcome data. The Joint Tactical Simulation (JTS) model, developed by Lawrence Livermore National Laboratory, was used to evaluate non-lethal weapon utility in MOOTW missions.

The focus of this presentation is to report the findings of a non-lethal weapons study completed for the Army's Dismounted Battlespace Battle Lab (DBBL). Important features of JTS are presented to validate why that particular simulation tool was chosen for the study. The scenario used in the simulation exercise is presented. Finally, the results and analysis of the simulation exercise are presented.

Thursday, 0830-1000 Working Group 12, Session 6

A Sensor Pointing Terrain Interaction Model and Analysis Methodology Applied to Two Operations Other Than War Scenarios

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The dynamic interaction of sensors with terrain and tactical targets deserves special attention to help sort out the relative value of high cost sensor package options. A phenomena of particular interest when considering a reconnaissance mission is the time related actual coverage of terrain provided by a given sensor package when used with a given tactical employment logic. How much area can be covered in a given time using a given search pattern with a given set of sensors? What difference does one search logic provide compared to another? What difference does one sensor field of view provide when compared to alternatives? The methodology used in the most high fidelity combat

simulations assigns a field of regard (FOR) and within that FOR a field of view (FOV). Each FOV is viewed in a set or random period of time. The search pattern within the FOR may be systematic or random depending on the sensor and the search logic. A model was developed which uses defense map agency (DMA) terrain to graphically portray terrain survielled by the sensor suite. The sensor suite is moved on or over the terrain. A specified sensor employment logic and search methodology are employed and the terrain is painted by the model to show which area is directly observed by which sensor or sensors. The Johnson methodology is linked to the model by Monte Carlo simulation to compute which targets on the terrain are acquired. An analysis of two scenarios is presented using this model which examines the performance of several air sensor packages. Both scenarios are Operations Other Than War. The first is a coastal defense operation set in Australia. The second scenario is a central European operation set in Bosnia. Both are oriented towards air reconnaissance in a sparse target environment where both target detection and target identification are of primary importance and target engagement is a lesser priority for the sensor platform. The results are extremely revealing and instructive and are not available from most other sensor modeling and analysis methodologies.

SUO SAS (Small Unit Operations Situation Awareness System) Utility Study

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We have assessed the "Utility to the Warfighter" of a SUO SAS and of various versions of a SUO SAS. Measures of Merit include Conflict Duration, Blue Casualties, and number of target kills (both Blue and Red). The primary simulation used was a quick-turn-around Monte Carlo simulation in which battlefield players behave according to rule sets. These rule sets are based on the information which the players receive. Hence false, stale, or lack of information causes players to behave far differently than accurate, fresh, easy-to-access information. Differences in early behavior propagate and aggregate throughout the battle.

Thursday, 1030-1200 Working Group 12, Session 7
Development of an Operations Research Software Package for Army Divisions

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There exists a great potential for applying operations research techniques to solve specific problems in the areas of operations, installation support, and training at the Army division level. Because of the operational tempo of today's active-duty and reserve component units, command must focus on accomplishing the daily missions. Also, due to their limited knowledge, planners may not be aware how operations research can be used to enhance planning and operations. Time, training funds, resources, safety, personnel, and equipment are all critical factors in this process. Operations research techniques could be used to improve division-level operations by saving time, managing resources more efficiently, and helping leaders make sound decision. This thesis research is designed to increase the awareness of how the use of operations research at the division level can aid planners and decision-makers in solving real problems encountered on a daily basis, thus improving unit operations. By using Microsoft Excel, Visual Basis, and Microsoft Access, a software package was developed to assist division planners in solving problems encountered in such areas as transportation, risk management, fuel service, dining facilities, and shelf storage. Using the software package can result in division planners managing time and resources more effectively.

Broadening the Lens of an Advanced Warfighting Experiment With Agent-Based Modeling

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The Hunter Warrior Advanced Warfighting Experiment (AWE) was a large-scale field experiment whose major objective areas were dispersed tactical operations on the dispersed, non-contiguous battlefield, C4I, and fires and targeting. The concepts and forces explored through Hunter Warrior were broadly rooted in analysis of the emerging "Revolution in Military Affairs" by each of the services, Joint Staff organizations, and numerous DoD agencies.

The "Swarrior" combat model was commissioned and funded by the Office of the Secretary of Defense (Net Assessment) and MCCDC to explore the utility of agent-based modeling techniques to address specific warfighting issues. The terrain and input parameters were derived from the 3rd phase of the Culminating Phase Experiment of the Hunter Warrior AWE. The model has been partially validated by the correspondence between the exercise results and the emergent behaviors of the simulated model agents. Swarrior represents a significant capability to expand the experimental "point" of results obtained from the actual ground exercise to a "region." The model is an example of an emerging and nontraditional analytic tool, which stands to reap great benefits for the land warfare arena.

During this presentation, we will highlight the pros and cons of this particular agent-based model; discuss and illustrate other agent-based paradigms, learning and adaptation methodologies, and search space strategies which we have investigated for possible incorporation into this or a similar model; and most importantly illustrate the initial attempts to broaden the narrowly-defined lens through which AWEs are currently looked at.

The Unit Order of Battle (UOB) Data Access Tool (DAT)

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The Unit Order of Battle (UOB) Data Access Tool (DAT) project is sponsored by the DMSO Data Engineering program. UOB DAT provides simulation developers with consistent and authoritative order of battle information.

UOB DAT consists of three main components, a data interchange format (UOB-DIF), a library of authoritative UOB data sources, and a data access tool (UOB-DAT). The interchange format presents unit order of battle information from all library sources in a single understandable format based on standards in the DDDS. The data access tool features a graphical interface that allows users to browse order of battle data and select individual units. Selected units form a task force that can be used to start a simulation, exercises, or real world contingencies. The tool supports organizing the reporting hierarchy of the task force, including adding specific or generic units. Further, users can "roll up" subordinate units into a parent unit, which is important for simulations that operate at aggregation levels above the basic unit.

Thursday, 1330-1500 Working Group 12, Session 8

Winner of the 1999 Hollis Award - ***Developing a Potential Light Infantry Force Structure for the Fielding of the Objective Crew Served Weapon (OCSW)***

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The US Army is interested in maximizing the combat power and effectiveness of its light infantry units. Since World War I the primary killing system and greatest contributor to the light infantry's combat power has been the machine gun. Currently, light infantry battalions employ the M240G or M60 machine guns as their medium machine gun, and the MK19 Grenade Launcher and M2 .50 Caliber Machine Gun as their heavy machine gun. The Army Research, Development and Engineering Center (ARDEC) is currently developing and testing a potentially more lethal crew-served weapon designed to possibly replace both the medium and heavy machine guns in the not so distant future (2010).

Our design team used the US Military Academy's Systems Engineering Design Process (SEDP) to develop a set of criteria to evaluate possible force structure alternatives, possible measures of effectiveness, and a set of alternative force structures for comparison. This study specifically focused on developing a force structure that would maximize the lethality and mobility of a light infantry battalion.

We plan to model the force structure alternatives using JANUS and a Visual Basic force-on-force simulation to create data for specific measures of effectiveness (MOEs) for comparison. The different MOEs will be used as criteria in a multi-attribute decision-making model. The resulting analysis will produce a potential future light infantry battalion force structure, weapons mix, and possibly an optimal basic load for employing the OCSW, based on the selected MOE criteria.

Indirect Fire System Requirements for Army After Next

Cadets Reed Burggrabe, Michael Fransen, Aaron Tolson, Suresh Ramgopal, and Scott Greco
Directed by MAJ Barry C. Ezell, and LTC James F. Sullivan, Ph.D.
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As the United States Army emerges from the 20th Century into an uncertain and extremely rapidly changing future, it is faced with the overwhelming prospect of keeping up with the different and increasing demands that the nation will place upon it. Not only will the military of the future need to deal with conventional threats such as large scale battles fought in open or remote terrain, but it will also need to effectively meet the requirements of low intensity conflict, operations other than war, urban warfare, and humanitarian missions. The conventional force of today is too restricted, slow, and heavy to be able to effectively operate in such diverse and dynamic environments. For this reason, Picatinny Arsenal wants to design an indirect fire system that will provide effective support to a force that will meet the new needs of our nation in the 21st Century. Picatinny Arsenal has tasked our Systems Engineering Design Group with determining the operational requirements for this future indirect fire system.

WG 13 – LITTORAL WARFARE AND REGIONAL SEA CONTROL – AGENDA

Chair: LCDR Jeff Cares, USN, CNO Strategic Studies Group
Advisor: RADM Mike McCaffree, Jr., USN (Ret.), IDA
Co-Chairs: Prof. Carlos Borges, Naval Postgraduate School
Paul Cassiman, Kapos Associates Inc.
Barry Justice, Logicon, Inc.
CDR Bob Kallio, USN, OPNAV N815L1
Terry McKearney, Kapos Associates, Inc.
Ryan O'Neil, JHU/APL
Advisor: RADM Mike McCaffree, USN (Ret.)
Room: 317

Tuesday, 1030-1200
A Methodology for Ranking Naval Fast-Firing Gun Configurations Against Anti-Ship Cruise Missiles
Curtis Smith, Teledyne Brown Engineering

Operational Optimization for Dual-Mode Surface Vessels
James H. King, Naval Surface Warfare, Carderock Division

Tuesday, 1330-1500
Joint WG-13 and WG-14 Session .... **Room 342**

New Initiatives in Navy Planning
Bruce Powers, Chief of Naval Operations (N816)

DD-21 Design Reference Mission Operational Situation Development
James Hillman, The Johns Hopkins University Applied Physics Laboratory

The New Mission Area Analyses (MAAs): Analysis in support of the Marine Corps' Combat Development Process
Dr. George Akst, Marine Corps Combat Development Command

Wednesday, 0830-1000
COMPOSITE GROUP C Session .... **Thayer Hall, South Auditorium**

Wednesday, 1030-1200
Joint WG-11, WG-13 and WG-14 Session .... **Room 342**

Anti-Submarine Warfare in the Littoral
CDR Larry Gordon, USN, Chief of Naval Operations (N84M)

Future Submarines Mission Study
Dr. Matthew J. Vanderhill, Lincoln Laboratory, Massachusetts Institute of Technology

Wednesday, 1330-1500
Littoral Warfare Combat Data and Missile Combat Salvo Equations
Prof. Wayne P. Hughes, Jr., Naval Postgraduate School

Future Naval Combatant Design: Salvo Equations and Entropy
LCDR Jeffrey R. Cares, USN, Chief of Naval Operations Strategic Studies Group

Thursday, 0830-1000
Analysis of the Factors That Determine Effective Logistics-Over-The-Store (LOTS) Sites
Phillip L. Doiron, Applied Research Associates, Inc.

Analysis of Joint Doctrine in the Future Operating Environment
Paul Cassiman, Kapos Associates, Inc.

Thursday, 1030-1200
Joint WG-11, WG-13 and WG-14 Session .... **Room 342**

Ocean Optics: Impacts on Threat Detection, Vulnerability Assessment, and LIDAR System Performance in Littoral Warfare
LCDR Kimberley Davis-Lunde, Naval Meteorology and Oceanography Command;
CAPT David Martin, Deputy Undersecretary of Defense for Science and Technology;
Dr. Alan Weidemann, Naval Research Laboratory;
Dr. Gary Gilbert, Space Naval Warfare Systems Command;
Ms. Laurie Jugan, Planning Systems, Inc.

Using a Mine-Hunting Sonar for Real-Time Environmental Characterization
Stephen C. Lingsch and William C. Lingsch, Naval Oceanographic Office

Joint Countermine Operational Simulation (JCOS): A Tool to Support Concept Exploration of Operational Maneuver from the Sea (OMFTS)
Joseph Manzo, The MITRE Corporation

Thursday, 1330-1500 (Working Group Session # 8)
JWARS: Littoral Warfare
CDR Steven "Boots" Barnes, USN, OSD PA&E, JWARS Office

The Assessment of joint Operational Experimentation: The Case of Fleet Battle Experiment Echo and Lessons Learned
Prof. Alex Callahan, Naval Postgraduate School

WG 13 – LITTORAL WARFARE AND REGIONAL SEA CONTROL – ABSTRACTS

Tuesday, 1030-1200 (Working Group Session # 1)
A Methodology for Ranking Naval Fast-Firing Gun Configurations Against Anti-ship Cruise Missiles

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As naval forces explore the maritime threat of the next century, a significant and potent challenge to surface warships will continue to be anti-ship missiles (ASMs). Today, cruise missiles can be launched against ships from a variety of platforms – bombers, fighters, rotary-wing aircraft, submarines, and ships. High technology developments to make ASMs stealthier, faster and smaller will considerably complicate problems for tomorrow's naval forces. An attack from numerous missiles – or low-flying, stealthy ASMs attacking from several directions – could severely stress a naval air defense system, thereby increasing the probability of at least one of the attacking missiles successfully getting through and hitting a ship. Classic military Operations Research techniques can be used for studying this issue. We developed and executed a gun-missile engagement model based on conditional probabilities to address the problems a ship's close-in weapon system (CIWS) will encounter against an ASM. The output data generated from the execution of this model provided the basis for analysis and assessment of alternative gun configurations against current and future ASMs. Our findings provided a greater understanding and appreciation of a problem that will have a profound impact on future maritime operational concepts. This paper will describe the methodology and will present some representative examples of our analysis and assessment.

Operational Optimization For Dual-Mode Surface Vessels

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As Low Observable surface vessels are deployed, their tactics must be developed to take greatest advantage of their stealth. Yet, to be effective, during some portions of their mission stealth may be compromised. One example of this is a hypothetical Surface Warfare craft which is designed to operate in two modes. In the first mode the craft operates at high speed with moderate signatures. In a second mode, it operates at low speed with very reduced signatures. This craft is to approach the shoreline without being detected and then conduct operations. In this Monte-Carlo based optimization, we trade off speed and stealth to find the combination which will minimize the probability of detection through the craft's mission. The craft must operate against a combination of detection threats, including shore-based radars and aircraft with radar, infrared and electro-optic detectors. As this optimization is developed, it will allow the tactic to be developed against both individual threats and various combinations. Similar tradeoffs must be accomplished for other surface ships. In previous analyses, the conditions were "static"; stealth is maintained while operations are conducted. This may not be realistic. We hope to expand the methodology from this present study to broader problems.

Tuesday, 1330-1500 (Working Group Session # 2)
Joint WG-13 and WG-14 SESSION .... **Room 342**

New Initiatives in Navy Planning

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The Navy is instituting a new planning process in FY99. It centers on Integrated Warfare Architectures (IWARs), and will bring the first P in PPBS to life. The approach is to break Navy planning into 12 parts for ease of analysis, and then synthesize them in fiscally constrained alternative paths for the Navy's future. The all-Navy work is being led by N81 (OPNAV's Assessment Division).

This talk by a senior member of N81 will focus on issue definition, growing pains, and expectations once the process is mature.

DD-21 Design Reference Mission Operational Situation Development

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The DD-21 Design Reference Mission (DRM) establishes an operational Context and provides notional scenarios in which the DD-21 might be used. The DRM is provided to industry as an aid in communicating the intended Government use of the ship. The operational context is described for both discrete events and an operating workload characterization, reflecting ship workload required by routine, transition, and warfighting operations. The discrete events allow the Government to understand how particular aspects of a DD-21 design, such as survivability or weapons system performance, meet the Operational Requirements Document (ORD). The operating workload activities allow the Government to understand how the DD-21 designs respond when stressed by simultaneous activities and degraded states of system capability. DRM assumptions characterize expectations for the 2015 timeframe, which may influence DD-21 system design concepts or approaches. DRM annexes provide information on Joint Force command, control, communications, intelligence, surveillance, and reconnaissance (C4ISR) assets; DD-21 threats and targets; the littoral warfare physical environment; an ordnance assets. The assumptions and annexes provide a consistent basis on which to assess how the DD-21 designs perform in the DRM Operational Context.

This presentation will provide an overview of the DD-21 concepts development process and the methodology for the development of eight operational situations which in their aggregate establish the DD-21 Design Reference Mission Context.

The New Mission Area Analyses (MAAs): Analysis in support of the Marine Corps' Combat Development Process

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The Marine Corps has instituted a new Mission Area Analysis (MAA) process to identify operational requirements and deficiencies. In the past, the MAA process was subjective, focused on single mission areas, and somewhat lacking in analytic rigor. The new methodology extensively employs the capabilities of models and simulations to provide quantifiable findings as the basis for the Marine Corps Combat Development Process.

An initial suite of models was selected and installed to provide insight across the functional areas of maneuver, fires, C4, ISR (Intelligence, Surveillance, and Reconnaissance), logistics, and force protection. We also surveyed the spectrum of scenarios that Marine Corps forces might face in the future, and selected a representative sample that spans that spectrum to develop further; this scenario set is continually being refined and expanded. The very nature of Marine Expeditionary Operations across the domains of land, sea, and air added to the complexity of the task. Furthermore, the Marine Corps is typically employed in a joint operation, and the contributions of the other services and allies are a key part of the scenario development.

The process begins with a concept, the cornerstone of which is *Operational Maneuver From The Sea (OMFTS)*, which describes the future concept of projection of naval power ashore. With the concepts as an underpinning, we develop scenarios to explore the implementation of those concepts. While this exploration is heavily based on the analytical models, it also critically depends on the inputs from the key components of the Combat Development System (Concepts, Doctrine, Total Force Structure, Requirements, and Warfighting Development and Integration). The overall assessment is a carefully blended integration of qualitative judgment and quantitative analysis. This assessment is designed to determine the required capabilities of the future force, identify the deficiencies, and determine the best approach to overcoming those deficiencies (i.e., changes to doctrine, organization, training and education, equipment, or support and installations (DOTES)).

Wednesday, 0830-1000
COMPOSITE GROUP C Session .... **Thayer Hall, South Auditorium**

<u>Wednesday, 1030-1200</u>
Joint WG-11, WG-13 and WG-14 Session .... **Room 342**

Anti-Submarine Warfare in the Littoral

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"Anti-Submarine Warfare is a core and enduring naval competency that will be a vital mission in the 21st century." This quote by the Chief of Naval Operations, Admiral J.L. Johnson, reflects renewed focus by the U.S. Navy on Anti-Submarine Warfare (ASW). The understanding of the role of the environment on our ASW weapons and sensor effectiveness is critical. This talk examines the mission of Naval Oceanography in assisting the operational Navy in this understanding. The critical environmental factors in the littoral on ASW as well as possible strategies to deal with this dynamic ocean environment will be discussed.

Future Submarine Mission Study

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In the second quarter of the next century adversary countries will pose a greater threat to U.S. surface forces, logistic choke points, and rear area bases primarily through advances in targeting and precision guided weapons, and it will become more difficult to insert our land and surface forces into the initial phases of regional conflicts. Submarines with their characteristics of stealth, endurance, and agility, thus have the potential to play an increased role in littoral conflicts by taking on new missions.

A short study was conducted to quantitatively evaluate future submarine missions to determine required payloads and to direct the development of new technology programs. This paper briefly summarizes that activity. The study began by trying to characterize the world in 2030 and then derived some implications for submarine operations in that time frame. Naval missions were reviewed, and a preliminary assessment was made whether the mission was a current, future, or inappropriate activity for submarines. For many of the power projection missions quantitative estimates of the numbers of weapons needed for subs to conduct the mission were developed. These payload estimates were compared to the capacity of current and future surface combatants and submarines. A particularly interesting case study of the 1986 raid on Libya highlighted that one or two appropriately equipped subs could carry the firepower of the entire raid with significantly simplified logistics requirements, force structure, and risks. Marine Corps fire support requirements were used to estimate the firepower required from submarines. Small Unit operations supported by subs and drawing on new DARPA concepts, such as the Advanced Fire Support System and dispersed missile Container/Launcher Units, were a potentially an attractive new mission. Submarine launched UAVs could also be used to support a variety of missions. The successful execution of these new missions, however, requires the maintenance of current U.S. submarine advantages, especially in the area of stealth.

<u>Wednesday, 1330-1500</u>
Littoral Warfare Combat Data and Missile Combat Salvo Equations

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This presentation is a marriage of the following:
(1) A review of "salvo equations" as superior to the alternatives (e.g., a Lanchester form) for modern missile combat involving warships.
(2) Historical data of the performance of cruise missiles in over 200 attacks against merchants and warships since 1967.
(3) Application of the salvo equation model and the historical data in hypothetical operations of U.S. Navy ships against a state with a competent coastal defense.

The presenter will conclude in favor of small combatants for littoral warfare that can be sent in harm's way without as much risk of jeopardizing the operation, as complementary to the existing ships in the U.S. Navy.

Future Naval Combatant Design: Salvo Equations and Entropy

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The sole mission of the Chief of Naval Operations Strategic Studies Group is the development of revolutionary naval warfare innovation.

Futuristic studies necessarily carry the baggage of technological and operational uncertainty. To cope with this uncertainty, the SSG's analytical staff has adopted Morse and Kimball's advice to use "hemibel thinking," that is, use simple models which represent the most important aspects of the problem and look for improvement of performance of three to ten times over existing performance. Using this approach, SSG has found that the Salvo Equations are extremely useful for determining the important variables in naval combatant design, how those variables might change in the future and what the trade-off between characteristics might be. In addition, the equations provide insight about combat entropy, or the loss of combat power due to "frictions" in salvo warfare. The results of SSG studies with respect to future naval combatant design will be presented.

Thursday, 0830-1000

Analysis of the Factors That Determine Effective Logistics-Over-The-Store (LOTS) Sites

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This research involved the development of a methodology for the selection of effective LOTS sites. In order to accomplish this objective, doctrine of the US military was reviewed to determine the various factors that affect LOTS site selection. Based on the information obtained in this doctrine review, data factors were identified for two areas of concentration. The two areas were the hinterland, where transportation activities for clearing the beach would take place, and the shoreline, where the cargo would be landed from ships offshore. The methodology developed consisted of creating overlays of all of the ranked critical factors and analyzing them to delineate the best sites within the two areas of concentration. Once the analysis of these two areas was completed, they were combined into a product that depicted the most effective LOTS sites. In order to validate the methodology, locations of actual preplanned LOTS sites in Korea were compared with the output of the LOTS site selection methodology. Seventy-five percent of the preplanned sites were in agreement with the results of our analysis. In conclusion, the LOTS site methodology is effective and should be incorporated into a software package to support planners for contingency operations.

Analysis of Joint Doctrine in the Future Operating Environment

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Approved abstract unavailable at printing.

Thursday, 1030-1200

Joint WG-11, WG-13 and WG-14 Session .... **Room 342**

Ocean Optics: Impacts on Threat Detection, Vulnerability Assessment, and LIDAR System Performance in Littoral Warfare

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CAPT David Martin, Deputy Undersecretary of Defense for Science and Technology
Dr. Alan Weidemann, Naval Research Laboratory
Dr. Gary Gilbert, Space Naval Warfare Systems Command
Ms. Laurie Jugan, Planning Systems, Inc.

Underwater optics can be a critical factor in mission planning and execution because of its effects on human vision as well as the performance of electro-optical (EO) surveillance and reconnaissance systems. Unfortunately, the performance of both passive (e.g., hyperspectral) sensors and active Laser Imaging, Detection, and Ranging (LIDAR) EO systems is highly dependent on water clarity. Likewise, while the combat swimmer continues to play a vital role in modern regional warfare, his performance is also subject to the optical environment. SEALS may be particularly vulnerable at key points in infiltration: clear water may allow detection by harbor sentries or fisherman; very turbid water may impact visibility range or viewing of navigational aids or the SDV control panel. Therefore, foreknowledge of the optical "battlespace" can be critical to mission and route planning. To meet this requirement, efforts by the Meteorology and Oceanography (METOC) community to characterize the littoral optical environment have gained increased momentum in recent years. However, coastal optics presents a formidable challenge because of the high spatial and temporal variability exhibited there: winds, tides and currents, river plumes, and human influences can, within hours, cause operationally significant changes.

We will describe the importance of underater and marine boundary layer optics to Naval and Joint operations in the littoral and overview its impacts on EO and human systems. We will include applications to ASW and submarine vulnerability, mine countermeasures, and naval Special Warfare. Satellite-based ocean color sensors for remote determination of the optical environment in denied-access areas will be discussed, including the hyperspectral Naval EarthMap Observer (NEMO).

Emerging tools and capabilities to predict the optical environment and its effects on the warfighter will be described, including the Littoral Optical Geospatial Integrated Climatology (LOGIC) and the Generic LIDAR Model (GLM). These tools will allow a number of products to be generated, including range of diver visibility, EO system performance estimates, laser bathymetry penetration depth, and asset vulnerability to EO detection. Such products will enhance the safety and tactical advantages of the warfighter.

Using a Mine-Hunting Sonar for Real-Time Environmental Characterization

Stephen C. Lingsch and William C. Lingsch
Naval Oceanographic Office

The Naval Oceanographic Office (NAVOCEANO) provides environmental support to Mine Warfare (MIW) in digital form for characterizing the environment. These data include bathymetry, sediments, mine burial probability, and climatology for currents, temperature, and salinity prior to an exercise or operation. In most cases, high-resolution data bases needed by MIW are on the order of centimeter resolution, much higher than available data bases. The mine-hunting phase of the operation using AN/AQS-14 mine-hunting side-scan sonar provides this information. Data are processed using the UNIfied Sonar Image Processing System (UNISIPS) for the processing and data-basing of the AN/AQS-14 sonar imagery. The Comprehensive Environmental Assessment System (CEAS), a Geographic Information System (GIS), is used for the integration of historical and in-situ environmental data. The AN/AQS-14 sonar imagery is processed in near-real-time (12 hours), providing the Mine Countermeasures (MCM) Commander with the current environmental picture, which is used for tactical planning. The MCM Commander can direct his assets, which include side-scan sonar, forward-looking search sonar, and Explosive Ordnance Demolition (EOD) divers efficiently, or avoid areas, which are not huntable.

The AN/AQS-14 side-scan sonar data are georeferenced, allowing for bottom characterization and identification of provinces in accordance with current MIW doctrine. In addition to bottom characterization, georeferencing can show sonar system artifacts not apparent in the standard waterfall display. Change detection is also performed, with historical or data collected during the operation.

In addition to sonar imagery, environmental data from the EOD divers (e.g., temperature, bottom grabs, and visibility), temperature and salinity collected using Expendable Bathythermographs (XBTs), and contact information are all entered into CEAS for comparison with climatology.

Presented are the GIS and image processing software, data-basing, and techniques used for MIW environmental support. Results will be presented from MIW exercises from the past two years.

Joint Countermine Operational Simulation (JCOS): A Tool to Support Concept Exploration of Operational Maneuver from the Sea (OMFTS)

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Approved abstract unavailable at printing.

Thursday, 1330-1500
JWARS: Littoral Warfare

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The Joint Warfare System (JWARS) will be a state-of-the-art, constructive simulation that shall provide a multi-sided and balanced representation of joint theater warfare. Users of JWARS will include the CINCs, Joint Task Force (JTF) Commanders/Staff, Services, Joint Staff, Office of the Secretary of Defense (OSD), and other DoD organizations. JWARS will be capable of performing Course of Action and Force Sufficiency analyses at IOC, and will be able to perform System Effectiveness and Trade-off analysis and Concept and Doctrine Development at FOC.

This presentation will provide insight into the Maritime warfighting functionality that has been designed into the JWARS simulation to date. Discussion will center around Surface Warfare, Mine Warfare, Undersea Warfare, Naval Blockade, Aegis TBMD and Forcible Entry (Amphibious Warfare). A Screen Cam image of the simulation will be available at MORSS and will provide a point of discussion where appropriate. The Joint Analytical Improvement Program (JAMIP) is the proponent of the JWARS model. The associated JAMIP Executive Committee (EXCOM) and Steering Committee (SC) are the associated approval authorities for the JWARS program. This presentation will discuss the importance of Joint warfare and its relationship to Maritime capabilities along with JAMIP oversight to the program.

The Assessment of Joint Operational Experimentation: the Case of Fleet Battle Experiment Echo and Lessons Learned

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Professor Gordon Schacher, Naval Postgraduate School
Professor Michael Sovereign, Naval Postgraduate School

The Fleet Battle Experiments (FBEs) are a series of operational experiments initiated by the Chief of Naval Operations to examine emerging systems, technologies and concepts. The Maritime Battle Center plans and implements these experiments in conjunction with the numbered Fleets. The Commander Third Fleet (COMTHIRDFLT) in San Diego is the operational sponsor for FBE-Echo, which is the fifth in the series. The Naval Postgraduate School (NPS) has been asked to perform assessment for FBE-Echo during March and April 1999. This presentation is based upon the planning and conduct of the FBE-Echo assessment.

FBE- Echo will draw upon its four predecessors, specifically Alpha and Bravo, which were also COMTHIRDFLT experiments. In particular there are follow-ons to the Precision Engagement, Network Centric Land Attack and Theatre Aircraft and Missile Defense from Alpha and the targeting process from Bravo. FBE-Echo will highlight new JV 2010 operational concepts and capabilities for Full-Dimension Protection against asymmetric threats in urban environments, network-centric undersea warfare, theatre air defense integrated with the civilian air picture, information superiority and also in Precision Engagement with fusion and reachback for information support of targeting and dynamic weapon-target pairing against urban and Weapon of Mass Destruction targets.

The Modular C2 Evaluation Structure (MCES), developed at NPS in conjunction with the Military Operations Research Society, will provide the framework for the assessment.

WG 14 – POWER PROJECTION, PLANNING AND EXECUTION – AGENDA

Chair: Jack Keane, JHU/APL
Co-Chairs: Tim Sullivan, Raytheon Systems Company
Jim Warren, Strategic Insight, Ltd.
Trena Covington, JHU/APL
Ron Johnson, USAF UAV Battlelab
Advisor: Bruce Powers, Chief of Naval Operations (N816)
Room: 319

Tuesday, 1030-1200
WG-14: Planning Tools .... **Room 319**
Planning Tools for the 21st Century Warrior: Challenges for Real-Time Operations Analysis
Dr. James Montgomery and Greg Schow, US Army STRICOM, Larry Willis, Defense Advanced Research Projects Agency (DARPA), Rich Moore, Lockheed Martin Information Systems Company

Virtual Simulation and Joint Experimentation – STOW and Joint Attack Operations
Mr. Rae Dehncke, Advanced Information Technology Services – JPO; C. Todd Morgan, Space & Naval Warfare Systems Center

Tuesday, 1330-1500
Joint WG-13 and WG-14 Session .... **Room 342**

New Initiatives in Navy Planning
Bruce Powers, Chief of Naval Operations (N816)

DD-21 Design Reference Mission Operational Situation Development
James Hillman, The Johns Hopkins University Applied Physics Laboratory

The New Mission Area Analyses (MAAs): Analysis in support of the Marine Corps' Combat Development Process
Dr. George Akst, Marine Corps Combat Development Command

Wednesday, 0830-1000
COMPOSITE GROUP C Session .... **Thayer Hall, South Auditorium**

Wednesday, 1030-1200
Joint WG-11, WG-13 and WG-14 Session .... **Room 342**

Anti-Submarine Warfare in the Littoral
CDR Larry Gordon, Chief of Naval Operations (N84M)

Future Submarines Mission Study
Dr. Matthew J. Vanderhill, Lincoln Laboratory, Massachusetts Institute of Technology

Wednesday, 1330-1500
WG-14: Power Projection Concepts .... **Room 319**
Cruise Missile Attack Center (CMAC) Concept of Operations
Troy Bentz, Naval Surface Warfare Center, Dahlgren Division (NSWCDD)

CVX and DD21 - Forging the Battle Group Concepts of the Future
Donald R. Bouchoux, John Lillard, Kevin Moore, Whitney, Bradley & Brown, Inc.

Thursday, 0830-1000
WG-14: Mission Effectiveness, Rehearsal and Precision .... **Room 319**
Model for Optimizing Munition Allocation in the Presence of Camouflage, Concealment, and Deception (CCD)
Dr. John F. Ebersole, Creative Optics, Inc., Arthur E. LaGrange, US Army Operational Test and Evaluation Command

Global Positioning System (GPS) Joint Operational Battlefield Environment (JOBE) Joint Feasibility Study (JFS)
George T. Cherolis, GPS JOBE JFS (TRW) and Dennis L. Lester, GPS JOBE JFS (SRC), Kirtland AFB

Thursday, 1030-1200
Joint WG-11, WG-13 and WG-14 Session .... **Room 342**

Ocean Optics: Impacts on Threat Detection, Vulnerability Assessment, and LIDAR System Performance in Littoral Warfare
LCDR Kimberley Davis-Lunde, Naval Meteorology and Oceanography Command;
CAPT David L. Martin, Deputy Undersecretary of Defense for Science and Technology;
Dr. Alan D. Weidemann, Naval Research Laboratory;
Dr. Gary D. Gilbert, Space and Naval Warfare Systems Center;
Ms. Laurie A. Jugan and Dr. Walton E. McBride, Planning Systems Incorporated

Using a Mine-Hunting Sonar for Real-Time Environmental Characterization
Stephen C. Lingsch and William C. Lingsch, Naval Oceanographic Office

A Modeling and Simulation Approach for Exploring Ship to Objective Maneuver (STOM) Concepts
Joe Manzo, The MITRE Corporation

Thursday, 1330-1500 (Working Group Session # 8)
WG-14: USAF Collaborative Mission Planning .... **Room 319**
Collaborative Tools For The Joint Air Operations Center
Major Douglas L. Clark, USAF Command and Control Battlelab

Speech Recognition
Major Eben A. Hughes, USAF Command and Control Battlelab

Warfighter Gateway
Major Richard M. Nehls, USAF Command and Control Battlelab

WG 14 – POWER PROJECTION, PLANNING AND EXECUTION – ABSTRACTS

Tuesday, 1030-1200 (Working Group Session # 1)
WG-14: Planning Tools .... **Room 319**

Planning Tools for the 21st Century Warrior: Challenges for Real-Time Operations Analysis

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In July 1998, as an outgrowth of its work on innovative Course of Action Analysis tools, DARPA commissioned a STRICOM-managed study to research existing tools and processes for planning Joint operations and conducting mission rehearsals. This study was an initial exploratory step toward identifying requirements for the next generation of tools and processes to support the high-tempo, information-intensive environments anticipated in Joint Vision 2010 and beyond. The study (1) defined the mission planning/rehearsal environment; (2) identified applicable existing technologies and tools; (3) assessed the maturity and applicability of those technologies and tools; and (4) made recommendations for demonstrating a prototype system to meet capability shortfalls.

The major result of the study is the need to develop interoperable, at least semi-automated planning tools. These tools must be synchronized across Service and Joint warfare functional areas. They will enable the military commander to make faster, more effective and better-informed decisions, thereby turning inside the enemy's decision cycle. They will essentially perform operations analysis in real-time, based upon digitized data.

This presentation (and paper) will summarize the results of the study and postulate an initial set of requirements for automated operations analysis tools for digitized warfare which will meaningfully increase commanders' knowledge of the battlefield in real-time and their subsequent ability to act swiftly and decisively. We would like to challenge the Operations Research community to get out in front of today's planners and analysts to identify and create real-time operations analysis tools for the next generation of warfighter to use on the digitized battlefield.

Virtual Simulation and Joint Experimentation – STOW and Joint Attack Operations

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Tuesday, 1330-1500 (Working Group Session # 2)
Joint WG-13 and WG-14 SESSION .... Room 342

New Initiatives in Navy Planning

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The Navy is instituting a new planning process in FY99. It centers on Integrated Warfare Architectures (IWARs), and will bring the first P in PPBS to life. The approach is to break Navy planning into 12 parts for ease of analysis, and then synthesize them in fiscally constrained alternative paths for the Navy's future. The all-Navy work is being led by N81 (OPNAV's Assessment Division).

This talk by a senior member of N81 will focus on issue definition, growing pains, and expectations once the process is mature.

DD-21 Design Reference Mission Operational Situation Development

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The DD-21 Design Reference Mission (DRM) establishes an operational Context and provides notional scenarios in which the DD-21 might be used. The DRM is provided to industry as an aid in communicating the intended Government use of the ship. The operational context is described for both discrete events and an operating workload characterization, reflecting ship workload required by routine, transition, and warfighting operations. The discrete events allow the Government to understand how particular aspects of a DD-21 design, such as survivability or weapons system performance, meet the Operational Requirements Document (ORD). The operating workload activities allow the Government to understand how the DD-21 designs respond when stressed by simultaneous activities and degraded states of system capability. DRM assumptions characterize expectations for the 2015 timeframe, which may influence DD-21 system design concepts or approaches. DRM annexes provide information on Joint Force command, control, communications, intelligence, surveillance, and reconnaissance (C4ISR) assets; DD-21 threats and targets; the littoral warfare physical environment; an ordnance assets. The assumptions and annexes provide a consistent basis on which to assess how the DD-21 designs perform in the DRM Operational Context.

This presentation will provide an overview of the DD-21 concepts development process and the methodology for the development of eight operational situations which in their aggregate establish the DD-21 Design Reference Mission Context.

The New Mission Area Analyses (MAAs): Analysis in support of the Marine Corps' Combat Development Process

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The Marine Corps has instituted a new Mission Area Analysis (MAA) process to identify operational requirements and deficiencies. In the past, the MAA process was subjective, focused on single mission areas, and somewhat lacking in analytic rigor. The new methodology extensively employs the capabilities of models and simulations to provide quantifiable findings as the basis for the Marine Corps Combat Development Process.

An initial suite of models was selected and installed to provide insight across the functional areas of maneuver, fires, C4, ISR (Intelligence, Surveillance, and Reconnaissance), logistics, and force protection. We also surveyed the spectrum of scenarios that Marine Corps forces might face in the future, and selected a representative sample that spans that spectrum to develop further; this scenario set is continually being refined and expanded. The very nature of Marine Expeditionary Operations across the domains of land, sea, and air added to the complexity of the task.

Furthermore, the Marine Corps is typically employed in a joint operation, and the contributions of the other services and allies are a key part of the scenario development.

The process begins with a concept, the cornerstone of which is *Operational Maneuver From The Sea (OMFTS)*, which describes the future concept of projection of naval power ashore. With the concepts as an underpinning, we develop scenarios to explore the implementation of those concepts. While this exploration is heavily based on the analytical models, it also critically depends on the inputs from the key components of the Combat Development System (Concepts, Doctrine, Total Force Structure, Requirements, and Warfighting Development and Integration). The overall assessment is a carefully blended integration of qualitative judgment and quantitative analysis. This assessment is designed to determine the required capabilities of the future force, identify the deficiencies, and determine the best approach to overcoming those deficiencies (i.e., changes to doctrine, organization, training and education, equipment, or support and installations (DOTES)).

COMPOSITE GROUP C Session ....Thayer Hall, South Auditorium

Wednesday, 1030-1200 (Working Group Session # 4)
Joint WG-11, WG-13 and WG-14 Session ....Room 342

Anti-Submarine Warfare in the Littoral

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"Anti-Submarine Warfare is a core and enduring naval competency that will be a vital mission in the 21st century." This quote by the Chief of Naval Operations, Admiral J.L. Johnson, reflects renewed focus by the U.S. Navy on Anti-Submarine Warfare (ASW). The understanding of the role of the environment on our ASW weapons and sensor effectiveness is critical. This talk examines the mission of Naval Oceanography in assisting the operational Navy in this understanding. The critical environmental factors in the littoral on ASW as well as possible strategies to deal with this dynamic ocean environment will be discussed.

Future Submarine Mission Study

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In the second quarter of the next century adversary countries will pose a greater threat to U.S. surface forces, logistic choke points, and rear area bases primarily through advances in targeting and precision guided weapons, and it will become more difficult to insert our land and surface forces into the initial phases of regional conflicts. Submarines with their characteristics of stealth, endurance, and agility, thus have the potential to play an increased role in littoral conflicts by taking on new missions.

A short study was conducted to quantitatively evaluate future submarine missions to determine required payloads and to direct the development of new technology programs. This paper briefly summarizes that activity. The study began by trying to characterize the world in 2030 and then derived some implications for submarine operations in that time frame. Naval missions were reviewed, and a preliminary assessment was made whether the mission was a current, future, or inappropriate activity for submarines. For many of the power projection missions quantitative estimates of the numbers of weapons needed for subs to conduct the mission were developed. These payload estimates were compared to the capacity of current and future surface combatants and submarines. A particularly interesting case study of the 1986 raid on Libya highlighted that one or two appropriately equipped subs could carry the firepower of the entire raid with significantly simplified logistics requirements, force structure, and risks. Marine Corps fire support requirements were used to estimate the firepower required from submarines. Small Unit operations supported by subs and drawing on new DARPA concepts, such as the Advanced Fire Support System and dispersed missile Container/Launcher Units, were a potentially an attractive new mission. Submarine launched UAVs could also be used to support a variety of missions. The successful execution of these new missions, however, requires the maintenance of current U.S. submarine advantages, especially in the area of stealth.

Wednesday, 1330-1500 (Working Group Session # 5)
WG-14: Naval Warfare Session ....Room 342
Cruise Missile Attack Center (CMAC) Concept of Operations

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CVX and DD21 - Forging the Battle Group Concepts of the Future

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Thursday, 0830-1000 (Working Group Session # 6)
WG-14: Mission Effectiveness, Rehearsal and Precision..........Room 319

Model for Optimizing Munition Allocation in the Presence of Camouflage, Concealment, and Deception (CCD)

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Creative Optics, Inc. has been developing tools for the DoD to assess the performance of man-in-the-loop and autonomous munitions degraded by camouflage, concealment, and deception (CCD). These tools range from our Mobile Army Camouflage Evaluation (MACE) portable data collection and assessment field test equipment to PC-based models for optimizing aircraft sortie and munition allocation in the presence of CCD.

The optimal allocation of resources is a primary goal of mission planning and logistics. CCD techniques are employed explicitly to induce uncertainty, vagueness, and error in both munition effectiveness and munition deployment. We have developed a mission planning model for determining the optimal allocation of a set of munitions against an ensemble of targets. This model takes into account the error-inducing effects of CCD as well as the numerical vagueness of available CCD effectiveness data.

The DoD has conduced the Joint Camouflage, Concealment, and Deception (JCCD) air-to-ground field test program to systematically quantify the effects of CCD on target acquisition. We have been able to successfully apply the JCCD data in our model for calculating the effects of CCD on optimal munition allocation.

Global Positioning System (GPS) Joint Operational Battlefield Environment (JOBE) Joint Feasibility Study (JFS)

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The GPS JOBE JFS was directed by the Director, Test, Systems Engineering, and Evaluation (DTSE&E) to determine the necessity and feasibility of conducting an Office of the Secretary of Defense (OSD)-sponsored Joint Test and Evaluation (JT&E). The fundamental purpose of the GPS JOBE JT&E will be to shed light on effects of hostile GPS Electronic Warfare (EW) on Joint operations and identify ways to minimize mission impacts. Throughout the JT&E nomination and JFS phase, the Joint community expressed three major concerns that provided a basis for the GPS JOBE problem statement and JT&E issues:

- What happens to warfighters and their support activities when GPS is denied or degraded?
- What can warfighters do to minimize risks in a GPS-denied/degraded environment?
- How can DOD reduce GPS EW vulnerabilities in future acquisition and integration efforts?

The GPS JOBE problem statement derived from these questions is as follows: Electronic Warfare vulnerabilities are a major shortfall of military GPS, the extent and impact of these vulnerabilities on joint operations are not known nor are the opportunities for mitigation well understood. The related issues that stem from this problem statement are as follows:

- To what extent are joint operations vulnerable to GPS EW with and without mitigation techniques?
- How well do current and enhanced T&E processes identify GPS vulnerabilities?

If chartered, the GPS JOBE JT&E will consist of a series of mini-tests and field tests that concentrate on performance and effectiveness of Joint reconnaissance and interdiction missions. It is envisioned these tests will be conducted on live test and training ranges and be augmented by virtual and constructive simulations. These tests will become increasingly complex as the focus shifts from small unit ground operations to larger scale operations that extend from the Joint Task Force (JTF) level down to tactical land, sea, and air elements.

This presentation will cover the background on the GPS JOBE JFS; proposed test architecture and approach; and expected benefits and products from the JT&E.

Thursday, 1030-1200 (Working Group Session # 7)
Joint WG-11, WG-13 and WG-14 Session......Room 342

Ocean Optics: Impacts on Threat Detection, Vulnerability Assessment, and LIDAR System Performance in Littoral Warfare

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Underwater optics can be a critical factor in mission planning and execution because of its effects on human vision as well as the performance of electro-optical (EO) surveillance and reconnaissance systems. Unfortunately, the performance of passive (e.g., hyperspectral) sensors and active Laser Imaging, Detection, and Ranging (LIDAR) EO systems is highly dependent on water clarity. Likewise, while the combat swimmer continues to play a vital role in modern regional warfare, his performance is also subject to the optical environment. SEALS may be particularly vulnerable at key points in infiltration: clear water may allow detection by harbor sentries or fisherman; very turbid water may impact visibility range or viewing of navigational aids or the SDV control panel. Therefore, foreknowledge of the optical "battlespace" can be critical to mission and route planning. To meet this requirement, efforts by the Meteorology and Oceanography (METOC) community to characterize the littoral optical environment have gained increased momentum in recent years. However, coastal optics presents a formidable challenge because of the high spatial and temporal variability exhibited there: winds, tides and currents, river plumes, and human influences can, within hours, cause operationally significant changes.

We will describe the importance of underwater and marine boundary layer optics to Naval and Joint operations in the littoral and overview its impacts on EO and human systems. We will include applications to ASW and submarine vulnerability, mine countermeasures, and Naval Special Warfare. Satellite-based ocean color sensors for remote determination of the optical environment in denied-access areas will be discussed, including the hyperspectral Naval EarthMap Observer (NEMO).

Emerging tools and capabilities to predict the optical environment and its effects on the warfighter will be described, including the Littoral Optical Geospatial Integrated Climatology (LOGIC) and the Generic LIDAR Model (GLM). These tools will allow a number of products to be generated, including range of diver visibility, EO system performance estimates, laser bathymetry penetration depth, and asset vulnerability to EO detection. Such products will enhance the safety and tactical advantages of the warfighter.

Using a Mine-Hunting Sonar for Real-Time Environmental Characterization

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The Naval Oceanographic Office (NAVOCEANO) provides environmental support to Mine Warfare (MIW) in digital form for characterizing the environment. These data include bathymetry, sediments, mine burial probability, and climatology for currents, temperature, and salinity prior to an exercise or operation. In most cases, high-resolution data bases needed by MIW are on the order of centimeter resolution, much higher than available data bases. The mine-hunting phase of the operation using AN/AQS-14 mine-hunting side-scan sonar provides this information. Data are processed using the UNIfied Sonar Image Processing System (UNISIPS) for the processing and data-basing of the AN/AQS-14 sonar imagery. The Comprehensive Environmental Assessment System (CEAS), a Geographic Information System (GIS), is used for the integration of historical and in-situ environmental data. The AN/AQS-14 sonar imagery is processed in near-real-time (12 hours), providing the Mine Countermeasures (MCM) Commander with the current environmental picture, which is used for tactical planning. The MCM Commander can direct his assets, which include side-scan sonar, forward-looking search sonar, and Explosive Ordnance Demolition (EOD) divers efficiently, or avoid areas, which are not huntable.

The AN/AQS-14 side-scan sonar data are georeferenced, allowing for bottom characterization and identification of provinces in accordance with current MIW doctrine. In addition to bottom characterization, georeferencing can show sonar system artifacts not apparent in the standard waterfall display. Change detection is also performed, with historical or data collected during the operation.

In addition to sonar imagery, environmental data from the EOD divers (e.g., temperature, bottom grabs, and visibility), temperature and salinity collected using Expendable Bathythermographs (XBTs), and contact information are all entered into CEAS for comparison with climatology.

Presented are the GIS and image processing software, data-basing, and techniques used for MIW environmental support. Results will be presented from MIW exercises from the past two years.

A Modeling and Simulation Approach for Exploring Ship to Objective Maneuver (STOM) Concepts

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Thursday, 1330-1500 (Working Group Session # 8)
WG-14: USAF Collaborative Mission Planning..........Room 319

Collaborative Tools For The Joint Air Operations Center

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The United States Air Force (USAF) has embraced the concept of a reduced forward presence during contingencies through distributed operations and the expeditionary air force concept. The USAF Command and Control Battlelab (C2B) has identified collaborative tools (CT) in the Joint Air Operations Center (JAOC) as an innovation that will enhance the efficiency and effectiveness of JAOC processes

To effectively meet the study goals the C2B conducted research to identify available collaborative tool capabilities. Once identified, CT capabilities were demonstrated to warfighter subject matter experts from Numbered Air Forces, Air Operations Groups, Army, Navy, and Marines to determine what collaborative tools and capabilities are required. The CT concept was assessed by warfighters during Expeditionary Force Experiment 1998 in a distributed JAOC environment.

In general terms warfighters require a collaborative capability that is powerful, fast, easy to use, and intuitive to learn. Several basic collaborative capabilities/tools were identified as essential. The standard computer embedded collaborative tools suite needed to support the JAOC warfighter include: video, audio, chat, whiteboard, video/audio broadcast, scrolling bulletins, shared applications, web tools, and virtual environments. Study revealed the keystone for implementation of collaborative tools is robust, redundant, and reliable communications connectivity with adequate bandwidth for rapid data exchange.

Collaborative tools must be fully DII COE compliant and interoperable with command and control systems architecture from the GCCS level down. While no single product meets all warfighter collaborative needs, the most capable GOTS/COTS product (or combination thereof) providing the closest approximation of warfighter requirements should be implemented.

Speech Recognition

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The United States Air Force has been interested in speech recognition technology since the early eighties. This interest was spurred by the steady escalation of aircraft cockpit complexity and increased demand on the pilot to stay "heads-up and "eyes out." The capability to enter data and commands verbally to the aircraft computers promised considerable manual workload reduction.

Since the early eighties, rapid improvement in microcomputer technology has enhanced recognition algorithms and hardware. The added robustness of the resulting recognition systems indicate that the technology has matured sufficiently to consider not only aircraft applications, but also applications in other highly task oriented and complex environments, such as the Joint Air Operations Center (JAOC).

Speech recognition technology may be effective in supporting JAOC planning and execution tasks. Speech recognition technologies can allow the warfighter to complete his tasking to develop the Air Tasking Order (ATO) faster, more intuitively and naturally, and with fewer constraints. With speech recognition capabilities the user could navigate through menus quicker, and fill-in data fields by speaking to the computer with or without the use of a mouse, keyboard, or light pen. Benefits will result through reduced operator workload and training.

Warfighter Gateway

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The United States Air Force will arrive at the 21st Century as an Expeditionary Aerospace Force (EAF) embracing the Air Expeditionary Force (AEF) concept as its vehicle for presentation of forces to a theater Commander-in-Chief (CINC). AEF assets will require a reliable C2 gateway to maintain connectivity with the Joint Force Air Component Commander (JFACC) command elements for dissemination of common situational awareness, threat information, and updated guidance while enroute to their theater of operations. Airborne AEF connectivity and reach back capabilities are presently either extremely limited or in most cases non-existent for the initial forces arriving in theater. Furthermore, existing fighter aircraft datalinks are limited to Line Of Sight (LOS) transmission while actual operations often require access to Beyond Line Of Sight (BLOS) information. No gateway link presently exists between SATCOM broadcast information (Tactical Related Application (TRAP)/Tactical Data Dissemination System (TDDS), Tactical Information Broadcast System (TIBS), and Global Broadcast System (GBS)) and fighter aircraft and ground force datalinks (Link 16, Improved Data Modem (IDM), and Situational Awareness Data Link (SADL). The planned divestiture of the Airborne Battlefield Command and Control Center (ABCCC) aircraft further complicates the C2 issue by creating an interim deficiency in BLOS communications relay for aircraft in direct support of ground forces. The purpose of this combined Initiative is to determine the operational utility of an airborne gateway capable of disseminating both retargeting and situational awareness information directly to cockpit displays of Link 16, IDM, or SADL equipped AEF aircraft.

WG 15 – AIR POWER AND COMBAT IDENTIFICATION ANALYSIS – AGENDA

Chair: Chuck Sadowski, Veridian Engineering, ACC/DRAI
Co-Chairs: Joanne Heath, Raytheon
Maj Robert Siegle, AFSAA/SAAA
Karen Childers, ACC/SAS
Mike Agin, Pioneer Technologies, JCSAR JT&E
Advisor: Audree Newman, AFMC OAS-DR
Room: 345

Tuesday, 1030-1200
SESSION FOCUS: The JSF and the Future .... **Room 345**

Virtual Simulation in Support of the JSF ORD
Timothy Menke, ASC/ENMAV

JSF Air-to-Air Combat Analysis
Joseph Mason, Veridian Engineering and Timothy Menke, ASC/ENMAV

Maximizing Return on Investment: Refining ACC's Modernization Planning Process
David Hickman, ACC/SAS and Lisa Jean Moya, ACC/SAS and Donna Farren, ACC/SAS

Tuesday, 1330-1500
SESSION FOCUS: Modeling Tools .... **Room 345**

Next Generation Campaign Level Air-to-Air Model
James Brady, S3I

A Bayesian Decision Model for Aggregating CID Evidence
Maj Robert Kewley, USMA Dept. of Sys. Engineering and L/C William Carlton, USMA Dept. of Sys. Engineering

The GLACIER Model
Thomas Donohue, AFRL/SNZT and Jon Wollam, Veridian Engineering

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Wednesday, 1030-1200
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Air-to-Ground CID Architecture Comparison Report
Maj Stu Stopkey, AFSAA

Air-to-Ground CID Requirements Study
Thomas Donohue, AFRL/SNZT and Paul Hylton, Veridian Engineering

Development of Joint CID Investment Strategy – An Analytical Approach
L/C Mark Tillman, J8 Joint Warfighting Capabilities Assessment Directorate and Ken Mellin, COLSA Corporation

Wednesday, 1330-1500
SESSION FOCUS: Weapons and Combat .... **Room 345**

Model for Optimizing Munition Allocation in the Presence of CCD
Dr. John Ebersole, Creative Optics and Arthur LaGrange, US Army OT&E Command Evaluation Analysis Center

Future Conventional Weapons and Force Structure Study
Maj Stu Stopkey, AFSAA and Norman Pallister, AFSAA

ACC: Tracking Combat Potential and Military Worth
David Hickman, ACC/SAS

Thursday, 0830-1000
SESSION FOCUS: Planning .... **Room 345**

Operations Planner: Strategy Cell Assistant
Maj Douglas Fuller, AF/XOOC

Geospatial Information Process Simulation
L/C Melissa Buckmaster, National Imagery and Mapping Agency

Geographical Information System Advancements for Mission Planning and Rehearsal
Phillip Doiron, Applied Research Associates

Thursday, 1030-1200
SESSION FOCUS: ABL and the Barchi Prize Honorable Mention .... **Room 345**

ABL High Value Airborne Asset Protection
Karen Childers, System Simulation Solutions, ACC/SAS

ABL Counter-Salvo Requirement Analysis
Karen Childers, System Simulation Solutions, ACC/SAS

Effectiveness of Aircraft Alternatives for the CSAR Mission (Barchi Prize Honorable Mention)
George Thompson, ANSER

Thursday, 1330-1500
SESSION FOCUS: Put the Man in the Loop! .... **Room 345**

JCSAR Distributed Interactive Simulation
Mike Agin, Pioneer Technologies and John Whitaker, Veridian Engineering

AF Battlelab Contributions to Expeditionary Aerospace Forces
Corrine Wallshein, AFSAA and Geoffrey Mason, AFSAA and Mark Goergen, SimSupport Inc

WG 15 – AIR POWER AND COMBAT IDENTIFICATION ANALYSIS - ABSTRACTS

Tuesday, 1030-1200
The JSF and the Future .... **Room 345**

Virtual Simulation in Support of the JSF ORD

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JSF Air-to-Air Combat Analysis

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Maximizing Return on Investment: Refining ACC's Modernization Planning Process

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Air Combat Command spends over seven billion dollars annually on the modernization and procurement of weapons systems. The Modernization Planning Process (MPP) provides two products in order to aid in the decision of where dollars are spent. The first is a set of Mission Area Plans giving a 25 year fiscally unconstrained outlook for each mission area's needs, priorities, and systems to buy and / or improve. The second is a list of system procurements , which are optimized by military worth, technical risk, and acquisition, ownership, and shared costs at various funding levels.

The current process is complex. It relies on subjective scoring to determine the military necessity of developing potential future systems and making improvements to current systems (Needs). The current process also uses subjective scoring techniques to determine the military worth of technologies or hardware solutions to identified needs (Solutions). A serious issue is the questionable tie-in with the POM process. The lack of coordination and cooperation with planners and programmers results in a product that has not been used extensively to support the POM.

The refinement effort attempts to use multi-objective decision analysis techniques to correct shortfalls in the current process. The goal is to conduct a parallel effort with the current process that will validate improvements and gain support from the planners and programmers. There are three major components of this study. The first is the refinement of the linkage between national strategy and the military worth of Solutions. We have reduced six hierarchical levels that terminated at a subjective evaluation of system worth to three levels which terminate at system attributes or measures of effectiveness. The second effort is to develop measures of effectiveness that can be used to objectively (either quantitatively or qualitatively) evaluate Solutions. The third piece of analysis is to develop a value model that will allow the determination of each Solution's military worth.

The conceived refinement provides a robust, traceable, and expandable process that will allow easier understanding and use by planners and programmers. It has its roots in facts and quantitative data and will allow users to more easily document the rationale for decisions and solutions sets.

Tuesday, 1330-1500
Modeling Tools ....Room 345

Next Generation Campaign Level Air-to-Air Model

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A discussion of the next generation campaign level air-to-air adjudicator for use in the Synthetic Theater Operations Research Model (STORM). STORM ensures that the Air Force has a full-support simulation for properly examining issues involving the utility and effectiveness of air and space systems in a theater-level, joint warfighting context. Under the current development profile, STORM will become the Air Force's campaign analytic tool for acquisition and course-of-action analyses around the turn of the century.

The objective of this new methodology is to increase the resolution of campaign level air-to-air combat modeling beyond that of models like THUNDER, while still remaining highly aggregated, in order to meaningfully account for losses and munition employment in air-to-air combat. This representation is designed to be calibrated from higher resolution models, such as BRAWLER, and also to be "SME-able" for communities that do not have access to more detailed modeling. Covered topics include the methodologies and behaviors of the adjudicator; test results from calibration to BRAWLER results; and lessons learned while generating an aggregate campaign air-to-air adjudicator.

A Bayesian Decision Model for Aggregating CID Evidence

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The tactical combat identification problem may be modeled as a decision to fire or not to fire based on the probability that the unknown target is an enemy. A Bayesian statistical model of this posterior probability allows the firer to aggregate observations of critical evidence into the firing decision. Observations of target location, target identification system response, visual recognition, target movement and orientation, and target firing activity are compared to assumptions about the prior distributions of these observations. These assumed distributions are generated from tactical knowledge of the battlefield, the current situational awareness picture, and performance characteristics of both human and automated target identification systems. Bayesian updating allows the model to integrate information about each observation as it becomes available. Once the model determines posterior probability that the target is enemy, the firer compares that probability to a variable threshold to make the firing decision. This Bayesian model quantifies the sensitivity of the firing decision to different situational awareness systems, different target identification systems, and different tactical techniques and procedures.

The GLACIER Model

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The constructive and deterministic GLobal Architecture Combat Identification Effectiveness Requirements (GLACIER) tool V1.0 was created to support the AFRL Air to Ground (A/G) CID Requirements Study being sponsored by The Air Force Combat Identification Integration Management Team (CID IMT) and HQ ACC/DRAI. GLACIER determines operational effectiveness of a sensor system-of-systems within the mission areas of Suppression of Enemy Air Defense (SEAD), Attack Operations (AO), Close Air Support (CAS) and Interdiction. It determines the expected number of desired and undesired (friend or foe) target kills based upon probability of target identification, sensor fusion, and probability of destruction. Sensor characteristics, operational doctrine and rules of engagement, architecture features, and mission area features are considerations accounted for in the tool.

A GLACIER run consists of a fixed-wing delivery aircraft loaded with air-to-ground weapons and an accompanying sensor suite flying a scripted route toward a fixed target set. The sensor suites may consist of visual, procedural, interrogation and reply (IFF), Non-Cooperative Target Identification (NCTI), or target identification broadcast. His on-board sensors are fused with information from off-board nodes such as a forward air controller (FAC), a Rivet-Joint surveillance aircraft, an unmanned airborne vehicle (UAV), a ground station which receives information from any of the above or from a spaceborne system, or any other target identification source. Correlation is considered perfect at this time. The weapon's circular error probable (CEP) at target is then determined from the relative targeting accuracy (RTA) of these combined sensors. The probability of target destruction is found via a Joint Munitions Effectiveness Manual (JMEM) look-up. Fixed-wing attrition is also input and used in determining the probability aircraft reaching its weapon release point.

<u>Wednesday, 0830-1000</u>
COMPOSITE GROUP C .... **Thayer Hall, South Auditorium**

<u>Wednesday, 1030-1200</u>
Combat Identification .... **Room 345**

Air-to-Ground CID Architecture Comparison Report

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The mission of providing accurate and timely combat identification information (CID) to aircraft employed in the air-to-ground role has been a high interest item since the Persian Gulf War. The increasing lethality and standoff range of present and future aircraft and weapons will further stress the CID mission. The Air Force Studies and Analyses Agency (AFSAA) conducted a CID architecture study under the sponsorship of ACC and ESC/ZJI. The study provided a quantitative evaluation and comparison of Air to Ground Combat Identification architectures, systems, and technologies in terms of mission effectiveness and fratricide avoidance within the CAS and near-battle mission area. The study was a quick-look to identify high potential technology areas for further investigation in a follow-on requirements study and to identify trends and trade-offs between possible CID technologies. The technology areas investigated were on-board non-cooperative target identification, off-board sensor information, FAC improvements, on-board cooperative systems, and situational awareness information from the tactical internet. The study objectives include determining the relative contributions of specific CID systems to the warfighter, data gathering on new technologies, and identifying possible synergies between technologies within a "system of systems" approach.

The study investigated the mission level impact and military worth of potential CID technologies for the 2008 timeframe. The study used the Extended Air Defense Simulation (EADSIM), a mission level model encompassing both the Air to Surface and Surface to Air mission areas. The main measures of outcome were the technologies effects on the ability of blue aircraft to destroy enemy tanks, effect on target sensors to correctly start the sensor to shooter chain, and ability to reduce fratricide.

Air-to-Ground CID Requirements Study

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The Air Force Combat Identification Integration Management Team (CID IMT) and HQ ACC/DRAI are sponsoring the Air to Ground (A/G) CID Requirements Study. Using a systematic approach, AFRL/SNZT will identify promising Air-to-Ground Combat Identification Architectures and their associated CID performance characteristics. These architectures wiil be both within and across mission areas. Key A/G CID issues will be studied in trade off analyses aimed at defining requirements for the CID Operational Requirements Document (ORD).

AFRL/SNZT will provide the study sponsors with analytical evidence of the relative ability of the selected SOS architectures to increase mission effectiveness. Key parameters will include ID System Characteristics, Fusion of Multiple ID Sources, Targeting, Aircraft Survival, Weapons Effects, Correlation of Off-Board Sources, Communication Networks, Operational Impacts, Environmental Factors, and Camouflage, Concealment and Deception (CCD). Current architectures being considered for study include:

1. Enhancements to the Forward Air Controller (FAC)
2. Onboard Interrogation and Reply (aka IFF)
3. Onboard Non Cooperative Target Identification (NCTI).
4. Offboard sources of ID
5. Own ID broadcast systems

The Team will model these architectures all the A/G mission areas [Close Air Support (CAS), Suppression of Enemy Air Defenses (SEAD), Theater Missile Defense/Attack Operations (TMD/AO) and Battlefield Air Interdiction (BAI)] in a threat environment [e.g., Integrated Air Defense - Surface To Air Missiles (SAM), Anti-Aircraft Artillery (AAA), etc.]. Both friendly and hostile maneuvers, the effect of noncombatants on the battlefield, signal phenomena, environmental, and other significant parameters will be integrated into the scenarios.

Development of Joint CID Investment Strategy – An Analytical Approach

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Wednesday, 1330-1500
Weapons and Combat.. Room 345

Model for Optimizing Munition Allocation in the Presence of CCD

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Creative Optics, Inc. has been developing tools for the DoD to assess the performance of man-in-the-loop and autonomous munitions degraded by camouflage, concealment, and deception (CCD). These tools range from our Mobile Army Camouflage

Evaluation (MACE) portable data collection and assessment field test equipment to PC-based models for optimizing aircraft sortie and munition allocation in the presence of CCD.

The optimal allocation of resources is a primary goal of mission planning and logistics. CCD techniques are employed explicitly to induce uncertainty, vagueness, and error in both munition effectiveness and munition deployment. We have developed a mission planning model for determining the optimal allocation of a set of munitions against an ensemble of targets. This model takes into account the error-inducing effects of CCD as well as the numerical vagueness of available CCD effectiveness data.

The DoD has conducted the JCCD (Joint Camouflage, Concealment, and Deception) air-to-ground field test program to systematically quantify the effects of CCD on target acquisition. We have been able to successfully apply the JCCD data in our model for calculating the effects of CCD on optimal munition allocation.

Future Conventional Weapons and Force Structure Study

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Every year the Air Force must examine future air-to-ground conventional weapons inventories and capabilities to determine if it will be able to meet its air campaign goals during future conflicts. The Air Force Studies and Analyses Agency (AFSAA) is conducting a future conventional weapons and force structure study under the sponsorship of AF/XO and SAF/AQ. The purpose of the study is to provide a quantitative evaluation and comparison of conventional air to ground force structure and weapons mixes. The study also highlights the potential impact of changes in budget and force structure on required weapons inventories. The study objectives include determining the relative contributions of specific weapon systems, the optimum conventional weapons mix for a given level of investment, and the impact of developmental weapons on campaign effectiveness.

The study investigates the campaign level impact and military worth of potential force structure and air-to-ground weapons inventory decisions for both the 2005 and 2010 , 2MTW scenarios. The Combat Forces Assessment Model (CFAM), a large scale linear program designed to assess the impact of changes in budget, attrition, force structure, and weapons inventories, models the air campaign. The main measures of outcome are time to meet air campaign goals and determining the "knee in the curve" between cost and effectiveness.

ACC: Tracking Combat Potential and Military Worth

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As the Air Force gets smaller it loses force capability redundancies. Reengineering and cost cutting are driving the effort to do more with less. It is now much more important to know the current state of the force and the impact potential changes have on force capability. The commander of the Air Force's Air Combat Command (ACC) directed the development of a combat potential metric to track the impact of directed funding reductions, modernization, acquisition, and decisions made at all levels of the organization. The metric developed captures the impact each squadron in ACC has on combat potential. Readiness data is captured from the Status of Resource and Training System (SORTS) on aircraft, critical items of equipment, and critical personnel for every SORTS reportable squadron. Other databases are used to track critical equipment and personnel for squadrons that are not SORTS reportable.

There are several problems in developing a total ACC combat potential metric. The ideal solution would be to use an interactive suite of combat and MOOTW models which consider engineering, mission, and campaign effects. This is currently infeasible. Tying the metric to a specific scenario or even a set of scenarios is useful but doesn't address the issue of scenarios changing over time. Using a generic scenario doesn't allow translation in terms of existing conflict metrics. Existing combat models don't usually capture the contribution of logistics, security forces, and other support or enabling assets on the outcome of a conflict.

The ACC combat potential metric addresses the impact of all combat and enabling squadrons while considering engineering, mission, and campaign effects. It produces a percent change from a stated baseline, which can be used to identify decisions counterproductive to combat capabilities. Future enhancements will address the full spectrum of conflict. The methodology used for this metric is being studied for incorporation into future the ACC modernization investment plans.

Thursday, 0830-1000
Planning .... **Room 345**

Operations Planner: Strategy Cell Assistant

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AF/XOOC, CHECKMATE, has acquired a PC-based tool that provides a strategy-to-task process for quickly and easily creating Master Air Attack Plans (MAAP) in the strategy cell of an Air Operations Center (AOC). This process starts at the National Level and logically develops objectives, measures of merit, and priorities for the each level of command down to the JFACC. Tasks are then developed as required to attain those objectives. Each task is then prioritized into a Joint Prioritized Integrated Task List. Assigning targets to these tasks produces the Joint Prioritized Integrated Target List (JPITL) that is used by the strategy cell to communicate the JFACC's air scheme of maneuver to the MAAP cell. The MAAP cell then produces a MAAP that is given to Combat Operations to produce and execute the Air Tasking Order (ATO). Operations Planner (OP) allows this process to be easily automated, manipulated, and archived. OP allows the production of the JPITL and MAAP. Embedded inside OP is SABSEL data to assist an experienced strategist in assigning limited aircraft and other assets to targets. Targets can be imported from the MIDB or added manually. Aircraft and Weapons can be added and assigned against targets. Targets are assigned to tasks using text- or map-based queries of the MIDB. Exports from Operations Planner can be imported to OPUS, and EADSIM for high fidelity routing and attrition analysis. Operations Planner's utility in rapid production of plans for current operations and exercises was the driver for its production for CHECKMATE.

The presentation will consist of a demo of Operations Planner at the unclassified level.

Geospatial Information Process Simulation

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A discrete event simulation model of the geospatial information production process employed by the National Imagery and Mapping Agency (NIMA) has been developed for the first time. This simulation model allows new ways of measuring personnel and equipment utilization and availability for the multiple product lines produced by NIMA. Examples of these product lines include hardcopy and softcopy products such as maps and nautical charts; high-resolution information and products for urban warfare and mission rehearsal; and precision targeting data. The system analysis is based on standard queuing assessments, which greatly impact the introduction of new product lines to the production process. This is critical for developing the future imagery architecture and its supporting requirements.

This methodology was developed to provide managers with a relatively simple, high level tool set to help them gain insight into current production processes, and to improve productivity while achieving efficiencies and economies. Standard simulation analysis is critical in projecting future capabilities in order to identify the impact of personnel and equipment changes on workloads; estimate production costs; estimate the impact of new technologies on future workloads; and estimate future capacity plans and costs of the manufacturing processes.

Geographical Information System Advancements for Mission Planning and Rehearsal

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This is an ongoing research effort where we will develop the requirements for a Naval Aviation Mission Planning and Rehearsal database. This database will have entities at three levels – entities for high performance aircraft, helicopters, and ground. We will also analyze the capability of a GIS to meet the requirements for database development to support mission planning and rehearsal systems. Specifically, we will investigate the family of GIS products from ESRI, which is a world leader in GIS software, as the baseline for GIS evaluation. We will analyze and identify those GIS capabilities that meet the mission planning and rehearsal requirements, what requirements are not met, and what future GIS capabilities may satisfy the requirements.

Once the GIS capabilities satisfying the requirements have been identified, then we will design and develop methodologies that will meet these needs. Some of the areas already identified, which would greatly improve the capabilities for mission planning and rehearsal, are as follows: Direct and collateral bombing operation damage prediction and assessment; Merging of data sources and OPFOR tactics to predict anti-aircraft and other threat locations; Multi-spectral image and geometry input/capture and manipulation for large area databases with scalable complexity; Creation of high resolution urban area databases that are mission/aircraft specific; and Support for training scenario planning and real-time training scenario control.

Thursday, 1030-1200

ABL and Barchi Prize Honorable Mention ....Room 345

ABL High Value Airborne Asset Protection

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The Airborne Laser (ABL) is a high-value stand-off platform designed to destroy enemy Theater Ballistic Missiles (TBMs) in the boost phase. In order to accomplish this mission, it maintains an orbit over friendly territory, with a stand-off similar to other high-value airborne assets (HVAAs), and protected by the same blue DCA force. This study was completed to determine vulnerability of ABL, and other HVAAs, to red air-to-air and surface-to-air threats.

The study answers the following objectives: given a stressing air-to-air threat, determine the ABL's ability to maintain its desired orbit without retrograde; assess various retrograde options; and, given various surface-to-air threats, determine the minimum stand-off distance the ABL needs to maintain to preserve kinematic escape capability.

Air-to-air analysis was completed in Brawler. A blue DCA force was assigned to protect the HVAA, and encountered a numerically superior, well-coordinated, advanced red air threat. Brawler runs were completed to determine Blue's capability to prevent Red air from forcing a retrograde and from attacking the HVAA. Spreadsheet analysis was accomplished to determine the pursuit capability of the red fighters if they were not stopped by the DCA. Surface-to-air analysis was completed on a spreadsheet to determine the escape capability of the ABL aircraft given the SAM capability and a range of missile-launch detection capabilities.

ABL Counter-Salvo Requirement Analysis

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The Airborne Laser (ABL) program is currently going through iterations of updating their Operational Requirements Document (ORD). As more analysis is completed, more robust requirements are being developed. One such area is the requirement for counter-salvo capability.

A counter-salvo requirement is needed to ensure the ABL retains a robust capability against a large number of Theater Ballistic Missiles (TBMs) launched within a short window. The challenge of determining the salvo requirement is in defining the characteristics of the salvo or "raid set", as well as the required performance against the raid. The characteristics of the raid set include not only the number of missiles and launch window, but the type or types of missiles, location of launch point or points (range, azimuth), trajectory, and other factors. Defining capability requirements is also challenging, as it must be noted that the ABL is the first line-of-defense against the threat. Its area of responsibility can cover a large region, and it does not protect against TBMs by itself, but is part of a Family of Systems that together must negate the threat.

Intelligence assessments of likely threats were evaluated to determine likely salvo capabilities. Factors determining a threat's capability to salvo TBMs can include missile inventories and launchers, as well as training, doctrine, and command and control. Operational scenarios derived from the assessments were modeled in ISAAC, an engagement-level simulation that models the ABL and the TBM threat with high fidelity. Operationally representative scenarios that cover the scope of the threats were derived and modeled to evaluate the realistic expectations, and understand the sensitivity of the capability to various raid factors. From this, several raid sets were used to define the required capability. These sets were designed to ensure a robust capability against the various types of raids that may be encountered.

Effectiveness of Aircraft Alternatives for the CSAR Mission (Barchi Prize Honorable Mention)

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The study compares the effectiveness of the H-60 helicopter and the V-22 tiltrotor for the Combat Search and Rescue (CSAR) mission. Future CSAR requirements are represented by applying projected loss rates to actual coalition sorties flown in Operation Desert Storm. Mission Effectiveness (successful rescues per downed rescue crewmember) is estimated using an ANSER-developed computer model. The model, a deterministic expected-value simulation, represents probability of rescue as a negative exponential function of elapsed time, and uses a multi-channel, multi-server queuing discipline to allocate limited rescue aircraft capability to demand. Compared to the H-60, the V-22 achieves approximately 3 times the number of saves per downed rescue crewmember in the study scenario. These results are sensitive to the relative survivability of the two rescue aircraft: further study in this area is warranted.

Thursday, 1330-1500
Put the Man in the Loop! .... Room 345

JCSAR Distributed Interactive Simulation

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As a result of some fairly significant combat rescue failures in recent history, the Office of the Secretary of Defense (OSD) Director Test System Engineering and Evaluation (DTSE&E) chartered the JCSAR JT&E to characterize current effectiveness available to the Warfighting CINCs and evaluate proposed enhancements. In addition to the normal compliment of live fly testing, the JCSAR JT&E executed two virtual simulation exercises that clearly demonstrated the viability of DIS exercises for the Warfighter and military operations researcher. During the DIS exercises the Test Team linked up to six manned-flight simulator facilities, representing upwards of 20 crews positions at various locations around the United States. This architecture provided a virtual battle-space representation of joint combat rescue operations as part of a Major Theater of War (MTW) scenario.

The purpose of the paper is to present lessons learned from two distributed interactive simulation (DIS) exercises conducted as part of the Joint Combat Search and Rescue (JCSAR) Joint Test and Evaluation (JT&E). The paper will show:

- DIS exercises are a viable method for providing the Warfighter with second-to-none mission level training.
- The architecture can also provide insights into data not possible in live fly testing
- A sound test design is critical in obtaining meaningful effectiveness results.
- Finally, the paper will conclude with some suggestions for conducting further exercises that provide realistic training and credible test results.

AF Battlelab Contributions to Expeditionary Aerospace Forces

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Washington DC 20330-1570

This study establishes a new methodology to identify and prioritize AF Battlelab initiatives that contribute to Aerospace Expeditionary Forces (AEF) operations. Initiatives that aim to make AEF operations more effective and/or less resource intensive will be scored and ranked using weights from AF/XOP, the Air Staff office responsible for AEF. Sensitivity analyses will be performed to determine how sensitive the initiative ranking positions are to changes in the weights.

The AF Battlelabs were established in July 1997 to foster innovation and strengthen the AF Core Competencies: Air and Space Superiority, Global Attack, Rapid Global Mobility, Precision Engagement, Information Superiority, and Agile Combat Support. The battlelabs' mission is to prove innovative concepts and drive revisions to doctrine, organization, training, requirements, and/or acquisitions. From the six battlelabs (Aerospace Expeditionary Force Battlelab, Command and Control Battlelab, Force Protection Battlelab, Information Warfare Battlelab, Space Battlelab, and Unmanned Aerial Vehicle Battlelab), there are over fifty completed or approved initiatives. Nine of these have been or will be demonstrated in the first two of five Expeditionary Force Experiments (EFX). The goal of EFX is to mature the AF concept of Expeditionary Aerospace Forces. AF/XOP is committed to delivering the first of routine AEF cycles by fiscal year 2000. The results of this study intend to benefit later AEF cycles. This methodology will help senior AF decision makers evaluate battlelab initiative contributions to AEF operations.

WG 16 - SPECIAL OPERATIONS/OPERATIONS OTHER THAN WAR - AGENDA

Chair: Mr. Robert C. Holcomb, IDA
Cochairs: Mr. Robert L. Smith, Raytheon Systems Company
Greg Jannarone, Consultant
COL Brian Maher, USAF Special Operations School
LTC Joel Parker, USSOCOM
Mr. Larry Redmond, GTE
Mr. Kevin Brandt, Mitre
Advisor: Mr. Ray Stratton, Lockheed Martin
Room: 347

Tuesday, 1030-1200
C4ISR in OOTW
Dr. Cyrus J. Staniec and Terry Prosser, Logicon

Decision Analysis at USSOCOM
LTC Tim Hope, USSOCOM SOJ7-C

Tuesday, 1330-1500
The US Military Role in Smaller-Scale Contingencies
A. Martin Lidy, Institute for Defense Analyses

Agent-Based Modeling of War as a Complex Adaptive System
Captain Geoffrey Maron, Air Force Studies and Analysis Agency

Wednesday, 0830-1000
COMPOSITE GROUP C .... Thayer Hall, South Auditorium

Wednesday, 1030-1200
Simulation Support for URBAN WARRIOR
Major John Kelly, USMC, MAGTF Staff Training Program

MPARE and the Joint Special Operations Mission Planner
John Cox, USSOCOM

Wednesday, 1330-1500
Operational Analysis Support to a Joint Task Force
Samuel R. Frost, US Army Europe Operations Research Cell

Using Web-Based Collaboration to Enhance OOTW Training and Analysis
Julia Loughran and Marcy Stahl, Thoughtlink, Inc.

Thursday, 0830-1000
C4ISR for Special Operations and OOTW
CAPT Wayne P. Hughes, USN (ret), Naval Postgraduate School

Resources Potentially Available for Smaller-Scale Contingencies
A. Martin Lidy, Institute for Defense Analyses

Thursday, 1030-1200
Mission Tasked Organized Forces
Louis A. Bryant, SAIC

Measures of Effectiveness for the Major Players in OOTW
Gregory J. Bozek, SAIC

Thursday, 1330-1500
Stochastic Analysis of Resources for Deployments and Excursions (SARDE)
LTC Patrick J. DuBois, US Army Concepts Analysis Agency

Sensor Pointing Terrain Interaction Model and Analysis
Dr. Ephraim Martin IV, Lockheed Martin Electronics and Missiles

WG 16 - SPECIAL OPERATIONS/OPERATIONS OTHER THAN WAR -ABSTRACTS

Tuesday, 1030-1200

C4ISR in OOTW

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Approved abstract unavailable at printing.

Decision Analysis at USSOCOM

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Approved abstract unavailable at printing.

Tuesday, 1330-1500

The US Military Role in Smaller-Scale Contingencies

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This paper establishes a comprehensive framework of both civilian and military tasks that must be performed during smaller-scale contingencies. The framework is based on the sector and agency responsibilities established in Presidential Decision Memorandum-56 (PDD-56) for complex contingencies. The framework, however, is more inclusive and accommodates the full range of missions envisioned in current doctrine for military operations other than war. It also identifies the military tasks in support of the seven non-0military sector's which civilian interagency participants-US government and other allied organizations-typically lead in smaller-scale contingencies. Because the military tasks were developed for major theater wars and not smaller-scale contingencies, the paper identifies a number of modifications to existing military tasks to reflect more accurately the role of the military in these operations, and the addition of other tasks not currently included in the military task lists. The resulting framework provides interagency planners with a checklist of tasks that can be used to develop a mandate for a specific operation and to guide development of the civil-military coordination and collaboration architecture that such operations require.

A Better Way to Model Warfare for Analysis of Command and Control: Agent-based Modeling of War as a Complex Adaptive System

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Current combat models are inadequate for modeling strategic and non-linear effects. Most current models were constructed in a reductionist manner based on linear equations. this approach yielded attrition oriented models that do not capture the complexity inherent in warfare. While effects of many methods of warfare are inaccurately represented in attrition based models, methods dependent on non-linear effects suffer the greatest misrepresentation. The inaccurate representation of Marine forces prompted the Marine Corps into a pursuit of CAS modeling techniques for maneuver warfare. A similar recognized weakness in current campaign level models is the inability to represent the non-linear and strategic effects air power can have when applied to enemy centers of gravity. Air power brings more to a campaign than just the killing power of its munitions, but with current models, air power is played as a weapon delivery system only. The New Sciences of Complexity and Chaos provide a new framework with which to analyze systems. We are exploring the modeling of war as a complex adaptive system with an agent-based model and investigating the force multiplying effects of C2.

Wednesday, 0830-1000

COMPOSITE GROUP C .... Thayer Hall, South Auditorium

Wednesday, 1030-1200
Simulation Support for Urban Warrior

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Urban Warrior is the second phase of the Marine Corps Warfighting Laboratory's five-year experimentation plan. It focuses on combat in cities and urban areas and is a search for new concepts, tactics and technologies that will enable Marines to fight and win in this battlespace. The hypothesis of the experiment is "*Can we significantly increase the ability of a forward afloat force to execute simultaneous, non-contiguous operations in both the extended and constrained urban battlefields*". Urban Warrior was primarily a live experiment with Marines equipped with MILES equipment and position location equipment conducting a variety of operations in military bases throughout the San Francisco Bay area. The Joint Conflict and Tactical Simulation (JCATS) was used to augment the experiment by providing the effects of indirect fire weapons. A system known as Multi-C4I System IMMACCS Translator (MCSIT) was developed to allow interaction between live participants and constructive entities in JCATS. MCSIT was developed Lawrence Livermore National Laboratory and SPAWAR. During the experiment, the position and health status of live participants was reported periodically to JCATS through MCSIT. Fire missions from artillery batteries, Naval Gunfire Ships and tactical aircraft were executed in JCATS in response to requests from live participants. The results of these constructive missions were then reported from JCATS to Marine C4I systems and subsequently to the live participants through MCSIT. This presentation will discuss the challenges of integrating live and constructive simulations and provide lessons learned from this process.

MPARE and the Joint Special Operations Mission Planner (JSOMP): An Operational Capability in Support of the Joint Special Operations Task Force (JSOTF)

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MPARE: The objective of MPARE (Mission Planning, Analysis, Rehearsal, and Execution) is to provide the Theater Special Operations Commander with a capability to globally plan, analyze, rehearse, and execute within the Command and Control (C^2) structure at all levels of operations (strategic, operational, and tactical). MPARE is the coordination, integration and synchronization of all efforts associated with SOF utilization of information and information technologies. It is the enabling process to migrate all identified legacy and future efforts into the CINC's Flagship Capstone Concept of the Joint Special Operations Forces Command and Control System of Systems. MPARE will be accomplished through an evolutionary phased process that will bring stand alone MPARE and C^4I systems into a Joint Special Operations Command and Control Systems of Systems (JSOFC^{2}S^2). The JSOFC^{2}S^2 will form a network centric environment allowing any SOF element to access the full range of DOD and commercial information and decision support systems.

JSOMP: JSOMP is the USSOCOM response to a Special Operations Command Central (SOCCENT) request to provide joint, distributed, collaborative capabilities to serve immediate needs for automated mission planning as well as supporting command and control functions. Designed to be consistent with USCINCSOC's vision for the MPARE Concept, JSOMP supports the exercise of command and attendant staff processes on the same systems and equipment for both day-to-day operations as well as for mission preparation and execution.

Wednesday, 1330-1500
Operational Analysis Support for a Joint Task Force

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Rather than focusing on traditional conflicts the US now plans for Major Theater Wars and supports Small Scale Contingencies. This change in focus has resulted in calls for the operations research community to re-look analytical support provided to the operational and tactical levels of command. The US European Command (EUCOM) took steps in this revolution by providing Operations Analysis teams to Joint Task Forces (JTFs) in the European Theater starting in 1997. This capability is now part of the EUCOM Directive 55-11. This ensures that each JTF has the required analytical resources to plan for and execute its mission successfully. This paper focuses on the capabilities and products that the OA team brings to the fight. The platform to demonstrate the utility of the team is a series of AGILE LION exercises featuring a Southern European Task Force (SETAF)-led JTF deploying into Africa for an SSC. The authors will demonstrate products already developed and their impact on the success of the mission. Additionally, they will also offer their experiences and propose suggestions about how the OA teams can integrate themselves as a key part of the JTF staff.

Using Web-based Collaboration to Enhance OOTW Training and Analysis

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In 1998, ThoughtLink was funded by DARPA to explore how low-cost gaming and collaboration technologies could augment Joint Task Force (JTF) training for OOTW. Current OOTW training, particularly for JTF staff and interagency representatives, has some limitations. For JTF staffs, OOTW training is infrequent; large-scale exercises occur only every 18-24 months. Training often uses combat versus OOTW simulations and JTF training rarely or poorly incorporates outside participation from international organizations, interagency representatives, and non-governmental organizations. Finally, current JTF staff training has minimal focus on pre-deployment or post-deployment tasks.

Thursday, 0830-1000
C4ISR for Special Operations and OOTW

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C4ISR and SOF/OOTW are two massive subjects which when blended together comprehensively would be incomprehensible. The purposes of this short presentation are to show (1) how one separable aspect, the "ISR" part, can and should be brought to bear, (2) how valuable that in itself would be, and (3) five immediate, practical implementable consequences of (1) and (2). The substance is derived mainly from the MORS Workshop on MOOTW held in January 1997 and experience in teaching campaign analysis to Special Operations students at the Naval Postgraduate School.

Resources Potentially Available for Smaller-Scale Contingencies

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This paper describes the resources, other than those controlled by DOD, that are potentially available to respond to smaller-scale contingencies. It describes the environment in which these organizations operate and affects their involvement in an operation. The paper addresses US Government civilian resources outside the DOD, the United Nations capabilities, and those of other inter-governmental organizations (IGOs). It also describes the capabilities of the International Organizations and non-governmental organizations that are likely to be engaged in these types of complex contingencies even before the US military forces arrive in the area. The paper also identifies the major donor nations and businesses that may play a role in SSCs. The DOD should be aware of these organizations and their capabilities when responding during complex contingencies so that unity of effort and efficient use of resources can be achieved. During engagements the DOD should invite these organization to participate in peace support and humanitarian relief exercises and seminars so that understanding and confidence can be enhanced.

Thursday, 1030-1200
Mission Tasked Organized Forces

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A Mission Task Organized Force (MTOF) is a ready structured force possessing balanced capabilities that are adaptable based on mission requirements. The Army developed the MTOF concept during the 1997 Quadrennial Defense Review (QDR) to provide a means for the US Army to derive mission-based force requirements across the full spectrum of conflict in support of the National Military Strategy. The MTOF process is a strategy-to-task concept that uses missions derived from the NMS, the Defense Planning Guidance, and CINC requirements. This process develops a force tailored to perform warfighting, force generation, CINC engagement, homeland defense, domestic support and SSCs. Since its inception in 1997, the MTOF process has been enhanced to include the ability to predict viable missions, validate force requirements, delineate appropriate measures of effectiveness for respective mission types, resource the required force with existing forces, and derive lift requirements for the resourced force. It is anticipated that this process can be adopted within the Joint environment as a viable methodology to determine integrated multi-service CINC force requirements for OOTW as well as MTW requirements.

Measures of Effectiveness for the Major Players in Military Operations Other Than War

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SAIC was tasked to derive measures of effectiveness for assessing progress toward achieving objectives in selected MOOTW. The tasks associated with MOOTW span the full range of military capabilities, from the non-combat functions of providing humanitarian assistance to the combat functions inherent in missions such as peace enforcement. The SAIC investigation examined the critical tasks for both friendly (US and allied) forces and those of the other major players with whom the friendly forces must contend or cooperate to achieve their objectives. These other players can include belligerent parties, major international organizations (IOs), non-governmental organizations (NGOs), and the many indigenous groups in the area of operations. The critical tasks of those players may involve political, social, or economic issues not directly in the purview of the US or allied force, but which must be understood by the commander of that force to fully appreciate the dynamics of MOOTW operational environments. This study used two different approaches to develop MOE. The first methodology proceeded from research into the recognized military doctrine for each of the twelve MOOTW missions to the identification of their defining mission criteria. From these criteria, the team established the critical tasks that are essential for mission success and decomposed those into components and subsequently MOE, organized by phases over the course of the operation. The MOE for the other players may not conform to any form of recognized doctrine, but rather are based on the nature of the conflict or crisis involved. *Each basic form of conflict or crisis produces a set of potential effects or conditions to which the players must respond. From these effects and conditions, the study team derived the relevant actions and MOE for the other players.*

Thursday, 1330-1500
Stochastic Analysis of Resources for Deployments and Excursions (SARDE)

This paper discusses the follow-on methodology to the SARDE study. It is based on queuing theory and incorporates stochastic processes (simulation) using the simulation software AWESIM to forecast the numbers and types of forces required to service SSCs that the US military could be involved in during the period 1996 to 2006. Although the methodology has many benefits, possibly the biggest may be its ability to estimate the distribution of the required force type. These estimates can be used to evaluate the risk associated with unit availability based on a given resourced force structure, as well as the development of requirements in the force structure development process. the methodology is described and results shown.

A Sensor Pointing Terrain Interaction Model and Analysis

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The dynamic interaction of sensors with terrain and tactical targets deserves special attention to help sort out the relative value of high cost sensor package options. A phenomena of particular interest when considering a reconnaissance mission is the time related terrain coverage provided by a given sensor package when used with a given tactical employment logic. How much area can be covered in a given time using a given search pattern with a given set of sensors? What difference does one search logic provide compared to another? What difference does one sensor field of view provide when compared to alternatives? The methodology used in the most high fidelity combat simulations assigns a field of regard (FOR) and within that FOR a field of view (FOV). Each FOV is viewed in a set or random period of time. The search pattern within the FOR may be systematic or random depending on the sensor and the search logic. A model was developed which uses defense map agency (DMA) terrain to graphically portray terrain survielled by the sensor suite. The sensor suite is moved on or over the terrain. A specified sensor employment logic and search methodology are employed and the terrain is painted by the model to show which area is directly observed by which sensor or sensors. The Johnson methodology is linked to the model by Monte Carlo simulation to compute which targets on the terrain are acquired. An analysis of two scenarios is presented using this model which examines the performance of several air sensor packages in a reconnaissance mode. Both scenarios are Operations Other Than War. The first is a coastal infiltration operation set in Australia. The second scenario is a central European operation set in Bosnia. Both are oriented towards air reconnaissance in a sparse target environment where both target detection and target identification are of primary importance and target engagement is a lesser priority for the sensor platform. The results are extremely revealing and instructive and are not available from most other sensor modeling and analysis methodologies.

WG 17 - JOINT CAMPAIGN ANALYSIS – AGENDA

Chair: William C. Burch, Applied Military Technologies
Co-Chairs: COL Robert D. Clemence, Jr., The Joint Staff, J-8
COL W. Forrest Crain, Center for Army Analysis
COL James R. Methered, US European Command
Cindy Noble, TRADOC Analysis Center
Mike Hopkins, Defense Modeling and Simulation Office
Alan R. Goldman, National Ground Intelligence Center
Advisor: Richard P. Morris, The Boeing Company
Room: 348

Tuesday, 1030-1115
Mobility Requirements Study--2005 A Unique Approach
LCDR Aasgeir Gangsaas, The Joint Staff, J-8, Joint Warfighting Division

Tuesday, 1115-1200
Estimating Logistic Consumption for Joint Campaign Analysis
Dr. Kevin Saeger and LtCol Robecca Corder, Office of the Secretary of Defense, PA&E

Tuesday, 1200-1245
Combat Analysis for the Joint Warfighter
LTC Berry E. Bagemore, US Atlantic Command

Tuesday, 1245-1330
An Optimization Model for QDR 2001
Dr. Frederio A. Miercort and Jim Bexfield, Institute for Defense Analysis

Tuesday, 1330-1415
Modeling Joint C4ISR Architectures
MAJ Ross Snare and Tim Bailey, TRADOC Analysis Center

Tuesday, 1415-1500
Digitization in Campaign Modeling
MAJ Kurt A. Bodiford and MAJ James D. McMullin, Center for Army Analysis

Wednesday, 0830-1000
COMPOSITE GROUP C .... **Thayer Hall, South Auditorium**

Wednesday, 1030-1115
Modeling Skill-Technology Synergy in Combat Assessments
Dr. Wade Hinkle and Dr. Michael Fischerkeller, Institute for Defense Analysis

Wednesday, 1115-1200
Suggestions on Conversion of Evaluations of Foreign Ground Force Human Factors to Modeling Inputs
Gerald A. Halbert and John R. Lynch, National Ground Intelligence Center

Wednesday, 1200-1245
JWCA Analytical Process
LTC Joseph A. Waldron, The Joint Staff, J-8

Wednesday, 1245-1330
Use of ORSA Tools in Software Program Management
COL Lawrance Arrol, Program Manager for Intelligence Fusion

Wednesday, 1330-1415
The German Approach to the Future: Incorporating the US Future into the German Past to Plan for the 21st Century
David P. Harding, National Ground Intelligence Center

Wednesday, 1415-1500
Authoritative Data Sources and Unit Order of Battle (UOB) Data Access Tool (DAT)
Mike Hopkins, Defense Modeling and Simulation Office

<u>Thursday, 0830-0915</u>
Non-Combatant Evacuation Operation (NEO) Simulation (NEOSIM)
LTC Patrick J. DuBois, Center for Army Analysis

<u>Thursday, 0915-1000</u>
Northeast Asis Low Corps and Division (NEA CDS) 3.0
MAJ Jeffrey S. Smidt, TRADOC Analysis Center

<u>Thursday, 1030-1115</u>
Current Operations in Bosnia
COL W. Forrest Crain and Karsten Engelmann, Center for Army Analysis

<u>Thursday, 1115-1200</u>
Bosnia Benchmark Assessment-Interim Update
MAJ Rick Holdren and Karsten Engelmann, Center for Army Analysis

<u>Thursday, 1200-1245</u>
Analysis of Expeditionary Aerospace Forces
MAJ Robert A. Morris, Air Force Studies and Analysis Agency

<u>Thursday, 1245-1330</u>
Next Generation Campaign Level Air-to Air Model
Jim Brady, Systems, Simulations and Solutions, Inc.

<u>Thursday, 1330-1415</u>
Bosnia Force Structure Analysis (Troop-to-Task)
COL W. Forest Crain and Karsten Engelmann, Center for Army Analysis

<u>Thursday, 1415-1500</u>
Operational Analysis Support for a Joint Task Force
Samuel R. Frost and CPT Eric J. Niksch. US Army Europe

WG 17 - JOINT CAMPAIGN ANALYSIS - ABSTRACTS

<u>Tuesday, 1030-1115</u>
Mobility Requirements Study--2005 A Unique Approach

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The Joint Staff in conjunction with the Office of the Secretary of Defense (OSD) and the Services are working on the Mobility Requirements Study--2005 (MRS-05). MRS-05 is a follow-on study to MRS-BURU and findings will be used to influence programmatic decision surrounding the next Quadrennial Defense Review.

Anticipating the task of conducting a mobility requirements study, the Director, Force Structure, Resources, and Assessments (DJ-8) sponsored a series of workshops. From May to July 1998 a series of four workshops were held to develop the study methodology. Participants included the Joint Staff, OSD, the Services, various Unified Commands and other government agencies.

These workshops laid the foundation for the study scope, assumptions, objectives, and essential elements of analysis. The workshops also established the various sub-working groups, identified which organizations would bring resources to bear and set up the hierarchy for the study.

We propose to present a paper detailing the study development, methodology and selected interim results.

<u>Tuesday, 1115-1200</u>
Estimating Logistic Consumption for Joint Campaign Analyses

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As a major initiative under JV 2010, focused logistics combines improvements in information, logistics and transportation technologies to provide for the delivery of tailored sustainment packages to the theater. Last year OSD/PA&E and the Joint Staff (J-4) briefed MORS on the interim results of an exploratory analysis--Experiment in Modeling Focused Logistics (EMFL)--that sought to quantitatively assess the benefits of focused logistics. This work, recently concluded, highlights several key deficiencies of current analytic tools and data sources that preclude a rigorous examination of the benefits of focused logistics. One of the key deficiencies is the inability to accurately calculate logistics consumption within a theater campaign. This presentation will present the key findings from EMFL and then will describe an ongoing OSD/PA&E initiative to develop an improved tool for estimating consumption. The tool, combining results from a warfare model (currently TACWAR) and a detailed equipment-level consumption model, can be used for stand-alone analysis or to provide supply demand to a distribution simulation for further analysis. The presentation will cover the initial phase of development that includes an interface to TACWAR and the methodologies used to derive consumption for fuel and ammunition. We will also give a demonstration of the tool and address the significant data issues.

Tuesday, 1200-1245
Combat Analysis for the Joint Warfighter

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Operations analysts have supported military decision-making since the inception of the Military Operations Research discipline. Effective application of analytical techniques, methods and processes established a legacy of results that significantly contributed to our military successes. The value of analysis for joint planners during deliberate planning is well established within our Defense Planning System. Bringing analytical support to bear in crisis action planning can provide similar value. Today's increasingly dynamic and almost exclusively joint operational environment often places a joint force commander and supporting staff in a complex, time-compressed and unfamiliar setting. During a crisis, they must produce a viable plan in an intense and time-critical environment. This presentation demonstrates an approach for providing automated decision support to the joint warfighter within strictly limited time horizons. Process is more important than the analytic tool. The analyst's credibility, gained by demonstrating an ability to provide timely and relevant conclusions and recommendations, is key to infusing structured analysis into crisis action planning. This presentation relates experiences gained within Joint Task Force (JTF) Commander and Staff training exercises at US Atlantic Command.

Tuesday, 1245-1300
An Optimization Model for QDR 2001

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The Weapons and Resource Requirements Model (WORRM) has been used in support of a number of studies. For example, earlier versions of the model were used in the FY 95 Heavy Bomber Force Study and in the Deep Attack Weapons Mix Study (DAWMS)--both the weapons mix and B-2 analysis.

WORRM is a one-sided campaign model, formulated as a linear program, which can be used to maximize target value destroyed, minimize platform attrition, or minimize a weighted combination of platform attrition, weapons used and sorties flown. The model can also determine optimal inventory levels of specified weapon types, subject to a budget constraint.

Principal inputs to the model include target damage goals, target distribution and defense coverage, platform arrival schedules, platform sortie rates, sortie effectiveness, weapon inventories and platform attrition rates. Principal outputs include platform/weapon allocation to targets, target kills by platform and weapon type, platform attrition, weapons expended and optimal weapon mix.

This model could serve as a complement to two-sided campaign analysis tools such as TACWAR and JWARS. This presentation will provide an overview of the model, describe how it could be used in conjunction with a two-sided campaign model and provide some comments on how it compares with similar optimization tools.

Tuesday, 1330-1415
Modeling Joint C4ISR Architectures

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TRAC (TRADOC Analysis Center) conducted the J-6 Sensor-to-Shooter Battle Management Study that involved modeling joint C4ISR architectures. This joint battle management study examines the effects, at a campaign level, of joint C4ISR improvements encompassing parallel dissemination, common operational picture, and automated weapon target pairing. The joint battle management system includes the hardware, software, personnel, and facilities used to coordinate, deconflict, and synchronize rapid targeting and attacks when multiple components have the capability to locate, identify, track, attack, and evaluate targets in overlapping areas of responsibility.

A modified Southwest Asia scenario is used in the simulation. The scenario is initiated 24 hours earlier than the original to enable the modeling of a deep battle with its associated sensors, shooters and targets. The scenario is joint in that it contains US Army, Navy, Air Force and Marine elements.

The study examined joint battle management architectures. This presentation will discuss joint C4ISR modeling and simulation techniques and measures used and how the analysis supported decisions makers.

Tuesday, 1415-1500
Digitization in Campaign Modeling

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Over the past several years, analysts at the Center for Army Analysis (CAA) have worked to analyze the force enablers of "digitizing" the force. The analysts have enhanced the suite of campaign models available to replicate the enablers of digitization. The Combat Sample Generator (COSAGE), Concepts Evaluation Model (CEM) and TACWAR are used to evaluate combat capabilities.

Modeling digitization has evolved through several studies: Campaign XXI; Breaking the Phalanx; Division Redesign; and Go to War. Information dominance and the related logistic enhancement are the key capabilities modeled in COSAGE and CEM. The functions replicated allowed the modeling of digital capabilities at the individual division, corps, or army level.

The enhancements added to CAA modeling have provided useful insights about the capabilities of digital forces and the capabilities of a mix of analog and digital forces.

Wednesday, 0830-1000
COMPOSITE GROUP C .... Thayer Hall, South Auditorium

Wednesday, 1030-1115
Modeling Skill-Technology Synergy in Combat Assessments

Dr. Wade Hinkle and Dr. Michael Fischerkeller
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Combat assessment and force balance methodologies will play important roles during the next Quadrennial Defense Review in analyzing capabilities of postulated forces, in planning scenarios and in determining the proper balance between readiness and modernization. Recent research at IDA suggests the analytic tools currently used for these purposes may substantially undervalue the contributions of military skill and advanced operational concepts. The operational community has long recognized the importance of skill and operational concept, but few assessment tools account for those factors formally or rigorously.

IDA's work in this area began as internally-funded research on the causes for the Coalition's historically low loss rate in the Gulf War. This study won MORS 1997 Barchi Prize and led to two linked exploratory projects for OSD/PA&E and the Army. These projects used a combination of statistical analysis and historical data, combat simulation experimentation and critical cases to develop and initially test a formal set of hypotheses about how technology, skill and operational concept interact to produce combat outcomes. All testing to date has been confirmatory. The results strongly suggest it would be worthwhile to move to a large-scale testing and consideration of whether and how the resulting mathematical model ought to be included in the "Revolution in Analytic Affairs" or other QDR-related efforts to improve existing analytic tools.

Wednesday, 1115-1200
Suggestions on Conversion of Evaluations of Foreign Ground Force Human Factors to Modeling Inputs

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This presentation discusses conversions of evaluations of foreign ground force human factors to inputs usable by the modeling and simulation (M&S) community. These human factors include leadership, moral and cohesion and unit training. The NGIC foreign ground forces evaluation criteria describes the expected level of performance of a foreign ground force. Normally one ground force will be rated lower than another and this rating is meaningful in describing differences in potential performance. The rating number by itself is not usable to the M&S community. After rating a country's ground forces, a look up table is utilized to determine what comparative differences in performance can be expected between ground forces rated at different levels.

The look up table describes the ability of units to perform operations such as reconnaissance, delivery of fire and ability to maneuver. Ground forces that are not as proficient as other ground forces cannot execute operations at the same level of accuracy, timeliness or effectiveness as those rated at a higher level.

This proposed methodology is not complete, has not been verified, but is an attempt to describe the differences in the ability to conduct combat operations. This methodology has relevance during stability and support operations, periods of maneuver or defense and has implications for information warfare.

Wednesday, 1200-1245
JWCA Analytical Process

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Presentation will focus on the Joint Warfighting Capability Assessment (JWCA) process and include a discussion of the JWCA teams' role in the requirements generation process in support of the Joint Requirements Oversight Council (JROC). JWCA teams are responsible for completing assessments that provide military recommendations to improve joint warfighting capabilities and requirements. The domain of the Strike JWCA is related to conventional strike weapons, platforms and associated mission support architecture. The JWCA is responsible for identifying analytical methodologies for use in conducting two types of assessments: 1) capabilities assessments to determine alternatives to CINC shortfalls or to influence programmatic decisions over the FYDP and 2) POM assessments as stipulated by the Defense Planning Guidance. The Strike JWCA applies a variety of analytical tools and assessment processes to accomplish its mission. Presentation will include examples of analytical support for recent assessments and a decision support tool to meet the need for quick-turn assessments.

Wednesday, 1245-1330
Use of ORSA Tools in Software Program Management

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The Department of Defense and specifically the Department of the Army requires the use of software metrics. This presentation will discuss the use of software metrics in an Army software intensive product development. Specifically, this presentation will address specific techniques related to select matrics, the use of the metrics by contractor program managers, as well as by Army product and project managers. Discussion will focus primarily on the relationship of metrics to program cost, schedule and performance during the development portion of a software systems lifecycle.

Wednesday, 1330-1415
The German Approach to the Future: Incorporating the US Future into the German Past to Plan for the 21st Century

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The German Federal Armed Forces (Bundeswehr) currently find themselves in a state of transition unprecedented in their post-war history. Germany's emergency as the preeminent economic and political power in Europe, increased social pressure for change and the evolving international security environment requiring a broader spectrum of force capabilities are all forcing German civilian and military leaders to relook the way they approach security and structure the armed forces. As the Bundeswehr looks to the future, what is it using as its paradigm for planning the future force? This paper will explore how the German Armed Forces Staff is studying likely future threats to European security, drawing on its past experiences, and studying the US vision of the future, most notably Force XXI and JV 2010, to devise a uniquely German force to handle what it considers its most likely potential conflicts in the coming years. These studies, currently under way and informing the Structural Review Commission which the new Social Democrats government is launching this month, will determine the development of the Bundeswehr for the next century.

The implications for NATO and the US are significant since the Bundeswehr represents potentially the most capable European military force in post-communist Europe. Expanding global US commitments will likely require greater assistance from our allies. The Germans recognize that their future defense budgets will remain flat, but at the same time, they have far to go to modernize to attain the types of standards implicit in FORCE XXI. Can they do it? Do they want to do it? If not, in what areas will they fall short and what changes will they adopt to compensate? What will the future Bundeswehr look like and how will it mesh with US forces in a multinational deployment? The answers to these questions have implications for US and Alliance interoperability. I intend to map out a likely course for future Bundeswhr development based on the models they are currently studying and derive some general conclusions of interest to US force developers.

Wednesday, 1415-1500
Authoritative Data Sources

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The Authoritative Data Sources (ADS) Project sponsored by the Defense Modeling and Simulation Office (DMSO) directly supports the Department of Defense (DoD) Modeling and Simulation (M&S) Master Plan (DoDD 5000.59P). This project specifically supports the M&S Master Plan goal to provide authoritative requirements of the environment, systems and human behavior in a shared/reusable format. The objective of the ADS project is to catalog all of the data sources within DoD that can be used to support modeling and simulation. The intent is to use the catalog to expedite the search process that occurs with each M&S development and/or implementation event. DMSO established an Authoritative Data Sources Working Group in 9994. The working group defined the terminology commonly associated with the project and developed a taxonomy of 13 top level and 373 sub-categories by which to catalog the sources. The effort, catalog and designate M&S began in April 1996 and has to date collected a standard set of metadata for each of 1,061 sources. The metadata, intended to expedite the knowledge acquisition phase of either model development or application is available today on the Modeling and Simulation Resource Repository (MSRR). The library supports a very robust key word or category search capability and a number of reports can be obtained from the database. DMSO is coordinating with the DoD Data Administration Office at the Defense Information Systems Agency to expand the ADS catalog across DoD, not just M&S.

The Unit Order of Battle Data Access Tool

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The Unit Order of Battle (UOB) Data Access Tool (DAT) project is sponsored by the DMSO Data Engineering program. UOB DAT provides simulation developers with consistent and authoritative order of battle information.

UOE DAT consists of three main components: 1) a data interchange format (UOB DIF); 2) a library of UOB data sources; and 3) a data extraction tool (UOB DAT). The interchange format presents unit order of battle information from all library sources in a single understandable format based on standards in the DDDS. The data access tool features a graphical interface that allows users to browse order of battle data and select individual units. The selected units can then be used to form a task force and start a simulation exercise. The tool supports organizing the reporting hierarchy of the task force, including adding specific or generic units. Further, users can "roll up" subordinate units into a parent unit which is important for simulations that operate at aggregation levels above the basic unit.

Thursday, 0830-0915
Non-Combatant Evacuation Operation (NEO) Simulation (NEOSIM)

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The fall of the Berlin Wall indicating the end of the Cold War dramatically changed the number, type and nature of the events to which the US commits military resources. Rather than focusing on conflict with the Warsaw Pact in Central Europe, the US now militarily plans for Major Theater Wars (MTW) and commits to Small Scale Contingencies (SSC). This change in focus is commonly referred to as the revolution in military affairs. As a result of this revolution, there have been calls for a complimentary revolution in analytical analysis. Specifically, there are numerous requests for a theater simulation to model SSC to compliment existing theater campaign simulation models readily available. Attempts to create a SSC theater simulation model have not been made due to the inability to define SSC success or Measures of Effectiveness (MOE).

This paper discusses the Center for Army Analysis' initial effort to model SSC. The SSC type selected is the NEO, which is widely considered the most structured and easiest to define success and establish MOEs. The approach combines the modeling expertise of CAA with the expert knowledge of the Southern European Task Force (SETAF) to produce an initial model for a specific planned NEO and then broadened it for building a generic model for future NEO. The methodology is described and results shown in this presentation.

Thursday, 0915-1000
Northeast Asia Low Corps and Division (NEA CDS) 3.0

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The NEA CDS 3.0 is based on the Defense Planning Guidance (DPG) and the NEA Theater Resolution Scenario 3.0 developed by the TRADOC Analysis Center (TRAC). NEA CDS 3.0 assumes US forces are involved in a single major theater war (MTW). The scenario is a joint offensive operation employing forces based on Joint Vision 2010 concepts. The force year is 2010 for both the threat and Blue forces.

One of the objectives is to provide a realistic and reusable tool that can be used to examine the joint operational battle space areas outlined in Joint Vision 2010 and the respective Services 2010 vision statements. The scenario focuses on five battle space domains: land, air, sea, space, and the electromagnetic spectrum.

Thursday, 1030-1115
Current Operations in Bosnia

COL W. Forrest Crain and Karsten Engelmann, Center for Army Analysis, 6001 Goethals Road, Fort Belvoir, VA 22060, (703) 806-1501
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The US led Multi-National Division-North [MND(N)] is one of the subordinate commands of the NATO-led Stabilization Force (SFOR), SFOR's responsibility is to help ensure that a peaceful, secure environment exists to allow the components of the General Framework, Agreement for Peace (GFAP) to be implemented. One element of the GFAP is the return of displaced persons and refugees (DPRE's). One key location for DPRE's returns is the contentious town of Broko. MND(N) supported the return of DPREs to Broko through the allocation of physical resources and through analysis. While returning the DPREs, the Office of the High Representative (OHR) wanted to achieve these objectives:

1) verify the legitimacy of claims to property;
2) provide for the maximum return as quickly as possible;
3) do not reward ethnic cleansing.

Taken together, accomplishing these objectives makes the return of thousands of individuals a most challenging undertaking. MND(N) assisted in solving this problem by applying an information-based approach that analyzed key components of the collected information. The results were provided to the decision maker to assist in determining the optimum rate and process of return most suited to accomplishing the above objectives. This paper discusses the processes by which the information approach was conducted as well as additional aspects of the DPRE approach.

Thursday, 1115-1200
Bosnia Benchmark Assessment-Interim Update

MAJ Rick Holdren and Karsten Engelmann, Center for Army Analysis, 6001 Goethals Road, Fort Belvoir, VA 22060, (703) 806-5532
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This is a joint TRADOC Analysis Center and Center for Army Analysis Center presentation. The "Benchmark Assessment" is a process by which the NATO-led Stabilization Force (SFOR) assesses the progress the nation of Bosnia and Herzegovina has made towards implementing the General Framework Agreement for Peace (GFAP). There are ten criteria by which progress is measured on a semi-annual basis. These criteria are broken down into various objectives, benchmarks based on those objectives and specific questions to evaluate each of the benchmarks. An expert assessment of each question was executed and a weighting scheme applied to determine the final criteria scores. The purpose of the interim report was to update the critical military-related criteria to be briefed at NATO's 50th anniversary in Washington, D.C. This paper discusses the processes by which the "Benchmark Assessment" is conducted as well as the additional aspects of the interim report.

Thursday, 1200-1245
Analysis of the Expeditionary Aerospace Forces

MAJ Robert A. Morris and MAJ Eric A. Beene, Air Force Studies and Analysis Agency, 1570 Air Force Pentagon, Washington, D.C. 20330-1570, (703) 588-8887, E-mail: afsac.eaf@ pentagon.as.mil

In response to reduced Air force budgets and higher operations tempos caused by higher overseas commitments, in August 1998 the Chief of Staff of the Air Force directed the standup of the Aerospace Expeditionary Forces (AEF) to open by 1 October 1999. On 23 September 1998, Major General Donold Cook (AF/XOP) in coordination with BGen(S) Ben Robinson (AF/DXOC) appointed AFSAA to "collect information with direct analyses as required" to support the implementation of the Expeditionary Aerospace Force. Since that time, the AFSAA team has organized an "analysis flight plan" to meet the challenges of their charter. Using the AF/XOPE Implementation Task Plan as the initial guide, AFSAA developed nine areas for in-depth study, consisting of the following: EAF seminar wargame; low density/high demand analysis; expeditionary location feasibility; battlefield assessment; FDO analysis; split operations; EAF historical research; EAF scenario development; deconflicting competitive sourcing and privatization impacts on EAF.

The efforts required for EAF implementation consists of organizing and leveraging existing analysis. quick-turn evaluation of concepts and recommendations, long-term analysis of capabilities and requirements and ongoing studies focused on improving expeditionary operations in the future. This presentation discusses the EAF concept, the prioritizing of analysis requirements, selected methods and techniques employed, lessons learned and future requirements.

Thursday, 1245-1330
Next Generation Campaign Level Air-to-Air Model

Jim Brady, Systems, Simulations and Solutions, Inc., 1700 Diagonal Road, Suite 500, Alexandria, VA 22314, (703) 684-8268; E-mail: jim@s3i.com

A discussion of the next generation campaign level air-to-air adjudicator for use in the Synthetic Theater Operations Research Model (STORM). STORM ensures that the Air Force has a full support simulation for properly examining issues involving the utility and effectiveness of air and space systems in a theater-level joint warfighting context. Under the current development profile, STORM will become the Air Force's campaign analytic tool for acquisition and course-of-action analyses around the turn of the century.

The objective of this new methodology is to increase the resolution of campaign level air-to-air combat modeling beyond that of models like THUNDER, while still remaining highly aggregated, in order to meaningfully account for losses and munitions employment in air-to-air combat. This representation is designed to be calibrated from higher resolution models, such as BRAWLER, and also to be "SME-able" for communities that do not have access to more detailed modeling. Covered topics include the methodologies and behaviors of the adjudicator; test results from calibration to BRAWLER results; and lessons learned while generating an aggregate campaign air-to-air adjudicator.

Thursday, 1330-1415
Bosnia Force Structure Analysis (Troop-to-Task)

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An analysis of the current troop-to-task for the US led Multi-National Division-North [MND(N)] was conducted using two approaches. The first approach consisted of developing an optimal force structure based on an estimated force cap or level. This approach developed an optimal force structure to that force cap level based upon force and type unit capabilities and the mission priorities for peace operations as defined by SACEUR, Commander Stabilization Force (COMSFOR) and the MND(N) Campaign Plan; expert evaluations of unit capabilities to perform various tactical tasks required by current operations; and developed unit values and "costs" based upon how many soldiers in each unit (because this counted against force cap). Then the tasks were weighted in accordance with the commander's priorities and using an additive value technique, computed weighted scores for the various force alternatives to develop preferred force alternatives. In parallel, we applied the "cost" and "benefit" values to develop a Pareto frontier to identify the relative goodness of each alternative. In the second approach, a task to troop analysis without a force cap limitation was conducted. Here, we identified those tasks that are required to be performed and then built mission task organized force (MTOF) type simultaneity stacks to meet the requirement. It came as no surprise that the two approaches produced two different answers. The difference between the force structures developed by these two approaches represents the risk associated with a force cap-limited force.

Thursday, 1415-1500
Operational Analysis Support for a Joint Task Force

Samuel R. Frost and CPT Eric J. Niksch, HQ, US Army Europe, Unit 29351, , APO AE 09014,0049-6221-57-6415
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Rather than focusing on traditional conflicts, the US now plans for Major Theater Wars (MTW) and supports Small Scale Contingencies (SSC). This change in focus has resulted in calls for the operations research community to re-look analytical support provided to the operational and tactical levels of command. The US European Command (EUCOM) took steps in this revolution by providing Operational Analysis (OA) Teams to Joint Task Forces (JTF) in the European Theater starting in 1997. This capability is now official and is part of EUCOM Directive 55-11. This directive ensures that each JTF has the required analytical resources to plan for and execute its mission successfully.

This paper focuses on the capabilities and products that the QA team brings to the fight. The platform to demonstrate the utility of the team is a series of AGILE LION exercises featuring a Southern European Task Force (SETAF) led JTF deploying into Africa for a SSC. The authors will demonstrate products already developed and their impact on the success of the mission. Additionally, they will also offer their experiences and propose suggestions about how the OA team can integrate themselves as a key part of the JTF staff.

WG 18 – MOBILITY AND TRANSPORT OF FORCES – AGENDA

Chair: Lt Col Steve Baker, HQ USAFA/DFM
Co-Chairs: Mr Bob Drash, GRCI
Mr Dave Merrill, AMC/XPY
Maj Roger Perret, AFSAA
Lt Col Glen Bailey, AFIT/ENS
Advisor: Mr Frank McKie, CAA
Room: 314

Tuesday, 1030-1200: MOBILIZATION AND MOVEMENT REQUIREMENTS
Army Movement Requirements Generation Process
Mr Giles Mills, CAA

Advances in Mobilization Modeling – Update
Ms Julianne Allison, CAA

Do "Eaches" Matter? The Impact of Individual Items on a Port Simulation
Dr. Joe Knickmeyer, MTMCTEA

Tuesday, 1330-1500: LOADING ANALYSES
Solving the Airlift Loading Problem Using Reactive Tabu Search
2LT Jonathan Romaine, Lt Col T. Glen Bailey, Prof. Richard Decro, LTC William Carlton, AFIT/ENS

Air Mobility Command Outsize and Oversize Airlift Capability Analysis of Alternatives
Maj Robert Brigantic, Capt Anthony Papatyi, HQ AMC/XPY

Wednesday, 0830-1000: ROUTE SELECTION AND ENROUTE MODELING
Route Selection for the Mobility Analysis Support System Using Tabu Search
Maj David Ryer, Lt Col T. Glen Bailey, Prof. James Moore, LTC William Carlton, AFIT/ENS

Modifications and Enhancements to the Airlift Flow Model (AFM)
Capt Timothy Smetek, HQ AMC/XPY

Wednesday, 1030-1200
COMPOSITE GROUP D .... Room 144

Wednesday, 1330-1500: MOBILITY CONTINGENCY ANALYSES
The Simulation and Visualization of Airborne Operations
Maj Sam Szvetecz, Lt Col T. Glenn Bailey, LTC Jack Kloeber, LTC William Carlton, AFIT/ENS

Global Air Traffic Management (GATM) Impact Study
Ms Lori Evans, HQ ACC/XP

Stochastic Analysis for Deployments and Excursions **RIST PRIZE FINALIST**
LTC Patrick DuBois, CAA

Thursday, 0830-1000: AIRLIFT ENROUTE INFRASTRUCTURE
NATO Strategic Mobility Infrastructure Study
Maj Jean Mahan, USTC/J5, Maj Brian Lloyd, Capt Tim Smetek, HQ AMC/XPY

Effects of Fuel Infrastructure Enhancements on Air Mobility
Mr Brent Thomas, RAND, Ms Laura Williams, Naval Postgraduate School

Thursday, 1030-1200: THEATER AND END-TO-END MODELING
A Standards-Based Methodology for Representing Throughput in Transportation/Movement Modeling
Dr Niki Deliman, Dr David Horner, Mr Burney McKinley, Army Waterways Experiment Station

Simulation Tools for the Warfighter: JRSO&I Applications
LCDR Steven MacDonald, MTMCTEA

End-to-End Modeling: Results and Considerations
Dr Elizabeth Abbe, CAA

Thursday, 1330-1500: MOBILITY REQUIREMENTS STUDY '05
Air Mobility Assumptions and Analysis in the Mobility Requirements Study for FY2005 (MRS-05)
Mr Dave Merrill, HQ AMC/XPY

Mobility Requirements Study 2005 -- A Unique Approach
LCDR Aasgeir Gangsaas, Joint Staff J8

Mobility Requirements Study 2005 – Modeling Future Mobility Requirements
CDR Christopher Hase, Joint Staff J4

WG 18 – MOBILITY AND TRANSPORT OF FORCES - ABSTRACTS

Tuesday, 1030-1200: MOBILIZATION AND MOVEMENT REQUIREMENTS
Army Movement Requirements Generation Process

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Prior to performing a deployment analysis, the movement requirements (i.e. mobility footprint) must be generated for the force to be deployed for a given Contingency Operation. Movement requirement data include origin of cargo, type of cargo, dimensions for the cargo and destination of the cargo along with unit and non-unit cargo availability and required to delivery dates (RDD) in the theater. The focus of the Army has been to determine the movement requirements from "fort to foxhole". The Center for Army Analysis has been and continues to improve their Movement Requirements Generation Process. A big improvement over the recent months has been to create the movement requirements to cover the "fort" to Port of Embarkation and Port of Debarkation to Tactical Assembly Area. This presentation will cover the overall process and recent advancements in movement in the Movement Requirements Generation. Recent applications include the Army's Total Army Analysis OSD's Mobility Requirements study -- FY2005.

Advances in Mobilization Modeling – Update

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In recent years, there has been increased interest in modeling the mobilization process. The readiness of Army units for deployment by their prescribed available to load dates (ALDs) at their ports of embarkation (POEs) has long been assumed, i.e., this assumption has not been questioned nor has there been a focus on or in-depth analysis done of the mobilization system. Because of downsizing, the moving of troops back to CONUS from Europe, and various other reasons, there is now more interest in analyzing this process. The Mobilization Capabilities Evaluation Model (MOBCEM) has been under development for several years for use as an analytical tool. MOBCEM will provide the Army with the ability to evaluate and improve mobilization capability, through the modeling of the mobilization system from Home Station (HS) to POE. It will include the modeling of Active Component and Reserve Component units, individual personnel, and materiel at all levels of mobilization though full mobilization. MOBCEM is currently in Phase II of three phases of development. Phase I focused on processing which takes place at HS and Mobilization Station (MS)/Power Projection Platform (PPP). The other major nodes (CONUS Replacement Center, Training Center, and POI) are being designed and implemented in Phase II, which is expected to be completed in mid 1999. The mobilization processes of the other services will be added in Phase III. MOBCEM will be a component of the Joint Warfighting System (JWARS). This presentation will cover the features, capabilities, status, and potential applications of MOBCEM.

Do "Eaches" Matter? The Impact of Individual Items on a Port Simulation

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The Military Traffic Management Command (MTMC) is a major component command of the US Transportation Command (USTRANSCOM), responsible for movement of military goods and personnel by surface worldwide. The MTMC Transportation Engineering Agency (MTMCTEA) is the analytical center of this organization, and provides deployment analysis support to HQMTMC, USTRANSCOM,

the materiel development and acquisition community and the warfighting CINCs. The backbone of this support is an integrated set of analytical models called collectively the Force Projection Model (FPM). These models simulate the complete Defense Transportation System, from home station to destination theater tactical assembly area. A primary component of the system is the Port Simulation Model (PORTSIM), a discrete event simulation of ocean terminal operations. PORTSIM moves cargo at the individual item or vehicle level of detail through a port complex defined in a spatially detailed Geographic Information System database. A fundamental tenet of MTMCTEA is that the transportation system cannot be accurately modeled without consideration of the physical characteristics of individual items. The process of Verification, Validation and Accreditation (VV&A) of PORTSIM provides an excellent opportunity to test this article of faith. This presentation describes the techniques being developed to support PORTSIM VV&A, with particular emphasis on statistical analysis of simulation behavior and sensitivity. This work is being conducted in a collaborative effort by MTMCTEA, Argonne National Laboratory, and the Virginia Modeling, Simulation and Analysis Center (VMASC), and includes formal metamodeling of the PORTSIM simulation. Paradoxically, a successful metamodel may suggest that "eaches" do not matter after all.

Tuesday, 1330-1500: LOADING ANALYSES
Solving the Airlift Loading Problem Using Reactive Tabu Search

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We investigate several strategies for solving the airlift loading problem formulated as a multidimensional, a multiple knapsack problem with packing constraints. Our basic approach extends Chocolaad's Java based implementation of a combined knapsack/packing reactive tabu search to explicitly account for a multiple and different strategic airlift platforms (specifically C-17s and C-5s), with variations on the number and sequencing of aircraft. We introduce an aspiration criteria base on random selection of candidates, and present validated results comparing our solutions to those produced by the Windows version of the current Airlift Loading Model.

Air Mobility Command Outsize and Oversize Airlift Capability Analysis of Alternatives

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The fundamental mission of the Air Mobility Command (AMC) is to provide this nation with rapid global mobility through military airlift and air refueling forces. A key component of this mission is cargo airlift -- the airlift of supplies and equipment whose urgency or nature cannot wait for surface transportation. AMC has identified a critical deficiency in its ability to meet this tasking. This deficiency is due to the poor reliability and maintainability of the C-5 Galaxy fleet -- AMC's largest outsize and oversize capable aircraft.

The C-5 fleet is expected to provide the highest proportion of AMC's cargo airlift capability, but it has AMC's lowest mission capable and departure reliability rates. A substandard mission capable rate in effect reduces the number of available C-5 aircraft. As a result, AMC cannot meet some of its planned wartime mission requirements. This problem is even more pronounced when one considers that the anticipated shortfall is primarily outsize and oversize cargo. Analysis of Major Theater War (MTW) scenarios indicates that about 70 percent of the cargo required in the critical first 30 days is outsize and oversize. Accordingly, the shortfall associated with poor C-5 reliability results in a high risk assessment for this scenario.

This presentation will review the alternatives considered to address AMC's outsize and oversize cargo airlift requirements, present results of the effectiveness of each alternative, and summarize the most cost-effective solutions.

Wednesday, 0830-1000: ROUTE SELECTION AND ENROUTE MODELING
Route Selection for the Mobility Analysis Support System Using Tabu Search

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Strategic and tactical airlift routing possesses numerous side constraints such as vehicle capacities, route length and time windows in a sizable network with multiple depots and a large fleet of heterogeneous vehicles. Consequently, finding optimal solutions to problems of this type is not practical. We present an alternative approach using a reactive tabu search heuristic implemented in the Java programming language for solving vehicle routing problems (VRPs) within the Mobility Analysis Support System (MASS). Currently, MASS requires all possible routes to be manually selected, a tedious and time consuming process that relies on experiences and past performance of the model to obtain quality routes for the mobility system. We demonstrate how our meta-heuristic efficiently solves a real world variation of the VRP used in MASS.

Modifications and Enhancements to the Airlift Flow Model (AFM)

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The Airlift Flow Model is the primary simulation model used by HQ AMC to assess the impact of fleet composition, en route capabilities, and concept of operations on strategic and tactical airlift capabilities. The model is currently seeing extensive use in the Outsize and Oversize Analysis of Alternatives, the Intra-theater Lift Assessment Study, and MRS-05. The model will also be used this year to study the feasibility of AMC's Weapons of Mass Destruction CONOPS.

In order to best meet the challenges that these studies present, AFM is undergoing significant modifications and enhancements. To begin with, the mission planning algorithms have been revised to accommodate the notion of Parking and Working MOG which will allow the model to more realistically handle winds, weather, crews, MHE, and other real-world constraints. Another enhancement is the revision of the fuel planning methodology, which allows AFM to determine mission fuel in accordance with Flight Performance Manual procedures. To meet the needs of WMD studies, AFM is being adapted to model trans-load operations to include moving crew stage bases, increasing ground times, re-directing cargo flow, and changing aircraft routing schemes, all during simulation run-time. Finally, a graphical user interface was added to AFM which greatly simplifies the construction of input files and more importantly gives the user an extremely powerful platform to analyze the volumes of output data produced by the model. All of these changes have greatly enhanced the utility of AFM and will ensure that it meets the needs of AMC well into the future.

Wednesday, 1030-1200
COMPOSITE GROUP D .... Room 144

Wednesday, 1330-1500: MOBILITY CONTINGENCY ANALYSES
The Simulation and Visualization of Airborne Operations

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We present an object-oriented simulation that models the strategic brigade airdrop mission. Representing a continuation of the work begun by Belano, Petry, and Fox, this C++ version of the simulation produces a ground dispersal prediction, and generates a high quality visualization of the airdrop operation and environment. The presentation includes a visualization of the simulation results produced on a Silicon Graphics Onxy2 Visualization Supercomputer, and demonstrates its use as an interactive tool for mission planning and prototyping of new aircraft formations or tactics

Global Air Traffic Management (GATM) Impact Study

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Civilian authorities require GATM capabilities to operate in the world's airspace with new separation standards and an air traffic management system in 2010. Global increases in users requiring passage through this finite airspace has resulted in mandated changes in civil airspace structure, control systems, and aircraft hardware. GATM enhancements will provide precise navigation tolerances, improved communication, and enhanced surveillance. These restrictions require aircraft not properly equipped to fly at lower than optimum altitudes which will result in longer flight times, additional fuel and refueling resources. Military aircraft in civil-controlled airspace must comply with U.S. national and foreign national and international regulations. Exceptions are only in the case of military emergency. This study quantifies the impact of not having U.S. Air Force Air Combat Command (ACC) fighters and bombers GATM compliant. Results will aid decision-makers on the criticality of modernizing ACC aircraft with GATM enhancements. An Excel spreadsheet model quantifies fighter impact in terms of increased time, fuel and tanker support. Operational planners provide bomber non-GATM impacts in terms of increased fuel and tanker support. Fighter non-GATM impacts will hamper peacetime training operations and contingency deployments more than wartime operations. Campaign impact is minimal since delays due to GATM do not exceed the amount of time fighters arrive in advance of their support IAW the Time-Phased Force and Deployment Data (TPFDD). Bombers flying in non-GATM airspace not only increase fuel and tanker requirements, but also critically impact high altitude peacetime training while en route to a military training area.

Stochastic Analysis for Deployments and Excursions **RIST PRIZE FINALIST**

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Approved abstract unavailable at printing.

Thursday, 0830-1000: AIRLIFT ENROUTE INFRASTRUCTURE
NATO Strategic Mobility Infrastructure Study

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AMC/USTC analysts have a history of analyzing a host of air mobility issues for U.S. force movements. This past year we were asked to broaden the scope of analysis to include US and allied force movements going by air. In a NATO scenario, over and outsize allied force air movement requirements are additive to U.S. only requirements. The result is additional workload for US air mobility assets and the European en route system. Our study was focused on the European En Route Infrastructure requirements for a NATO scenario. Significant challenges to this analysis included interweaving U.S. and NATO data sources, defining appropriate assumptions and sensitivities, and anticipating the reactions of a multi-national political audience.

Effects of Fuel Infrastructure Enhancements on Air Mobility

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Fuel limitations can readily constrain airlift operations, thereby restricting the number of aircraft that can be serviced during a deployment. Hampered aircraft flow clearly limits the throughput of troops and cargo, a situation unacceptable in major regional contingencies (MRCs). In an effort to mitigate such fueling bottlenecks, the Defense Logistics Agency, (DLA) has proposed several possible fuel infrastructure enhancements. These construction projects would enhance the fueling capabilities at en route airfields supporting MRC-East and MRC West deployments.

In this study, we used the Airfield Capacity Estimator (ACE) and the Naval Postgraduate School/RAND Mobility Optimizer (NRMO) models to estimate the benefits of investigating in DLA's fuel infrastructure projects. Using time-phased force deployment data for MRC-E and MRC-W, we quantified the increases in cargo and passenger throughput that could be expected from implementing each of the fuel projects. In this presentation, we will discuss the baseline throughputs as well as the projects' efficacy in increasing the deliveries of passengers and cargo.

Thursday, 1030-1200: THEATER AND END-TO-END MODELING
A Standards-Based Methodology for Representing Throughput in Transportation/Movement Modeling

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During planning stages of force deployment, it is critical to have an accurate assessment of the on road throughput capacity within a theater to support force projection and sustainment operations. In transportation and movement modeling along a road network, throughput is a key characteristic needed for assessing, planning, and scheduling movement of assets within a theater of operation. Currently, there are various approaches employed to estimate capacities based on road type and vehicle or convoy type. Typically, these approaches are based on limited empirical data, which exhibit high variability and are not readily applicable to other regions. There exists a need to develop a throughput methodology of sufficient resolution that is applicable to other regions. There exists a need to develop a throughput methodology of sufficient resolution that is applicable worldwide and incorporates factors accounting for local characteristics of the transportation network, environmental effects, and performance of vehicle systems. This paper will present a new methodology for estimating capacity based on recommended standards for mobility modeling. The NATO Reference Mobility Model (NRMM), the proposed standard for ground vehicle movement in M&S, was utilized to generate accurate estimation of vehicle/convoy speeds along routes. A fractal methodology was employed to generate a random sample of level, rolling, and mountainous profiles. Throughput estimates were made along the routes and statistical analysis was performed to determine associated means and variations for different road types, scenarios, and vehicles. Results of this research will be implemented in JWARS to represent ground movement.

Simulation Tools for the Warfighter: JRSO&I Applications

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There are a number of modeling and simulation tools available today that assist the Joint Services and DoD planners in transportation logistics. Two of these tools, the Enhanced Logistics Intra-theater Support Tool (ELIST) and Port Simulator (PORTSIM) will be discussed here. Both ELIST and PORTSIM have been used by Joint Staffs and warfighters in the field to evaluate Joint Reception, Staging, Onward movement, and Integration (JRSO&I); this includes the force projection of units through ports, and forward movement ashore to the tactical assembly areas in theater.

However, despite their success and utility to joint planners, these simulation tools have not yet been significantly utilized by the Navy/Marine Corps team; this is an opportunity. These tools can be of great use to Navy/Marine Corps decision-makers in the planning and execution of the "Expeditionary Logistics" vision.

ELIST is a modeling and simulation tool that evaluates the transportation feasibility of a movement plan. It "flows" forces and equipment over a theater's transportation infrastructure and determines whether infrastructure and transportation assets can support the warfighting commanders' required force delivery dates. In other words, ELIST simulates the deployment of forces within a theater of operations. PORTSIM simulates port operations and determines port throughput at the item level of detail. It also identifies system and infrastructure constraints and port specific clearance profiles.

This paper provides an overview of ELIST and PORTSIM and some of the models' functionality. The intent is to summarize the utility these tools have to the Joint Services and DoD planners in transportation logistics, while highlighting the potential for future use. Two sample scenarios focusing on the JRSO&I of U.S. Marine Corps forces in S. Korea are discussed and an analysis on port throughput, closure, asset usage, and routes illustrate some of the ways these tools are used in JRSO&I and other areas of logistics.

End-to-End Modeling: Results and Considerations

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In order to access the capability to meet strategic mobility requirements, the Army needs analytically derived information from a comprehensive study of total movement requirements. Because of modernized capability for mobility analysis, the Center for Army Analysis (CAA) is prepared to meet this need. Such modernized capability includes inter-modal end-to-end deployment solutions, continued high resolution analysis of lift (strategic and in-theater), expanded emphasis on facility modeling, characterization of time phased sources of shortfall (vehicles and infrastructure), and decision support to identify improvements in deployment (e.g., alternate modes, vehicle mixes, routes, ports). These integrated end-to-end solutions incorporate in-theater deployment activity to identify improvements within the CONUS and strategic deployments.

Based on modeling capability of the Global Deployment Analysis System (GDAS), CAA will perform simulations of nearly simultaneous deployment of US forces into major regions for future operations of interest. Results for this presentation will consider issues of particular interest to the Army (e.g., the redistribution of prepositioned equipment (afloat and on land) disengagement and redeployment from a secondary theater, and time dependent disruptions of critical ports and canals). This presentation will also focus on considerations found particularly important to end-to-end modeling; i.e., capability to incorporate transshipment from commercial to military strategic lift, dynamic arrivals of vehicles and port opening capability, diversion during time-phased degradation of WMD scenarios, capability to utilize vehicles and ports more efficiently because of effective scheduling methodology, impact of cohesive flow of forces and prioritization of special forces, and appropriate levels of resolution for vehicles, ports, facilities, and cargo.

Thursday, 1330-1500: MOBILITY REQUIREMENTS STUDY '05

Air Mobility Assumptions and Analysis in the Mobility Requirements Study for FY2005 (MRS-05)

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The SECDEF has directed the Chairman of the Joint Chiefs of Staff (JCS J-4 and J-8) and the Director of Program Analysis and Evaluation (OSD/PA&E) to lead the MRS-05 effort. Significant changes in the current Defense Planning Guidance and Illustrative Planning Scenarios for the future will lead to changes in the need for air mobility assets. These changes include operating in a Weapons of Mass Destruction (WMD) environment, projecting power from positions of ongoing postures of engagement (POE) around the globe, conducting major theater wars (MTWs) and special operations missions concurrently, and considering the impacts of terrorist threats, harbor mining, and attrition of mobility locations, equipment, and personnel. Individually, these changes could significantly change the way this nation projects power around the world. Collectively, there is sure to be a substantial change in the way we do business. This presentation will introduce the Mobility Working Group to the MRS-05, the assumptions used for air mobility operations, and discuss the analysis of a huge number of cases, using very detailed data on a very constrained timeline. This presentation should allow 20 minutes of time for participant discussion following the 20 minute briefing.

Mobility Requirements Study 2005 -- A Unique Approach

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The Joint Staff in conjunction with the Office of the Secretary of Defense (OSD) and the Services are working on the Mobility Requirements Study - 2005 (MRS-05). MRS-05 is a follow-on study to MRS-BURU and findings will be used to influence programmatic decision surrounding the next Quadrennial Defense Review.

Anticipating the task of conducting a mobility requirements study, the Director, Force Structure, Resources, and Assessment (DJ-8) sponsored a series of workshops. From May to July 1998 a series of four workshops were held to develop the study methodology. Participants included the Joint Staff, OSD, Services, various Unified Commands, and other government agencies.

These workshops laid the foundation for the study scope, assumptions, objectives, and essential elements of analysis. The workshops also established the various sub-working groups, identified which organizations would bring resources to bear, and set up the hierarchy for the study.

We propose to present a paper detailing the study development, methodology and selected interim results.

Mobility Requirements Study 2005 – Modeling Future Mobility Requirements

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The Joint Staff in conjunction with the Office of the Secretary of Defense (OSD), unified CINCs, and the Services are working on the Mobility Requirements Study - 2005 (MRS-05). MRS-05 will be used to influence programmatic decisions and the next Quadrennial Defense Review.

Deterministic network models are used in requirements analysis. The Analysis of Mobility Platform (AMP) model provides end to end coverage of the mobility spectrum from origin to Tactical Assembly Area (TAA). AMP integrates the functionality of Enhanced Logistics Intratheater Support Tool (ELIST) and Model for Intertheater Deployment by Air and Sea (MIDAS). Modeling the 2005 force structure, transportation assets, and infrastructure resources, unit arrival timelines are compared against warfighting requirements determined by the Tactical Warfare (TACWAR) model. Mobility options are costed and set against risk parameters in developing study recommendations.

This presentation, augmenting LCDR Gangsaas' paper on MRS-05, will elaborate on the methodology and models used in evaluating future mobility requirements. We present a paper detailing the study development, methodology and selected interim results.

WG19 – LOGISTICS and RELIABILITY, AVAILABILITY & MAINTAINABILITY (LOGRAM) – Agenda
Chair: LTC Charles H. Shaw, III, CPL (USA); U.S. Naval Postgraduate School
Co-Chairs: MAJ Dave Kunzman (USMC); Studies & Analysis Div., MCCDC
Ms. Anne Hale; The SABRE Group (TSG)
Mr. Dennis Collins; Reserve Component Automation System (RCAS) Office
Ms. Jane G. Krolewski; US Army Systems Analysis Activity (USAMSAA)
Advisor: RADM Donald Eaton (USN, Retired); U.S. Naval Postgraduate School
Rooms: 310 and 312

Tuesday, 22 June 1999, 1030-1200 -Welcome and Strategic and Operational Logistics
Welcome, Introductions, and Administrative Requirements (15 Min)

Centralized Multi-Period Depot Level Maintenance Planning for U.S. Marine Corps Ground Equipment (45 Min)
Barchi Prize Finalist for Composite Group D Presentation
Capt. Chris Goodhart (USMC), HQMC, ATTN: LX

A Focused Logistics C4ISR Operational Architecture Assessment Methodology (30 Min)
Dr. Fairly Vanover, Senior Analyst, TRADOC Analysis Center (TRAC), Fort Lee

Tuesday, 22 June 1999, 1330-1500 - Strategic and Operational Logistics (continued)
Industrial Base Secondary Item Analysis (30 Min)
Mr. Kevin E. Shorter, Operations Research Analyst, US Army Materiel Systems Analysis Activity

Economic Retention Policy for Reparable Parts (30 Min)
Mr. Tovey Bachman and Mr. Robert Burleson, Research Fellows, Logistics Management Institute (LMI)

A Multi-Echelon, Multi-Indenture Readiness Based Sparing Model (30 Min)
Dr. Ronald H. Nickel, Dr. Walter Nunn, Dr. Igor Mikolic-Torreira, Dr. James Jondrow, and Mr. Craig Goodwyn, Center for Naval Analyses and Dr. Jon W. Tolle, University of North Carolina

Wednesday, 23 June 1999, 0830-1000 - Strategic and Operational Logistics (continued)
Deployment Stock Package (30 Min)
Mr. Kevin E. Shorter, Operations Research Analyst, US Army Materiel Systems Analysis Activity

Intra-Theater Logistics Modeling in JWARS (30 Min)
Major Paul Warhola (USMC), Joint Warfare System (JWARS) Office

Can ISO 9000 Compliant Assurance Practices Replace Naval Aviation Maintenance Program Practices? (15 Min)
RADM Donald Eaton (USN, Retired), Logistics Chair, and Dr. Jane N. Feitler, Visiting Professor, Dept. of Systems Management

Wednesday, 1030-1200
COMPOSITE GROUP D .... Room 144

LOGRAM LOGISTICS (LOG) BREAKOUT SESSIONS .... Room 312

Wednesday, 23 June 1999, 1330-1500 - Logistics Simulations
A Simulation for Capability Assessment of Logistics Support Alternatives (50 Min)
Mr. Salvatore J. Culosi, Logistics Management Institute

Simulation Marginal Analysis (40 Min)
Michael Slay, Research Fellow, Logistics Management Institute

Thursday, 24 June 1999, 0830-1000 - Logistics Simulations (continued)
Simulation Tools for the Warfighter: JRSOI Applications (30 Min)
LCDR Steven D. MacDonald, SC, USN, Joint Transportation Officer, Military Management Traffic Command, Transportation Engineering Agency (MTMCTEA)

Cargo Throughput Model Comparisons (30 Min)
Maj Randy Riddle and Mr Steve Brown, HQ AFOTEC/TSE

Dynamic Distribution Models for Combat Service Support (CSS) (30 Min)
Kevin R. Gue, PhD., Assistant Professor, Dept. of Systems Management

Thursday, 24 June 1999, 1030-1200 - Other Logistical Analyses
Applying the Bootstrap Method to Calculate Inventory Reorder Points (30 Min)
Dr. Ronald D. Fricker, Jr., RAND

Analysis of Factors Affecting Joint Logistics-Over-The-Shore (JLOTS) Sites (30 Min)
Mr. Phillip L. Doiron, Senior Scientist/Operations Research Analyst, Applied Research Associates, Inc.

Optimal Stockage Policy Analysis for the Special Operations Forces Support Activity (SOFSA) (30 Min)
LTC Charles H. Shaw, III; CPL, Military Instructor, Dept. of Operations Research, U.S. Naval Postgraduate School

Thursday, 24 June 1999, 1330-1500 - Other Logistics Models & Simulations
An Object-Oriented Discrete-Event Simulation of Logistics (Modeling Focused Logistics) (45 Min)
LCDR John L. Ruck (USN), OPNAV, N816D

A Standards-Based Methodology for Representing Throughput inTransportation/Movement Modeling (45 Min)
Dr. Niki C. Deliman, Dr. David A. Horner, Mr. Burney McKinley, USAE Waterways Experiment Station and Ms. Laura Bunch, MEVATEC

LOGRAM RELIABILITY, AVAILABILITY & MAINTAINABILITY BREAKOUT SESSIONS................................Room: 310

Wednesday, 23 June 1999, 1330-1500 - Reliability Modeling and Analyses
Risk Analysis and LogNormal Random Variables for Mechanical Failures (30 Min)
Mr. Douglas V. Horacek, Operations Research Analyst, US Army Aviation and Missile Command (USAAMCOM)

Development and Application of a Component Level Reliability Modeling Tool (30 Min)
Dr. Michael J. Cushing, Mr. Eric Grove, and Mrs. Jane G. Krolewski, US Army Materiel Systems Analysis Activity

Development of an Exponential Test Design and Evaluation Tool with Application to an Army Program (30 Min)
Mr. John A. Sereno, Dr. Michael J. Cushing, and Mrs. Jane G. Krolewski, US Army Materiel Systems Analysis Activity

Thursday, 24 June 1999, 0830-1000 - Reliability Modeling and Analyses (continued)
System Availability Evaluation: A Review for the Beginner and Expert Alike (45 Min)
Capt Jeffrey D. Havlicek, C4ISR Operations Research Analyst, AFOTEC/TSE

Bayesian Reliability Growth Models for Missile Testing (45 Min)
LTC David H. Olwell, Ph.D, Associate Professor, Department of Operations Research, U.S. Naval Postgraduate School (NPS)

Thursday, 24 June 1999, 1030-1200 - Reliability, Availability & Maintainability (RAM) Models
Using Models to Estimate Reliability, Availability & Maintainability (30 Min)
Maj Randy Riddle (USAF), HQ AFOTEC/TSE

A Life Cycle Cost Simulation Model for Reliability, Availability & Maintainability (RAM) Analysis of Unmanned Aerial Vehicles (UAVs)
Dr. Keebom Kang, RADM Donald R. Eaton, (USN, Retired), and LTC Brad Naegle (USA), Department of Systems Management, NavalPostgraduate School

Operational Use of the MC Rate Equation (30 Min)
Maj Randy Riddle, Capt Rob Neher, Capt Neal Bruegger, Capt Jeff Havlicek, and Lt Andy Coop (USAF), HQ AFOTEC/TSE

Thursday, 24 June 1999, 1330-1500 - Reliability, Availability & Maintainability (RAM) Models
Verification and Validation (V&V) of the Aircraft Readiness Model (ARM 1.1) (30 Min)
Maj Randy Riddle and Lt Andy Coop (USAF), HQ AFOTEC/TSE

Verification and Validation (V&V) of an Availability Model for the T-6A Aircraft (30 Min)
Maj Randy Riddle, Capt Joerg Walter, and Lt Andy Coop (USAF), HQ AFOTEC/TSE

Operational Materiel Readiness of Naval Combat Systems (30 Min)
Harry A. Watson, Jr and Raymond Ward, NWAS

Alternate for WG19:

Estimating Logistic Consumption for Joint Campaign Analyses (45 Min)
Dr. Kevin Saeger , OSD/Programs, Analysis & Evaluation/Planning & Analytic Support Division and Lt Col Rebecca Corder (USAF) OSD/Programs, Analysis & Evaluation/Information Management & Analysis Group

WG19 – LOGISTICS AND RELIABILITY, AVAILABILITY & MAINTAINABILITY - ABSTRACTS

Tuesday, 22 June 1999, 1030-1200
Centralized Multi-Period Depot Level Maintenance Planning for U.S. Marine Corps Ground Equipment

Barchi Prize Finalist for Composite Group D Presentation

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The Marine Corps builds multi-period, depot-level maintenance schedules and budgets for over 150 major types of ground equipment. The objective is to maintain the highest possible level of equipment readiness (measured in terms of numbers of assets available for use) while showing how that readiness can be achieved by adhering to the proposed itemized budgets. A dynamic model is being developed for use at the Service headquarters level to build multi-period repair lists and itemized budgets by maximizing utility of the corresponding mixes of serviceable equipment. The model balances flow of resources (serviceable or unserviceable assets) from one period to the next and is constrained primarily by available budget totals and minimum required numbers of serviceable assets by type. It uses existing reliability data to project unserviceable returns to the depots; these projections may be replaced in the model's near-term periods with planned quantities developed at maintenance conferences. Results desired from the model also include quantification and measurement of the risks to equipment readiness associated with diminishing budgets for depot-level repair.

A Focused Logistics C4ISR Operational Architecture Assessment Methodology

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This presentation offers a methodology for assessing the adequacy of Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) Operational Architectures for supporting the Joint Vision 2010 Focused Logistics Operational Concept. The methodology will: 1) synthesize literature to define the six tenets of Focused Logistics; 2) describe the Focused Logistics C4ISR Operational Architectures that support the tenets; 3) identify major problem related to each tenet; 4) compare the interrelationship among these problem; 5) determine the frequency of the interrelationships; 6) quantify the relative importance of these problems; 7) identify the most important problem areas; 8) stratify the problems in terms of related missions and functions; 9) define and weight potential problem solutions; and 10) evaluate and rank the value of the solutions. The six tenets of Focused Logistics are: Joint Deployment/Rapid Distribution; Multinational Logistics; Information Fusion; Agile Infrastructure; Joint Logistics Command and Control; and Joint Health Services Support. The solutions will be in terms of doctrine, organization, training, materiel, leadership, and people. Problems will be identified from literature and Subject Matter Experts. The Excel Spreadsheet and Statistical Package for Social Sciences (SPSS) will be used for a statistical Analysis. The Expert Choice Decision Support System will be used for evaluating and ranking alternative solutions. The results are expected to show the solutions that provide the most value per capital investment.

Tuesday, 22 June 1999, 1330-1500
Industrial Base Secondary Item Analysis

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Economic Retention Policy for Reparable Parts

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Once purchased, stock should be disposed of only if the savings in retention cost—primarily for warehouse space—and revenue from disposal exceed the probable cost of repurchasing it later to meet new customer demand. Previously we developed a method for deriving economic retention levels that better balanced these costs for consumable items. We now extend this method to reparable items, computing both serviceable and unserviceable retention levels.

For unserviceables, condemnation histories are used to compute empirical probabilities of depleting candidate retention levels in various amounts of time. We use these probabilities to estimate the repurchase cost associated with each of several candidate retention levels. Disposal cost, the difference between repurchase cost and revenue from disposal, is then compared to retention cost, including storage and the cost of repair. The economic retention level is the candidate level for which these costs are most nearly equal. For serviceables, the depletion probabilities are computed using both demands and condemnations.

We develop distinct retention levels (both unserviceable and serviceable) for items with demand frequency, demand quantity, and price in various ranges.

A Multi-Echelon, Multi-Indenture Readiness Based Sparing Model

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This presentation describes a new approach to determining sparing policies for deployed units. Unlike models that compute system availability as the product of the subcomponent availabilities, this model computes the expected time to return a failed system to an up status. The model uses a birth-death process model to calculate the probability of waiting for a failed subcomponent and the expected waiting time and standard deviation of the waiting time given the wait is greater than zero. The time to return the system to an up status or the time to repair a failed subcomponent is the maintenance time plus the expected maximum waiting time for any needed subcomponents. For multi-indenture applications, the component are topologically ordered so that waiting times are computed for child components before the parent components or systems. Optimal sparing policies are obtained with an interior point algorithm. Comparisons with existing models will be presented.

Wednesday, 23 June 1999, 0830-1000
Deployment Stock Package

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Approved abstract unavailable at printing.

Intra-Theater Logistics Modeling in JWARS

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Logistics is the science of planning and executing the movement and maintenance of forces. With the proper application of logistics combat power can achieve its full potential; without it that same power withers on the vine – or worse. JWARS is a constructive, multi-sided, balanced simulation of joint theater warfare. It is critical to the analyst that a proper representation of logistics be designed and implemented in the model. This presentation describes the status of development through the first released version of JWARS. It explains the design of the intratheater multi-modal network and the movement and distribution of personnel, equipment and supplies across the network. It also addresses the effect of logistics on the warfight and the warfight's effect on logistics.

Can ISO 9000 Compliant Assurance Practices Replace Naval Aviation Maintenance Program Practices?

RADM Donald Eaton (USN, Retired), Logistics Chair, and Dr. Jane N. Feitler, Visiting Professor
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LOGRAM LOGISTICS (LOG) BREAKOUT SESSIONS..Room 312

Wednesday, 23 June 1999, 1330-1500
A Simulation for Capability Assessment of Logistics Support Alternatives

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In late 1993 , the Joint Logistics Systems Center (JLSC) recognized the need for a unique simulation to quantify how logistics business process improvements reduce the cost of increasing weapon system availability. The Logistics Management Institute (LMI) was tasked to build this simulation capability, which has become known as CALOSAL. Its name is derived from its utility in conducting a Capability Assessment of Logistics Support Alternatives. Heretofore, analytic solutions to quantify improvements in logistics business processes were not able to capture the many constraints and policies reflected in the current DoD logistics support system. On the other hand, existing simulations that eliminate problems with analytic solutions have tended to focus on intermediate logistics performance measures such as supply availability and backorders at the retail and wholesale level. CALOSAL offers a unique capability to quantify improved business process in terms of both cost (inventory and transportation) and ***improved weapon system readiness – the ultimate effectiveness measure.*** The prototype capability was completed in 1995. Since then it has been enhanced to accommodate various applications not envisioned in the initial design. The Air Force has used it to help structure its Agile Logistics program and is currently adopting it as its Supply Chain Management (SCM) simulation. Some Air Force applications include readiness assessments of alternative processes for repair and distribution of secondary items and methods for setting retail levels in a constrained environment. The Navy has also explored the simulation's potential to help address the weapon system availability implications of alternative options for combining consolidated ship allowances (COSALs).

Simulation Marginal Analysis

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Simulation and marginal analysis are commonly used techniques – but not together. Marginal analysis is a popular way to solve many problems in operations research. Simulation can be used on a much broader range of problems, but only to assess solutions – not to generate them. Unfortunately, the inaccuracy inherent in simulation interferes with marginal analysis, where small incremental changes are compared based on their marginal cost/benefit impact. These incremental benefits are overwhelmed by simulation's natural variability, absent a prohibitively large number of replications. We have discovered a way to make to make simulation fast and accurate enough to work with marginal analysis. This permits generating solutions for the vast range of problems which cannot modeled analytically. We will explain the new technique and demonstrate an inventory optimization model embodiment. This model effectively solves some of the classic unsolved problems in inventory theory.

Thursday, 24 June 1999, 0830-1000
Simulation Tools for the Warfighter: JRSOI Applications

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There are a number of modeling and simulation tools available today that assist the Joint Services and DoD planners in transportation logistics. Two of these tools, the Enhanced Logistics Intra-theater Support Tool (ELIST) and Port Simulator (PORTSIM) will be discussed here. Both ELIST and PORTSIM have been used by Joint Staffs and warfighters in the field to evaluate Joint Reception, Staging, Onward movement, and Integration (JRSO&I). This includes the force projection of units through ports, and forward movement ashore to the tactical assembly areas in theater. However, despite their success and utility these simulation tools have not yet been significantly utilized by the

Navy/Marine Corps team. These tools can be of great use to Navy/Marine Corps decision-makers in the planning and execution of the "Expeditionary Logistics" vision.

ELIST is a modeling and simulation tool that evaluates the transportation feasibility of a movement plan. It "flows" forces and equipment over a theater's transportation infrastructure and determines whether infrastructure and transportation assets can support the CinC's required force delivery dates. In other words, ELIST simulates the deployment of forces to and within a theater of operations. PORTSIM simulates port operations and determines port throughput at the item level of detail. It identifies system and infrastructure constraints and specific clearance profiles.

This paper provides an overview of ELIST and PORTSIM and some of the models' functionality. The intent is to summarize the utility these tools have to the Joint Services and DoD planners in transportation logistics, while highlighting the potential for future use. Two sample scenarios focusing on the JRSO&I of U.S. Marine Corps forces in S. Korea are discussed and an analysis on port throughput, closure, asset usage, and routes illustrate some of the ways these tools are used in JRSO&I and other areas of logistics.

Cargo Throughput Model Comparisons

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Approved abstract unavailable at printing.

Dynamic Distribution Models for Combat Service Support (CSS)

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Approved abstract unavailable at printing.

Thursday, 24 June 1999, 1030-1200

Applying the Bootstrap Method to Calculate Inventory Reorder Points

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Analysis of Factors Affecting Joint Logistics-Over-The-Shore (JLOTS) Sites

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Approved abstract unavailable at printing.

Optimal Stockage Policy Analysis for the Special Operations Forces Support Activity (SOFSA)

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The Special Operations Forces (SOF) Support Activity (SOFSA) maintains the Joint Operational Stocks (JOS) used as a rotating pool of end-use items by United States Special Operations Forces. The JOS items are actually administered by the Directorate of Logistics (J4), United States Special Operations Command (USSOCOM) at MacDill AFB in Tampa, FL. By using a rotating pool of assets, USSOCOM can reduce the total quantities of items that need to be purchased. The problem addressed is how to determine which items to carry (i.e. - the breadth

or range) and how many of each item to stock (i.e. - the depth) for JOS inventories to provide the maximum readiness to our forces, constrained by funding. Currently no systematic approach is used to determine JOS inventory levels. This research develops a systematic and analytic methodology to answer this problem. Specifically, two models will be developed, the inventory model and the allocation model. The inventory model will determine the range and depth of the inventory to be stocked using a combination of historical data; estimated usage based on proposed scenarios; and generating range and depth figures using a simulation based on anticipated usage. The allocation model will use the inventory model results and provide the best allocation of available funds to provide the maximum increase in readiness.

Thursday, 24 June 1999, 1330-1500
An Object-Oriented Discrete-Event Simulation of Logistics (Modeling Focused Logistics)

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A Standards-Based Methodology for Representing Throughput inTransportation/Movement Modeling

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Approved abstract unavailable at printing.

LOGRAM RELIABILITY, AVAILABILITY & MAINTAINABILITY (RAM) BREAKOUT SESSIONS.........Room 310

Wednesday, 23 June 1999, 1330-1500
Risk Analysis and LogNormal Random Variables for Mechanical Failures

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Modeling crack growth and detection by using the sum and difference of two Lognormal random variables. Developed software for calculating the probabilities for both the sum and difference of log normal random variables and also the observations given the probability of the two Lognormal random variables. Also, developed software to calculate three risk assessment probabilities. The three risk assessment probabilities are: (1) Probability that an inspection missed the crack and the part failed, (2) Probability that the cracked part was removed, and (3) Probability a cracked part is removed and yet the part failed. The software can easily be run on modern personal computers and requires FORTRAN 90 to run executable files. The Software developed is specifically for risk assessments of metal parts for Turbine Engines.

Development and Application of a Component Level Reliability Modeling Tool

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Eric Grove, Operations Research Analyst
Jane G. Krolewski, Reliability Engineer
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Approved abstract unavailable at printing.

Development of an Exponential Test Design and Evaluation Tool with Application to an Army Program

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Thursday, 24 June 1999, 0830-1000
System Availability Evaluation: A Review for the Beginner and Expert Alike

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Approved abstract unavailable at printing.

Bayesian Reliability Growth Models for Missile Testing

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Missile developmental and operational testing is very expensive. It requires estimating the probability that a missile exceeds a certain reliability level. Estimation is complicated by upgrades to the missile as failure modes are identified and removed, resulting in sequence of trials that are not identically distributed. Several models exist to describe this growth in reliability. The number of trials required to get precise estimates of the desired probability are large, and under a frequentist approach only result in approximate confidence intervals, not probability statements.

In this paper, we apply Bayesian methods to incorporate engineering knowledge and past experience into the statistical problem, using each of three reliability growth models. We use Markov Chain Monte Carlo methods to analyze the posterior distribution, and provide graphical and numerical predictions of the asymptotic reliability, and the likely number of redesigns and failure until we meet a desired reliability level. Additionally, pre-posterior analysis allows us to have insight into the number of missile trials necessary to achieve our analytical goals with the postulated prior knowledge, and the sensitivity of our analysis to those prior beliefs.

We illustrate with the THAAD program. Given five failures, what does the future hold? We compare traditional analysis methods (which produce very pessimistic forecasts) with our methods, which by explicitly drawing on engineering knowledge and prior historical norms can result in much more optimistic and realistic predictions. We highlight all the sensitivity of the analysis to the assumptions used, particularly comparing the Bayesian assumptions with the classical ones. We discuss safeguards against malevolent manipulation.

We discuss extensions and implications of the work. The methods have been implemented on a PC., and source code will be available.

Thursday, 24 June 1999, 1030-1200
Using Models to Estimate Reliability, Availability & Maintainability

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Approved abstract unavailable at printing.

A Life Cycle Cost Simulation Model for Reliability, Availability & Maintainability (RAM) Analysis of Unmanned Aerial Vehicles (UAVs)

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Estimating the life cycle cost of a major weapon system is a very complex process. Many uncertain factors, such as changes in fleet size, mission, and global/regional contingencies, make this process even more complicated. We developed a spreadsheet-based Life Cycle Cost simulation model to estimate the total ownership cost of new weapon systems. This model can be used major weapon system acquisition decisions under uncertainty. We applied this model to the Outrider UAV program. The Navy can adopt this model for its vertical takeoff and landing (VTOL) UAV studies.

Operational Use of the MC Rate Equation

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Thursday, 24 June 1999, 1330-1500
Verification and Validation (V&V) of the Aircraft Readiness Model (ARM 1.1)

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Verification and Validation (V&V) of an Availability Model for the T-6A Aircraft

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Operational Materiel Readiness of Naval Combat Systems

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Operational Availability (Ao) is the primary measure of material readiness for Navy mission-essential systems, subsystems, and equipments installed in platforms (ships and aircraft). Ao has applications in the design phase and acquisition process of new equipment as well as in readiness improvement programs. Ao is a key element in System Effectiveness (SE), where $SE = f(Ao, P_C, P_P)$. P_C is defined as performance capability and P_P is defined as decision-making ability. Moreover, Ao requirements drive logistic support requirements. Operational Availability is defined as the probability that at any point in time the system will perform its specified function when required in an actual environment. This paper will present the analytical methods used to evaluate the overall system readiness as well as the readiness of the individual system components and reliability blocks. We will indicate how, through sensitivity studies, one can calculate overall ownership cost as a function of Ao, MTBF, etc. Finally, in this paper we will demonstrate the process underlying operational readiness assessment of naval combat systems and how this assessment supports readiness improvements within the Fleet.

Alternate for WG19:

Estimating Logistic Consumption for Joint Campaign Analyses

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WG 20 – MANPOWER AND PERSONNEL – AGENDA

Chair: Larry Looper, AFRL/HEJD
Co-Chairs: Capt Edward T. Dewald, USMC, HQMC
MAJ John Jessup, USA, USA Recruiting Command
LCDR Paul A. Soutter, Navy Recruiting HQ
Robert Stevens, HQ USA TRADOC
Advisor: Her J. Shukiar, RAND
Room: 308

Tuesday, 1030-1200
Econometric Projection of Army Personnel Strength
Gregory Hildebrandt, Naval Postgraduate School, Systems Management Department, Monterey, CA 93943, (831) 656-2637

PICAS: Pilot Inventory Complex Adaptive System
Capt Marty Gaupp, Maj Raymond Hill, and LtCol T Glenn Bailey, Department of Operational Sciences, Air Force Institute of Technology

Does Long or Hostile Duty Hurt Retention?
James Hosek and Mark Totten, RAND, PO Box 2138, Santa Monica, CA 90407-4818, jrh@rand.org

Tuesday, 1330-1500
Estimation of Navy Enlistment Supply Models at Recruiting Station and Metropolitan Area Levels
Stephen L. Mehay, Professor, Department of Systems Management, Naval Postgraduate School

Enhancing the Army's Recruit Assignment System
Peter M. Greenston, US Army Research Institute for the Behavioral and Social Sciences

Recruiter Size and Allocation Model(RSAM)
Maj Neil E. Fitzpatrick, HQ, US Army Recruiting Command

Wednesday, 0830-1000
Recruiting Market Analysis and Planning System
Maj Rick E. Ayer, Market Research and Plans Division, HQ US Army Recruiting Command

Command Level Mission Model (CLEMM)
Maj C. Ray Pettitt, Jr., HQ, US Army Recruiting Command

RSLES: The Recruit Station Location Evaluation System
Kevin R. Gue, Department of Systems Management, Naval Postgraduate School

Wednesday, 1030-1200
COMPOSITE GROUP D .... **Room 144**

Wednesday, 1330-1500
Objective Force Model
Paul Hogan, and Patrick Mackin, The Lewin Group

Forecasting the Army's Individual Account (TTHS)
Maj John R. Crino, Strength Analysis and Forecasting Division, Deputy Chief of Staff for Personnel and Steven Wilcox, Oliver Hedgepeth, Jeffrey Roach, and Steig Hallquist, GRC International

WEEM: Incorporating Women into the Army's Enlisted Force
Maj Clark H. Heidelbaugh, US Total Army Personnel Command

Thursday, 0830-1000
Projecting the Impacts of Civilian Force Shaping
Maj Pete Vanden Bosch, Civilian Personnel Analysis, AF Personnel Operations Agency/DPYC

Assessing the Diversity of the Officer Corps
LtCol Patrick J. Driscoll, Department of Mathematical Sciences, US Military Academy

Downsizing Air Force Space Command's Headquarters by Value-Focused Thinking
Maj Harry N. Newton and Capt Robert M. Block, Department of Mathematical Sciences, US Air Force Academy

Thursday, 1030-1200
NCO Leader Development in the 21st Century
Herbert J. Shukiar, John D. Winkler, and John Peters, RAND

Unit Positioning and Quality Assessment Model (UPQUAM)
Maj Martin L. Fair, HQ US Army Recruiting Command

Soldier Time on Station: A Case Study in the Use of Operations Research Techniques in the Army Personnel Community
Maj Gene M. Piskator, Training and Analysis Branch, Deputy Chief of Staff for Operations, US Army Personnel Command

Should Fleet Experience Correlates Drive Navy College Scholarship Criteria? USNA as a Case Study
William Bowman, US Naval Academy and Stephen L. Mehay, Naval Postgraduate School

Thursday, 1330-1500
Combining Data Envelopment Analysis and Statistical Regression to Determine Efficiency and Effectiveness in Military Advertising Strategies
Patrick L. Brockett, William W. Cooper, and Maj Michael J. Kwinn, Jr., Management Science and Information Systems Department, The University of Texas at Austin

Rist Prize Finalist
Forecasting and Allocation of US Army Recruiting Resources
P.L Brockett, J.J. Rousseau, and L. Zhou, Center for Cybernetic Studies, The University of Texas at Austin, Austin, B. Golany, Technion-Israel Institute of Technology and D.A. Thomas, Department of Systems Engineering, US Military Academy

Recruiter Selection Methodology
Maj David K. Grimm and Maj Robert H. Fancher, HQ US Army Recruiting Command

WG 20 – MANPOWER AND PERSONNEL – ABSTRACTS

Tuesday, 1030-1200
Econometric Projection of Army Personnel Strength

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This study supports the achievement of the required end strength using the Army's Strength Management System by projecting retention rates for various categories of enlisted personnel. The Strength Management System currently employs exponential smoothing models to forecast the first-term retention rates for specified groups of enlisted personnel. These groups, called C-groups, are defined by gender, high school graduation status, Armed Forces Qualifying Test scores, and term of enlistment.

This analysis generalizes the exponential smoothing models by using econometric methods. Several Multivariate Autoregressive Moving Average (MARMA) models are estimated to forecast the retention rates for the C-groups. These MARMA models include both economic variables and lagged retention rates. The included economic variables permit the retention forecast to depend on factors in the external environment. In addition to increasing the predictive power of the forecasting models, the inclusion of the economic variables enhances the understanding of changes in the retention rates. The economic variable of particular note is the lagged military-to-civilian pay ratio, which has a significant positive effect on the retention rate.

The inclusion of lagged dependent variables as explanatory variables in the econometric models is derived from various behavioral models. For example, if service members form adaptive expectations of the values of certain economic variables, the inclusion of a lagged dependent variable is appropriate. A lagged dependent variable is also appropriate if the effect of an economic variable on retention rate is distributed over time.

PICAS: Pilot Inventory Complex Adaptive System

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The retention of skilled pilots continues to be a problem that plagues the United States Air Force. After spending millions of dollars on training and education, it is disheartening to see the mass exodus of experienced aviators that has been occurring in the past decade. Many blame the economy, others the Air Force, but few are able to accurately predict how or why they are all leaving. The current personnel models do not adequately determine retention rates. Complex adaptive systems theory, however, might provide some insight. By modeling the system at the pilot's level, allowing each to be represented by an autonomous, independent, agent continually adapting to its environment and the other agents in it, an alternate model can be built, one that accounts for the interactions among the pilots, not just their interactions with their environment. PICAS is just such a model. Constructed in the Java language, the PICAS model exploits the notions of complex adaptive systems theory and employs dynamic user controls to discern retention rates. Pilots "evolve", for lack of a better word, to a greater fitness within their environment, and in the process, the model user can better determine what kind of environment needs to be created in order to ensure that the pilots are in fact retained for their services. We discuss the theory underlying PICAS, the development of PICAS, and the use of PICAS as a tool for exploratory modeling.

Does Long or Hostile Duty Hurt Retention?

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Since the end of the Cold War, U.S. armed forces have engaged in a wide variety of peacekeeping, humanitarian, and disaster relief operations. In addition, the U.S. has continued to maintain forces stationed abroad, although fewer in number than during the Cold War. This study first documents the increase in long or hostile duty, differentiating the pattern and level of increase across the Services. The study then develops measures of long or hostile duty at the level of the individual service member and employs these measures in an analysis of their effect on retention. Analyses are conducted by Service for first-term and early career personnel. The results indicate that for many personnel, the extent and nature of long or hositle duty in the mid-1990s on net resulted in an increase in retention, not a decrease as feared by many. However, in the Navy and Air Force, there were negative effects among about half of first-term personnel. The study also places the relationship between deployment and retention in the context of a dynamic retention model in order to provide a conceptual basis for understanding the empirical results. Finally, the results point to the importance of balancing the burden of long or hostile duty among personnel, and also to accurately shaping service members' expectations about long or hostile duty. (A full report has been completed on this study.)

Tuesday, 1330-1500

Estimation of Navy Enlistment Supply Models at Recruiting Station and Metropolitan Area Levels

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In response to increased difficulties in meeting its recruiting mission, the Navy has proposed a significant increase in both recruiters and recruiting facilities. Expanding both recruiters and facilities requires decisions on their geographic placement. Prior enlistment supply modeling has seldom attempted to account for the geographic location of recruiting resources. However, a facility that is located in close proximity to its target market can reduce both travel time and costs and thus increase recruiter productivity. The purpose of this research is to estimate the direct and indirect effects of facilities and recruiters on new contract production.

The study assembles data on Navy recruiting and recruiters, and local area characteristics for all U.S. zip codes for 12 quarters. Full data are available for the Army and Navy. This data is then aggregated to three higher geographic levels: recruiting stations, metropolitan areas, and Navy Recruiting Districts. Appropriately specified production models are estimated for each of these three levels, as well as for the zip code level. The research seeks to answer the following questions: Do the estimated effects of recruiters depend on their geographic location? What are the direct and indirect effects of recruiting stations? Do collocated stations affect Navy production? What are the interservice competition effects among recruiters?

Enhancing the Army's Recruit Assignment System

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The Army's Recruiting Quota System, known as REQUEST, assigns applicants to jobs based on meeting minimum qualifications and current job-fill requirements. REQUEST does not attempt to assign would-be recruits into jobs for which they would be most productive. It does not (and cannot) discriminate among applicants who range from least to most qualified. In addition, it does not consider future recruit supply when assigning recruits to near-term versus future seats. In sum, the existing classification procedure virtually ignores differential abilities and the dynamic aspect of allocation.

To address such shortcomings the Army Research Institute (ARI) has conducted research to improve the selection, classification, and utilization of enlisted personnel, and this led to development of a prototype Enlisted Personnel Allocation System (EPAS). Prototype testing has been completed recently and the project is moving toward implementation. Testing has shown that large gains in (recruit) mean predicted performance, on the order of 0.25 to 0.50 standard deviation units, can be obtained. Achievement of such gains, using existing procedures, would be prohibitively expensive.

Designed to enhance REQUEST by introducing optimization into what is a sequential process, EPAS models the assignment process as two phases. In the first phase, a large linear programming (LP) model is formulated to represent the monthly flow of applicants and training class seats over the recruiting business cycle. The model is solved for the allocation of (applicant) supply groups to job training starts that maximizes recruit predicted performance while meeting training management goals. The LP model solution is updated weekly and used to generate an ordered list of job recommendations particular to each supply group. In the second phase of individual applicant assignment, these recommendations are merged with those generated by existing procedures and presented to the applicant.

Recruiter Size and Allocation Model (RSAM)

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The objective of the model is to accurately forecast an appropriate number of On-Production Regular Army (OPRA) recruiters to successfully recruit the United States Army Recruiting Commands (USAREC) near and far terms accession goals. In order to answer "How many recruiters does USAREC need in the future?" and "Where do we put them?" the SRAM uses a Non-Linear Program (NLP) methodology to derive an "optimal" number of recruiters for each of the 41 subordinate recruiting battalions (RBNs) while ensuring five key constraints are not violated. The goal of the model is to minimize our recruiter numbers, but on the other hand ensure we have sufficient authorized OPRA numbers to accomplish current and future accession goals. The model is constrained by: (1) ensuring future accession missions are achieved based on historical recruiter "write rate" data recorded for each RBN, (2) ensuring the current OPRA strengths in each RBN are not drastically altered by a solved solution (i.e. the new "solution" does not have an RBN lower than 80% of its current strength nor higher than 120% of current strength), (3) ensure the RBNs have an appropriate number of high school seniors for each recruiter, (4) give each RBN an appropriate share of recruiters relative to the past DoD quality production that came from each individual RBN area, and (5) give each RBN a relative share of recruiters according to forecasted contract information (data based on market segmentation). A more descriptive mathematical model will be presented during the MORS Symposium.

Wednesday, 0830-1000
Recruit Market Analysis and Planning System

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The Recruiting Market Analysis and Planning System is a new process being implemented at the United State Army Recruiting Command for prioritizing and targeting markets, shaping advertising strategies, refining incentives and determining future recruiting strategies. The process is a hybrid of the Army mission planning process and civilian marketing decision support systems (MDSS). The goal of RMAPS is to gather and interpret information and turn it into a basis for making management decisions.

RMAPS is a heuristic process that begins with an analysis of key indicators and trends in the youth market gathered primarily through longitudinal surveys. Once the market analysis is complete, an analysis of environmental factors such as economic, political and social trends provides background information through which the market analysis can be filtered. Finally, theories of marketing, advertising and recruiting are applied to the gathered information to determine probable courses of action concerning market strategies, advertising strategies, recruiting strategies, and policy changes.

Command Level Mission Model (CLEMM)

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The Command Level Mission Model (CLEMM) is a tool used to forecast recruiter net production and equitably distribute battalion level missions to the 41 Recruiting Battalions in the US Army Recruiting Command (USAREC). The model uses dynamic regression to predict what each battalion will achieve for each of three mission categories: GA, SR, and Other. A GA is a high school diploma graduate who scores 50 or higher on the Armed Services Vocational Aptitude Battery (ASVAB). A SR is high school senior and an Other refers to all remaining recruit categories. Each of these three mission categories is a dependent variable. Independent variables include factors such as past production, assigned recruiters, unemployment rates, policy variables, and monthly effects. A "best fit" regression model is developed for each battalion (by category) using stepwise regression. The model is then used to forecast the net production.

Net production forecast are used for: (1) notifying the Command's leadership of projected accession data, and (2) distributing the Command's contract mission requirement for the upcoming mission cycle (usually the Recruit Ship Quarter (RSQ)). Contract mission refers to the number of new recruits a recruiter must "sign" into the Army.

A more descriptive mathematical model will be presented during the MORS Symposium.

RSLES: The Recruit Station Location Evaluation System

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Recent troubles in military recruiting underscore the need for the Department of Defense (DoD) to make the best use of limited fiscal and physical resources to obtain needed recruits. A recent study by the GAO suggested that the Services look for opportunities to leverage assets such as recruit stations to achieve production goals at a lower cost. We have developed the Recruit Station Location Evaluation Station (RSLES) to help facilities planners do joint analysis on the locations of joint- and single-service stations and the allocation of recruiters to those stations. We describe the RSLES decision support system and its embedded optimization model, which locates recruiting stations for multiple, competing services at minimum cost to the DoD. The model embodies a non-linear econometric model of recruit production that uses detailed zip-code level data such as population and geographic area. Location decisions are modeled with integer variables, resulting in a mixed integer, non-linear problem, which we solve using a piecewise linear approximation. We show some results of our analysis in several metro areas.

Wednesday, 1030-1200
COMPOSITE GROUP D .... Room 144

Wednesday, 1330-1500
Objective Force Model

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The "objective force", as we apply the term, is that grade and year of service profile of personnel which, conceptually, provides the most effectiveness or productivity for the resources required to build and maintain that force that meets a specified level of requirements. In this study, we provide a discussion of our concept of an objective force, emphasizing that such a force will vary over time as a function of the inherited force, supply conditions for both recruiting and retention of personnel, training costs, and other factors.

We have developed a prototype objective force model and applied it to nuclear ratings in the Navy. The model includes a behavioral model of retention based in the Annualized Cost of leaving Model, an explicit model of promotion, and recruiting and training costs. We describe the model, its application in principle, and the results of applying the model to selected Navy ratings.

Forecasting the Army's Individual Account (TTHS)

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The Army Strength Analysis and Forecasting Division in ODCSPER is currently redesigning its Individuals Account (TTHS) model. The objective is to create a forecasting model that will serve the Army's Individuals Account forecasting requirements into the 21st Century. The Army's Individuals Account is approximately 13% of the Army's total strength and is significant in measuring the Army's manning level at the aggregate, grade and MOS level of detail. This presentation will identify the forecasting techniques used for the Individuals Account sub-accounts (Trainees, Transients, Holdees, Students, Officer Accession Students, and Cadets).

WEEM: Incorporating Women into the Army's Enlisted Force

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The Army's Women's Enlisted Expansion Model (WEEM) recommends the maximum female content of each Military Occupational Specialty (MOS) by grade based on personnel policy constraints. PERSCOM uses the model's output to determine female training requirements and female accession targets. Several factors constrain the maximum female content: the number of combat positions coded for males only, male and female overseas assignment equity, maintaining an adequate pool of male combat replacements, and other policy constraints. The model, coded in FORTRAN, is hard to maintain and is not flexible enough to analyze various gender related personnel policies. PERSCOM is analyzing WEEM to determine how to improve or replace the model. Currently, RAND is studying Army policies that impact on gender equity. They intend to recommend revised guidelines for considering MOS eligibility and assignment with respect to gender. PERSCOM will compare RAND's recommendations with current WEEM methodology recommendations for maximum female content for MOSs. Current analysis of WEEM includes developing an MS EXCEL-based tool that replicates WEEM logic for a single MOS to determine how sensitive WEEM output is to changes in personnel policy and alternative courses of action. Additionally, PERSCOM has built a prototype, next generation gender model using Statistical Analysis Software (SAS). Our intention is to use or modify either the existing WEEM model or this SAS model to incorporate RAND's policy recommendations to provide Army leadership a tool to conduct decision analysis on gender policies affecting accessions and MOS gender populations.

Thursday, 0830-1000
Projecting the Impacts of Civilian Force Shaping

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The civilian force in each of the military services has experienced a considerable increase in experience over the last ten years, as measured by years of service or years until retirement eligibility. Leadership has been concerned with when this trend will stop, what its effects are, and how best to counter them. For instance, OSD is proposing legislation that would give the services more authority to "force shape" -- induce more senior workers to retire or separate voluntarily and replace them with a less experienced group. This presentation describes some of the modeling and analysis associated with the USAF force shaping proposal and makes some suggestions as to how best to use force shaping and other tools to modify the civilian force profile.

Assessing the Diversity of the Officer Corps

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We propose a new methodology for assessing and selecting successful pools of candidates against specified institutional criteria that avoids explicit aggregation of individual candidate information. This
methodology, called Normed Attribute Projection, is based on a simple, multi-dimensional vector approach that enables one to define a threshold acceptability representing institutional tolerance for candidate variation. We demonstrate the applicability of this n-dimensional assessment model for the new OER (DA FORM 67-9, OCT 97). The implementation of this model will enable selection boards to:

(1) quickly assess the qualifications of the candidate pool based on institution goals and desired composite characteristics,
(2) identify the most promising candidates without losing visibility of individual attribute scores (as is done in aggregate measures), and
(3) identify an equivalence frontier across which selections for promotion can be made that maintain a true diversity within the officer corps according to institutional goals.

Downsizing Air Force Space Command's Headquarters by Value-Focused Thinking

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The Defense Reform Initiative of 1997 requires a 10% manpower reduction in the headquarters for each major command by FY 2003. The National Defense Authorization Act of 1998 calls for the same type of reduction but at the 25% level; however, OSD is seeking a waiver for the 25% reduction. Our talk discusses how Air Force Space Command is planning for these reductions.

Preparing for the downsizing at Space Command has been led by the TAT (Task Analysis Team)--a colonel-level group of twenty leaders from across the headquarters. The TAT has met twice weekly for six months to determine what recommendations they will make to the AFSPC senior leadership.

The TAT required each directorate to complete a database describing any task which takes an average of four or more manhours per week. The data for each task included ratings on how the task contributed to command goals and the command mission, as well as, information on whether the task was most appropriately performed at a management headquarters level. Each of the resulting 4,000+ tasks were scored using a Value-Focused Thinking Model that the Air Force Academy helped develop. The database and value scores were then used to identify tasks which were high-cost, low-value.

Initiatives to save manpower on these high-cost, low-value tasks by streamlining, reorganizing, or deleting work were formed and explored by liaisons (TAT members) working with directors throughout the headquarters. Initiatives that survived the interaction with the effected directorate(s) comprised the final package of recommendations to the senior AFSPC leadership.

Thursday, 1030-1200
NCO Leadership Development in the 21st Century

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Approved abstract unavailable at printing.

Unit Positioning and Quality Assessment Model

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The Unit Positioning and Quality Assessment Model (UPQUAM) is a marketing and enlisted quality assessment modeling tool used for conducting strategic United States Army Reserve (USAR) unit positioning and quality assessment for the United States Army Reserve Command (USARC) and the United States Army Recruiting Command (USAREC).

The model answers four basic questions: volume?, quality?, comparison?, and prominent vocation? The model uses historical production data to assess the quality of the enlistments for the USAR. The model first computes the fill rate of each unit. Each unit needing soldiers is then placed into a needs database where it is further reviewed to assess the potential problem of the unit. The model then answers the quality question by calculating a weighted average Armed Services Vocational Aptitude Battery (ASVAB) score, by category, by component, for each zip code having a contract throughout the United States. Comparisons are made with respect to the population and other sister service's data. Once the problem Military Occupational Specialty (MOS) is identified, the model then determines a more suitable location for the unit having this particular MOS.

The USAR unit structure and location and quality of historical enlistment contracts is the operating premise of the model. This model's purpose is to determine the appropriate unit structure location of USAR units throughout the United States to assess, recruit, and maintain quality soldiers for the United States Army Reserve (USAR). A more descriptive mathematical model will be presented during the MORS Symposium.

Soldier Time on Station: A Case Study in the Use of Operations Research Techniques in the Army Personnel Community

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Soldier Time On Station (TOS) between Permanent Change of Station (PCS) moves is becoming an important issue in the Army personnel community. Increasing average soldier TOS contributes to increased unit readiness, increased soldier morale, and decreased PCS costs. This presentation is a case study outlining the methodology used to accurately measure soldier TOS and identify the relevant factors affecting TOS. The presentation describes why soldier TOS is important, scoping of the problem to determine maximum and minimum TOS, how raw data was gathered and cleansed, and how significant variables affecting soldier TOS were identified. A number of different Operations

Research techniques were used, to include statistical analysis using ANOVA and regression models, network analysis, and simulation modeling. The analysis indicates major factors affecting average soldier TOS include number and length of overseas tours, Initial Entry Training (IET) attrition and post-IET attrition. Additionally, the analysis indicates overseas assignment selection policies, deployment stabilization policies, and unit fencing affect the distribution, or equity, of soldier TOS. Finally, the author presents several feasible personnel policy changes to increase both average soldier TOS and TOS equity.

Should Fleet Experience Correlates Drive Navy College Scholarship Criteria? USNA as a Case Study

William Bowman, US Naval Academy, Stephen L. Mehay, Naval Postgraduate School

Approved abstract unavailable at printing.

Thursday, 1330-1500

Combining Data Envelopment Analysis and Statistical Regression to Determine Efficiency and Effectiveness of Military Advertising Strategies

Patrick L. Brockett, William W. Cooper and Maj Michael J. Kwinn
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In this presentation, we report work-in-progress on combinations of two analytic techniques in order to examine the impact of joint and service-specific advertising on military recruiting. This involves a two-stage approach as follows: In stage one, we apply Data Envelopment Analysis (DEA) to distinguish between efficient and inefficient performers. In stage two, we incorporate these results in a statistical regression model. This enables us to simultaneously estimate parameters for (a) efficient performers and (b) inefficient performers. The two-stage technique we use allows us to measure the efficiency of different advertising strategies and it also allows us to estimate performance inefficiencies and identify their sources in other variables as well as advertising.

Forecasting and Allocation of US Army Recruiting Resources (RIST Prize Finalist)

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Since the inception of the All-Volunteer Force in the early 1970's, the US Army Recruiting Command has been responsible for the necessary number (and quality) of individuals to meet the Army's needs. Recruiting is carried out by military recruiters supported by various functions. Foremost among these is advertising in national and other media. Effective management of this system, which costs several hundred millions dollars a year to maintain, requires the Army to know how efficiently the recruiting resources are used and what can be expected from different levels and mixes of these resources. No such methodology was available until the late 1980s. This paper presents a system developed for forecasting, allocating, and evaluating annual Army recruiting resources at the aggregate Headquarters level. The system was implemented during the force downsizing years following the collapse of the Soviet Union. The system was designed to provide senior Army planners with a methodology for constructing a seven-year program of recruiting objectives and aggregate resource requirements which was realistic and defensible in a time of reduced budgets, and enabled them to respond quickly to frequent congressional inquiries on budget issues. Model and software development were completed in 1992, and the system has since been in operation at both the Pentagon and the recruiting command.

Recruiter Selection Methodology

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The Army Personnel Command (PERSCOM) currently nominates Non-Commissioned Officers (NCOs) for recruiting duty based on successful performance in their initial accession skill. Many NCOs selected as recruiters are highly successful and consistently meet their mission quotas, while others fall far short of the mark. Developing a "recruiting specific" program or quantitative behavioral screening criteria to evaluate NCOs prior to selection based on their potential to succeed as recruiters could lead to greater productivity from the recruiting force and help prevent otherwise successful NCOs from tarnishing their careers by failing as recruiters. This study outlines the process used in developing a successful recruiter assessment test, thereby demonstrating a way to predetermine potentially successful recruiters. An approach is offered for implementing this test, thus providing the Army a methodology to select the best NCOs for recruiting duty.

Additionally, the pay-off for an improved recruiting force is tremendous. Using a discrete event simulation of the Army recruiting process, the increased productivity potential of an effective recruiter selection process is dramatically demonstrated. The results of the simulation provide a favorable look at the cost/benefit analysis for this recruiter selection tool.

WG 21 – READINESS – AGENDA

Chair: Mr. Scott Flood, Chief of Naval Operations (N81)
Co-Chairs: Dr. Laura Junor, Center for Naval Analyses
LTC William Carleton, United States Military Academy
Mr. Thomas Denesia, U.S. Space Command
Advisor: Mr. Joseph Angelo, ODUSD(R)/(RP&A)
Room: 321

Tuesday, 1030-1200
Advisor Opening Remarks
Mr. Joseph Angelo, ODUSD(R)/(RP&A)

Dynamic Commitment
LTC Charles E. Bruce, Joint Staff (J-8)

NORAD and Y2K
Lt. Col John Weatherford NORAD-USSPACECOM/ANS

Tuesday, 16330-1500:
Understanding the Process of Aviation Material Condition
Dr Laura J. Junor, Dr. James M. Jondrow, Center for Naval Analyses

A Readiness-Based Flying Hour Requirements Methodology for Programming and Budgeting
Dr Gregg Suess, Center for Naval Analyses

The "Top Ten" List as a Management Tool: When is it helpful and when is it not?
Brent Boning and Peter Francis, Center for Naval Analyses

Wednesday, 0830-1000
Focused Logistics Readiness
Robert J. McKay, Battelle Memorial Institute @ U.S. Army Logistics Agency

Equipment Serviceability Reporting Analysis
LTC William B. Carlton, MAJ Greg Graves, US Military Academy

Readiness In Relation To Logistics Metrics
Gene A. Markel, U.S. Army Logistics Integration Agency

Wednesday, 1030-1200
Readiness – What are we Measuring in Logistics?
Paul C Setcavage, Logistics Integration Agency

A Simulation for Capability Assessment of Logistics Support Alternatives (CALOSAL)
Salvatore J. Culosi, Logistics Management Institute

Air Combat Command: Tracking Combat Potential and Military Worth.
Mr. David M. Hickman, HQ ACC SAS

Wednesdayy, 1330-1500
COMPOSITE GROUP E .... **Room 144**

Thursday, 0830-1000
The Geometry of Distributed Learning: Training and Readiness Implications
Mr. Joseph C. Barto, III, Mr. Robert Fleming, Camber Corp.

A Structural Equation Modeling Analysis of Naval Readiness
B. Charles Tatum, Navy Personnel Research and Development Center

Organizational Product Analyses for Readiness Assessments
Daniel L. Cuda, Ronald E. Porten, Institute for Defense Analyses

Thursday, 1030-1200
Army Movement Requirements Generation Process
Mr. Giles Mills III, Center for Army Analysis

Advances In Mobilization Modeling - Update
Author: Ms. Julianne Allison, Center for Army Analysis

Prototype US Air Force Readiness Assessment System: Emerging Decision Support Capabilities
Mr. William Bajusz, AB Technologies

WG 21 – READINESS - ABSTRACTS

Tuesday, 1030-1200
Dynamic Commitment

Charles E. Bruce, LTC, Reserve Force Advisor/ORSA Officer
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The Joint Staff working with the Office of the Secretary of Defense, combatant commands, Services, and Defense agencies developed the DYNAMIC COMMITMENT Wargame Series, in support of the 1997 Quadrennial Defense Review (QDR).

During previous defense studies, the primary driving factor in force sizing had been that force estimated to be necessary to meet the strategy of fighting and winning two major theater wars, with the elements of the force capable of responding to other contingencies viewed as a lesser included set. With these "other contingencies" drawing increasingly on both the time and resource commitments of all Services, it was viewed as essential that the '97 QDR include an evaluation of the current and projected U.S. Forces against anticipated worldwide commitments. To more accurately assess the impact of these types of operations, it was deemed important to evaluate not only the force required to execute this wide spectrum of operations, but also the impact of "transitioning" rapidly between events across the spectrum of conflict. This "dynamic commitment" of U.S. Forces provided the wargame series its name.

DYNAMIC COMMITMENT provided an innovative and effective means of evaluating the suitability of projected U.S. forces to respond to the range of challenges. The purpose of this MORS presentation is to open a dialogue with the analysis community as we begin to improve methodologies and tools which may be used to address future DoD strategic challenges.

NORAD and Y2K

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The Y2K problem is a potential hardware and software performance deficiency in some current information technology and processing systems. In the current highly networked systems environment of the Department of Defense (DOD), the failure of one system could potentially affect an entire network causing widespread system failures. To minimize the operational impact of the Y2K problem, the Secretary of Defense has directed the U.S. Unified Commands and NORAD to perform individual system renovation and certification, function centric testing, and mission centric evaluations.

The NORAD Y2K OPEVAL Task Force was formed and given the authority to evaluate all NORAD Y2K Thin Line of Systems for operational mission areas. A Y2K Thin Line of Systems is defined by the Joint Staff Y2K Operational Evaluation Guide as the... *"minimum essential automated information platforms/systems required to support operations."*

NORAD's must provide a valid operational mission evaluation of numerous linked, geographically widespread systems across four critical Y2K dates mandated by the Joint Staff. The process by which a thin line of systems is evaluated in a simulated Y2K environment is called an Operational Evaluation (OPEVAL). NORAD is tasked to perform two OPEVALs. VIGILANT VIRGO 99-1 was held on 2-4 December 1998 and focused entirely on the missile warning element of NORAD's Integrated Tactical Warning/Attack Assessment (ITW/AA) function. (Analysis determined that NORAD's missile warning function can be accomplished without any degradation in a Y2K environment.) In comparison, AMALGAM VIRGO 99-2 will provide CINCNORAD a "sensor to shooter" evaluation of critical "Thin Line" systems across all four major mission areas; missile warning, space warning, air warning, and aerospace control. Additionally, United States Space Command (USSPACECOM) and United States Strategic Command (USSTRATCOM) control critical linked systems, which either support or are supported by the NORAD "Thin Line" of systems. These other, non-NORAD, systems will also be evaluated during AMALGAM VIRGO 99-2 in order to properly evaluate the "sensor to shooter" linkage.

This paper will describe the process by which NORAD determined its "thin line of systems", the data collection and analysis process, and the overall OPEVAL effort.

Tuesday, 1530-1700:
Understanding the Process of Aviation Material Condition

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Fully Mission Capable (FMC) rates are the primary indicator of aviation material condition in the Navy. Understanding why these rates change and whether a given change suggests corrective action is difficult for two reasons. First, the understanding of the process behind aviation material condition needs improvement. Second, the existing metrics commonly used to explain movements in FMC rates are largely engineering metrics, and are poor proxies for readiness.

This paper begins by introducing several new measures related to aviation material condition using Maintenance Action Form (MAF) data. The new measures include a mission-degrading failure rate, average number of days between mission-degrading failures, and the average number of days to repair mission-degrading failures. We have also created several logistics measures from the perspective of those seeking the parts. All of these new metrics are created with an historical tail going back to 1993.

With these new metrics, we are able to determine whether uptime or downtime is the reason for a given change in FMC. We also use regression analysis to determine the drivers of up and downtime (such as manning or spares), and ultimately how they impact FMC.

A Readiness-Based Flying Hour Requirements Methodology for Programming and Budgeting

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Approved abstract unavailable at printing.

The "Top Ten" List as a Management Tool: When is it helpful and when is it not?

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When confronted with an apparent decline in readiness measures, a common approach for determining the source of the trouble is to generate lists of the most common faults or degraders for the platforms under consideration. We examine this practice with an eye to the following questions:

1) What is the best way to use such a list?
2) Will this method always succeed in identifying the source of the readiness decline? Can it be misleading?
3) Are there other diagnostic tools that might be more effective?

Using hypothetical and real-world examples, we find that this approach often works in practice but that it can miss some problems. We suggest that there are occasions where changes in the top-ten list may be more illuminating than the composition of it, and propose that such information be collected regularly so that such changes are more readily detected.

Wednesday, 0830-1000
Focused Logistics Readiness

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Focused Logistics Readiness (FLR) is one of several emerging initiatives sponsored by the Army Logistics Integration Agency (LIA) which supports the Revolution in Military Logistics (RML). FLR addresses two intractable problems whose solution has eluded logistical system designers. Using new business process tools and integrated computer data, FLR will conduct a demonstration to (1) attain near real-time (daily) situational awareness of the logistics components of unit readiness. Then, (2) harnessing the information-based capabilities of the *total* logistics system – strategic, operational and tactical - FLR will act on that knowledge to provide real-time, *automated* readiness solution support. In the first phase of the demonstration (FY 99), FLR will capture the daily status of unit equipment serviceability (UES) and equipment on hand (EOH). It will provide this knowledge, suitably arrayed, to supporting echelons of the logistics, operational, and financial communities. In the second phase (FY 00), FLR will develop an automated capability to directly assess and improve readiness in *real-time*, rather than relying on post-haste analysis. This requires a common, well-ordered set of performance metrics, to establish common management goals; integrity of indentured unit, weapon system, and repair part requirements, to determine priorities; and an availing, proactive readiness support methodology, to better meet established standards. FLR will benefit the Army by providing more timely and accurate readiness reporting, a

matter of continuing concern to leadership. It will coordinate operational, tactical and logistics decisions across the Army to provide more cost-effective readiness support in peace; and leaner, more responsive support in all operations.

Equipment Serviceability Reporting Analysis

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Equipment readiness is a reportable component under the existing Army Unit Status Reporting process. However, many decision-makers, including the US Congress, have questioned whether these measures accurately portray the true "readiness" posture of units in the field. Anecdotal reports indicate that the current reporting process may not reflect conditions faced by units in day-to-day operations. This presentation reports the results of a detailed analysis of current Equipment Serviceability reporting procedures and provides alternative reporting schemes that will serve to more accurately report a unit's overall equipment serviceability status.

Readiness In Relation To Logistics Metrics

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The current rush to develop systems of metrics for all kinds of military systems and operations brings with it a multitude of challenges and questions requiring resolution. This paper presents findings and results from a two year logistics performance metrics design and development effort undertaken at the Army's Logistics Integration Agency (LIA). It includes the content, structure and rationale for the set of logistics performance measures (i.e., metrics) that has evolved and emerged from this effort, and briefly describes the implementation of the resulting Army logistics metrics system on an internet web site. Of particular interest is the role of materiel readiness in relation to the larger structure of other logistics performance metrics. Readiness is viewed as a primary concern of the logistician, because this is the ultimate product the logistician delivers to his basic customer, the warfighter. Moreover, logistics metrics--including both readiness and sustainment metrics--will necessarily occupy a key position at the core of any battlefield information and management systems that we may ultimately move toward as we look to the new challenges presented by the military missions of the future. The paper concludes that this is an area of study that still contains as many open questions and issues as it does answers, perhaps more.

Wednesday, 1030-1200
Readiness – What are we Measuring in Logistics?

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There is a lack of precision by national leaders concerning the term "readiness." The term is sometimes narrowly defined only to include unit readiness, or other times, total Army readiness. Ambiguity extends into the time dimension measures of current or potential application of military forces. This presentation explores these problems, introduces several efforts undertaken to more clearly define readiness, and argues for indented metrics that lead to a new term of Ground Force Military Effectiveness.

A Simulation for Capability Assessment of Logistics Support Alternatives (CALOSAL)

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In late 1993 the Joint Logistics Systems Center (JLSC) recognized the need for a unique simulation to quantify how logistics business process improvements reduce the cost of increasing weapon system availability. The Logistics Management Institute (LMI) was tasked to build this simulation capability, which has become known as CALOSAL. Its name is derived from its utility in conducting a Capability Assessment of Logistics Support Alternatives. Heretofore, analytic solutions to quantify improvements in logistics business processes were not able to capture the many constraints and policies reflected in the current DoD logistics support system. On the other hand, existing simulations that eliminate problems with analytic solutions have tended to focus on intermediate logistics performance measures such as supply availability and backorders at the retail and wholesale level. CALOSAL offers a unique capability to quantify improved business process in terms of both cost (inventory and transportation) and ***improved weapon system readiness – the ultimate effectiveness measure.*** The initial prototype demonstration of this capability was completed in 1995. Since then it has been enhanced with additional design features to accommodate various applications not envisioned in the initial design. It has also been used selectively to assist the Services improve their logistics support processes. The Air Force has used it to help structure its Agile Logistics program and is currently adopting it as its Supply Chain Management (SCM) simulation. Some Air Force applications include readiness assessments of alternative processes for repair and distribution of secondary items and methods for setting retail levels in a constrained environment. The Navy has also explored the simulation's potential to help address the weapon system availability implications of alternative options for combining consolidated ship allowances (COSALs).

Air Combat Command: Tracking Combat Potential and Military Worth.

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As the Air Force gets smaller it loses force capability redundancies. Reengineering and cost cutting are driving the effort to do more with less. It is now much more important to know the current state of the force and the impact potential changes have on force capability. The commander of the Air Force's Air Combat Command (ACC) directed the development of a combat potential metric to track the impact of directed funding reductions, modernization, acquisition, and decisions made at all levels of the organization. The metric developed captures the impact each squadron in ACC has on combat potential. Readiness data is captured from the Status of Resource and Training System (SORTS) on aircraft, critical items of equipment, and critical personnel for every SORTS reportable squadron. Other databases are used to track critical equipment and personnel for squadrons that are not SORTS reportable.

There are several problems in developing a total ACC combat potential metric. The ideal solution would be to use an interactive suite of combat and MOOTW models which consider engineering, mission, and campaign effects. This is currently infeasible. Tying the metric to a specific scenario or even a set of scenarios is useful but doesn't address the issue of scenarios changing over time. Using a generic scenario doesn't allow translation in terms of existing conflict metrics. Existing combat models don't usually capture the contribution of logistics, security forces, and other support or enabling assets on the outcome of a conflict.

The ACC combat potential metric addresses the impact of all combat and enabling squadrons while considering engineering, mission, and campaign effects. It produces a percent change from a stated baseline which can be used to identify decisions which are counterproductive to combat capabilities. Future enhancements will address the full spectrum of conflict. The methodology used for this metric is being studied for incorporation into future the ACC modernization investment plans.

Wednesdayy, 1330-1500
COMPOSITE GROUP E .... Room 144

Thursday, 0830-1000
The Geometry of Distributed Learning: Training and Readiness Implications

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A technology rich environment should enable revolutionary education and training advances in two ways. First, technology should provide our trainers and educators with the ability to provide real time access to the subject matter experts knowledge base ensuring the most current and relevant material is being presented to the target audience. Second, the ability to capture student/trainee educational and training skills qualifications and the student/trainee knowledge, skills and abilities requirements should enable our instruction to be much more focused on providing our students and trainees with the right skills just in time to perform the tasks.

Education and training at the right place and time using information technology requires a clear process and technical understanding of the Distributed Learning geometry. That geometry is the ability to deliver courseware—content, to delivery platforms—context, through multiple infrastructure vehicles—connectivity. Without quality courseware the best infrastructure and the best networks are just latent technology. Training and education content that is not current and available is irrelevant. Since the user's interest is solely in their ability to obtain current, accurate subject matter material, access to that content when and where needed is the essential imperative. As important is the understanding of the geometry will lead too much more informed and productive resources decisions by senior leaders. This paper will discuss the functional requirements of this information rich education and training system, the dependent relationship of the Distributed Learning Geometry, and the training and readiness implications.

A Structural Equation Modeling Analysis of Naval Readiness

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At the 1998 MORS Symposium, researchers from the Navy Personnel Research and Development Center (NPRDC) discussed the general concept of readiness and suggest some emerging analytical tools for predicting and forecasting readiness. One of the tools recommended was Structural Equation Modeling (SEM). During the past year, NPRDC has collected readiness data and used SEM to model the relationship between human resources and unit performance of naval ships. The tested model was derived from a conceptual examination of readiness reported by Tatum, Laabs, and Nebeker (1998). In that report, the authors suggested that the mental quality and skill level of the enlisted personnel, as well as the billet fill and the training levels of naval ships, could predict unit performance. Analysis of the data using SEM revealed that the hypothesized model fit the data well. The presentation will describe the data, explain the SEM tools used, and discuss the implications of the findings for research and policy.

Organizational Product Analyses for Readiness Assessments

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Explaining the relationships between supporting military units is one aspect of improving causal explanations of Operational Readiness. This presentation begins with the generally accepted unit categories of Combat, Combat Support, and Combat Service Support and seeks to generalize their various organizational products across Service roles. By classifying products by organization type, and then describing and classifying specific organization products, a more detailed explanation can be made of readiness "production" processes. The presentation seeks to distinguish key variables for readiness forecasting and make recommendations for additional study.

Thursday, 1030-1200

Army Movement Requirements Generation Process

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Prior to performing a deployment analysis, the movement requirements (i.e. mobility footprint) must be generated for the force to be deployed for a given Contingency Operation. Movement requirement data include origin of cargo, type of cargo, dimensions for the cargo and destination of the cargo along with unit and non-unit cargo availability and required delivery dates (RDD) in the theater. The focus of the army has been to determine the movement requirements from "fort to foxhole". The Center for Army Analysis has been and continues to improve their Movement Requirements Generation Process. A big improvement over the recent months has been to create the movement requirements to cover the "fort" to Port of Embarkation and Port of Debarkation to Tactical Assembly Area. This presentation will cover the overall process and recent advancements in the Movement Requirements Generation. Recent applications include the Army's Total Army Analysis and OSD's Mobility Requirements Study – FY2005.

Advances In Mobilization Modeling - Update

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In recent years, there has been increased interest in modeling the mobilization process. The readiness of Army units for deployment by their prescribed available to load dates (ALDs) at their ports of embarkation (POEs) has long been assumed, i.e., this assumption has not been questioned nor has there been a focus on or in-depth analysis done of the mobilization system. Because of downsizing, the moving of troops back to CONUS from Europe, and various other reasons, there is now more interest in analyzing this process. The Mobilization Capabilities Evaluation Model (MOBCEM) has been under development for several years for use as an analytical tool. MOBCEM will provide the Army with the ability to evaluate and improve mobilization capability, through the modeling of the mobilization system from Home Station (HS) to POE. It will include the modeling of Active Component and Reserve Component units, individual personnel, and materiel at all levels of mobilization through full mobilization. MOBCEM is currently in Phase II of three phases of development. Phase I focused on processing which takes place at HS and Mobilization Station (MS)/Power Projection Platform (PPP). The other major nodes (CONUS Replacement Center, Training Center, and POE) are being designed and implemented in Phase II, which is expected to be completed in mid 1999. The mobilization processes of the other services will be added in Phase III. MOBCEM will be a component of the Joint Warfighting System (JWARS). This presentation will cover the features, capabilities, status, and potential applications of MOBCEM.

Prototype US Air Force Readiness Assessment System: Emerging Decision Support Capabilities

Mr. William Bajusz, AB Technologies, e-mail: bajusz@incisive.net

Approved abstract unavailable at printing.

WG 22 - ANALYTIC SUPPORT TO TRAINING - AGENDA

Chair: Mr. Brian R. McEnany, Science Applications International Corporation, PP, FS
Co-Cchairs: Dr. Angelo Mirabella, Army Research Institute
Mr. Randy Oser, Naval Air Warfare Center Simulation and Training Division
Advisor: Mr. Michael Parmentier, Director (Readiness and Training) OUSD (R)
Room: 323

Tuesday, 1030-1200 INTRODUCTION AND JOINT TRAINING SUPPORT
The Joint Simulation System (JSIMS) Overview and Progress Report
LTC George F.Stone III and COL James R. Taylor, JSIMS Joint Project Office

Joint Training; Mission-Focused and Requirements-Based
LTC Douglas A. Burrer and CDR Jeffrey A. Harley, The Joint Staff (J7) Joint Exercise and Training Division

Military Operations Other Than War in the Training Domain
Mr. Joe Puckett, Warrior Preparation Center, EUCOM

Tuesday, 1330-1500 JOINT TRAINING AND AAR SUPPORT
Applying Knowledge Discovery Technologies to Support After Action Reviews (AAR)
Mr. Ralph Burkhart, Dr. William C Hopkinson and Dr. Jennifer McCormack, Science Applications International Corporation

Planning Tools for the 21st Century Warrior: Challenges for Realtime Operations Analysis
Dr. James Montgomery, US Army STRICOM

Simulation-Based Mission Rehearsal for Special Operations Aviators
Dr Robert Nullmeyer, Aircrew Training Research Division , Air Force Research Laboratory

Wednesday, 0830-1000 COLLECTIVE TRAINING SUPPORT
Quality Fleet Feedback Program
CAPT Lee Dick, Director, Acquisition Div, Directorate of Naval Training

Training for Future Battle Staffs
Dr. Bruce Sterling, US Army Research Institute, Armored Forces Research Unit

Performance Measurement for Future Battle Staffs
Mr. Stephen Hess, Aptima, Inc

Wednesday,1030-1200 INDIVIDUAL TRAINING SUPPORT
The Geometry of Distributed Learning: Training and Readiness Implications
Mr. Joseph C. Barto, III and Mr. Robert Fleming , Camber Inc.

The Retention and Re-acquisition of Skills: Data and Models
Dr. Robert A. Wisher and Dr. Mark A. Sabol, US Army Research Institute for Behavioral and Social Sciences

Army Enlisted Attrition Study: IET Attrition
Dr. Martin R. Walker, US Army TRADOC Analysis Center

Wednesdayy, 1330-1500
COMPOSITE GROUP E .... Room 144

Thursday 0830-1000 COLLECTIVE TRAINING SUPPORT
Using Web-based Collaboration to Enhance OOTW Training and Analysis
Julia Loughran and Marcy Stahl, ThoughtLink, Inc.

Army Experiment Five (AE5) Training Assessment
Wesley L. Hamm and Don McConnell, The Mitre Corporation

Impacts of Force Modernization on Measurement of Unit Performance
Dr. Larry Meliza, US Army Research Institute, Simulator Systems Research Unit and Bill R. Brown and Louis Anderson, Advancia Corporation

Thursday, 1030-1200 COLLECTIVE TRAINING SUPPORT
CCTT Accreditation: Methods and Results for a Horse of a Different Color
LTC Jeffery Wilkinson, TSM CATT, National Simulation Center and G. Steven Williams, SOTEC Studies and Analysis, Inc.

Cost and Training Effectiveness Analyses (CTEA) for large-scale Simulations
Mr. Dan Gardner , ODUSD(R), and Mr. Fred Hartman, Institute for Defense Analysis

Training and Cost Effectiveness File Data Base
Dr. Henry Simpson, Department of Defense, Manpower Data Center

Thursday, 1330-1500 INDIVIDUAL TRAINING SUPPORT
A Research Partnership Addressing Crew Resource Management Training
Dr. Robert Nullmeyer, Aircrew Training Research Division, AF Research Laboratory

Simulation and Training for 21st Century Soldiers
SFC Chris Augustine, TRAC-Monterey

Synthetic Representation of Patient Injuries in a Medical Training Federation
Dr. Michael D. Proctor and Captain Gregory Creech (USA), University of Central Florida

Analysis Of Performance Based Indicators Influencing Military Functional Skill Retention Using A Human Resource Research Model
MAJ Teddy Mora, US Army Reserve, Fort McCoy, WI

WG 22 - ANALYTIC SUPPORT TO TRAINING -ABSTRACTS

Tuesday, 1030-1200 - INTRODUCTION AND JOINT TRAINING SUPPORT .... **Room 323**

The Joint Simulation System (JSIMS) Overview and Progress Report

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JSIMS shall be used by unified commands, other joint organizations, and the Services for the following activities: training, education, developing doctrine and tactics, formulating and assessing operational plans, and assessing warfighting situations. The primary purpose of JSIMS is to support training and education of ready forces by providing realistic joint training across all phases of military operations for all types of missions. JSIMS will be high level architecture (HLA) compliant in order to support interoperability with other DoD simulations. JSIMS will provide flexible support for joint training across the force by using efficient, composable simulations tailored to the users' needs. JSIMS will consist of core objects and run-time infrastructure developed and constructed to comply with HLA requirements.

The Universal Joint Task List (UJTL) and accompanying Service Task Lists (STLs) provide the common language and reference system to communicate mission requirements among the above activities. JSIMS will be used within the UJTL paradigm to support the Joint Training System (JTS). JSIMS will contain a core of common representations to meet the requirements of joint and Service training, run-time hardware, software infrastructure, and interfaces augmented by representations of air/space, land, and maritime warfare functions. These representations will be provided by executive agents (EAs) and development agents (DAs) from the Army, Air Force, and Naval Forces for each warfare domain (land, air/space, and maritime). In addition, EAs from the Defense Intelligence Agency (DIA), Defense Information Systems Agency (DISA), US Transportation Command (USTRANSCOM), and US Special Operations Command (USSOCOM) will be included.

This paper will review the above topics providing an update on the current status of JSIMS and its progress in meeting the goals of Joint Vision 2010.

Joint Training; Mission-Focused and Requirements-Based

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The fundamental premise of joint training from a strategic perspective is that training is the foundation of, and for, readiness. The system developed to institutionalize this assertion, and subsequently integrated throughout the CINCs and Combat Support Agencies, is known as the Joint Training System. The central focus of the JTS is enhanced training to support the fundamental warfighting missions of the CINCs and CSAs, thus ensuring that we truly train the way we intend to fight. The Chairman of the Joint Chiefs of Staff asserts this philosophy using specific language in the "Joint Training Master Plan 2000 for the Armed Forces of the United States." The JTMP contains the statement...

The desired end state of joint training is the improved readiness of joint forces, a training and exercise strategy aligned with the National Military Strategy, improved interoperability, complete integration of the entire DOD team (including the interagency process), a more stable way to optimize the application of scarce Service resources, and a unified DOD training and exercise effort that includes incorporation of combat support agencies, multinational partners, and the reserve components. The vision for the JTS and the future JTS remains dedicated to this goal. The evolution of JV2010 concepts and theory, taken with advances in RMA, will require that the future JTS evolve accordingly. The Joint Staff's vision for the future JTS embraces the anticipated changes, and is undertaking a proactive campaign to marshal the benefits of these technological advances.

Military Operations Other Than War in the Training Domain

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As a result of the shift of primary mission in the European Theater from the traditional two-sided, force on force Warfighter scenario to one of Military Operations Other than War (MOOTW), the Warrior Preparation Center has experienced a corresponding shift in the training requirements from the military organizations it supports. Because of this shift in training mission, the WPC has discovered that the old training paradigm of an Opposing Force combined with a computer simulation model no longer meets the requirement to satisfy training objectives for MOOTW scenarios. This paper recounts one simulation center's experience of adjusting to this shift in mission requirement.

The paper is divided into ten sections, and is concluded with a summary. To provide some background information, section one presents the traditional training paradigm for the two-sided Warfighter scenario. To demonstrate the thrust of the new requirement, a list of the MOOTW Training Exercises the WPC has been involved in the past three years is provided in section two. In order to gain a better perspective on types of events that occur in a MOOTW Training Scenario, section three provides a specific example of an event taken from an exercise. A comparison of the two different constructs required for a Warfighter exercise and a MOOTW exercise is examined in section four. Section five discusses the traditional role of scripting in exercises. Section six focuses on the driver methodology in MOOTW and Warfighter exercises. Section seven lists the effects that the new MOOTW training mission has had on Exercise Control. The dynamic state of exercises, both Warfighter and MOOTW, is discussed in section eight. Section nine talks about the requirement for a new tool to assist in the planning, execution and analysis of MOOTW exercises. Section ten then describes the new tool developed at the Warrior Preparation Center to accommodate this new requirement, the Master Events Management System (MEMS).

Tuesday, 1330-1500 JOINT TRAINING AND AAR SUPPORT
Applying Knowledge Discovery Technologies to Support After Action Reviews (AAR)

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Considerable time and resources have been expended towards developing distributed training systems to support training for military commanders and their staffs. After Action Review (AAR) is a critical aspect of training that directly impacts the benefit of these training systems value to the training audience. A number of constructive training systems are under development such as JSIMS, WARSIM, and NASM. These systems require significant new capabilities such as real-time AAR. A large amount of effort is required to plan and execute large-scale training exercises. Current AAR methodologies are generally manual, ad-hoc in nature, and are hypothesis-driven from the mission exercises specified for the training exercise. For example, training exercises such as Prairie Warrior and ULCHI LENS FOCUS can take from 9 to12 months of planning effort. These exercises are developed based on a set of high-level training objectives. These objectives are in turn the basis for defining data logging plans, and AAR analysis activities. Since AAR activities are hypothesis-driven, novel knowledge and lessons-learned can not be discovered. New technologies such as data mining and knowledge discovery are being investigated to develop advanced tools for AAR. These tools will allow commanders to query and analyze exercise data during an exercise and to gain and maintain the competitive edge on the battlefield.

The developing digital C4I systems require new methods of capturing, analyzing, and displaying data for AAR. The digital systems create an abundance of information for use by an AAR system. The temporal and spatial event space in information based warfare and digital systems become less comprehensible to the human data collector. Extracting data and correlating cause – effect relationships continues to lag behind these systems. AAR systems in support of the digitized Army must be highly adaptive to the commander and his staff and also forward looking. Techniques, such as data mining and intelligent agents in support of knowledge discovery offer the potential to provide commanders with new insights that may shorten the decision making cycle. The ability to rapidly harvest, pattern match, sequence, and correlate data will provide the warfighter the insights from an exercise to realize the maximum benefits from training. The purpose of this paper is to present new concepts in data mining and intelligent agents and discuss their potential application to commander's AAR systems.

Planning Tools for the 21st Century Warrior: Challenges for Realtime Operations Analysis

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In July 1998, as an outgrowth of its work on innovative Course of Action Analysis tools, DARPA commissioned a STRICOM managed study to research existing tools and processes for planning Joint operations and conducting mission rehearsals. This study was an initial exploratory step toward identifying requirements for the next generation of tools and processes to support the high-tempo, information-intensive environments anticipated in Joint Vision 2010 and beyond. The study (1) defined the mission planning/rehearsal environment; (2) identified applicable existing technologies and tools; (3) assessed the maturity and applicability of those technologies and tools; and (4) made recommendations for demonstrating a prototype system to meet capability shortfalls.

The major result of the study is the need to develop interoperable, at least semi-automated planning tools. These tools must be synchronized across Service and Joint warfare functional areas. They will enable the military commander to make faster, more effective and better-informed decisions, thereby turning inside the enemy's decision cycle. They will essentially perform operations analysis in real time, based upon digitized data.

This presentation (and paper) will summarize the results of the study and postulate an initial set of requirements for automated operations analysis tools for digitized warfare which will meaningfully increase commanders' knowledge of the battlefield in real time and their subsequent ability to act swiftly and decisively. We would like to challenge the Operations Research community to get out in front of today's planners and analysts to identify and create real time operations analysis tools for the next generation of warfighter to use on the digitized battlefield.

Simulation-Based Mission Rehearsal for Special Operations Aviators

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A new generation of flight simulators supports both training and combat mission rehearsal (MR). The Mission Rehearsal System (MRS) at the 58th Special Operations Wing was the first such system to become operational. A powerful database generation system allows a rehearsal-quality database to be developed in as little as 72 hours. The MRS includes MH-53J, MH-60G, and MC-130P cockpit simulators, an aerial gunner/scanner simulator, an electronic combat simulation system, a training observation center, and a network that integrates these elements. The MRS has supported several rehearsals, including a joint Air Force and Army special operations forces training exercise that simulated a strike mission to recover critical avionics equipment from a remote research facility in a hostile third-world nation. Extensive interviews were conducted with participating aircrews and mission planners. These experts rated the value of simulation-based MR. Perceived value varied widely concerning various planning products, processes, and outcomes. We also developed a human activity system model to provide a conceptual structure for the elements that comprise simulation-based MR. It specifically addresses: (1) the context for simulation-based MR (crisis action planning) and how the MRS fits into it; (2) MRS components, functions and structure; and (3) processes that enhance MR effectiveness. MR experts validated the model and reported that it captured the essential elements of simulation-based MR. Early experiences have demonstrated that all three categories are necessary for effective MR. Both the nature of perceived MR benefits and the human activity system view of MR will be addressed.

Wednesday, 0830-1000 COLLECTIVE TRAINING SUPPORT
Quality Fleet Feedback Program

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The Quality Fleet Feedback (QFF) program was established by the Navy in 1998 to provide a formal system of exercise data collection, reconstruction, analysis, and rapid data feedback to fleet commanders, deploying battle groups, and the entire training continuum. It is based on Measures of Effectiveness (MOEs) and Measures of Performance (MOPs) derived from Navy Mission Essential Task Lists (NMETLs). QFF will provide both rapid feedback based on preliminary analysis as well as detailed training feedback based on in-depth analysis to address "Why" questions. It is intended to provide the fleet performance indicators, to support tactics and doctrine development, and to support the Naval training continuum. It will also embrace modeling and simulation and help populate the JSIMS data base, and serve a broad customer base which will enhance commonality between the fleets. The USS Constellation Battle Group has been targeted for the initial QFF implementation 4th Quarter FY99. Included in the presentation will be a description of the QFF data collection engineering , the product component, the data management component, and the process vision.

Training For Future Battle Staffs

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The need for rapid, accurate tactical decision making (TDM) will increase in the future. While information age technology will provide future TDM teams with an increased quantity and quality of data, TDM teams will be responsible for quickly turning that data into information and intelligence and making rapid decisions within the enemy's decision cycle. The theory of naturalistic decision-making (NDM) offers a streamlined decision model suitable to the needs of future TDM teams. In NDM, teams (or individuals) use recognition of patterns and situational cues to form an integrated representation of the situation (situation awareness or SA) from which an initial decision arises. This decision is mentally simulated or played out, which results in its being accepted, modified or rejected.

This presentation discusses research on prototype training methods, using the NDM model, designed for future staffs. The training method uses short, structured vignettes designed to teach staffs how to develop and maintain shared mental models of both the tactical situation and team. Teams are also trained to use these mental models to make effective decisions. Techniques to be discussed include pre-mortem (a-priori uncovering of causes for mission failure), discussion of roles and functions (team mental model building), SA calibration (task mental model building) and post mortem (uncovering why decisions were made; information not available, not shared, misinterpreted, flaws in tactical and team mental models, etc.). The research will be performed in the context of a reengineered tactical operations center (TOC), using simulations of futuristic information management tools and an innovative staff organization.

Performance Measurement for Future Battle Staffs

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The introduction of information-age technologies promises to provide today's military with tools to plan, control and coordinate adaptive, fluid team and multi-team missions and visualize the battlefield for improved situation awareness (SA). Rapid introduction of digital technologies is leading to fast-paced changes in individual and team processes, redistributing knowledge, changing staff expectations, and altering staff responsibilities and functions. The pace of change in the future battlespace requires that a mix of techniques be employed to assess impacts of new technologies and develop new tactics, techniques and procedures for their use in adaptive C2 organizations. A combination of virtual, live and constructive simulation will help balance costs of impact assessment and performance evaluation.

This presentation discusses current work that demonstrates a range of individual and team-level measures appropriate for evaluation and modeling of human performance in digital C2 environments for future staffs. The discussion covers theory-driven measurement and analysis techniques that provide insights on staff performance aspects that are unique to command decision-making in digitized environments. These include measures of information management, situation awareness, organizational awareness, individual and team workload, and communication and coordination. These measures allow us to go beyond traditional outcome-based approaches that tell us *what* a staff has accomplished, by providing additional insights into *how* the staff achieved its goals, the processes employed, and the tools that helped it to do so. We will further discuss how these measures and empirical data can be incorporated into constructive models used to predict the performance impacts of future technologies.

Wednesday, 1030-1200 INDIVIDUAL TRAINING SUPPORT

The Geometry of Distributed Learning: Training and Readiness Implications

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Distributing training content has many advantages over the traditional institutionally developed training content and courseware delivered in a "school house" setting. But to exploit these advantages, it may be necessary to modify how we analyze, design, develop, implement, evaluate, and manage training. For example, "just-in-time" instruction is feasible but requires continual updates of both content and courseware to maintain quality and avoid obsolescence. This requirement, in turn may increase the demand for staffing and other resources at the distributing agency. Also possible within the information technology is the capability to adapt instruction to individual skill differences, provide continuous feedback, and assess student qualification. Consequently, a technology rich environment should enable revolutionary education and training advances in two ways. First, technology should provide our trainers and educators with the ability to provide real time access to the subject matter experts knowledge base ensuring the most current and relevant material is being presented to the target audience. Second, the ability to capture student/trainee educational and training skills qualifications and the student/trainee knowledge, skills and abilities requirements should enable our instruction to be much more focused on providing our students and trainees with the right skills just in time to perform the tasks required.

Education and training at the right place and time using information technology requires a clear process and technical understanding of the "Distributed Learning Geometry." The "Distributed Learning Geometry" describes the dependent relationship between the independent variables of content, context and connectivity. That geometry is the ability to deliver courseware—content, to delivery platforms—context, through multiple infrastructure vehicles—connectivity. Without quality courseware the best infrastructure and the best networks are just latent technology. Training and education content that is not current and available is irrelevant. Since the user's interest is solely in their ability to obtain current, accurate subject matter material, access to that content when and where needed is the essential imperative. Resources drive the interaction between content, context, and connectivity. Clearly any one of those factors could easily consume every dollar available and more. Therefore, the most important result of a clear understanding of the "Distributed Learning Geometry" will empower senior leaders to make much more informed and productive resources decisions. The presentation will systematically describe the foregoing and other implications of the distributed learning problem set.

The Retention and Reacquistion of Skills: Data and Models

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The retention of skills over periods of nonuse has long been of interest to researchers studying human learning and memory. In the military, a primary assumption underlying a substantial training investment is that trainees will retain the knowledge and skills they acquire in training long enough to perform effectively in their job assignments. However, decades of research studies have shown that significant forgetting can occur over even brief periods, depending on a host of factors. This paper will examine the underlying assumptions, factors, data, and models that constitute our understanding of skill retention. A series of studies conducted by the Army Research Institute that re-examined skill retention during Operation Desert Storm and in subsequent mobilization training exercises with the Individual Ready Reserve will be highlighted. The construct of training reacquisition, that is re-learning what has grown rusty, will be introduced along with supporting data for a model of reacquisition. How distributed learning technologies can be employed in the future to mitigate the skill decay curve will be presented.

Army Enlisted Attrition Study: IET Attrition

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The purpose of this study was to examine a critical problem for the United States military: personnel attrition rates have increased significantly for the past few years. Army leaders have lacked empirical explanations as to why these rates have increased. The rise in attrition rates and the variability of these rates place significant pressure on the Army's personnel system, reducing recruiting and training efficiency.

The methodology used for the study consisted of three separate phases that included both qualitative and quantitative research techniques. The first phase, the Organizational Data analysis, included the development of a trend analysis on attriting soldiers. A research taxonomy was created for evaluating personnel attrition along with the survey data collected to refine models of voluntary versus involuntary attrition. The second phase, a Case Study analysis, included structured interviews with trainees who were being discharged from training. This research provided a richer understanding of the reasons or factors affecting trainees' inability to meet Army standards or their decision to be discharged from the Army. The third phase consisted of an extensive survey analysis. The survey analysis identified the underlying reasons trainees gave for being discharged, determined soldiers' expectations and perceptions of various aspects of the enlistment process, and differentiated the responses of those individuals who completed versus those who did not make it through Army training.

While researchers have typically investigated and modeled personnel attrition in the aggregate, this study decomposed attriting personnel into four categories based upon a taxonomy developed for evaluating personnel attrition. The resulting four personnel attrition models provided enhanced identification of those individual and organizational characteristics that are associated with personnel attrition. These models also provided better prediction of those trainees who would complete, versus be discharged from, Army training. The study results were used to identify a ten-point strategy for changing enlistment procedures in order to reduce training attrition and improve Army readiness.

Wednesdayy, 1330-1500
COMPOSITE GROUP E .... Room 144

Thursday, 0830-1000 COLLECTIVE TRAINING SUPPORT
Using Web-based Collaboration to Enhance OOTW Training and Analysis

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In 1998, ThoughtLink was funded by DARPA to explore how low-cost gaming and collaboration technologies could augment Joint Task Force (JTF) training for OOTW. Current OOTW training, particularly for JTF staff and interagency representatives, has some limitations. For JTF staffs, OOTW training is infrequent; large-scale exercises occur only every 18-24 months. Training often uses combat versus OOTW simulations and JTF training rarely or poorly incorporates outside participation from international organizations, interagency representatives, and non-governmental organizations. Finally, current JTF staff training has minimal focus on pre-deployment or post-deployment tasks.

This presentation includes a description of ThoughtLink Inc.'s 1998 work, assessing JTF training and how low-cost gaming and collaboration technologies might augment this training. It will include a summary of ThoughtLink's work in this area for 1999.

In 1999, under funding from DARPA and OSD's CCRP, ThoughtLink is developing a collaborative, Internet-based environment for low-cost OOTW training, analysis, and collaborative planning. The environment is designed to address the training shortfalls mentioned above. It can be used more frequently because it is lower in cost; it can easily include outside participation because it is web-based, and it can be designed around scenario segments that address all phases of an OOTW exercise.

The goal of this web-based environment is to provide a low-cost, easy-to-use tool that will provide JTF staffs and interagency representatives the opportunity to work together in planning large-scale exercises and to practice OOTW-specific skills, including collaboration and consensus-building. The environment will capture interactions and products created by the participants, therefore providing a rich source of data for OOTW analysis

Army Experiment Five (AE5) Training Assessment

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Army Experiment Five was the 1998 Army Chief of Staff initiative devoted to "Training Army XXI Leaders to Exploit Situational Awareness." Headquarters, TRADOC was the executive agent for he AE5 experiments and AUSA presentation. AE5 consisted of a Digital Training Exercise at Fort Hood, a Digital Training Experiment at Fort Leavenworth, and three separate, but related, digital training events that provided tangible residual benefits to the Army, as well as a presentation that served as the Army Strategic Communication Plan's premier event. The objectives of AE5 were to: 1) support the development of a Digital Leaders' Reaction Course (DLRC) proof of principle; 2) identify methods for optimizing the use of situational awareness (SA); 3) support the implementation of emerging training strategies for Army XXI; 4) enhance training and training support systems for leaders of digitized units; 5) leverage early user capabilities of emerging training systems; and 6) present results at the AUSA annual convention.

The AE5 objectives were met through four major axes - Leavenworth, Hood, Training Assessment, and Presentation. These axes were designed to: 1) assess the effectiveness of emerging Army XXI training strategies and systems, such as the "3-Step Training Process," digitally enhanced After Action Reviews, and linkage of next-generation simulators and simulations to Army Battle Command Systems; and 2) present the training methods, tools and insights during the AUSA annual convention. The *AE5 Assessment Report* contains information and analysis on digital training for leaders, Brigade and below mission planning and mission rehearsal, and TES and AAR capabilities that are of interest to the training, simulation and command and control program communities.

The top-level findings of the experiment report are: 1) using the 3-Step Training Process can significantly increase leaders' ability to exploit SA in a digitized force; 2) the DLRC environment is a cost-effective method for increasing leader proficiency in decision making; and 3) using technology supported AARs repetitively during C2 decision training greatly enhances the leader and staff learning process. This paper summarizes the observations, conclusions and recommendations in the experiment report and provides the rationale behind the top-level findings.

Impacts of Force Modernization on Measurement of Unit Performance

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The Army is accomplishing force modernization under the Force XXI program to address the five objectives of rapidly projecting and sustaining forces, protecting committed forces, winning the information war, conducting precision strikes, and dominating the battlespace. Force modernization is being implemented, in part, through fielding of new weapon, reconnaissance, surveillance, target acquisition, and digital command and control systems. Attaining the objectives of force modernization also requires the gradual evolution of tactics, techniques, and procedures (TTPs). The U.S. Army Training and Doctrine Command (TRADOC) defined six Patterns of Operations to provide an initial description of how Force XXI units will fight and guide the evolution of Force XXI TTPs. As part of a TRADOC-requested effort to define instrumentation systems and other resources needed to support the training of Force XXI units in live force-on-force exercises, the Army Research Institute has considered the role of unit performance measurement. This paper presents and defends measures of performance (MOPs) for use in deciding how well Force XXI units address the five force modernization objectives and apply the six Patterns of Operations. These MOP combine to assess the extent to which improved knowledge of the battlespace and less restrictive capabilities to engage the enemy enable Force XXI units to control the timing, location, and manner of contact with the enemy. This paper also describes problems in applying selected MOPs.

Thursday, 1030-1200 COLLECTIVE TRAINING SUPPORT
CCTT Accreditation: Methods and Results for a Horse of a Different Color

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The purpose of this paper is to provide an overview of the methods, results, and selected lessons learned from the U.S. Army Training and Doctrine Command (TRADOC) accreditation of the Close Combat Tactical Trainer (CCTT).

CCTT is a virtual simulation training environment designed to provide the capability for the active and reserve components of the United States Army to train the total combined arms force on a fully interactive, realistic, real time battlefield. The environment is needed to train and sustain individual and collective (crew through battalion task force) tasks and skills in command and control, communications, and maneuver while integrating the functions of combat support and combat service support units. This requires the conduct of combat operations with appropriate and challenging opposing forces that will ensure realistic individual, crews and staff actions, placing the stresses of combat on all participants.

The size, complexity, and uniqueness of CCTT mandated that the accreditation team "bend and extend" current Army guidance provided for conducting accreditations. The CCTT accreditation focuses on the assessment of eleven CCTT acceptability criteria that culminate in a task-based assessment of the Mission Training Plan tasks. This accreditation established the basis for the integration of this collective trainer into the Combined Arms Training Strategy.

Cost and Training Effectiveness Analyses (CTEA) for large-scale Simulations

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In response to the DoD IG Audit Report, "Requirements Planning and Impact on Readiness of Training Simulators and Devices," a number of efforts have been initiated to answer questions relating to the training benefit, impact, and value added from use of large scale simulations for training. These simulations may link together hundreds of participants at many different geographic locations and are more complex and costly than traditional training devices and simulators by an order of magnitude or more. The military Services have little experience in evaluating large-scale simulations and there are no standard evaluation methods. The Office of the Deputy Under Secretary of Defense for Personnel and Readiness is currently driving a multi-faceted programmatic effort to respond to the DoD IG questions. First, various organizations are conducting studies and analyses to contribute to the CTEA knowledge base from both the training effectiveness and costing perspectives. For example, the Defense Modeling and Simulation Office (DMSO) has undertaken to develop a common practices guide for the appropriate use of M&S from program inception to full operational capability. Second, the Functional Working Group of the Training Council has formed a sub-group on CTEA to incorporate the individual Services and Joint Staff efforts to address this issue across the breadth of training from Joint Task Force Exercises to Service Title X. This information will help training evaluators, developers, and users estimate the training- and cost-effectiveness of various types of training, and identify relevant examples of published evaluations. The functional working group is also conducting analyses to determine possible DoD policy changes necessary to assure the cost-effectiveness of large-scale simulations. Third, the department has tasked the Defense Manpower Data Center (DMDC) to develop a training effectiveness evaluation framework for large-scale training simulations. In connection with this effort, DMDC has developed a historical training and cost-effectiveness database that summarizes the results of prior evaluations and that can be used to identify relevant case studies of exemplary evaluation practice.

Training and Cost Effectiveness File Data Base

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Approved abstract unavailable at printing.

Thursday, 1330-1500 – INDIVIDUAL TRAINING SUPPORT

A Research Partnership Addressing Crew Resource Management Training

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The 58th Special Operations Wing (58 SOW) and the Air Force Research Laboratory (AFRL) have a long-standing partnership to address training issues in the context of actual training programs. We are currently investigating how Crew Resource Management (CRM) behaviors relate to mission performance. Recently, observers independently rated CRM and mission performance, and recorded specific behaviors associated with high or low ratings. CRM and mission performance ratings were highly correlated. In addition, the *most effective crews* exhibited "signature" behaviors not observed in other crews. Instructors reviewed these results and reported that patterns in the data accurately reflect trends in the MC-130P crew force.

These operationally meaningful and statistically reliable crew performance data have allowed 58 SOW and AFRL to actively impact aircrew training across the Air Force. The Air Force Instruction (AFI) guiding CRM training was revised in 1998 to reflect our findings. This new AFI requires Commands to document CRM behaviors and use the results to match CRM instruction with the actual needs of the target populations. Our analytic strategy provided the organizing structure for these data. MC-130P CRM lessons are being redesigned to apply research results. A major goal is to instill in all crewmembers the signature CRM behaviors that were once the domain of only the most effective crews. Data collection mechanisms are also being implemented to document how well this goal is met. We will emphasize our evolving methods for measuring CRM performance and assessing training effectiveness, and discuss impacts on Air Force training.

Simulation and Embedded Training for 21st Century Soldiers

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21st Century soldier systems will pose unique challenges to training. Systems such as the Objective Infantry Combatant Weapon (OICW) possess technological capabilities like indirect fire, smart munitions and kinetic energy that render current force-on-force training support tools, such as the Multiple Integrated Laser Engagement System (MILES), ineffective. Systems like Land Warrior integrate man pack computers with GPS, digital communication and laser technology. Advances in processor speed, size and weight make it possible to utilize Land Warrior capabilities to pass and receive data. This would greatly assist in training and could also be used as a data collection tool. This presentation will discuss how soldier system technology can impact training and analysis in the near future. It will focus on using live distributed simulations to arbitrate training exercises and to capture data for real-time analysis.

Synthetic Representation of Patient Injuries in a Medical Training Federation

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Simulators for medical training are becoming more common everyday. Each medical training simulator appears to be able to manifest a limited number of patient conditions extremely well and other conditions either not at all or very poorly. Hence training is limited and disjointed. At the same time, operational and logistical readiness requirements have prompted development of comprehensive identification and simulation of patient conditions. These operational and logistical readiness models and simulations of patient conditions like those contained in the Operational Requirements-based Casualty Assessment (ORCA) simulation offer considerable definition of injuries but are not currently available in a form that can be represented on training simulations. The High Level Architecture (HLA) provides a forum through which a cooperative and mutually beneficial simulation federation can be composed between disparate simulation systems. Conceptually a architecture can be developed through which these currently separate simulation systems can support one another. This paper describes a STRICOM sponsored effort that manifests ORCA described injuries in the Combat Trauma Patient Simulation HLA federation. We develop a conceptual model for generating, storing and using ORCA injuries within the federation, a prototype Injury Simulation Object Model (SOM), conduct a limited test of the system within the Federation and report results of our testing.

Analysis Of Performance Based Indicators Influencing Military Functional Skill Retention Using A Human Resource Research Model

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The Army uses data gathered about MOS training to make prediction about how long soldiers can retain knowledge and skills in their MOS and what types of continuing education/training they need to maintain prescribed proficiency levels. MOS skill training is more in-depth than military functional skill training within the U.S. Army Reserve. Soldiers use MOS knowledge regularly in their jobs. Military Functional Skills (MFS) tend to be used on a more irregular basis and are usually considered additional duties for soldiers. The Army Reserve Institute used data for understanding soldiers' memory patterns for skills they acquired through training and on the job, and serve as a basis for developing training and practice. Leaders have used ARI findings as a basis for developing training strategies to prolong MOS skill retention. Prior to conducting these studies, the ARI had no field data available to support MFS predictions within the Army Reserve. The author conducted three studies as part of a two-year research program designed to help reservists with training and MFS retention. Although most of these MFS covered on these studies were categorized as additional duties, they often are crucial in planning, coordinating and executing readiness activities such as mobilization, movement and training. The author will present a practical model to predict MFS loss levels. A review of the research process and results will be covered during this presentation. It will cover how to effectively measure MFS retention loss levels, find new ways to maintain satisfactory performance training over time, and how to maximize positive return on investment and increase cost/benefit ratios.

WG 23 – BATTLEFIELD PERFORMANCE, CASUALTY SUSTAINMENT & MEDICAL PLANNING – AGENDA
Chair: Maj Robert Syvertson, Office of the Surgeon General
Co-Chairs: LTC Pat McMurry, USA Medical Department Center & School
Jamie Pugh, Space & Naval Warfare Center
Maj Bruce Shahbaz, AMRDD C&S
Advisor: William Pugh, Naval Health Research Center
Room: 325

Tuesday 1030-1200
Development of Allied Medical Publication 8: Medical Planning Guide for the Estimation of NBC Battle Casualties, Volume 2: Biological
Julia Klare, Doug Schultz, Institute for Defense Analyses

Knowledge Acquisition Matrix Instrument: Bioagent Casualty Modeling
Ms. Gillian Rickmeier, Mr. George H. Anno, Dr. Gene McClellan, Pacific Sierra Research

Tuesday 1330-1500
Exploratory Models for Predicting Leader Development in US Military Academy Cadets
LTC Paul Batone, LTC Scott Snook, United States Military Academy

Intelligent Automation of Critical Decision Information for Battlefield Simulator Training
LTC (Ret) William J. Gerber, LTC George F. Stone III, Modeling and Simulation – Knowledge Engineering Group, PM-WARSIM

A Quantitative Approach to Modeling Ground Force Casualty Stream Composition
James Zouris, Naval Health Research Center

Wednesday 0830-1000
Suggestions on Conversions of Evaluations of Foreign Ground Force Human Factors to Modeling Inputs
Gerald A. Halbert, John R. Lynch, National Ground Intelligence Center (NGIC)

An Assessment of MODSAF CSS Representation
MAJ Mark M. Lee, Mr. Robert L. Albright, TRADOC Analysis Center-Ft. Lee

Wednesday 1030-1200
Behavioral Impacts on Battlefield Performance in JWARS
Judy Schandua, JWARS, Chuck Burdick, JWARS (Lockheed Martin), Jan Morrow, NGIC, Jerry Halbert, NGIC

Modifications to the Dupuy Casualty Estimation Methodology and Medical Course of Action Analysis Tool
MAJ Bruce Shahbaz, Army Medical Department Center and School

Wednesdayy, 1330-1500
COMPOSITE GROUP E .... **Room 144**

Thursday 0830-1000
Structure and application of the healthcare complex model – A tool for reengineering healthcare delivery
Sam Clark, George Miller, Vector Research

Structure and application of the healthcare management model – A tool for evaluating disease management programs
Tim Olson, George Miller, Vector Research

Thursday 1030-1200
Medical Mission Planning and Rehearsal using STOW JSAF
Doug Hardy, SPAWAR Systems Center, Bruce Walter, Greystone Technology

Modeling Casualty Stream Composition Across Echelons of Care Over the Course of Combat Operations
G. Jay Walker, GEO Centers, Naval Health Research Center

Thursday 1330-1500
Modeling Medical Admission During Shipboard Combat Operations
Chris Blood, James Zouris, Naval Health Research Center

Reengineering the Marine Corps Logistical Footprint for Forward Resuscitative Surgery
Michael R. Galarneau, Gerry Pang, Paula J. Konoske, Naval Health Research Center

WG 23 – Battlefield Performance, Casualty Sustainment, and Medical Planning – ABSTRACTS

Tuesday, 1030-1200

Development of Allied Medical Publication 8: Medical Planning Guide for the Estimation of NBC Battle Casualties, Volume 2: Biological

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Abstract: In its role as U.S. representative to the NATO NBC Medical Working Party, the Office of the Army Surgeon General (OTSG) has initiated development of a series of NBC casualty estimation manuals. These manuals, covering nuclear, biological and chemical casualties, are designed to update and expand Allied Medical Publication 8 (AMED P-8), a manual for estimating casualties of nuclear attacks last published by NATO in the early 1960s. The purpose of these manuals is to provide medical planners with worst-case estimates of expected casualties over time under a range of operational scenarios. They consider variations in unit formation, meteorological conditions, agent and weapon system. AMED P-8 Biological is the most ambitious document in the series; it will include more agents and more varied operational scenarios than either the nuclear or chemical volumes.

Volumes 1 and 3 in this series, AMED P-8 Nuclear and AMED P-8 Chemical, are now under ratification review by NATO member nations. The Institute for Defense Analyses (IDA) and Pacific-Sierra Research Corporation (PSR) are now working to complete the remaining biological volume. IDA uses its indigenous casualty estimation methodologies and the operational expertise of the its staff to generate operational scenarios and to estimate the amount of agent troops would be exposed to in each. Based on a given agent exposure, PSR then uses a combination of methodologies to determine whether an individual becomes ill, whether and when he/she becomes sufficiently ill to enter the medical system, the time of onset of disease, the time course of disease, and whether or not the disease will result in death. For some agents, PSR also determines the degree of performance degradation for ill individuals over time.

Knowledge Acquisition Matrix Instrument: Bioagent Casualty Modeling

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Abstract: The Knowledge Acquisition Matrix Instrument (KAMI) is a questionnaire for obtaining qualitative data to support modeling of human response to biological agent exposure. It is designed for bioagent-induced diseases that are wartime or terrorist threats but for which only limited human response data is available. The KAMI focuses on modeling parameters including infectivity, lethality, dose-dependent onset and duration, illness severity profiles, and time to death or recovery. In 1998, the KAMI was distributed to national and international subject matter experts to gather information on anthrax, plague, botulism, and VEE based on their experience from animal studies, epidemiology, vaccine development, accidental lab exposures and naturally occurring disease. Two expert panel meetings were held to review and reach a consensus on the KAMI data. This presentation describes the data gathering and analysis and how the results are used to generate casualty estimates for Volume II of Allied Medical Publication 8: Medical Planning Guide for the Estimation of NBC Casualties (Biological).

Tuesday 1330-1500

Exploratory Models for Predicting Leader Development in US Military Academy Cadets

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Abstract: While a host of factors influence the outcome of military operations, the impact of leaders, though difficult to qualify, can be decisive. This recognition has made the question of how to develop strong leaders one of perennial concern to military organizations. The present study examines a single cohort/class of U.S. Military Academy cadets over time, testing the power of both cognitive and personality variables to predict military leadership performance across the four-year training experience. Multiple regression procedures identify several exploratory models that successfully predict Military Development (MD) grades for each of four college years, as well as total cumulative averages on Military Development. A model predicting cumulative MD across four years (Multiple $R= .30$, $F\ (5, 258) = 5.26$, $p < .001$) includes as significant predictors the personality variables of Hardiness, Emotional Stability, and Extraversion. Additional predictors are the

Mental Rotation Test (MRT), a measure of cognitive-spatial abilities, and Traditional Values, which can be construed as either a personality or belief system (cognitive pattern) variable. Models predicting military leadership performance separately for the four academy years show a similar pattern of both cognitive and personality variables as significant, although cognitive variables appear to recede, and personality variables increase in importance as cadets advance to the upper classes. For example, cognitive-spatial abilities (MRT), Social Judgement (ability to analyze a problem scenario for its social components), and Traditional Values all predict Military Development grades for "Plebes" (freshmen), but not for "Cows" (juniors) or Firsties (seniors). On the other hand, personality Hardiness, Extraversion, and Emotional Stability all emerge as predictors of leadership for upperclassmen, juniors and seniors. Future research will refine and expand these predictive models, adding variables to represent critical developmental activities and experiences as well as important social background characteristics. The ultimate goal of this effort is to provide data-based models that identify the major predictors of leadership performance, accounting for the largest amount of variance in both performance and growth. Such models can lead to improved academy leader development programs and curricula, and should also prove useful beyond the academy in military leader training programs.

Intelligent Automation of Critical Decision Information for Battlefield Simulator Training

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Abstract: In training exercises for commanders using a constructive battlefield simulation, human operators observe the battle simulation on computer monitors and manually synthesize the reports that are sent to the commander and his/her staff. These reports are filtered, based upon the commander's requests for specific, critical information, to avoid overwhelming the commander with data. A meta-expert system, the Intelligent Simulation of the Battlefield (ISB) is under development for assisting military commanders with training for managing battlefield information and decision making. Janus, a battlefield simulation widely used for command and control training, is being used to provide the input for a commander's Maneuver Control System (MCS) and the Intelligence Officer's All Source Analysis System (ASAS). The reporting of filtered information from Janus to MCS/ASAS will be automated to replace the human operators. That automation will be provided by the Simulation Information Filtering Tool (SIFT) / Intelligent Simulation Reporting Agent (ISRA) / S2 Autonomous Agent (S2A2) programs. SIFT/ISRA/S2A2 will allow a commander to specify his/her critical information requirements through a graphical interface. The SIFT/ISRA/S2A2 program will then encode messages for status of friendly forces, detections of opposing forces (OPFOR), assessments of OPFOR probable Courses of Action, and/or other critical information as requested by the commander being trained. Finally, it will send the encoded messages in standard formats to the command and control systems or even observer/controller workstations. This technology has great impact on information management, stimulation of command and control systems and after-action review for both Army and joint tactical operations.

A Quantitative Approach to Modeling Ground Force Casualty Stream Composition

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Abstract: Accurate forecasting of medical resource requirements during combat operations is contingent upon obtaining reliable estimates of the expected casualty occurrences. The forecasts needed include a determination of the overall wounded-in-action (WIA) and disease and non-battle injury (DNBI) incidence expected and the composition of these patient streams in terms of specific injuries and illnesses. Empirical data from US combat operations and recent peacetime deployments were used to estimate the types of diseases and injuries (in terms of Patient Condition codes) that would occur in a present-day combat scenario. Separate methodologies were employed to project Patient Condition code probabilities, for wounded in action, non-battle injury (NBI), and disease admissions. The Patient Condition code percentages are then incorporated into Ground Forces Casualty Projection System (FORECAS) which projects casualty rates and the total number of admissions. Patient Condition codes are then assigned to these admissions by first taking random draws from a uniform distribution and then using the inverse transformation method to obtain a result that is Poisson Distributed. Determination of the distribution of injuries and illnesses in terms of PC codes is essential to the assessment of the needed medical resources required at the various levels of medical care and for the various theaters of operation.

Wednesday 0830-1000
Suggestions on Conversions of Evaluations of Foreign Ground Force Human Factors to Modeling Inputs

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abstract: This presentation discusses conversions of evaluations of foreign ground force human factors to inputs usable by the modeling and simulation (M&S) community. These human factors include leadership, moral and cohesion and unit training. The NGIC foreign ground forces evaluation criteria describes the expected level of performance of a foreign ground force. Normally one ground force will be rated lower than another and this rating is meaningful in describing differences in potential performance. The rating number by itself is not usable to the M&S community. After rating a country's ground forces, a look up table is utilized to determine what comparative differences in performance can be expected between ground forces rated at different levels.

The look up table describes the ability of units to perform operations such as reconnaissance, delivery of fire, and ability to maneuver. Ground forces that are not as proficient as other ground forces cannot execute operations at the same level of accuracy, timeliness, or effectiveness as those rated at a higher level.

This proposed methodology is not complete, has not been verified, but is an attempt to describe the differences in the ability to conduct combat operations. This methodology has relevance during stability and support operations, periods of maneuver or defense, and has implications for information warfare.

An Assessment of MODSAF CSS Representation

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ABSTRACT: This paper describes the Combat Service Support (CSS) representation in the Modular Semi-Automated Forces (ModSAF) simulation. TRAC-LEE enhanced the baseline representation in conjunction with functional experts from the Combined Arms Support Command (CASCOM). With functional guidance from CASCOM TRAC-LEE developed representation of a FXXI Forward Support Company (FSC). While supporting CASCOM in a simulation exercise (SIMEX) with exploratory analysis of a future US Army Strike Force, TRAC-LEE added further CSS enhancements. With experience gained in these activities, TRAC-LEE continues to add CSS representation and has suggestions for further improvements.

Wednesday 1030-1200

Behavioral Impacts on Battlefield Performance in JWARS

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Abstract: Human behavior on an individual scale is inherently difficult to predict, but unit behavior, given some insight into the basic underlying aspects of characterization of the unit, is an increasingly more tractable problem. In the next generation of analytical models, there is concern about treating all units of the same size with identical equipment as equivalent. Most observers recognize that units with limited training, less combat experience, or poor leadership perform at a lower level than units which have significant training, extensive experience, and good leadership. To reflect those differences, the National Ground Intelligence Center has ranked various ground forces according to ten characteristics that are believed to be related to performance. The JWARS Land IPT has adopted this concept of "soft factors" which influence performance and has made provisions for using them in the JWARS model, if the analyst desires to do so. Specifically, three of the factors have been incorporated into JWARS which can affect the unit performance characteristics of speed of movement, length of time to change formation, and rate of effective fire. This presentation describes the "soft factors developed by NGIC," explains how they are being used in JWARS, and discusses possible extension of the concept in future versions of the model to more factors and more effects.

Modifications to the Dupuy Casualty Estimation Methodology and Medical Course of Action Analysis Tool

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Abstract: The casualty estimation formula developed by Colonel (U.S. Army, Retired) Trevor Dupuy in his book Attrition: Forecasting Battle Casualties and Equipment Losses in Modern War (Nova Publications, 1995) was modified as a result of using the "goal-seeking" function in Excel®. These modification resulting in a smaller standard deviation and a smaller 95% Confidence Interval, which indicates that the modifications provide a more accurate estimate then the original formula.

The Army Medical Department (AMEDD) does not have an approved course of action tool for conducting workload requirement analysis for its division level medical units. An automated course of action tool is urgently needed to assist combat health support (CHS) planners determine support requirements. The Medical Course of Action Tool (M-COAT) possesses the capability to meet this requirement.

Wednesdayy, 1330-1500
COMPOSITE GROUP E .... **Room 144**

Thursday 0830-1000
Structure And Application Of The Healthcare Complex Model – A Tool For Reengineering Healthcare Delivery

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Approved abstract unavailable at printing.

Structure And Application Of The Healthcare Management Model – A Tool For Evaluating Disease Management Programs

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Approved abstract unavailable at printing.

Thursday 1030-1200
Medical Mission Planning and Rehearsal using STOW JSAF

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Abstract: Mission rehearsal and attendant course of action analyses are becoming increasingly prominent as resources available to a commander become fewer and fewer. The ability to use simulation-based wargaming tools to execute multiple contingencies/scenarios during an overall mission planning process allows a commander to develop and refine his intentions for the execution of that mission. Using those same tools to collect and analyze quantitative data on the results of each course of action provides the means to identify specific points in the operation which are critical to overall success. For this methodology to be effective, the requirements and contributions of each mission area must be accurately represented within the process to ensure the commander has a complete picture. For the Joint Medical Operations-Telemedicine ACTD, the Synthetic Theater of War (STOW) entity level simulation system was chosen to provide a medical mission planning and rehearsal capability.

STOW is an object-based distributed simulation that provides a synthetic battlespace for joint command and staff training and mission rehearsal. The STOW-simulated synthetic forces include over 450 types of entities from all services including rotary-wing aircraft, individual combatants, non-combatants, combatant ships, commercial air, and merchant ships. For purposes of mission rehearsal, planned operations are modeled and force on force interactions are simulated. Resulting WIA and DNBI casualties are transported, treated, and evacuated in accordance with doctrine defined by the staff medical planners.

The development of a medical component for STOW by SSC-SD is providing Joint Commanders and staff with significantly increased visibility into the medical support requirements of a planned operation as well as equipping medical planners with a real time mission rehearsal and planning tool.

Modeling Casualty Stream Composition Across Echelons of Care Over the Course of Combat Operations

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Abstract: Modeling the medical resources needed to support a combat operation requires the capability to project the types of patient conditions likely to be resident at each echelon of care at any point during the military action. A model will be presented simulating a typical casualty flow and the expected patient count at each echelon level during each day of the operation as well as summary results at various stages of the operation. While the parameters of this particular model are based on a historical five-tier medical echelon system and the International Classification of Disease (ICD) diagnostic coding schema, the model can be easily generalized for possible future scenarios, including alternative echelon structures, varying evacuation policies and Patient Condition Code diagnoses. Drawing on the records of over 86,000 combat-related hospitalizations, this presentation will also track the length of stay (LOS) experience through a multi-echelon system of care during the Vietnam conflict. Among the topics discussed are the distribution of LOS at each echelon, the average LOS by ICD category and an examination of how treatment status (completed vs. continuing) impacted LOS times.

Thursday 1330-1500

Modeling Medical Admission During Shipboard Combat Operations

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Abstract: To assist in determine medical resource requirements, the shipboard casualty projection system, SHIPCAS was developed to provide projections of the number of wounded-in-action (WIA) and disease and nonbattle injuries (DNBI) likely to be sustained on board U.S. Navy ships during combat operations. The parameters of the patient condition distributions of the casualty straems were estimated and applied to the projected DNBI and WIA incidence rates. As the probability of a specific diagnosis occurring is generally quite small, the Poisson distribution was used to calculate the frequency of each patient condition, given the empirically derived probabilities. Empirical data from previous combat operations were utilized to obtain the patient condition distributions for WIAs. Data used for the modeling of DNBIs included hospitalizations aboard aircraft carriers to ascertain differences in illness type attributable to theater of operations and combat deployment status. Percent distributions and lengths-of-stay (LOS) statistics of major diagnostic categories were compared between Vietnam combat support and peacetime modes of operations, and between WestPac and Mediterranean theater of operations.

Reengineering the Marine Corps Logistical Footprint for Forward Resuscitative Surgery

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Abstract: Emerging operational strategies and concepts place increasing emphasize on aggressive, early casualty care in highly mobile, modularized field medical facilities. Providing life-saving resuscitative surgery within these constraints relies upon the development of new medical delivery systems equipped to administer abbreviated, staged interventions. In the present study, conducted by the Naval Health Research Center (NHRC), a method was developed for estimating the logistical requirements for a compact, self-contained, and highly mobile field surgical suite. This effort relied upon the identification of the projected patient stream, the complement of anticipated injuries requiring intervention, and a more narrow definition of forward resuscitative surgery than previous employed. Estimates of casualty stream and composition were derived from the FORECAS casualty projection model also developed by NHRC. These values were then used to calculate the anticipated number of each staged surgical procedure the suite would be equipped to administer. Using the derived proportion of each procedure, the estimated quantity of materiel required to support the forward resuscitative surgical mission was projected.

WG 24 – MEASURES OF EFFECTIVENESS – AGENDA

Chair: Lt Col Mark Reid, USAFA/DFCS
Cochair: CDR Paul Hoffman, USSTRATCOM/J533
Cochair: MAJ Sue Romans, OASA/RDA
Cochair: David W. Cann, NUWC Division Newport
Advisor: Mr Robert Meyer, NAWC-Weapons Division
Room: 322

Tuesday, 1030-1200
TRAC2ES OT&E, An Approach to Evaluate the Patient Movement Mission and Unit Operations
Ron Gustafson, Al Mazzei, AFOTEC/XOO, Kirtland AFB, NM

Dependence of Salvo Shots and Analysis of Mixed Data
Kevin C. Smith, COMOPTEVFOR, Norfolk, VA

A Sensor Pointing Terrain Interaction Model and Reconnaissance Analysis Methodology Applied to Two Operations Other Than War Scenarios
Author: Ephraim Martin IV, Lockheed Martin Electronics & Missiles, Orlando, FL

Tuesday, 1330-1500
Requirements Study and Design of the Fire Control System for the Objective Crew Served Weapons
MAJ Greg Brouillette, 2LT Susan Castorina, 2LT Timothy Cook, 2LT Joseph Stanyer, United States Military Academy, West Point, NY

Quantifying Mission Success of the RAH-66 Comanche
MAJ Gregory Graves, MAJ Robert Watson, 2LT Nathan Mann, United States Military Academy, West Point, NY

Winner of the 1999 Hollis Award - ***Developing a Potential Light Infantry Force Structure for the Fielding of the Objective Crew Served Weapon (OCSW)***
Frank D. Sturek, CPT(P); David Ritter, 2LT, Student; Kingsley Fink Jr., 2LT, Student; USMA

Wednesday, 0830-1000
JOINT SESSION with WG 8, 9, 10, 24 and 25....................Room 144

Wednesday, 1030-1200
Wargame 2000 and Assessment for National Missile Defense
Dr. Michael Lyons, MITRE, Joint National Test Facility, Modeling, Simulation and Wargaming Directorate, Schriever Air Force Base, Colorado

An Analysis of Command Decision Time Delays
Dr. Ralph S. Klingbeil, Naval Undersea Warfare Center Division Newport, Newport, RI

An Interoperability Assessment Methodology for Air and Missile Defense
Mr. R. Edward Pugh, Demonstration and Test Directorate, Program Executive Office, Air and Missile Defense, Huntsville, AL
Mr. Arthur Meier and Mr. Edward Freeman, Science Applications International Corporation, Huntsville, AL

Wednesday, 1330-1500
Measures of Effectiveness for the Informatin-Age Army
Richard E. Darilek, Jerome Bracken, John Gordon, Brett Lewis, Brian Nichiporuk and Walter Perry, RAND.

JMEM/Air-to-Surface Weaponeering System (JAWS)
Carolyn E. Holland, AAC/ENMS, Eglin AFB FL

Weapons Effects Analysis and Probability Software (WEAPS)
Carolyn E. Holland, AAC/ENMS, Eglin AFB FL

Thursday, 0830-1000
COMPOSITE GROUP F....................Room 144

Thursday, 1030-1200
An Acquisition and Launch Planning Method for Predicting the Functional Availability of Satellites to Meet User Requirements
Mr. William Justin Comstock, Welkin Associates, Ltd., Chantilly, VA

Utility Assessment for Air Force Space Command's Long Range Plan
Don Olynick, ANSER Corporation, Colorado Springs, CO

GPS Joint Operational Battlefield Environment (JOBE) Joint Feasibility Study
George T. Cherolis, TRW/TACCSF, Dennis L. Lester, SRC/TACCSF, Kirtland AFB, NM

Thursday, 1330-1500
Tomahawk Mission Planning Threat Analysis Output Sensitivity to Input Database Errors Nick Talarico, Boeing

AoAs Need MOEs Too
Chris Feuchter, Office of Aerospace Studies, Kirtland AFB, NM

Cost-Effective Strategies For Vulnerability Assessment
Martha K. Nelson, Franklin and Marshall College, Lancaster, PA

WG 24 – MEASURES OF EFFECTIVENESS – ABSTRACTS

Tuesday, 1030-1200
TRAC2ES OT&E, An Approach to Evaluate the Patient Movement Mission and Unit Operations

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In order to improve the efficiency of its operations and to also place greater emphasis on providing information of value to theater operations, the Air Force Operational Test and Evaluation Center has recently reorganized and restructured its business management process. Key to this restructuring has been the implementation of a process that starts by considering the impact of each system on theater operations. Two newly formed Mission Directorates (Air & Space Operations and Integrated Logistics) are now bringing a comprehensive understanding of theater operations to the OT&E planning process. In addition to the increased emphasis on "MISSION" (theater operation), OT&E must also retain its traditional role of evaluating the "SYSTEM" (unit operations/operator use of the system) and the "OPERATIONAL REQUIREMENTS" (system operational and support characteristics in the ORD). This paper illustrates the application of a "strategy-to-task" approach that considers the Universal Joint Task List, doctrine, CONOPS, and operational experience to decompose the patient movement mission into major functional elements. A risk/impact analysis is then applied to determine major risk areas to the patient movement mission. As a result of this process, the TRAC2ES OT&E will focus on information constraints affecting patient backlog management. Three key mission elements found to have a potentially major impact on the information constraints and patient backlog management include: global/theater command and control, patient/resource statusing, and communications. The OT&E process also involves the formulation of key questions and measures to focus on the problem, poses a conceptual approach to separate physical and information constraints, develops an evaluation decision space, and identifies the potential value of OT&E information to the warfighter.

Dependence of Salvo Shots and Analysis of Mixed Data

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It is a common practice in the DoD acquisition community to treat two missile shots in a salvo as independent and, so, to analyze the expected probability of kill for the salvo by taking one minus the square of the complement of the probability of kill for a single shot. In this paper we show that the assumption of independence between shots in this calculation is unsound when there are significant variations from scenario to scenario (as is often the case). We make no general recommendations about weapons system testing based on this result, but clearly there are implications. In conclusion, we examine the practical problem of data analysis when there is only single shot data and when there is both single shot and salvo shot data. In the latter case, we conclude that there is no objective way to combine such data.

A Sensor Pointing Terrain Interaction Model and Reconnaissance Analysis Methodology Applied to Two Operations Other Than War Scenarios

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The dynamic interaction of sensors with terrain and tactical targets deserves special attention to help sort out the relative value of high cost sensor package options. A phenomena of particular interest when considering a reconnaissance mission is the time related terrain coverage provided by a given sensor package when used with a given tactical employment logic. How much area can be covered in a given time using a given search pattern with a given set of sensors? What difference does one search logic provide compared to another? What difference does one sensor field of view provide when compared to alternatives? The methodology used in the most high fidelity combat simulations assigns a field of regard (FOR) and within that FOR a field of view (FOV). Each FOV is viewed in a set or random period of time. The search pattern within the FOR may be systematic or random depending on the sensor and the search logic. A model was developed which uses Defense Mapping Agency (DMA) terrain to graphically portray terrain surveilled by the sensor suite. The sensor suite is moved on or over the terrain. A specified sensor employment logic and search methodology are employed and the terrain is painted by the model to show which area is directly observed by which sensor or sensors. The Johnson methodology is linked to the model by Monte Carlo simulation to compute which targets on the terrain are acquired. An analysis of two scenarios is presented using this model which examines the performance of several air sensor packages in a reconnaissance mode. Both scenarios are Operations Other Than War. The first is a coastal infiltration operation set in Australia. The second scenario is a central European operation set in Bosnia. Both are oriented towards air reconnaissance in a sparse target environment where both target detection and target identification are of primary importance and target engagement is a lesser priority for the sensor platform. The results are extremely revealing and instructive and are not available from most other sensor modeling and analysis methodologies.

Tuesday, 1330-1500

Requirements Study and Design of the Fire Control System for the Objective Crew Served Weapons

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The Joint Service Small Arms Program (JSSAP) Office is researching and developing a next generation crew served weapon to replace the current family of crew served weapons at the light infantry BN and below (the M240G, M2, and the Mk 19). The Objective Crew Served Weapon (OCSW) is an automatic grenade launcher which use air burst technology to detonate its 25mm high explosive rounds over head. Thus eliminating or drastically reducing the enemy's ability to effectively seek and find cover. The JSSAP Office tasked a USMA Cadet and faculty team to design a possible Fire Control System for the OCSW which optimizes the gunners ability to complete all the tasks of the crew served weapons it will replace. The Cadet / Faculty design team conducted a requirements study, identify the critical objectives, performance parameters, developed criterion, measure of effectiveness, and alternatives, and modeled the alternatives. The design team will present the recommended alternative, simulation results, and other results and conclusions of our Systems Engineering Design Process.

Quantifying Mission Success of the RAH-66 Comanche

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In the current military environment of limited resources, traditional methods of operational testing and evaluation of reconnaissance systems are not cost effective. Side-by-side testing of the Comanche with Kiowa Warrior or other aircraft would be costly to perform. The concept of mission success templates was developed in an attempt to provide an alternative to this evaluation method. The mission success template concept relies upon mapping system performance to force success. The desired outcome is a quantitative measure of mission effectiveness.

Our design team initially developed a functional decomposition of the critical mission elements that comprise reconnaissance. These critical elements were then further reduced into measures of effectiveness. Since the mission success templates are to be used in the operational test and evaluation, the measures of effectiveness were required to be quantifiable and physically measurable. Once these measures were developed, the focus shifted to an aggregation method and development of minimum acceptable performance levels for the measures of effectiveness. An innovative approach to determining the weights of the measures of effectiveness is the use of the Quality Function Deployment.

This presentation will focus on the measures of effectiveness and their contribution to the successful performance of reconnaissance. Additionally, it will show the process utilized in developing mission success templates for a reconnaissance platform. Finally, it will provide the current status of the mission success templates being developed in support of the Operational Test and Evaluation of the RAH-66 Comanche.

Winner of the 1999 Hollis Award - ***Developing a Potential Light Infantry Force Structure for the Fielding of the Objective Crew Served Weapon (OCSW)***

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The US Army is interested in maximizing the combat power and effectiveness of its light infantry units. Since World War I the primary killing system and greatest contributor to the light infantry's combat power has been the machine gun. Currently, light infantry battalions employ the M240G or M60 machine guns as their medium machine gun, and the MK19 Grenade Launcher and M2 .50 Caliber Machine Gun as their heavy machine gun. The Army Research, Development and Engineering Center (ARDEC) is currently developing and testing a potentially more lethal crew-served weapon designed to possibly replace both the medium and heavy machine guns in the not so distant future (2010).

Our design team used the US Military Academy's Systems Engineering Design Process (SEDP) to develop a set of criteria to evaluate possible force structure alternatives, possible measures of effectiveness, and a set of alternative force structures for comparison. This study specifically focused on developing a force structure that would maximize the lethality and mobility of a light infantry battalion.

We plan to model the force structure alternatives using JANUS and a Visual Basic force-on-force simulation to create data for specific measures of effectiveness (MOEs) for comparison. The different MOEs will be used as criteria in a multi-attribute decision-making model. The resulting analysis will produce a potential future light infantry battalion force structure, weapons mix, and possibly an optimal basic load for employing the OCSW, based on the selected MOE criteria.

Wednesday, 0830-1000

JOINT SESSION with WG 8, 9, 10, 24 and 25..Room 144

Wednesday, 1030-1200

Wargame 2000 and Assessment for National Missile Defense

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Wargame 2000, under the sponsorship of the Ballistic Missile Defense Organization, is a real-time, interactive, discrete event, human-in-the-loop simulation for national and theater missile defense applications. The primary purpose of Wargame 2000 (WG2K) is to simulate air and missile defense command and control infrastructures, which implies BMC3 and C4I elements needed for air and missile defense, to support the execution of specified air and missile defense concepts of operation. WG2K is under development at the Joint National Test Facility with an initial demonstration of game capability for national missile defense in early 1999.

In addition to the primary purpose of WG2K, there are other uses required of the simulation, including a mode of application during developmental or operational tests. For example, WG2K is expected to interoperate with real C4I systems to provide realistic execution and live system test in the places where these operations would normally be conducted, including interoperating with mobile command posts and/or units. Participants will respond according to designated roles and responsibilities, and observations would include human factors with associated measures of effectiveness. A test strategy for humans-in-the-loop and WG2K includes goals, performance measures and communication parameters. This paper addresses decision aids which should increase the effectiveness of commanders and measures of effectiveness based on time of response and on accuracy of decisions. Additionally, certain critical operational issues (COIs) for national missile defense testing are traced through sub-issues and hypotheses to relevant data collection by WG2K. The COIs include threat negation, battle management decision support, interoperability and graceful degradation, system supportability (long term) and survivability with security.

An Analysis of Command Decision Time Delays

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Time delay in making command decisions is an important aspect of combat operations and should be accounted for in operations analysis and modeling. Exercise data on decision time delays by Anti-Submarine Warfare Commanders (ASWC) were analyzed in order to estimate time delay statistics. The types of decisions appear to be categorized into two groups: (1) recognitional and (2) analytical. The probability density functions of the time delays were analyzed and could be reasonably fit by a number of statistical distributions. Theoretical arguments are presented that suggest that the underlying decision making process can be described by an inverse gaussian distribution.

An Interoperability Assessment Methodology for Air and Missile Defense

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After the Gulf War of 1991, missile defense became a higher priority for the Department of Defense (DoD). The U.S. Army began definition of a missile defense mission and implementation of improved defenses against the growing manned aircraft, ballistic missile, and cruise missile (CM) threat. In support of these initiatives, the Program Executive Office, Air and Missile Defense, (PEO AMD) develops, integrates, acquires, and fields quality air and missile defense systems to defeat all current and future air and missile threats. The PEO AMD's goal is to produce systems that are fully interoperable within the Army Air and Missile Defense Task Force (AMDTF) and capable of fully integrated joint operations. The AMDTF concept currently includes PATRIOT, THAAD, MEADS, SHORADS and associated command and control elements. Protection of deployed forces and forward-based assets is being addressed as part of this concept. The PEO AMD is applying a methodology that capitalizes on various live and simulated tests and exercises to perform cost-effective, periodic assessments of AMDTF interoperability. One method of beginning to assess the AMDTF against the CM threat is through PEO AMD's involvement in live, joint exercises. This paper describes the AMDTF concept and the methodology being employed by PEO AMD to begin assessing interoperability against cruise missiles. The discussion includes the process of derivation and application of the technical issues, criteria, and MOEs defined for such assessments. The All Service Combat Identification Evaluation Team and Roving Sands exercises are used as examples to illustrate the approach and typical results.

Wednesday, 1330-1500
Measures of Effectiveness for the Informatin-Age Army

Richard E. Darilek, Jerome Bracken, John Gordon, Brett Lewis, Brian Nichiporuk and Walter Perry, RAND.

JMEM/Air-to-Surface Weaponeering System (JAWS)

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The primary goal of the Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME) is to provide Joint Service authenticated non-nuclear munitions effectiveness information for operational commanders, weaponeers, analysts, weapon system designers, testers, trainers, logisticians and DoD targeteers and planners. In support of this effort the Joint Munitions Effectiveness Manuals (JMEM) Air-to-Surface (AS) Working Group developed the JMEM/AS Weaponeering System (JAWS) CD-ROM product. It operates in Microsoft Windows on PCs. This presentation and demonstration will focus on JAWS version 2.0.

JAWS is a single source for air-to-surface analysis and weaponeering and target vulnerability. This CD-ROM hypertext document includes all JMEM/AS manuals, available effectiveness data and the methodologies/programs to generate effectiveness. JAWS includes Weapon Effectiveness, Selection, and Requirements (Basic JMEM/AS); Delivery Accuracy; Target Vulnerability; Weapon Characteristics; Radar and Visual Deliveries; Risk Estimates for Friendly Troops; Target Acquisition; Weaponeering Guide; Buildings and Hardened Structures; Tomahawk Weaponeering (Conventional), U/RGM-109C Block III and U/RGM-109D Land Attack; Conventional Air-Launched Cruise Missile Systems Description and Effectiveness; WINJMEM (Windows automated weaponeering program); Windows PC Effects (Penetration and

Cratering Effects program); JSWM (Joint Smart Weapons Method), JAT (JMEM/AS Trajectory program); TAM (Target Acquisition Program); GAU-8 Gun method; Sensor-Fuzed Weapons (SFW) Lookup Program; Hard-Target Lookup Program; and the Target Vulnerability Data Access Program (TVDAP). JAWS provides rapid weaponeering and analysis using precalculated table look-up solutions or WINJMEM and associated programs to provide individual (Open-End) or large batch file calculations. An online help manual is provided.

Weapons Effects Analysis and Probability Software (WEAPS)

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WEAPS is an enhanced weapons effectiveness model currently under development by AAC/ENM, Modeling, Simulation, and Analysis Division, Eglin AFB. A beta release is planned for the May 1999 timeframe. WEAPS will evaluate the performance of one delivery platform with a loadout of like weapons against multiple targets protected by multiple threats. The primary outputs of WEAPS are probability of kill (P_k) and expected kills per sortie (EKS) for each valid combination of aircraft, weapon, target, delivery profile, and weather condition. P_k and EKS are the basis for all theater and campaign models used in Analysis of Alternatives (AoAs), weapon trade studies, operational assessments, and wargaming exercises. WEAPS will feed models such as CFAM, THUNDER, and CTEM.

The source of data for the WEAPS model is the Weapon Effects Database (WEDB). The WEDB contains aircraft, weapon, and target parameters as well as delivery profiles and associated weather states. Approximately 200 inventory, POM, and conceptual weapons; 14 aircraft; 200 targets; and 350 delivery profiles comprise the WEDB. The WEDB is a dynamic database and is reviewed annually by the Munitions Working Group (MWG) that supports the NCAA process.

WEAPS will operate in a Microsoft Windows PC environment and will be distributed on a CD-ROM. The user-friendly graphical interface will make use of wizards to guide the user through complex tasks of data entry. The on-line help incorporates the latest Windows HTML help system.

Thursday, 0830-1000
COMPOSITE GROUP F .... Room 144

Thursday, 1030-1200
An Acquisition and Launch Planning Method for Predicting the Functional Availability of Satellites to Meet User Requirements

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In 1997 a panel convened by the Director of Central Intelligence to investigate satellite acquisition planning reported that Mean Mission Duration is not a sufficient estimator on which to base future satellite acquisitions and launches. The National Reconnaissance office was subsequently directed to develop new methods which 1) are based on intelligence value, 2) incorporate improved methods of estimating the useful life of satellites, and 3) are applied consistently across NRO programs.

The method presented herein models the expected useful life of a satellite as the product of its survivor function R(t), its duty cycle as a function of time, and its payload collection capability adjusted for the weighted value of user requirements. Time series of individual satellite functional availability scores are then rolled up into a composite constellation score that is used as the basis of future satellite acquisitions and launches.

Utility Assessment for Air Force Space Command's Long Range Plan

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Measuring how well you do your job can be very difficult in terms of what to measure, how to measure it, and the usefulness or utility of the information assessed. However, Air Force Space Command (AFSPC) is doing this as part of their Integrated Planning Process (IPP). AFSPC began by identifying the tasks they are assigned based on direction from Air Staff, DoD, and other levels of national guidance. They then quantified the accomplishment of these tasks employing utility and decision analysis tools to derive a military utility score for all current and future systems over a 25-year time horizon.

This presentation builds on the AFSPC work in progress, briefed at last years MORSS, to address how the military utility of current programs and future concepts (including non-material solutions, sustainment of current programs, etc.) are evaluated. Initially, workshops were scheduled to develop a candidate list of measures to evaluate task performance appropriate for each of the 33 AFSPC tasks. Along with a definition of each measure, the group (Mission Area Teams) also identified the appropriate type of measure to use (histogram, straight or curved line, "s"shaped curve, etc.), units of measurement, and the range of values (i.e the minimum and maximum utility points) for each measure. Next, a single dimensional value function was developed for each of the 201 task measures, which were then used to evaluate each current program and future concept through the year 2025. The results were then aggregated to compile one score for each program as an input to the next phase of the IPP process, the optimization routine. Details of the process as well as some lesson learned will be presented in this briefing.

GPS Joint Operational Battlefield Environment (JOBE) Joint Feasibility Study

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The GPS JOBE JFS was directed by OSD Director, Test, Systems Engineering, and Evaluation (DTSE&E) to determine the necessity and feasibility of conducting the GPS JOBE JT&E. The fundamental purpose of the GPS JOBE JT&E is to shed light on effects of hostile GPS EW on joint warfighter operations and identify ways to minimize mission impacts. Throughout the nomination and JFS phases, the joint community expressed three major concerns that provided a basis for the problem statement and JT&E issues. Their expressed concerns were:

- What happens to warfighters and their support activities when GPS is denied or degraded?
- What can warfighters do to minimize operational risks in a GPS- denied/degraded environment?
- How can DOD reduce GPS EW vulnerabilities in future acquisition and integration efforts?

The GPS JOBE JFS problem statement is: Electronic Warfare vulnerabilities are the major shortfall of military GPS, the extent and impact of these vulnerabilities on joint operations are not known nor are the opportunities for mitigation well understood. The JT&E issues are:

Issue 1: To what extent are joint operations vulnerable to GPS EW with and without mitigation techniques?

Issue 2: How well do current and enhanced T&E processes identify GPS vulnerabilities.

The JT&E currently plans a set of three tests centered on the reconnaissance and interdiction missions. The test structure will progress from a relatively simple Test 1 to the more complex Test 3 over a three-year period. Parts of these tests will be field tests and others will use a combination of M&S and live systems.

This presentation will cover the background on the GPS JOBE JFS; the test design; and MOEs developed to evaluate the issues shown above.

Tomahawk Mission Planning Threat Analysis Output Sensitivity to Input Database Errors

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Approved abstract unavailable at printing.

AoAs Need MOEs Too

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An Analysis of Alternatives (AoA) has been referred to as a little agreement between punches. A lot of those punches seem to be associated with selecting appropriate measures of effectiveness (MOEs). What's the problem? It's a tangle of misconception, preconceived notions, and hidden agendas (gasp). How to avoid the pitfalls and pratfalls of AoA measures of effectiveness.

Cost-Effective Strategies For Vulnerability Assessment

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In this era of decreased defense budgets and limited resources, it is important for decision-makers to determine the optimal strategy for assessing the vulnerability or lethality (V/L) of a weapon system and the role of alternative activities (e.g., modeling and simulation, analysis, experimental testing, live-fire testing, etc.) in that strategy. Selecting the optimal assessment strategy requires, however, a consistent methodology be in place for the identification and measurement of the costs and benefits of potential assessment plans, the weighing of the costs against the benefits for each plan considered, and the comparison of alternative competing plans.

This paper explores the potential of adapting the principles of the Cost as an Independent Variable (CAIV) methodology to the evaluation of competing strategies of V/L assessment. The analyses of the identified impacts (i.e., costs and benefits) of alternative assessment strategies, the uncertainties (i.e., risk) associated with these impacts, and the priorities assigned by decision-makers to the information expected to be produced by these assessment strategies serve as inputs to the evaluation approach proposed.

The Taxonomy of the V/L Analysis Process (V/L Taxonomy) provides the framework for 1) identifying the information required for an adequate assessment of the critical V/L issues of a weapon system, 2) determining the appropriateness of various analytical processes and/or testing procedures (e.g., live-fire testing) for obtaining needed information, and 3) selecting the optimal strategy from a group of alternative V/L assessment strategies, weighing the costs, benefits, and uncertainties associated with each alternative.

This paper is based on the results of a study performed under the auspices of the Scientific Services Program for the U.S. Army Research Laboratory, Survivability/ Lethality Analysis Directorate. In this study the role of Full-Up System-Level Live-Fire Test and Evaluation in cost-effective V/L assessment was explored. It is proposed that the methodology used in identifying and measuring the impacts of FU SL LFT&E is equally applicable to the consideration of other elements of assessment strategies.

WG 25 TEST & EVALUATION - AGENDA

Chair: Blair J. Budai, 412 Test Wing, EW Directorate
Advisors: Dr. Marion Williams, AFOTEC/CN
Wink Yelverton, Chief, EO/IR Systems Branch
Cochairs: LTC Patrick Cannon, JADS JTF
Peter Christensen, MITRE/Washington C3 Center
Maj. Mark Waltensperger, HQ AFOTEC/TSX
Charles Walters, Test and Evaluation Center
Dr. David Young, HQ AFOTEC/SA
CDR Mary Jo Zurey, COMOPTEVFOR
Room 324 – 25A
Room 326 – 25B

Tuesday, 1030 - 1200
Working Group Session 1A, Theme: Test Process..........Room Thayer 324

Modeling and Simulation Support of F-22 and AIM-9X OT&E
Mr. Robert D. Dighton, Institute for Defense Analyses

Operational Test and Evaluation in the Stimulated Environment
CDR John A. Ross, COMOPTEVFOR

Strategies for Year 2000 (Y2K) Operational Evaluation of Command and Control Systems
Ms. Janet Forbes, Joint Interoperability Test Command; Ms. Kathleen Wigton and Dr. Ernest Montagne, TRW S&IT Group

Tuesday, 1030 - 1200
Working Group Session 1B, Theme: Modeling & Simulation..........Room Thayer 326

Electronic Combat System Testing and Simulation: Preliminary Results and Measures from JECSIM Program
Major James Przybysz and Dr Frank Gray, HQ AFOTEC

Modeling and Simulation for Tactics Development: The A-10 High Altitude Safe Escape Test
1Lt Anne E. Catlin, 422 TES/DOA

Simulation Based Acquisition
Ms. Robin Frost, DTSE&E/SE

Tuesday, 1330 - 1500
Working Group Session 2A, Theme: OT Lessons Learned..........Room Thayer 324

The Cost of Making Operational Test and Evaluation "Affordable"
CDR Darrel Westbrook, COMOPTEVFOR

The Erosion of Independence in Operational Testing
Mr. George W. Covert, Jr. and Mr. Rick Jernigan, TEXCOM

Passive RF Surveillance Flight Test Lessons Learned
Mr. Arthur Ferrier, 413 Flight Test Squadron

Tuesday, 1330 - 1500
Working Group Session 2B, Theme: Verification & Validation..........Room Thayer 326

A Practitioner's View of Verification and Validation
Mr. Keith Curtis, Mr. Duane Hartge, Ms. Jayne Lyons, and Ms. Rosemary Seykowski, MITRE

VV&A Lessons Learned: A Management Perspective
Dr. Paul R. Muessig and Ms. Michelle L. Kilikauskas, Naval Air Warfare Center, Weapons Division; Mr. John Wrobleski, and Mr. Dennis R. Laack, Computer Sciences Corp.

Wednesday, 0830 – 1000
JOINT SESSION with WG 8, 9, 10, 24 and 25..........Room 144

How to Test a System of Systems, Focusing on Lessons Learned

Dr. Pat Sanders, DTSE&E
Dr. Bob Bell, Scientific Advisor, MCOTEA
Dr. Hank Dubin, Technical Director, OPTEC
COL Mark Smith, Director, JADS JTF
Dr. Marion Williams, Technical Director, AFOTEC

Wednesday, 1030 - 1200
Working Group Session 4A, Theme: Electronic Warfare..........Room Thayer 324

Joint Advanced Distributed Simulation (JADS) Electronic Warfare (EW) Baseline Testing
Maj. Darrell Wright, JADS Test Force and Mr. Jeff Cheney, 412th Test Wing (AFEWES)

Methodology for Quantifying the Credibility of M&S for Use in T&E
James H. Kirkland, Nichols Research Corporation

Wednesday, 1030 - 1200
Working Group Session 4B, Theme: C4I..........Room Thayer 326

Simulation Testing Operations Rehearsal Model (STORM)
Ms. Mary Anne Tatum, HQ TEXCOM

Supporting Task-Based Operational T&E through Commercial Software Tools
D. McGowen, S. Brown, R. Brunson, and J. Thurston, AFOTEC; D. Mitta and A. Mykityshyn, GTRI

Realistic Operational Communications Scenarios (ROCS)
Maj Paul L. Cole, MCOTEA

Wednesday, 1330 - 1500
Working Group Session 5A, Theme: Infra-red..........Room Thayer 324

Missile Warning Sensor Stimulator (MWSS)
Maj. Kimberly J. King, Major, AFOTEC/OL-NN, and Mr. John Gill, TRW

Advanced EO/IR Threat Simulator
Mr. Dennis McKinney, Naval Air Warfare Center Weapons Division

Wednesday, 1330 - 1500
Working Group Session 5B, Theme: JSF..........Room Thayer 326

Joint Strike Fighter Air-to-Air Combat Analysis for the Joint Operational Requirements Document
Mr. Joseph L. Mason, Veridian Engineering

Virtual Simulation in Support of the Joint Strike Fighter's Joint Operational Requirements Document
Mr. Timothy E. Menke, ASC/ENMAV

Thursday, 0830 - 1000
COMPOSITE GROUP F SESSION..........Room Thayer 144

Thursday, 1030 - 1200
Working Group Session 7A, Theme: Test & Training..........Room Thayer 324

The Theory and Practice of Real Time Casualty Assessment Force-on-Force Testing
Mr. Brian Barr, HQ, TEXCOM

Gunfight at Fort Hunter Liggett (FHL) Garrison, Combat Development Experimentation Command
Mr. Michael Tedeschi, HQ Space Warfare Center

Automated Test Resources Information System 2
Mr. Earl VanDoren, HQ AFOTEC

Thursday, 1030 - 1200
Working Group Session 7B, Theme: Data Analysis ....Room Thayer 326

OC Curve Analysis of Sample Size
Mr. Kevin C Smith, COMOPTEVFOR

Automation and Standardization of Mission Level Evaluation
Major Suzanne M. Beers, HQ AFOTEC

Bayesian Reliability Growth Models for Missile Testing: Saving Money and Increasing Precision by Using Knowledge Better
LTC David H. Olwell, Naval Post-graduate School

Thursday, 1330 - 1500
Working Group Session 8A, Theme: ACTDs...Room Thayer 324

Predator Unmanned Aerial Vehicle Operational Testing
Capt Chris Dusseault, HQ AFOTEC

Test and Evaluation of the Joint Countermine Advanced Concept Technology Demonstration
Mr. Collin Schaffer, Johns Hopkins University Applied Physics Laboratory

US Army's OPTEC Role in AWE and ACTDs
LTC Peter A. Davidson, OPTEC

Thursday, 1330 - 1500
Working Group Session 8B, Theme: Missile Defense ....Room Thayer 326

Tactical Ballistic Missile Threat Trajectory Sensitivity Study
Mr. Charles V. Riley, US Army Materiel Systems Analysis Activity

National Missile Defense (NMD) System Operational Test and Evaluation
Maj Phillip Baca, Joint Interoperability Test Command; Mr. Ric Harrison and Dr. Ernest Montagne, TRW S&IT Group

A Hardware-in-the-Loop Approach for Assessments of U.S. Army Air and Missile Defense Interoperability
Mr. R. Edward Pugh, PEO, Air and Missile Defense; Mr. Arthur Meier and Mr. Edward Freeman, SAIC

WG 25 - TEST & EVALUATION - ABSTRACTS
25A: ROOM - THAYER 324; 25B: ROOM THAYER 326

Tuesday, 1030 - 1200
Working Group Session 1A, Theme: Test Process...Room Thayer 324

Modeling and Simulation Support of F-22 and AIM-9X OT&E

Mr. Robert D. Dighton
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An emerging initiative is the use of modeling and simulation (M&S) tools to augment field testing during operational test and evaluation (OT&E) of weapon systems. This paper addresses the planned use of M&S to support OT&E of the F-22 and AIM-9X acquisition programs. These developmental weapon systems have well-defined M&S applications, as defined in their approved TEMPs, representing an acceptable balance between M&S outputs and flight test data sources for OT&E.

F-22 OT&E will utilize outputs from a manned air combat simulator (ACS) under development at the prime contractor Lockheed-Martin's Marietta facility, several constructive models, and flight test results. This paper will describe the development plans for the ACS, along with the outputs expected to be provided as OT&E inputs. Planned inputs from constructive models to AFOTEC operational effectiveness and suitability evaluations will also be described. Data from the 240 sorties dedicated to support OT&E, along with additional data from a combined DT/OT phase, will be also used to validate the ACS, allowing the ACS to provide inputs to the AFOTEC effectiveness analysis for a much broader range of scenarios (target types and densities) than can be provided on existing test ranges.

The AIM-9X program is also making extensive use of M&S tools in its development program, from early development testing through OT&E. This joint program (Navy lead) is utilizing a broad range of constructive models and hardware-in-the-loop simulations in the prime contractor Raytheon's Tucson facility, at China Lake, and at Eglin AFB. The goal is to use the outputs from the same suite of simulations throughout EMD, including AFOTEC and OPTEVFOR OT&E analyses, to augment the live missile test launches. Another development program requirement is integration of the AIM-9X with the Joint Helmet Mounted Cueing System (JHMCS).

Operational Test and Evaluation in the Stimulated Environment

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Building a 7,000 ton vessel capable of diving to deep depths, powered by a nuclear reactor/steam plant, and containing weapons that can be launched while submerged and hit a target a thousand miles away is certainly not an easy task. A submarine is perhaps the most complicated piece of equipment built in the world. With a shrinking budget and a cost of $2 billion per unit, there is very little room to build test platforms to refine the production platform. We have to get it right the first time.

The Command and Control System (CCS) is the intelligence of the submarine. It is here that all of the submarine's sensors report and it is here that all decisions are made regarding the submarine's operations. Because of the integration of many subsystems, the need for time sensitive information and tactical response of the Commanding Officer, the success of the CCS is essential to the success of the submarine's ability to complete its mission. The Navy is designing it's next generation CCS as a module that will be fitted into the VIRGINIA Class submarine. To ensure integration of all the CCS functions in this module, the VIRGINIA Class will utilize a Command and Control System Module (CCSM) Off-hull Assembly and Test Site (COATS).

COATS will include the actual hardware and software of the submarine control room, coupled to extensive simulation and stimulation systems. During a one-year test program, submarine sensors will be stimulated to drive subsystems within COATS. Not only will hardware and software be tested to verify compatibility and connectivity, but the final phase of COATS testing will include operational testing by fleet operators reacting to mission driven scenarios to determine the potential to satisfy operational effectiveness and suitability of the VIRGINIA platform.

The VIRGINIA Class submarine is an excellent opportunity to examine the benefits and limitations of full scale off hull testing. This presentation will discuss the COATS facility and its integration into OT&E world.

Strategies for Year 2000 (Y2K) Operational Evaluation of Command and Control Systems

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The Joint Interoperability Test Command (JITC) is the operational test agency for the Global Command and Control System (GCCS). We have developed a unique methodology for applying DoD Y2K Management Plan guidance in an operational evaluation.

GCCS is the DoD command and control system of record and is operational at over 600 sites worldwide. The size, complexity, and sensitive nature of this system present significant challenges to the Y2K tester. To meet these challenges, we are conducting a comprehensive test program composed of these building blocks: Application testing, System testing in the laboratory, Field testing with test scripts, Field testing with operational scenarios. The advantage of this building block approach is to start small and apply lessons learned in subsequent tests.

Our methodology for each building block encompasses these features: Baseline tests-Determine performance in the current time frame; Y2K tests-Determine performance across selected Y2K critical dates (e.g., Jan 1, 2000, and Feb 29, 2000). The test program addresses these critical GCCS functional areas: Situational awareness (common operational picture, missile warning, etc.); Force planning (deliberate and crises action planning); Office automation and messaging (word processing, email, etc.).

In keeping with the operational nature of the field tests, we decomposed each functional area into activities, functions, and mission tasks. The principal measure of performance is mission task success, which supported two critical operational issues: performance and interoperability.

This paper will discuss our unique test methodology and lessons learned that apply to other Y2K testing efforts.

Tuesday, 1030 - 1200
Working Group Session 1B, Theme: Modeling & Simulation ....Room Thayer 326

Electronic Combat System Testing and Simulation: Preliminary Results and Measures from JECSIM Program

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The Joint Electronic Combat test using SIMulation (JECSIM) program was chartered to define which parts of EC testing can be accomplished with constructive simulations and which parts must be done with live or virtual simulations. This presentation shows some initial results. Live and virtual simulations of a semi-active surface-to-air missile against on-board and off-board EC techniques are compared to constructive simulations of the same events. All constructive simulations were run in the Joint Modeling and Simulation System (JMASS) environment. Time series comparisons include missile seeker boresight errors, gimbal angles, track Doppler, and acceleration commands. Discrete signal comparisons include target track, noise track, guidance enable, anti-EC activation, and relative velocity vectors at intercept. We demonstrate how these comparisons can be used as subjective and objective validation data to support accreditation decisions for different applications. We also demonstrate how detailed simulation performance data can be used to estimate how well the simulations would perform for engagements where no other data is available. The latter uses straight-forward linear regression techniques and leads naturally to new *measures of credibility (MOCs)*. MOCs provide a quantitative link from operational measure-of-effectiveness requirements to constructive simulation performance criteria.

Modeling and Simulation for Tactics Development: The A-10 High Altitude Safe Escape Test

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With the upgrade of the LASTE targeting computer in the A-10 Thunderbolt II avionics package, the A-10 has gained the capability of high-altitude bombing. Operational units identified the need for new high altitude safe escape (HASE) maneuvers for threat evasion for release altitudes over 10,000 feet in a reduced-threat scenario, as the current low-altitude rule-of-thumb safe escape maneuver (SEM) expends excessive energy. While new maneuvers are easy to fly in the airplane, simulated threats and instrumented test range time can be prohibitively expensive for accomplishment of development and evaluation of new maneuvers. Therefore, the A-10 test team at the 422 Test and Evaluation Squadron was tasked to develop new SEM's by modeling and simulation.

To develop the new SEM's, the test team identified maneuver parameters and designed an experiment to choose a representative set of maneuvers for testing. The maneuvers were simulated with BLUEMAX IV, and then run against TEAM 2.1 and RADGUNS 2.2b for evaluation in a low-threat environment. Vulnerability results were compared with bombing accuracy for each maneuver, and characteristics of the maneuvers with the best accuracy for the lowest vulnerability were identified. A final set of the best maneuvers was validated with flight testing on the Nellis Range Complex.

Simulation Based Acquisition

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Simulation Based Acquisition (SBA) is a joint Industry and Department of Defense initiative to define an acquisition process that employs a robust, collaborative use of simulation technology to integrate the acquisition process across acquisition phases and programs. The intent of the initiative is to reduce the time, resources and risk associated with acquisition, enable the integrated product and process development (IPPD) and improve the quality of the fielded product. In 1998, a Joint SBA Task Force was created to draft a road map to implement SBA. This document, the SBA Road Map, was delivered in September 1998. Since that time, the Acquisition Council of the Executive Council for Modeling and Simulation (EXCIMS) has taken ownership of the Road Map. Through events, such as the NDIA SBA Workshop held in Dallas in November 1998, it has sought DoD and Industry's buy-in of this strategy. This paper provides an overview of SBA and provides the latest information on this DoD initiative. SBA will impact all areas of acquisition, from conception of system requirements to fielding and sustainment of a system, and to its eventual disposal. It concerns the total life cycle of a combat system.

Tuesday, 1330 - 1500

Working Group Session 2A, Theme: OT Lessons Learned..Room Thayer 324

The Cost of Making Operational Test and Evaluation "Affordable"

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Operational Test and Evaluation (OT&E) was once considered the final exam of a weapon system acquisition program. The operational test community would be given the project at the end of a lengthy development effort and operational tests would be conducted to determine the effectiveness and suitability of the system and its readiness for fleet introduction. Often the results were bad news to the developer and the relationship between developer and tester was typically adversarial. Realizing that OT&E must be early in the development, a new way of doing business was forged in the early 1990's. This methodology has evolved to the point that now OT&E is fully integrated with the development effort. Operational testers are part of the integrated product team environment. This relatively new way of doing OT&E

has had success in minimizing development costs and improving OPEVAL test results, but it has also led to some over reliance by the developer on the operational tester. It is a delicate balance that must be reached between developer and tester to ensure independence is maintained.

There are many tools available for the tester to provide feedback to the developer prior to the final report of effectiveness, suitability, and fleet introduction. This presentation will examine those techniques and tools which the operational testers at COMOPTEVFOR have utilized to support program managers. The VIRGINIA Class submarine program is an excellent example of how early involvement by operational testers can benefit the project. Likewise there are several examples of programs that did not heed the recommendations of the operational tester and as a result, suffered avoidable setbacks. Particular examples relevant to the VIRGINIA Class submarine project and supporting sub projects will be examined.

The Erosion of Independence in Operational Testing

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Approved abstract unavailable at printing.

Passive RF Surveillance Flight Test Lessons Learned

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Tuesday, 1330 - 1500
Working Group Session 2B, Theme: Verification & Validation ....Room Thayer 326

A Practitioner's View of Verification and Validation

Keith Curtis, Duane Hartge, Jayne Lyons, Rosemary Seykowski
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This paper chronicles an evolving verification and validation (V&V) process that goes beyond current practices and presents the initial results based on applying the model-test-model paradigm. Program Executive Office for Theater Surface Combatants (PEO(TSC)) sponsors a modeling and simulation Pilot Program focused on predicting the combat system effectiveness of integrated ship defense (ISD) systems. The ISD Pilot Program goal is to develop an engineering-level federation of simulations based on DoD's High Level Architecture (HLA). The PEO(TSC) engineering-level federation closely represents the actual combat system installed on Navy ships. This unique development approach explores the potential to provide PEO(TSC) decision makers with a level of detail on combat system effectiveness in a test environment that exceeds current capability. The federation simulates system effectiveness, targeting the measures of effectiveness (MOEs) and measures of performance (MOPs) associated with the series of Development Tests (DT) and Operational Tests (OT) for the Ship Self Defense System conducted in June 1997. The federation was designed to accommodate V&V practices by producing results in the format identical to data collected during the live tests. Thus, the tools used to analyze the live test data were also used to conduct V&V of the federation.

VV&A Lessons Learned: A Management Perspective

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Identifying and quantifying the minimum essential M&S accreditation requirements is the most important part of answering the question, "How Much VV&A Is Enough?" The approach used by the Joint Accreditation Support Activity (JASA) is to identify high risk elements of M&S use so that VV&A efforts can be focused on those parts of the OR problem that are critical to reaching a credible analytical result from M&S use. JASA has used this risk-based approach to tailoring VV&A efforts with great success to support numerous major weapons system acquisition programs. In keeping with the theme of this symposium, "Focusing Military Operations Research, From our Heritage to the Future" this briefing provides a management level perspective on VV&A lessons learned so that program managers can better focus their VV&A resources on essential work. These lessons were compiled during support of the F/A-18 E/F, Joint Strike Fighter (JSF), AIM-9X programs.

The presentation will begin with a brief overview of JASA's risk-based approach to identifying risks related to M&S use, and tailoring general VV&A methods to address these risks. This introduction will be followed by a discussion of lessons learned from planning, executing and reporting of VV&A activities. The briefing will conclude with a summary of how these lessons can be applied by other programs in

planning their VV&A efforts.

The presentation will be most useful for program management personnel, from top level managers to middle level planners and analysts who are responsible for developing and implementing cost-effective VV&A plans.

Wednesday, 0830 - 1000

Joint Panel with WG8, WG9, WG10, and WG24...Room Thayer 144

How to Test a System of Systems, Focusing on Lessons Learned

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Wednesday, 1030 - 1200

Working Group Session 4A, Theme: Electronic Warfare..Room Thayer 324

Joint Advanced Distributed Simulation (JADS) Electronic Warfare (EW) Baseline Testing

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The paper describes the methodologies and implementations utilized by JADS-EW to establish baseline performance data from testing at the Open Air Range (OAR) and a Hardware-in-the-Loop (HITL) facility, US Air Force Electronic Warfare Evaluation Simulator (AFEWES).

AFEWES laboratory's real-time, actual-frequency simulations of radio frequency (RF) guided Surface-to-Air-Missiles (SAMs) and Anti-Aircraft Artillery (AAA) projectiles were used to supplement data shortfalls from OAR Threat System testing of an Aircraft Self Protection EW suite. Key points of discussion include: 1) Gather/Evaluate OAR repeatable baseline data; 2) Gather/Evaluate HITL repeatable baseline data ; 3) Build JADS-EW end-to-end scenarios.

The Air Force Flight Test Center, Edwards AFB, CA manages both the OAR and AFEWES, the later is located at Air Force Plant No. 4 in Fort Worth, Texas.

Methodology for Quantifying the Credibility of M&S for Use in T&E

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The purpose of this paper is to describe a methodology for quantifying the credibility of modeling and simulation (M&S) for use in test planning, analysis, and interpolation/extrapolation of test results in Test and Evaluation (T&E). The methodology is being developed as part of the Joint Electronic Combat Using Simulation (JECSIM) Joint Test and Evaluation (JT&E). JECSIM was chartered to investigate the utility of digital models and simulations in the developmental and operational Test and Evaluation (T&E) of threat semi-active missile systems against friendly forces' fighter, bomber, and helicopter aircraft with and without electronic countermeasures (ECM). The JECSIM joint task force defined two issues to guide the project and ensure coverage of the charter objectives. The first issue, related to capability, credibility, and usability assessments of M&S, is focused on comparisons between test measurements and M&S predictions. The second addresses the sensitivity of endgame parameters to the ultimate measure of ECM effectiveness, probability of kill (P_k). The issues are as follows:

Issue #1: Determine the degree to which existing M&S can be used to predict test results from semi-active missile system engagements with tactical and bomber size aircraft in ECM environments.

Issue #2: Determine the sensitivity of P_k calculations to changes in the end-game geometry parameters predicted by M&S.

From these issues, the JT&E Technical Advisory Board (TAB) derived the objective of extending M&S results to non-tested scenarios and models. Per the TAB, JECSIM should, "based on quantitative data where possible, provide an assessment of where the model can be used to better understand areas not tested…". As examples of this issue, the TAB cited: What is the risk of using test results against a fighter-size target to estimate the effectiveness of ECM techniques against a bomber-size target? What is the risk of using "validated" model results of one semi-active system to estimate the effectiveness of another semi-active system?

For our case risk is directly related to credibility. This paper describes **extension analysis** as the process for evaluating the credibility of M&S of threat semi-active systems in an electronic combat (EC) environment. Credibility in this context applies to both how well M&S predicts actual test results, as well as confidence we have in its application to non-tested scenarios. We will express "credibility" of M&S in terms of the probability or belief that its output is within a specified tolerance. Tolerance being the allowable difference between M&S and test results. This paper describes how tolerances, relative to P_k accuracy, are derived, and how confidences in M&S predictive capabilities are determined relative to these tolerances.

JECSIM will apply extension analysis to four scenarios: Scenario 1: Analysis of the tested region; Scenario 2: Interpolation across "data gaps" within the tested region; Scenario 3: Extensions into "untested regions" using the validated M&S; Scenario 4: Extensions into new regions by replacing an existing model with another model within the M&S.

In each scenario above, the product will be the probability that the M&S of a component/subcomponent meets the required tolerance. This paper also describes the methodology for setting the tolerances on M&S of components/subcomponents as well as the composite M&S.

Wednesday, 1030 - 1200

Working Group Session 4B, Theme: C4I……………………………………………………………Room Thayer 326

Simulation Testing Operations Rehearsal Model (STORM)

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This year the Force XXI Battle Command Brigade-and-Below (FBCB2) system, which provides digitized situational awareness (SA) and command and control (C2) information at echelons brigade-level and below, will undergo operational testing. The concept for the Simulation Testing Operations Rehearsal Model (STORM) was generated from the requirement to test the FBCB2 in a realistic command, control, communications, computers, and intelligence environment, while reducing troop requirements and test costs.

In the past year the scope of the FBCB2 operational test has increased to two live brigade Tactical Operation Centers (TOCs), two live maneuver battalions with TOCs, and a live opposing force (OPFOR) battalion. STORM will augment the live forces by simulating three additional blue force battalions. It will also wrap simulated OPFOR units around the live OPFOR battalion in the field to provide a realistic threat environment.

STORM is a federation of entity-based simulations operating in a distributed interactive simulation environment. To assist in test preparation, STORM has the capability of scenario generation, database population, test rehearsal, and training. During the test, STORM will transmit and receive SA and C2 messages between the live forces and the simulation to provide a "seamless" synthetic battlefield environment. The simulated forces will appear on the live FBCB2s, and the live FBCB2s will appear in STORM. Tactical internet users should not be able to differentiate the live forces from the STORM-simulated forces. The visualization capability in STORM can be used both during and after the test to assist in analysis and after-action reviews.

Supporting Task-Based Operational T&E through Commercial Software Tools

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supply when assigning recruits to near-term versus future seats. In sum, the existing classification procedure virtually ignores differential abilities and the dynamic aspect of allocation.

To address such shortcomings the Army Research Institute (ARI) has conducted research to improve the selection, classification, and utilization of enlisted personnel, and this led to development of a prototype Enlisted Personnel Allocation System (EPAS). Prototype testing has been completed recently and the project is moving toward implementation. Testing has shown that large gains in (recruit) mean predicted performance, on the order of 0.25 to 0.50 standard deviation units, can be obtained. Achievement of such gains, using existing procedures, would be prohibitively expensive.

Designed to enhance REQUEST by introducing optimization into what is a sequential process, EPAS models the assignment process as two phases. In the first phase, a large linear programming (LP) model is formulated to represent the monthly flow of applicants and training class seats over the recruiting business cycle. The model is solved for the allocation of (applicant) supply groups to job training starts that maximizes recruit predicted performance while meeting training management goals. The LP model solution is updated weekly and used to generate an ordered list of job recommendations particular to each supply group. In the second phase of individual applicant assignment, these recommendations are merged with those generated by existing procedures and presented to the applicant.

Recruiter Size and Allocation Model (RSAM)

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The objective of the model is to accurately forecast an appropriate number of On-Production Regular Army (OPRA) recruiters to successfully recruit the United States Army Recruiting Commands (USAREC) near and far terms accession goals. In order to answer "How many recruiters does USAREC need in the future?" and "Where do we put them?" the SRAM uses a Non-Linear Program (NLP) methodology to derive an "optimal" number of recruiters for each of the 41 subordinate recruiting battalions (RBNs) while ensuring five key constraints are not violated. The goal of the model is to minimize our recruiter numbers, but on the other hand ensure we have sufficient authorized OPRA numbers to accomplish current and future accession goals. The model is constrained by: (1) ensuring future accession missions are achieved based on historical recruiter "write rate" data recorded for each RBN, (2) ensuring the current OPRA strengths in each RBN are not drastically altered by a solved solution (i.e. the new "solution" does not have an RBN lower than 80% of its current strength nor higher than 120% of current strength), (3) ensure the RBNs have an appropriate number of high school seniors for each recruiter, (4) give each RBN an appropriate share of recruiters relative to the past DoD quality production that came from each individual RBN area, and (5) give each RBN a relative share of recruiters according to forecasted contract information (data based on market segmentation). A more descriptive mathematical model will be presented during the MORS Symposium.

Wednesday, 0830-1000

Recruit Market Analysis and Planning System

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The Recruiting Market Analysis and Planning System is a new process being implemented at the United State Army Recruiting Command for prioritizing and targeting markets, shaping advertising strategies, refining incentives and determining future recruiting strategies. The process is a hybrid of the Army mission planning process and civilian marketing decision support systems (MDSS). The goal of RMAPS is to gather and interpret information and turn it into a basis for making management decisions.

RMAPS is a heuristic process that begins with an analysis of key indicators and trends in the youth market gathered primarily through longitudinal surveys. Once the market analysis is complete, an analysis of environmental factors such as economic, political and social trends provides background information through which the market analysis can be filtered. Finally, theories of marketing, advertising and recruiting are applied to the gathered information to determine probable courses of action concerning market strategies, advertising strategies, recruiting strategies, and policy changes.

Command Level Mission Model (CLEMM)

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The Command Level Mission Model (CLEMM) is a tool used to forecast recruiter net production and equitably distribute battalion level missions to the 41 Recruiting Battalions in the US Army Recruiting Command (USAREC). The model uses dynamic regression to predict what each battalion will achieve for each of three mission categories: GA, SR, and Other. A GA is a high school diploma graduate who scores 50 or higher on the Armed Services Vocational Aptitude Battery (ASVAB). A SR is high school senior and an Other refers to all remaining recruit categories. Each of these three mission categories is a dependent variable. Independent variables include factors such as past production, assigned recruiters, unemployment rates, policy variables, and monthly effects. A "best fit" regression model is developed for each battalion (by category) using stepwise regression. The model is then used to forecast the net production.

Net production forecast are used for: (1) notifying the Command's leadership of projected accession data, and (2) distributing the Command's contract mission requirement for the upcoming mission cycle (usually the Recruit Ship Quarter (RSQ)). Contract mission refers to the number of new recruits a recruiter must "sign" into the Army.

A more descriptive mathematical model will be presented during the MORS Symposium.

RSLES: The Recruit Station Location Evaluation System

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Recent troubles in military recruiting underscore the need for the Department of Defense (DoD) to make the best use of limited fiscal and physical resources to obtain needed recruits. A recent study by the GAO suggested that the Services look for opportunities to leverage assets such as recruit stations to achieve production goals at a lower cost. We have developed the Recruit Station Location Evaluation Station (RSLES) to help facilities planners do joint analysis on the locations of joint- and single-service stations and the allocation of recruiters to those stations. We describe the RSLES decision support system and its embedded optimization model, which locates recruiting stations for multiple, competing services at minimum cost to the DoD. The model embodies a non-linear econometric model of recruit production that uses detailed zip-code level data such as population and geographic area. Location decisions are modeled with integer variables, resulting in a mixed integer, non-linear problem, which we solve using a piecewise linear approximation. We show some results of our analysis in several metro areas.

Wednesday, 1030-1200
COMPOSITE GROUP D .... Room 144

Wednesday, 1330-1500
Objective Force Model

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The "objective force", as we apply the term, is that grade and year of service profile of personnel which, conceptually, provides the most effectiveness or productivity for the resources required to build and maintain that force that meets a specified level of requirements. In this study, we provide a discussion of our concept of an objective force, emphasizing that such a force will vary over time as a function of the inherited force, supply conditions for both recruiting and retention of personnel, training costs, and other factors.

We have developed a prototype objective force model and applied it to nuclear ratings in the Navy. The model includes a behavioral model of retention based in the Annualized Cost of leaving Model, an explicit model of promotion, and recruiting and training costs. We describe the model, its application in principle, and the results of applying the model to selected Navy ratings.

Forecasting the Army's Individual Account (TTHS)

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The Army Strength Analysis and Forecasting Division in ODCSPER is currently redesigning its Individuals Account (TTHS) model. The objective is to create a forecasting model that will serve the Army's Individuals Account forecasting requirements into the 21st Century. The Army's Individuals Account is approximately 13% of the Army's total strength and is significant in measuring the Army's manning level at the aggregate, grade and MOS level of detail. This presentation will identify the forecasting techniques used for the Individuals Account sub-accounts (Trainees, Transients, Holdees, Students, Officer Accession Students, and Cadets).

WEEM: Incorporating Women into the Army's Enlisted Force

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The Army's Women's Enlisted Expansion Model (WEEM) recommends the maximum female content of each Military Occupational Specialty (MOS) by grade based on personnel policy constraints. PERSCOM uses the model's output to determine female training requirements and female accession targets. Several factors constrain the maximum female content: the number of combat positions coded for males only, male and female overseas assignment equity, maintaining an adequate pool of male combat replacements, and other policy constraints. The model, coded in FORTRAN, is hard to maintain and is not flexible enough to analyze various gender related personnel policies. PERSCOM is analyzing WEEM to determine how to improve or replace the model. Currently, RAND is studying Army policies that impact on gender equity. They intend to recommend revised guidelines for considering MOS eligibility and assignment with respect to gender. PERSCOM will compare RAND's recommendations with current WEEM methodology recommendations for maximum female content for MOSs. Current analysis of WEEM includes developing an MS EXCEL-based tool that replicates WEEM logic for a single MOS to determine how sensitive WEEM output is to changes in personnel policy and alternative courses of action. Additionally, PERSCOM has built a prototype, next generation gender model using Statistical Analysis Software (SAS). Our intention is to use or modify either the existing WEEM model or this SAS model to incorporate RAND's policy recommendations to provide Army leadership a tool to conduct decision analysis on gender policies affecting accessions and MOS gender populations.

Thursday, 0830-1000
Projecting the Impacts of Civilian Force Shaping

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The civilian force in each of the military services has experienced a considerable increase in experience over the last ten years, as measured by years of service or years until retirement eligibility. Leadership has been concerned with when this trend will stop, what its effects are, and how best to counter them. For instance, OSD is proposing legislation that would give the services more authority to "force shape" -- induce more senior workers to retire or separate voluntarily and replace them with a less experienced group. This presentation describes some of the modeling and analysis associated with the USAF force shaping proposal and makes some suggestions as to how best to use force shaping and other tools to modify the civilian force profile.

Assessing the Diversity of the Officer Corps

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We propose a new methodology for assessing and selecting successful pools of candidates against specified institutional criteria that avoids explicit aggregation of individual candidate information. This
methodology, called Normed Attribute Projection, is based on a simple, multi-dimensional vector approach that enables one to define a threshold acceptability representing institutional tolerance for candidate variation. We demonstrate the applicability of this n-dimensional assessment model for the new OER (DA FORM 67-9, OCT 97). The implementation of this model will enable selection boards to:

(1) quickly assess the qualifications of the candidate pool based on institution goals and desired composite characteristics,

(2) identify the most promising candidates without losing visibility of individual attribute scores (as is done in aggregate measures), and

(3) identify an equivalence frontier across which selections for promotion can be made that maintain a true diversity within the officer corps according to institutional goals.

Downsizing Air Force Space Command's Headquarters by Value-Focused Thinking

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The Defense Reform Initiative of 1997 requires a 10% manpower reduction in the headquarters for each major command by FY 2003. The National Defense Authorization Act of 1998 calls for the same type of reduction but at the 25% level; however, OSD is seeking a waiver for the 25% reduction. Our talk discusses how Air Force Space Command is planning for these reductions.

Preparing for the downsizing at Space Command has been led by the TAT (Task Analysis Team)--a colonel-level group of twenty leaders from across the headquarters. The TAT has met twice weekly for six months to determine what recommendations they will make to the AFSPC senior leadership.

The TAT required each directorate to complete a database describing any task which takes an average of four or more manhours per week. The data for each task included ratings on how the task contributed to command goals and the command mission, as well as, information on whether the task was most appropriately performed at a management headquarters level. Each of the resulting 4,000+ tasks were scored using a Value-Focused Thinking Model that the Air Force Academy helped develop. The database and value scores were then used to identify tasks which were high-cost, low-value.

Initiatives to save manpower on these high-cost, low-value tasks by streamlining, reorganizing, or deleting work were formed and explored by liaisons (TAT members) working with directors throughout the headquarters. Initiatives that survived the interaction with the effected directorate(s) comprised the final package of recommendations to the senior AFSPC leadership.

Thursday, 1030-1200
NCO Leadership Development in the 21st Century

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Approved abstract unavailable at printing.

Unit Positioning and Quality Assessment Model

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The Unit Positioning and Quality Assessment Model (UPQUAM) is a marketing and enlisted quality assessment modeling tool used for conducting strategic United States Army Reserve (USAR) unit positioning and quality assessment for the United States Army Reserve Command (USARC) and the United States Army Recruiting Command (USAREC).

The model answers four basic questions: volume?, quality?, comparison?, and prominent vocation? The model uses historical production data to assess the quality of the enlistments for the USAR. The model first computes the fill rate of each unit. Each unit needing soldiers is then placed into a needs database where it is further reviewed to assess the potential problem of the unit. The model then answers the quality question by calculating a weighted average Armed Services Vocational Aptitude Battery (ASVAB) score, by category, by component, for each zip code having a contract throughout the United States. Comparisons are made with respect to the population and other sister service's data. Once the problem Military Occupational Specialty (MOS) is identified, the model then determines a more suitable location for the unit having this particular MOS.

The USAR unit structure and location and quality of historical enlistment contracts is the operating premise of the model. This model's purpose is to determine the appropriate unit structure location of USAR units throughout the United States to assess, recruit, and maintain quality soldiers for the United States Army Reserve (USAR). A more descriptive mathematical model will be presented during the MORS Symposium.

Soldier Time on Station: A Case Study in the Use of Operations Research Techniques in the Army Personnel Community

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Soldier Time On Station (TOS) between Permanent Change of Station (PCS) moves is becoming an important issue in the Army personnel community. Increasing average soldier TOS contributes to increased unit readiness, increased soldier morale, and decreased PCS costs. This presentation is a case study outlining the methodology used to accurately measure soldier TOS and identify the relevant factors affecting TOS. The presentation describes why soldier TOS is important, scoping of the problem to determine maximum and minimum TOS, how raw data was gathered and cleansed, and how significant variables affecting soldier TOS were identified. A number of different Operations

A task-based operational test and evaluation (OT&E) process currently being implemented by the Air Force Operational Test and Evaluation Center (AFOTEC) requires a focus on the tasks performed by users of the system under test. In evaluating the system's operational effectiveness, testers will assess the contribution of that system to mission accomplishment. One means of understanding how the system might impact mission accomplishment is to establish the relationships between tasks and mission.

The primary objective of this presentation is to describe how task-based OT&E—as it is implemented on C4I systems—might be supported by commercially available software tools. This work identified a set of tools to support task-based OT&E. In order to identify a meaningful set of tools, we derived a set of tool requirements. These requirements, derived from data reflecting how task-based OT&E had been applied across a sample of nine C4I systems, encompassed general ("visionary") needs of operational testers, as well as their more immediate (short-term) needs. A total of 80 tool requirements (14 general requirements and 66 short-term requirements) were derived. The 66 short-term requirements were further categorized according to six functional areas: *Communication, Guidance and Training, Reference Documentation, Planning, Analysis,* and *Test Reporting*.

Results of our analysis identified commercially available tools that could address planning and analysis requirements. Tools supporting requirements engineering and management activities, the collection of task analysis data, and visual modeling and simulation activities were identified. Tool evaluations determined the extent to which this tool set satisfied general, planning, and analysis requirements derived from our review of C4I systems. The results of such evaluations allowed us to distinguish between tools and provide recommendations for tool selection.

Realistic Operational Communications Scenarios (ROCS)

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Wednesday, 1330 - 1500
Working Group Session 5A, Theme: Infra-Red..Room Thayer 324

Missile Warning Sensor Stimulator (MWSS)

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The battlefield proliferation of light vehicle and manportable antiaircraft missiles is driving the development and deployment of a number of electro-optical and infrared missile warning receivers and associated countermeasures. A methodology for operationally evaluating the effectiveness of these systems has been proposed and its feasibility examined. A laser-based stimulator can be built to provide correct in-band irradiance to trigger missile warning receiver detections and declarations in operationally realistic test scenarios. Such tests could, for the first time, be conducted with fully operational crews and aircraft performing realistic manuevers and tactics.

A proof-of-concept demonstrator is being built by AFOTEC and TRW and is designed to support the operational evaluations of the AAR-47 missile warning system. The laser is PC driven and has five surface-to-air missile programs and two special triggering or training algorithms. These algorithms emulate a missile launch to near impact of the target aircraft. It is housed in a small utility trailer and can be deployed to any test range or base. The stimulator is stand-alone and requires no support equipment other than communication with the aircraft. The laser is eye-safe beyond 16 meters and the stimulator includes the required safety controls. Two personnel must operate the stimulator due to safety requirements and can be fired up to 60 shots per hour. It has been tested against the MH-53 and C-130J and will be tested against the C-130H, C-17 and DIRCM Feb 99. IOC is scheduled for Oct 99 and will support the C-130J, CV-22 and MV-22 operational test programs.

Advanced EO/IR Threat simulator

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This briefing will discuss the development of a novel real-time electro-optical / infrared (EO/IR) threat simulator demonstration. This simulator, called the "Advanced EO/IR Threat Simulator", has the potential to be the most accurate method of analyzing threat missile responses to complex engagement scenarios short of live-fire. The simulator can achieve a high level of fidelity by employing a technique called "Threat Signal Processor-In-the-Loop with Detailed Scene Injection", or "T-SPIL with DSI". The T-SPIL with DSI technique involves actual threat missile signal processors that are fed simulated optics/reticle/detector responses to detailed dynamic scene images. The simulated optical / reticle / detector response is generated by a Real-Time Optical Scene Convolver (RTOSC), which is fed detailed scene images from a graphics supercomputer.

The RTOSC utilizes multiple Digital Signal Processors (DSP), operating in parallel, to apply the threat weapon system optical response to incoming pixel-based scene images. The output of the RTOSC is an analog signal that represents the optical / reticle / detector response of the real threat system. This signal is applied to the preamplifier input of the actual threat hardware which in turn responds as if it were attached to the actual optics, reticle and detector. Using this approach, the operator is only limited in the range of analysis by their ability to generate realistic scene images in real time.

A Real-Time Optical Scene Convolver demonstration circuit, capable of processing 100 scene pixels every 10 microseconds, has been fabricated and is currently undergoing performance testing. The second generation system, capable of processing at least 1000 scene pixels every 10 microseconds, is in the design stage. The briefing will include a discussion of the need for detailed scene images for analysis, lab test results with the first generation RTOSC, and technical specifications of the second generation system.

Wednesday, 1330 - 1500
Working Group Session 5B, Theme: JSF ....Room Thayer 326

Joint Strike Fighter Air-to-Air Combat Analysis for the Joint Operational Requirements Document

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Approved abstract unavailable at printing.

Virtual Simulation in Support of the Joint Strike Fighter's Joint Operational Requirements Document

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Approved abstract unavailable at printing.

Thursday, 0830 - 1000
COMPOSITE GROUP F SESSION..Room Thayer 144

Thursday, 1030 - 1200
Working Group Session 7A, Theme: Test & Training...Room Thayer 324

The Theory and Practice of Real Time Casualty Assessment Force-on-Force Testing

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Over the past 30 years the U.S. Army has conducted over 80 force-on-force tests or experiments in which opposing forces used some form of real-time casualty assessment (RTCA) methodology to assesses kills and remove players form the battlefield. Several generations of laser engagement systems have been developed by the test community, and these in turn have given rise to MILES, PRIME, and other systems used in home post training as well as at the National Training Center (NTC) and other Combat Training Centers (CTC). The training community has introduced a whole generation of soldiers and marines to the concept of RTCA training. Yet despite this rich heritage, the Army (testers, evaluators, analysts, trainers, combat developers, materiel developers, and decision makers) often lack even a basic understanding of the underlying assumptions and concepts that drive RTCA systems. As a result, we are ill-prepared to design tests to exploit the strengths of these powerful tools and are apt to misuse or abuse the data that they generate. This paper addresses the fundamental concepts of RTCA test and evaluation methodology. Underlying assumptions will be discussed along with strengths and weaknesses of RTCA testing and experimentation. Specific examples of past and current RTCA tests and experiments will be discussed.

Gunfight at Fort Hunter Liggett (FHL) Garrison, Combat Development Experimentation Command, CDEC's Last Fandango

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In the winter of 1997, the civilian scientists and Instrumented Battalion of TEXCOM's Experimentation Center (TEC) formerly CDEC, took their minds off deactivation by conducting a fire fight in the streets of the FHL garrison. The skirmish was a fully instrumented battle between attacking forces consisting of 82nd Airborne and Marines fighting TEC's infantry platoon/terrorists. The focus of the battle was to demonstrate capabilities of the Precision Guided Mortar Munition; a laser guided mortar round. The instrumentation and methodology was tested in June 1996 in a Proof of Principle. Instrumented forces included machine gun sites and escape or reinforcement vehicles pitted against a conventional Forward Observer Team, a Combat Observer Laser Team (COLT), and a force mix using both assets. There were four significant technical achievements met during the Proof of Principle and used during the 120 MM Precision Guided Mortar Munitions Real Resolution Experiment executed First Quarter FY 97: 1. A Mobile Instrumentation System was adapted to play gun sites on roof tops and window sites. 2. The limitations in the GPS accuracy and telemetry systems, the backbone of the player tracking system, were determined. 3. A transportable laser designator system suitable for surrogating a COLT system was developed. 4. A mechanism to transmit live range data across the country to a high-resolution weapon flyout model was developed. This discussion is to describe the Instrumentation and Methodology used during the experiment. Ideas will be provided on potential to replicate "the adventure" with current Test or Training assets.

Automated Test Resources Information System 2

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Potential adversaries reap the benefits of a worldwide proliferation of high-technology weapons and systems. To counter this growing threat of rogue nations with high-technology weapons and system capabilities the U.S. military community must maintain and expand a superior technological prowess of it warfighting force, a task that becomes more increasing complex with a flat or slightly increasing DoD budget line. Therefore, operational test capabilities and infrastructure must be maximized within DoD. By maximizing the test capabilities across military services a reduction in total cost to maintain and develop new infrastructure can be achieved. In an effort to maximize operational test capabilities and infrastructure AFOTEC has resurrected the Automated Test Resources Information System (ATRIS II). In the resurrection of ATRIS several changes were made. First the database was moved from a hierarchical database design to a relational database structure. Second the database was expanded from containing range data to also containing information on; facilities, test capabilities, instrumentation, data collection, data reduction as well as modeling and simulation information DoD wide. The mission of ATRIS is to provide information on DoD test resources to test managers. In addition, it will provide our test managers with Points of Contact for all test resources and serve as a viable test-planning tool. The primary objective is to overcome the "If it wasn't invented here" attitude of test officers and guide them to conduct test where it makes sense without duplicating test capabilities within the different services.

Thursday, 1030 - 1200
Working Group Session 7B, Theme: Data Analysis ....Room Thayer 326

Operating Characteristic Curve Analysis of Sample Size

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Classical methods of determining sample size are of little use in today's operational test environment. It's questionable whether the threshold criteria associated with MOP's are set with any consideration of the statistical implications. Furthermore, the fact that many "operational" measures of performance must be rendered as binomial combines with growing expenses and shrinking budgets to create a very difficult situation. The result has too often been that instead of classical methods no consistent method is used (except for arbitrary fiscal considerations). In this paper we propose a simple yet effective method for analyzing the statistical risks of a given sample size. This method is not a "sample size machine" that will spit out a single numerical answer. It requires significant judgement. But, it can enable such judgement by quantifying both producer's and consumer's risk over a range of hypothetical parameter values. Subsequently, one can make more informed comparisons of potential sample sizes. It will be particularly useful in explicating the risks involved in very small sample sizes.

Automation and Standardization of Mission Level Evaluation

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The operational test and evaluation community is charged with determining a system's capability to accomplish its mission in its intended operational environment. In order to determine what factors should be examined during the OT&E and subsequent analysis, a mission decomposition should be accomplished to determine where the system fits within the strategy-to-task framework. This approach is currently being implemented at HQ AFOTEC, however, a more standardized and automated approach needs to be applied. This paper describes the project to develop a standardized and semi-automated method to define the mission level evaluation that should be accomplished, based upon a strategy-to-task based mission decomposition. The project has been broken into three tasks...defining the tasks associated with the mission decomposition in a uniform modeling language, defining the operational tasks in the form of objects whose attributes include such things as cost, resources, etc to be used as building blocks in an object-oriented test concept development system, and the development of the GUI that will allow the test concept developer to use the tools.

Bayesian Reliability Growth Models for Missile Testing: Saving Money and Increasing Precision by Using Knowledge Better

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Missile developmental and operational testing is very expensive. It requires estimating the probability that a missile exceeds a certain reliability level. Estimation is complicated by upgrades to the missile as failure modes are identified and removed, resulting in sequences of trials that are not identically distributed. Several models exist to describe this growth in reliability. The number of trials required to get precise estimates of the desired probability are large, and under a frequentist approach only result in approximate confidence intervals, not probability statements.

In this paper, we apply Bayesian methods to incorporate engineering knowledge and past experience into the statistical problem, using different growth models. We use Markov Chain Monte Carlo methods to analyze the posterior distribution, and provide graphical and numerical predictions of the asymptotic reliability, and the likely number of redesigns and failure until we meet a desired reliability level. Additionally, pre-posterior analysis allows us to have insight into the number of missile trials necessary to achieve our analytical goals with the postulated prior knowledge, and the sensitivity of our analysis to those prior beliefs.

We illustrate with the THAAD program. Given a test history, what does the future hold? We compare traditional analysis methods with our methods, which by explicitly drawing on engineering knowledge and prior historical norms can result in much more optimistic and realistic predictions. We present scenarios where the number of live fires can be reduced by as many as ten missiles, at a savings of over $100 million. We highlight all the sensitivity of the analysis to the assumptions used, particularly comparing the Bayesian assumptions with the classical ones. We discuss safeguards against malevolent manipulation.

Thursday, 1330 - 1500
Working Group Session 8A, Theme: ACTDs .... Room Thayer 324

Predator Unmanned Aerial Vehicle Operational Testing

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This presentation will focus on the continuing effort to conduct an Operational Test and Evaluation (OT&E) on the Predator Unmanned Aerial Vehicle (UAV) system. As the first Advanced Concept Technology Demonstration (ACTD) asset to transition to a full acquisition program, the Predator UAV has presented some unique challenges to the operational test community. Among these are how to incorporate applicable ACTD test data into the operational test and how to start a test program without definitive user requirements. Operational testers are also faced with the task of evaluating operational capabilities not conclusively demonstrated during the ACTD including survivability, supportability, and deployability of the system. This discussion will chronologically trace test efforts completed to date, highlighting how these efforts are contributing to the OT&E of the Predator system.

Test and Evaluation of the Joint Countermine Advanced Concept Technology Demonstration

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This presentation addresses the test and evaluation lessons learned and insights gained from the Joint Countermine Advanced Concept Technology Demonstration (JCM ACTD). The JCM ACTD was the first complex, system of systems (SoS) ACTD and, as such, required the development of a new test and evaluation approach. Integrating a disparate group of new technologies into two major joint exercises, and devising an evaluation methodology that accurately and fairly assessed their performance, proved to be a major challenge. As the ACTD unfolded, some elements of the initial evaluation approach had to be significantly modified. The results of the demonstrations provided both expected and unexpected insights into system performance and operational concepts, but also left some questions unanswered.

The analysis methodology called for a comparison of observed and expected system performance. Expected performance was based on component tests or simulations. This technique was developed to compensate for the lack of a large body of representative test performance data. Each component system was then assessed based on its performance (Measures of Performance), its contribution to the operational effectiveness of the SoS (Measures Of Effectiveness), and the influence of the component system on meeting the overall SoS requirements.

The presentation will first provide an overview of the JCM ACTD objectives and structure. Then, the JCM ACTD test and evaluation approach will be presented. Areas where this approach had to be modified will be discussed, along with the reasons for the modifications. Finally, the insights and lessons garnered from the JCM ACTD will be presented.

US Army's Operational Test and Evaluation Command's (OPTEC) Role in Advanced Warfighting Experiments (AWE) and Advanced Concepts Technology Demonstrations (ACTDs)

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Approved abstract unavailable at printing.

Thursday, 1330 - 1500
Working Group Session 8B, Theme: Missile Defense..Room Thayer 326

Tactical Ballistic Missile Threat Trajectory Sensitivity Study

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Performance estimates that are used in the evaluation of missile defense systems typically consist of "footprints" within which a desired level of intercept capability exists. These "footprints" are traditionally generated using "end-to-end" digital simulations in which a single "nominal trajectory" is modeled for each threat type. However, for each threat type, missile to missile variability will result in a distribution of trajectories that differ from the "nominal trajectory". To date, it has been presumed that the "nominal trajectory" is representative of this distribution. The purpose of this study is to determine the degree to which performance footprints based on the "nominal trajectory" are representative of system performance for the expected distribution of target trajectories. A family of possible target trajectories (including a "nominal trajectory) will be generated using a six degree of freedom simulation of a single threat tactical ballistic missile. The performance of a missile defense system will be characterized against each trajectory. This characterization will consist of decisions of whether or not a success probability exceeds a given threshold at various points in space. Analysis of simulation results will determine the degree to which performance decisions based upon the nominal trajectory differ from those based on the larger population. This presentation will discuss the methodology and, if available, the results of this study.

National Missile Defense (NMD) System Operational Test and Evaluation

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The Joint Interoperability Test Command (JITC) is forging new ground as a member of the integrated Operational Test Agency (OTA) team for the National Missile Defense (NMD) System. The size and complexity of the NMD system, coupled with the unique acquisition strategy and the accelerated schedule, pose challenges for the operational test community. The JITC and the other members of the integrated OTA team, the Army Operational Test and Evaluation Command (OPTEC) and the Air Force Operational Test and Evaluation Center (AFOTEC), have developed a comprehensive strategy for operational test and evaluation (OT&E) of the NMD System. This strategy is designed to meet the unique challenges posed by the NMD system and provide timely information to acquisition decision makers.

The OT&E strategy comprises these three phases: Early Operational Assessment (EOA) to assess potential operational effectiveness, suitability, and interoperability; Early User Test and Evaluation (EUT&E) to characterize NMD System performance and assess interoperability; Initial OT&E to evaluate operational effectiveness and suitability and certify interoperability.

The JITC will rely on multiple data sources, including integrated flight tests, integrated ground tests, risk reduction flights, wargames, and models and simulations, to support the interoperability evaluation.

The JITC's NMD system interoperability evaluation focus areas are: Joint Technical Architecture Compliance; Battle Management Command, Control, and Communications; Cheyenne Mountain Air Station Integration; NMD Message Set Development.

To facilitate timely reporting, JITC uses the OTA Team-developed Continuous Evaluation Report Tracking System (CERTS), a database of T&E-related information to support formal reports and informal feedback to the entire NMD community: Office of Secretary of Defense, Services, and program management offices. CERTS concepts can be applied to other major programs.

This presentation will describe JITC's comprehensive interoperability evaluation strategy and participation in the NMD program evaluation.

A Hardware-in-the-Loop Approach for Assessments of U.S. Army Air and Missile Defense Interoperability

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The U.S. Army is responding to the growth of the air and missile threat with a concept of complementary, interoperable defense systems. The Program Executive Office, Air and Missile Defense (PEO AMD) refers to the concept as an Air and Missile Defense Task Force (AMDTF). The AMDTF currently includes PATRIOT, THAAD, MEADS, SHORADS and associated command and control elements. Implementation of this concept portends the acquisition of more complex, software-intensive, highly integrated systems of systems. The PEO AMD is applying a tailored test and evaluation methodology to determine the level of interoperability of the developing systems. This methodology features a continuous, incremental assessment of the AMDTF's capabilities. Assessing the interoperability of this array of systems in today's cost-constrained environment requires innovative approaches, including greater use of modeling and simulation. This paper describes a hardware-in-the-loop approach being applied to the assessment of the interoperability of such systems. The PEO AMD has developed an in-house capability to address interoperability by using tactical software and hardware driven by a simulation. The capability is known as the Task Force Exerciser (TFX). This capability allows for early assessment of interoperability as a system's software is being developed. The first use of the TFX was in November 1998 [Task Force Interoperability Exercise (TFIX) 99-1]. This discussion includes an overview of the TFX development approach and architecture. The objectives of TFIX 99-1 and selected lessons learned are presented regarding the exercise objectives and the use of the TFX to support assessments of interoperability.

Alternates

Fuzzy Logic: What Good is it Anyway?

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Although the idea of fuzzy logic is not new...Lofti Zadeh proposed it in 1965...it took almost 20 years for the idea to really catch on. What finally helped it gain acceptance and credibility? Applications to real-world problems. The control community, and particular the control community in Japan who capitalized upon the benefits of fuzzy logic in their designs, demonstrated how fuzzy logic could outperform standard control methods and thus boosted its use into the mainstream of the control community.

Fuzzy logic, with its capability to capture human reasoning processes and allow for gradual transitions from one state to another, is applicable as a surrogate or enhancement to many tasks facing the analysis community. However, the lack of examples leaves the fuzzy logic practitioner with nothing to point to in his fight against the traditionalists on the application of his methods. This presentation will highlight some of the success stories of fuzzy logic's use for analytical tasks, and make suggestions for other areas where it might be used successfully.

Development and Application of a Component-Level Reliability Modeling Tool

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The reliability models used most widely in the DoD assume that aging does not occur. Traditionally, component reliability modeling relied primarily on the one-parameter Exponential model, a largely system-level model. This model is the simplest available model, and the analytical procedures are straightforward. The difficulty with this model is that aging is not addressed, and hence it is primarily appropriate for modeling early-life reliability. Due to the lack of new starts, the Army must economically extend the useful life of our existing systems and cannot ignore aging effects. Life-cycle reliability requires the use of more complicated models such as the Weibull distribution. However, it can be unclear to the practitioner which analytical procedures are appropriate for specific applications. Computer-based tools and guidance are needed for the application of these more complicated models.

This paper presents the development and application of an Army tool that uses the three-parameter Weibull distribution to evaluate component failure data and model the effects of aging. The use of the third parameter is an improvement over common commercial practices, which use a two-parameter Weibull and do not consider a failure-free period. The addition of the failure-free period more accurately models the physical reality of many failure processes such as fatigue and other damage-accumulation models. Identification of the failure-free parameter should enable and motivate expanded life-cycle reliability and maintenance decision making. This information can improve initial sparing, preventive maintenance programs, and predictive capabilities.

System Availability Evaluation: A Review for the Beginner and Expert Alike

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One of the most frequent quantitative evaluation measures of weapon system suitability is availability. Users continue to appreciate an assessment of how frequently a system will be usable to perform the mission. In this presentation, we explore the mathematical modeling techniques of availability estimation.

The presentation starts with several types of availability measures being discussed. Next, a state-space derivation of availability using a graphical model is presented. The model can be considered an intuitive representation of a state space process. This approach leads to a more rigorous derivation of availability. The origins of several common formulas for availability are shown. Finally, the presentation closes with some thoughts regarding availability estimation techniques using reliability and maintainability test data. Traditional parametric confidence interval techniques are compared to distribution-free methods.

TRAC2ES OT&E: An Approach to Evaluate the Patient Movement Mission and Unit Operations

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In order to improve the efficiency of its operations and to also place greater emphasis on providing information of value to theater operations, the Air Force Operational Test and Evaluation Center has recently reorganized and restructured its business management process. Key to this restructuring has been the implementation of a process that starts by considering the impact of each system on theater operations. Two newly formed Mission Directorates (Air & Space Operations and Integrated Logistics) are now bringing a comprehensive understanding of theater operations to the OT&E planning process. In addition to the increased emphasis on "MISSION" (theater operation), OT&E must also retain its traditional role of evaluating the "SYSTEM" (unit operations/operator use of the system) and the "OPERATIONAL REQUIREMENTS" (system operational and support characteristics in the ORD). This paper illustrates the application of a "strategy-to-task" approach that considers the Universal Joint Task List, doctrine, CONOPS, and operational experience to decompose the patient movement mission into major functional elements. A risk/impact analysis is then applied to determine major risk areas to the patient movement mission. As a result of this process, the TRAC2ES OT&E will focus on information constraints affecting patient backlog management. Three key mission elements found to have a potentially major impact on the information constraints and patient backlog management include: global/theater command and control, patient/resource statusing, and communications. The OT&E process also involves the formulation of key questions and measures to focus on the problem, poses a conceptual approach to separate physical and information constraints, develops an evaluation decision space, and identifies the potential value of OT&E information to the warfighter.

Task-based Operational Test and Evaluation

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The April 1997 Four-Star Command and Control summit declared that "The Air Force must commit to a fundamentally different way to evolve requirements, develop, test, field, and sustain C2 systems." In response to this direction, the C2 General Officers Steering Group (GOSG) leading the Command and Control Test Integrated Product Team (C2IPT), tasked HQ AFOTEC/TK to propose an alternative to the current approach of requirements-based operational test and evaluation. The alternative developed by AFOTEC is task-based operational test and evaluation.

Task-based operational test and evaluation is a fundamentally different approach than requirements-based operational test and evaluation. Whereas the focus of requirements-based operational test and evaluation is determining operational effectiveness and suitability based on system performance as compared to requirements, the focus of task-based operational test and evaluation is determining operational effectiveness and suitability based on task accomplishment.

The foundation for task-based operational test and evaluation is operational task analysis. Operational task analysis is a process that examines a targeted mission. This process decomposes the mission into tasks that must be accomplished in order to satisfactorily complete the mission. These tasks are then related to the system functionality that supports the task accomplishment. These relationships form a traceability matrix that allows system functionality to be associated with task and ultimately mission outcomes. Operational task analysis is most beneficial when it is done early and continuously in program development. It is an iterative process involving the user, contractor, product center, responsible test organization, and operational test agency. Operational task analysis provides the structure for early operational test agency participation in program development by furnishing operational insight to the program office and acquisition decision maker. Evaluation of test data collected during any part of program development can be made at the mission level using the operational task analysis.

In summary, task-based operational test and evaluation supports the GOSG C2IPT direction by providing an alternative to requirements-based operational test and evaluation. This alternative allows the operational test agency to better determine whether systems are operationally effective and suitable for the intended use by representative users before production or deployment. This concept also provides the opportunity for meaningful early operational test agency participation during program development.

Using Models to Estimate Aircraft Reliability, Maintainability, and Availability

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This presentation describes four levels of models developed for estimating aircraft RM&A parameters during operational test planning and execution. Since the amount and type of failure, repair, and system data grows over the life of an acquisition program, we have found it useful to have RM&A models which are able to operate with progressive levels of data detail as the information available grows in amount and type. The four levels presented progress from the lowest level, subsystem failure and repair data/predictions only, to the highest level, a complete set of scored operational test data and complete system-level mission characterization. The four models will be characterized and demonstrated.

Verification and Validation of an Availability Model for the T-6A

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This presentation provides an overview of the verification and validation efforts on the availability model built for the T-6A operational test program. The T-6A Aircraft Readiness Model (T-6A ARM) was derived from the ARM 1.1, a "generic" aircraft availability model originally designed to support the F-22 operational test and evaluation. The T-6A ARM is built in MODSIM II, a programming language by CACI Products Co. A description and demonstration of the model's operation is briefly given, with the focus of the presentation being the experiments and analysis undertaken to prove the T-6A ARM is a valid representation of the operation it models.

Dependence of Salvo Shots and Analysis of Mixed Data

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It is a common practice in the DoD acquisition community to treat two missile shots in a salvo as independent and, so, to analyze the expected probability of kill for the salvo by taking one minus the square of the complement of the probability of kill for a single shot. In this paper we show that the assumption of independence between shots in this calculation is unsound when there are significant variations from scenario to scenario (as is often the case). We make no general recommendations about weapons system testing based on this result, but clearly there are implications. In conclusion, we examine the practical problem of data analysis when there is only single shot data and when there is both single shot and salvo shot data. In the latter case, we conclude that there is no objective way to combine such data.

WG 26 – ANALYSIS OF ALTERNATIVES – AGENDA

Chair: Col Philip J. Exner, OSD PA&E
Co-Chairs: James Cooke, OSD PA&E
Bruce D. Wyman, ANSER
Ronald R. Luman, Johns Hopkins University
Advisor: Mr. Thomas L. Gibson, OSD PA&E
Room: 328 & 342

Tuesday, 22 June, 1030-1200 .... **Room 342**

AoAs: The Good, the Bad, and the Ugly
Col. Philip J. Exner, USMC, Land Forces Division, Program Analysis and Evaluation, Office of the Secretary of Defense

Revised DoD Guidance for Analyses of Alternatives
Mr. James C. Cooke, Land Forces Division, Program Analysis and Evaluation, Office of the Secretary of Defense

Tuesday, 22 June, 1330-1500 .... **Room 328**

The Air Force Analysts' Handbook
Mr. Christopher A. Feuchter, Office of Aerospace Studies (OAS), Kirtland AFB, NM

AoAs Need MOEs Too
Mr. Christopher A. Feuchter, Office of Aerospace Studies (OAS), Kirtland AFB, NM

Wednesday, 23 June, 0830-1000 .... **Room 342**

Army Analyses of Alternatives Framework

Mr. **Vernon M. Bettencourt**, Technical Advisor to the Army Deputy Chief of Staff for Operations and Plans; Mr. **Michael J. Moore**, Chief, Studies and Analysis Division, Army DCSOPS; Mr. **Michael Bauman**, Director, TRADOC Analysis Center, Ft. Leavenworth, KS; Mr. **Allan Resnick**, Assistant Deputy Chief of Staff for Combat Developments, US Army TRADOC, Ft. Monroe, VA; Mr. **Robert Chandler** Chief, Artillery and Air Defense Analysis Division, AMSAA, Aberdeen Proving Grounds, MD; Dr. **James J. Streilein**, Director, US Army Operational Test and Evaluation Command, Aberdeen Proving Grounds, MD; Mr. **Roy Reynolds**, Director of Operations, White Sands Missile Range TRADOC Analysis Center, White Sands, NM

Wednesday, 23 June, 1030-1200 .... **Room 328**

Raptor Employment Analysis
Mr. Jeffrey Kramer, USA TRAC-WSMR, White Sands Missile Range, NM

Communications Assessment Model (CAM) Process
LtCol Daniel Collins, USAF, Ph.D., Chief CINC Support Division , and David Berry; Thomas Graziano; John Stuber; William Devens (MITRE); Jack Trainor (MITRE); Joseph Hutson (SAIC); Karen Kelly (SAIC); Frank McLesky (SAIC), Defense Information Systems Agency (DISA), C4I Modeling, Simulation, and Assessment Directorate (D8)

Wednesday, 23 June, 1330-1500 .... **Room 328**

USMC AoAs and Requests for Alternative Approval (RAAs)
Dr. George Akst, Deputy Director, Studies and Analysis Division, MCCDC, Quantico, VA

Use Of Multiple Criteria Decision Analysis in the Marine Corps Advanced Amphibious Assault Vehicle (AAAV) Program
Mr. David V. Strimling, Dr. James M. Eridon, Mr. Russell H. Bittle, Jr., General Dynamics Land Systems, Warren, MI

Thursday, 0830-1000
COMPOSITE GROUP F .... **Room 144**

Thursday, 24 June, 1030-1200 .... **Room 328**

Conducting the AoA Cost Analysis--An Effective Process
Mr. Steve Miller, ASC/RA, Wright-Patterson AFB, OH and Mary Benze, Office of Aerospace Studies (OAS), Kirtland AFB, NM

Showing the Military Utility of a Space Maneuvering Vehicle in a Campaign Level Context
Capt. James R. Hunter, USAF, Lead, Future Space Vehicle & Weapon Development, and Charles Galbreath, Capt, Space Systems Analyst, Eric Frisco, Capt, Space Systems Analyst, SMC/XR, Systems Engineering & Integration Branch

Thursday, 24 June, 1330-1500 ....Room 328

Defense Planning Projection

Dr. William H. Jarvis, Force Planning Division, OSD, PA&E; and Tom Phalon, Senior Analyst, GRCI

A Hybrid, Interactive, Multiple Attribute, Exploratory (HIMAX) Approach to Force Evaluation for Army After Next

John D. Pinder, RAND Graduate School, Santa Monica,

WG 26 – ANALYSIS OF ALTERNATIVES – ABSTRACTS

Tuesday, 22 June, 1030-1200 *(Location: Thayer Hall, Rm 342)*

AoAs: The Good, the Bad, and the Ugly

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This presentation describes the characteristics of good and bad AoAs from a DoD perspective, and includes examples from actual AoAs submitted to OSD for review. The briefing discusses the nature and uses of AoAs, presents principles for conducting robust and useful AoAs, and includes some suggestions for design and conduct of AoAs that would improve the quality of these analyses. The briefing will also include a discussion of institutional factors that tend to limit the ability of analysts to conduct ideal AoAs.

Revised DoD Guidance for Analyses of Alternatives

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The purposes of acquisition support analyses are to facilitate communications, aid decision-making by illuminating the relative advantages and disadvantages of the alternatives, and document acquisition decisions. The Director, Program Analysis and Evaluation has a regulatory responsibility to develop guidance to the services on the conduct of AoAs for major systems. Although there are many questions and concerns common to any major acquisition, there are no easy shortcuts or checklists for assessing the cost and operational effectiveness of major defense acquisition programs. Certain elements are common to most analyses, such as scenarios, models, data, alternatives, and metrics. This presentation will review the emerging DoD guidance to the services on expectations for AoAs at various milestones, including extensive discussion on the selection of scenarios, metrics, and alternatives. Trade-off and affordability analyses at the whole-system and at the sub-system/component level will be discussed. It will also describe the interaction of the AoA analysis with major system test events and the Acquisition Program Baseline.

Tuesday, 22 June, 1330-1500 (Location: Thayer Hall, Rm 328)

The Air Force Analysts' Handbook

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The military OR profession resembles a medieval guild with its masters and apprentices (senior and junior analysts). This worked during the heyday of the cold war, but for years the masters have been vanishing into retirement faster than apprentices have been hired and trained to replace them. As a partial remedy, the Air Force Analytic Community is sponsoring development of the Air Force Analyst's Handbook. This handbook focuses on the process of OR in the Air Force, not its quantitative techniques. Nominally authored by Air Force Materiel Command's (AFMC) Office of Aerospace Studies, senior Air Force analysts throughout the community have contributed suggestions and participated in an ongoing review of its content. The subject matter and status of the handbook are discussed in this paper.

AoAs Need MOEs Too

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Abstract: An Analysis of Alternatives (AoA) has been referred to as a little agreement between punches. A lot of those punches seem to be associated with selecting appropriate measures of effectiveness (MOEs). What's the problem? It's a tangle of misconception, preconceived notions, and hidden agendas (gasp). This presentation discusses how to avoid the pitfalls and pratfalls of AoA measures of effectiveness.

Wednesday,23 June, 0830-1000 *(Location: Thayer Hall, Rm 342)*

Army Analyses of Alternatives Framework

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In recent OSD senior level materiel acquisition decision meetings and AoA briefings, the OSD staff raised issues concerning the scenarios, threat, and Joint context for Army analyses. Issues raised include: threat levels and capabilities; Army tactical scenarios; impact of deep strike and operational level operations on tactical battles; timeframes for analysis; assumptions concerning other service capabilities; Army modernization plans; and alternatives addressing affordability (high/low mixes). As a result of these issues, the Army conducted an assessment to identify ways for improving Department of the Army policies, processes, and practices for tasking, conduct, control, coordination, and documentation of AoAs for major materiel program decisions. This panel session will include five presentations. The initial presentation will describe the results of the baseline assessment of the current Army AoA framework and the new concept for Army AoAs. This presentation will also identify initiatives necessary to implement the new AoA concept that will shape the Army's future analysis framework for supporting requirements determination and materiel acquisition decisions. The second presentation will describe the Army TRADOC's concept-to-requirements process and its role in the AoA paradigm. The third presentation will describe Army item and system level performance analysis and its role in the AoA paradigm. The fourth presentation will describe the role of developmental and operational testing supporting the new AoA paradigm. Topics include MOE and scenario linkages, as well as feedback mechanisms between T&E and AoAs. The fifth presentation will describe the analytical and experimental underpinnings of the Force XXI Battle Command - Brigade and Below (FBCB2) Tactical Internet and highlight the relationship of these analyses and experiments to the new AoA framework.

Wednesday, 23 June, 1030-1200 (Location: Thayer Hall, Rm 328)

Raptor Employment Analysis

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Raptor is a suite of anti-armor mines, sensors, communications, and controls, which result in a minefield that is more flexible in tactical usage, more lethal to the enemy, and safer to friendly forces and non-combatants than conventional minefields. The Raptor improves the commander's ability to dominate the battlespace through the employment of unmanned and unobserved obstacles capable of detecting, reporting, and selectively engaging enemy vehicles. An operational effectiveness (OE) analysis conducted during the summer of 1997, the Raptor Milestone I Analysis of Alternatives (AoA), showed the positive contribution Raptor could make to the battlefield. However, Raptor is a new system which has neither fielded equivalent, nor previous field performance history from which to compare its performance. ARDEC, the materiel developer, proposed a closer look at the OE conducted for the AoA, to assess additional system parameters, Raptor employments, and potential threat reactions not captured in the original AoA, which would reinforce the findings that Raptor is a valuable asset for the maneuver commander. The Raptor employment analysis was performed in three phases: Phase I used a SWA scenario from the original AoA to examine mine placement, threat reactions, and Raptor performance parameters. Phases II and III simulated Raptor in a European environment. This paper presents a brief overview of the Raptor employment, followed by the analytical description and results.

Communications Assessment Model (CAM) Process

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The CAM process is a communications assessment and modeling tool that evaluates the impact of communications demands on current and evolving theater-level Defense Information Infrastructure/Defense Information Systems Network (DII/DISN) communications networks and systems supporting the CINCs, Joint Staff, and OSD. The CAM process can identify critical communication nodes and links requiring performance improvement and can answer "what-if" questions in the event of node failures. It provides a performance analyses on data, voice, and video communication network links during different stages of various scenarios ranging from a Major Theater War (MTW), a Small Scale Contingency (SSC), or to Non-combatant Evacuation Operations (NEO). The CAM process is tailored to address specific assessment requirements for each network involved in a particular scenario with respect to its adequacy to support hostilities in a CINC's area of responsibility (AOR). The CAM process provides DOD warfighters and planners with knowledge regarding where additional attention is needed to resolve areas of communications deficiencies or imbalances. The presentation will demonstrate the CAM concept (i.e., the process used to develop a model and assess the communications network), its past successes, and an animated graphical presentation of the assessment that demonstrates a profusion of data utilizing a commercial off the shelf (COTS) simulation software tool in an easily understandable manner.

Wednesday, 23 June, 1330-1500 *(Location: Thayer Hall, Rm 328)*

USMC AoAs and Requests for Alternative Approval (RAAs)

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The Marine Corps acquisition system is very different from that of the other services in that there are very few big-ticket items. In fact, there is a total of one ACAT I program in the entire Marine Corps: the Advanced Amphibious Assault Vehicle (AAAV). The main reason for this is that the Navy manages all aircraft-related programs (including Marine Corps-unique aircraft, such as the AV-8B), and the Marine Corps relies heavily on the Army for development of ground weapon systems (such as tanks and anti-tank weapons). Thus, most of the acquisition programs in the Marine Corps are either ACAT III or IV. The Marine Corps has a standing AoA IPT to determine the required supporting analyses for these programs — the alternatives are an AoA or an alternative based on a Request for Alternative Analysis (RAA). While these analyses have much in common with the more familiar large AoAs, they can differ significantly with respect to scope, detail, and level of effort. The purpose of this talk is to discuss the similarities and differences of these types of studies, and perhaps provide a few examples of smaller scale AoAs or RAAs.

Use Of Multiple Criteria Decision Analysis in the Marine Corps Advanced Amphibious Assault Vehicle (AAAV) Program

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Multiple Criteria Decision Analysis (MCDA) was an integral part of concept definition for the Marine Corps AAAV program. Two levels of trade studies were performed: whole system and subsystem/component trades. Whole system trades determined the "best" balance of AAAV "core capability" performance requirements, cost, and weight. Subsystem/component level trades selected specific technologies to meet the performance requirements defined for each "core capability" in the whole system trades.

Whole system trades began with a mission area analysis that included definition of threat, user/source requirements, and operational & organizational concept(s). Low, moderate, and high target performance levels were then identified for system "core capabilities." Using a Design of Experiments (DOE) approach, functional relationships between the "core capability" target performance level requirements and combat effectiveness, cost, and weight were developed for use in a Multi Criteria Mathematical Programming (MCMP) model. The MCMP model was used to generate a set of non-dominated candidates that were then evaluated using MCDA to select the "best" alternative(s) as defined by "core capability" performance levels.

Subsystem/component trades were conducted based on the "core capability" performance level requirements selected in the whole system trades. Each "core capability's" level helped further expand/focus its technology search and evaluation criteria. The set of candidates, now defined by real technologies, was then evaluated using MCDA to select the "best" alternative(s).

This paper will describe the analysis process used for the AAAV whole system and subsystem/component trades.

Thursday, 0830-1000

COMPOSITE GROUP F.. Room 144

Thursday, 24 June, 1030-1200 — *Location: Thayer Hall, Rm 328)*

Conducting the AoA Cost Analysis--An Effective Process

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One of the major challenges in conducting the cost analysis for an Analysis of Alternatives (AOA) is getting the cost analysis accomplished with the limited resources available. This paper presents an example of how one AoA, the High Altitude Endurance-Unmanned Aerial Vehicle, attacked the problem and put in place a process that worked--one that included all the stakeholders up front, worked issues as they arose, and kept the cost analysis on track.

Showing the Military Utility of a Space Maneuvering Vehicle in a Campaign Level Context

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The Space Maneuvering Vehicle (SMV) has the potential for revolutionizing military affairs as we know it. It is a multi-mission support platform all four space mission areas: Space Support, Space Force Application, Space Force Enhancement, and Space Control. But before the acquisition decision is made, how do we prove that an SMV provides any additional worth to the war fighter on top of the forecasted space capability as a quantitative check to the US taxpayer? As directed by Air Force Space Command, SMCXR has undergone a rigorous qualitative analysis of the what makes an SMV unique and how it might support the campaign as well as operations other than war. Using a four pronged approach of qualitative analysis, quantitative analysis, cost effectiveness analysis, and technical risk assessment, we attempt to show what worth an SMV is to campaign level outcomes and cost requirements to achieve those outcomes. Using aggregated measures of effectiveness on the campaign we back out SMV architectures necessary to achieve the required level of effectiveness and associated cost and technology risks. The methodologies and results to date will be presented.

Thursday, 24 June, 1330-1500 (Location: Thayer Hall, Rm 328)

Defense Planning Projection

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The Defense Program Projection (DPP) is a long-term projection of DoD programs based on the President's budget FYDP and other official documents. This project provides: "...a rough 20 year "roadmap" of the modernization needs and investment plans of DoD, projecting the impact of the Program Planning Objectives, and of additional modernization or replacement of major systems (e.g., ships, aircraft, tanks and satellites) expected by the Military Department and Defense Agencies, against realistic levels of future funding."

The DPP effort results in a projection of the FYDP database twelve years beyond the end of the FYDP, currently out to FY 2017. Inputs to this analysis include the FYDP, analyst projections of the force structure, investment projections based on current service plans, as well as OD PA&E projections of the consequences of those plans. The DPP includes high and low excursions as well as an analysis and characterization of the budget, policy, and affordability risk inherent in the projection. DPP data and analyses have been used in the past in supporting the Quadrennial Defense Review.

The DPP study effort uses several measures of merit to determine investment adequacy and program supportability. These measures include average fleet age, age distribution, steady state procurement, affordability, modernization rates, and capability. A major portion of the DPP presentation to high level DoD officials consists of highlighting the extent to which service investment programs comply with PA&E determined goals.

This presentation focuses on the process of determining, analyzing, and reporting DPP projections and their compliance with program goals.

A Hybrid, Interactive, Multiple Attribute, Exploratory (HIMAX) Approach to Force Evaluation for Army After Next

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As the dawn of 21st Century approaches, the United States Army is, within its Army After Next (AAN) program, looking ahead to the year 2025. Projecting forward from present conditions, it envisions a future that is characterized by strategic uncertainty and regional instability. The greatest challenges in such an environment would stem from the frequency, diversity, complexity, and novelty-rather than the intensity-of regional conflicts. AAN planners are investigating a variety of rapidly deployable strike force options that are intended to meet these challenges. This type of force would need to be more capable than a modern heavy armored force, yet as transportable and self-sustaining as a contemporary light airborne infantry force. To achieve this exacting standard such a force must include new types of lightweight fighting vehicles that use advanced technology-either on board, or in other elements of the force-to augment their protection and firepower. In addition, this force must be organized around a concept of operations that exploits synergistic interactions among vehicles, weapons and sensors to increase its overall effectiveness. Thus, one of the key problems facing AAN planners is to decide what essential characteristics these new vehicles should have, and what type of operational concepts should govern their use.

This presentation describes a novel approach that is being developed to tackle the difficult force evaluation problem facing AAN. This new hybrid, interactive, multiple attribute, exploratory (HIMAX) approach interactively combines expert assessment with multiple attribute decision theory, combat simulation, and exploratory modeling to evaluate alternative force options. The HIMAX approach is ideal for evaluating future force options because it can: (1) capture synergistic operational interactions; (2) consider a range of mission scenarios and force options; (3) explicitly illustrate the impact of uncertainty in force characteristics and expert assessments; and (4) combine multiple objectives to assess overall force effectiveness. In general, the application of HIMAX to a specific problem involves six steps: preparation, generation, evaluation, exploration, interaction and prioritization. This methodology will be illustrated in the context of an analysis of AAN light strike force options. Some preliminary findings and recommendations derived from this analysis will also be discussed. These recommendations will primarily address the nature and composition of an AAN light strike force, but may also involve near-term decisions on how to allocate scarce research and development resources.

The specific methodology developed for this analysis will, necessarily, be customized to the particular problem facing AAN. Nonetheless, the HIMAX approach should be applicable to a wide range of similar force evaluation problems. Indeed, with appropriate modifications, the HIMAX approach might also be useful in other areas, such as strategic planning for space exploration.

WG 27 – COST ANALYSIS – AGENDA

Chair: Stephen E. Myers, Johns Hopkins University/Applied Physics Laboratory
CoChair: W. M. Kroshl, Johns Hopkins University/Applied Physics Laboratory
CoChair: Robyn Kane, ANSER Corporation
Advisor: LCDR Tim Anderson, Naval Postgraduate School
Room: 330

Tuesday, 1030-1200: DoD Cost Analysis Environment and Trends
The Defense Program Projection (DPP)
Thomas Phalon, GRCI and William Jarvis, OSD Force Planning

Current State of DoD Cost Models and the Future
Jerry Harbison, Management Analysis, Inc.

Estimating the Costs of Interoperability – 20 minutes
Dr. Conrad W. Strack, TASC

Tuesday, 1330-1500: Applied Cost Estimation
Estimating the Health Hazard Costs of Army Materiel – A Method for Helping Program Managers Make Informed Health Risk Decisions
Gary M. Bratt, Logistics Management Institute

A Fresh look at Estimating Development Costs
David A. Lee, Corald Belcher, Walter Cooper, Logistics Management Institute

Ten Steps to Smaller Cost Estimates (But, Not Necessarily Smaller Costs)
Dr. Stephen A. Book, The Aerospace Corporation

Approximating the Probability Distribution of Total System Cost
Dr. Paul R. Garvey, The MITRE Corporation

Wednesday, 0830-1000: Return on Investment and Cost Effectiveness Analysis
Using Return on Investment as a Strategy for Equipping Ships for Onboard Electronics Test and Repair
Leonard J. Kusek, Center for Naval Analysis

Cost-Effectiveness Analysis of Army Rail Outsourcing Options
Ron Bailey, Logistics Management Institute

Cost Effectiveness Strategies for Vulnerability Assessment
Dr. Martha Nelson, Franklin and Marshall College

Do Not Use Rank Correlation in Cost Risk Analysis
Dr. Paul R. Garvey, The MITRE Corporation

Wednesday, 1030-1200: Economic Analysis Session – "Innovations in Defense Business Management: Panaceas or Problems"
Chair: Dr. Dennis Smallwood, United States Military Academy

Commercialization and Globalization in Department of Defense Activities
LTC Michael J. Meese, United States Military Academy

Capital Budgeting and Defense Management
MAJ Shaun Wurzbach, United States Military Academy

Engineering Economics Applied to Capital Investments
Dr. Fairly Vanover, TRADOC Analysis Center (TRAC), Ft. Lee

Wednesday, 1330-1500: Cost Management Tools
Integrated Management Decision Support System (IMDSS)
Nona M. Riley, U.S. Army Space and Missile Defense Command

Air Force Total Ownership Cost (AFTOC) Management Information System
Wendy Kunc, Scott Belford, Air Force Cost Analysis Agency

Personnel Forecasting Workforce21 - A Proposed Methodology – 40 minutes
Stephen R. Parker, John A. Marriott, National Imagery and Mapping Agency

<u>*Thursday, 0830-1000*</u>
COMPOSITE GROUP F.. Room 144

Integrating Cost and Performance Models to Enable CAIV-Based System Requirements Allocation
Dr. Ronald R. Luman, Johns Hopkins University/Applied Physics Laboratory

<u>*Thursday, 1030-1200: Cost Estimating Applications*</u>
Empirical Analysis of Cost Progress Curves
Walt Cooper, Logistics Management Institute

Cost-Risk as a Figure of Merit in Trade Studies and Source Selections
Dr. Stephen A. Book, The Aerospace Corporation

CVX Investment Strategy Process
John Christian, Naval Sea Systems Command (SEA-03D3), Earl W. Hacker, Whitney, Bradley, and Brown, Inc.

<u>*Thursday, 1330-1500: Modeling of Affordability Issues*</u>
Requirements Analysis at Air Force Space Command
Dr. Larry Rainey, The Aerospace Corporation

Affordability Analysis of Alternative Spacecraft Launch Systems: The Light Gas Gun
William M. Kroshl, Johns Hopkins University/Applied Physics Laboratory

Strategic Mission Implementation: A Value-Focused Approach
Dr. James K. Lowe, Lt Col Steven F. Baker, Lt Col Steve Green, United States Air Force Academy

WG 27 – Cost Analysis – Abstracts

<u>*Tuesday, 1030-1200*</u>
<u>DoD Cost Analysis Environment and Trends</u>

The Defense Program Projection (DPP)

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The Defense Program Projection (DPP) is a long-term projection of DoD programs based on the FYDP and other official documents. This OSD PA&E projection satisfies the Defense Management Review requirement for a 20 year "roadmap" of the modernization needs and investment plans for DoD. It reflects the impact of Program Planning Objectives and additional modernization or replacement of major systems (e.g., ships, aircraft, tanks and satellites) expected by the DoD Departments and Agencies, balanced against realistic levels of future funding." The DPP results in a projection twelve years beyond the end of the present FYDP, currently to FY 2017. Inputs to this analysis include the FYDP, projections of force structure, and investment projections based on current service plans, as well as PA&E projections of the consequences of those plans. The DPP includes high and low excursions, as well as an analysis and characterization of the budget, policy, and affordability risk inherent in the projection. DPP data and analyses have been used to support both the Bottom-Up Review and the Quadrennial Defense Review. The DPP uses several measures of merit to determine investment adequacy and program supportability. These measures include average fleet age, age distribution, steady state procurement rates, affordability, and force modernization rate. A major portion of the DPP presentation to high-level DoD officials highlights the extent to which service investment programs comply with DoD goals. This presentation focuses on the DPP process for determining, analyzing, and reporting investment projections and compliance with DoD program goals.

Current State of DoD Cost Models and the Future

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This information briefing (and paper) looks into the current models available for force cost estimations. The original purpose for each of the models, their sponsors, and their individual strengths and weaknesses will be highlighted. A detailed discussion of the future and proposals for the "way ahead" are outlined by these key points:

- Convergence in Functionality
- General Knowledge and Utility Encourages Innovative Widespread Use
- Implement DOD and Industry Best Practice, Programs, Language
- Validated (Authoritative) Data Sources and Formats
- Joint Data Dictionaries Depart from Service Specific Language
- User Friendly Documentation
- Independent Evaluation
- Data and Idea Sharing, Encourage Cooperation

Estimating the Costs of Interoperability

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Theater defense against attack by ballistic missiles, cruise missiles, and aircraft is commonly viewed as requiring a joint service family of systems working cooperatively. Such cooperation often requires that an interoperability applique be added to legacy systems. Many proposed approaches whose cost is sought remain incompletely defined. Despite a severe lack of technical detail, cost estimation can occur by exploiting the fact that most strategies for interoperability require a software engine. Cost estimation can rely on estimating software size, structure, and functionality as driven by interoperability objectives. This method has produced life-cycle cost estimates for several proposed elements of interoperability including: CEC (Cooperative Engagement Capability), JCTN (Joint Composite Tracking Network), JDN (Joint Data Network), TCCS/CHS (Tactical Command and Control System/Common Host Software), the JTAMD Master Plan, JTAMD Demonstrations, National Cruise Missile Defense, Link 16 POM Initiatives, JMAA Architectures, and the Interoperability Program Plan. Systems for which interoperability costs have been estimated include: Aegis, LH, CV, E-2C, TPS-59, AWACS, Patriot, THAAD, JLENS, MEADS, Sentinel, JSTARS, Predator, SBIRS, TPS-75 with EMT, F-16 block 50, F-18 E/F, JSF, F-22, Navy Area, and Navy Theaterwide.

Tuesday, 1330-1500
Applied Cost Estimation

Estimating the Health Hazard Costs of Army Materiel – A Method for Helping Program Managers Make Informed Health Risk Decisions

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A model to assist the U.S. Army to estimate costs for unabated weapon system health hazards, based on the probability of a hazard occurring and the severity of that hazard. Health hazard categories are linked to types of clinic services that might be required as a result of exposure to a specific health hazard, and diagnostic categories based on the potential medical effects that could occur as a result of exposure to a specific health hazard. Incidence rates were researched and costs calculated based on industry- wide data on injuries, lost time, hospitalization, and disability. This framework provides a method to reasonably estimate the medical and lost military manpower costs of unabated health hazards associated with Army materiel. Using the outputs of the model will increase the effectiveness of health risk assessment and management, and better enable the Army to eliminate or control materiel health hazards and control life cycle costs. This model has potential application to other acquisition disciplines.

A Fresh look at Estimating Development Costs

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Cost and schedule overruns are all too common in DoD development programs. A likely cause is that present cost models do not allow estimators to cope with recent dramatic advances in technology, nor with the effects of acquisition reform initiatives. This presentation describes an effort to build first-principles analytic models of development costs on the basis of information about present-day development processes. The models are developed as solutions to optimization problems describing firms' incentives, using inputs from interviews with developers of electronic systems. Results to date include predictions for the variation of cost with completion time and with program content, and explanations of observations of the fractions of total cost spent on content and on integration, test, and rework.

Ten Steps to Smaller Cost Estimates (But, Not Necessarily Smaller Costs)

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A discussion of ten steps that guarantee smaller cost estimates. Though the estimates are guaranteed smaller, they are not guaranteed to be better, or even reasonable. These common errors, faulty assumptions, and misapplications of standard costing methodologies provide insight into just why so many cost estimates end up so far from the actual result.

Approximating the Probability Distribution of Total System Cost

Dr. Paul R. Garvey, Chief Scientist
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The probability distribution of a system's total cost can often be approximated analytically by a "simple formula." Analytical approximations provide insight into cost risk drivers and other influences not readily seen in empirical distributions of a system's total cost. Circumstances are presented for identifying when the probability distribution of a system's total cost can be approximated analytically.

Wednesday, 0830-1000
Return on Investment and Cost Effectiveness Analysis Session

Using Return on Investment as a Strategy for Equipping Ships for Onboard Electronics Test and Repair

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Approved abstract unavailable at printing.

Cost-Effectiveness Analysis of Army Rail Outsourcing Options

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Cost Effectiveness Strategies for Vulnerability Assessment

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In this era of decreased defense budgets and limited resources, it is important for decision makers to determine the optimal strategy for assessing the vulnerability or lethality (V/L) of a weapon system and the role of alternative activities in that strategy. Selecting the optimal assessment strategy requires a consistent methodology for the identification and measurement of the costs and benefits of potential assessment plans, the weighing of the costs against the benefits for each plan considered, and the comparison of alternative competing plans. This paper explores the potential for adapting the principles of the Cost As an Independent Variable (CAIV) methodology to the evaluation of competing strategies in V/L assessment.

Do Not Use Rank Correlation in Cost Risk Analysis

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Correlation exists between Work Breakdown Structure (WBS) element costs and between cost and schedule. It is a necessary consideration, however, subtleties associated with correlation must be well understood to avoid an improperly specified risk model. Two measures commonly used are Pearson's product-moment correlation coefficient and Spearman's rank correlation coefficient. From a WBS perspective, Pearson's product-moment correlation coefficient is the only appropriate measure of correlation for cost risk analysis.

Wednesday, 1030-1200
Economic Analysis Session – "Innovations in Defense Business Management: Panaceas or Problems"

Chair: Dr. Dennis Smallwood
Bernard Rogers Distinguished Professor of Defense Economics
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This session is intended to promote a broad discussion of alternative ways to support key components of DoD's revolutions in military and business affairs. The presentations concern the changes in the political, economic, and budgetary environment that affect the way DoD will operate in the future.

Commercialization and Globalization in Department of Defense Activities

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One of the promising opportunities for improving cost control is to expand the use of commercialization and globalization to reduce costs and improve effectiveness in defense spending. Several DOD panels have studied the opportunities and risks involved in increased

commercialization and globalization. This paper reviews the work of some of these panels to identify what proposals may be promising and how analytical methods could improve proposed innovations in defense business management.

Capital Budgeting and Defense Management

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One of the perennial issues in defense planning, budgeting, and cost estimation is how to properly account for capital expenditures. Businesses use a variety of accrual accounting and capital budgeting techniques to assist them with cost estimation of capital projects. This paper compares the defense and private sector accounting and budgeting systems and discusses the applicability of business practices to improve defense management of capital assets.

Engineering Economics Applied to Capital Investments

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Engineering Economics is used to assess the value of a given project and justify it. With the rapid pace of technological change increasing the complexity and elevating the cost and utility of resources such as training and information technology systems, the justification of these resources has become of monumental importance to corporate and Department of Defense (DOD) budgets. Because of this complexity, inadequate investment justification processes often lead to poor decision-making. Classic economic production theory focuses on production functions where inputs are dependent on each other. This presentation offers a methodology which extends classic microeconomics to production functions with two-variable inputs, where either input can produce some quantity of output independently, but neither input can produce the required quantity of output alone. The mathematical equations for independent production functions may be derived from historical data by using regression analysis curve fitting. From these equations, the three-dimensional production surface can be determined and bounded by the production constraints. The isoquant may then be determined which describes the combinations of the variables that will give the required production. From historical data, isocost curves may then be defined for combinations of system alternatives that achieve the required production. The tangency points of the isocost curves to the isoquant identify the most cost effective combination of alternatives that achieve the required production. Applications for this methodology include justifying the cost savings and payback period for various systems that must be used together to produce the required output, e.g., an aircraft trainer and an aircraft simulator.

Wednesday, 1330-1500
Cost Management Tools

Integrated Management Decision Support System (IMDSS)

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The trend towards multi-service and multi-national acquisition of systems has made the defense systems decision environment increasingly complex. The decision environment is larger, resources scarcer, and the impact of decisions more far-reaching. The IMDSS was developed to simultaneously simulate variation in program cost, schedule, and performance parameters to give managers improved insight into program risks, to perform programmatic "what-if" exercises, and to provide a data base of future performance-based activity. IMDSS is a flexible tool that adapts to the various ways program offices do business, and to the different stages of a program's life cycle. It is a decision management system providing a pro-active capability for identifying and managing risk. IDMSS is a rigorous, structured tool for managing risk. This presentation discusses the concept, computer model, and data base management system.

Air Force Total Ownership Cost (AFTOC) Management Information System

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Personnel Forecasting Workforce21 - A Proposed Methodology

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Thursday, 0830-1000
COMPOSITE GROUP F.......... Room 144

Integrating Cost and Performance Models to Enable CAIV-Based System Requirements Allocation

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Thursday, 1030-1200
Cost Estimating Applications

Empirical Analysis of Cost Progress Curves

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Traditional approaches to estimating the recurring production costs of weapon systems model cost as a function of cumulative quantities and production rates. Three years ago, at the request of the Resource Analysis Directorate, Office of Program Analysis and Evaluation, Office of the Secretary of Defense, we began a research program to explore empirically the effects of other factors on cost progress. Since starting the program, we have examined dual-sourcing, multi-year procurement, product complexity, major design changes, industry developments, and the investments that managers make in response to economic incentives.

Our first project focused on the expansion of traditional power law models of cost progress to account for dual-sourcing, multiyear procurement, product complexity and industry developments. (Cooper, Walter R., J. S. Domin, R. M. Feinberg, J. P. Johnson, D. A. Lee, and T. P. Lyon, Empirical Analysis of Cost Progress Curves: Tactical Missiles. The Logistics Management Institute, PA603T1, October 1997.) The study team applied the expanded form to some 14 tactical missile programs over the 20-year period from 1975 through 1994. Using data collected from Selected Acquisition Reports, the team found that the formulation provided useful insights into the effects of competition, complexity, and industry dynamics. We also suggested that it would be appropriate to explore an alternative model that accounts for investments in production technologies.

Our second project focused on the alternative model. (Lee, David A., V. Stouffer, and M. E. Etheridge, Empirical Analysis of Cost

Progress Curves: An Investment Incentives Model Applied to Electronics Systems. The Logistics Management Institute, PA702T1, November 1998.) Specifically, our sponsor asked us to explore the notion that falling unit costs result from investments in producibility and production technology made in response to economic incentives. We developed and tested this model on a small sample of military electronics systems. With this model, cost progress is determined by three principal parameters, the ratio of initial unit cost and lowest possible unit cost, the ratio of best possible lot cost e-folding investment, and the ratio of maximum investment to the e-folding investment. We implemented the model by expressing its three parameters as functions of three binary variables. These described the product as complex or not; the production facility as significantly automated or not; and competition or the threat of competition as present or not. The resulting model produced encouraging results, explaining most of the cost progress observed in randomly selected programs. Differences in cost progress are explained by straightforward descriptors of both the equipment and the production environment.

Cost-Risk as a Figure of Merit in Trade Studies and Source Selections

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CVX Investment Strategy Process

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The Navy has identified the need for a new class of aircraft carrier as a more affordable alternative to present designs. Achieving a more affordable design will require a substantial R&D program, addressing issues that have not been faced for many years. The CVX Program Office has developed a comprehensive decision aid for R&D investment planning. The tool uses a rigorous multiple-model approach to capture warfighting impact and programmatic considerations for a wide variety of R&D programs being considered for funding. The process integrates elements of the Quality Function Deployment (QFD) and Analytic Hierarchy Processing (AHP) processes with a linear programming technique to optimize the CVX R&D investment strategy. The model is used periodically to re-evaluate the CVX R&D effort and re-optimize the strategy. This effort will continue as the CVX program matures, and form the basis for life cycle cost estimates and strategies.

Thursday, 1330-1500
Modeling of Affordability Issues

Requirements Analysis at Air Force Space Command

Dr. Larry Rainey
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Affordability Analysis of Alternative Spacecraft Launch Systems: The Light Gas Gun

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Low cost access to space has the potential to drastically modify our current philosophy on the construction, design, and use of satellites in Low Earth Orbit. This DARPA sponsored study reviewed several variants of the light gas gun as a method to deliver payloads to Low Earth Orbit on demand. In the course of the study we developed an affordability model of the launch system. By introducing stochastic elements into the model we developed a range of financial operating parameters for the system. We also developed a satellite constellation life cycle cost model which highlighted the cost differences between "business as done today" and the way a satellite constellation could be operated if the capability to place modest (100Kg) payloads into Low Earth Orbit existed. The results of the launcher cost effectiveness analysis were then used as inputs to the satellite constellation life cycle cost model.

Strategic Mission Implementation: A Value-Focused Approach

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Alternate Papers

Joint Strike Fighter Program Evaluation of Affordability Initiatives

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Theory of Modeling and Simulation

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This presentation starts with a discussion of complexity and variety as defined by Beer and Ashby. Variety is seen to be a measure of complexity. An example is shown to illustrate how different perceptions can lead to different measures of variety. The concept of Requisite Variety is then developed. The application of the concept is born out in the Conant-Ashby Theorem which states that every regulator (e.g. mechanical or managerial) requires a model of that which it regulates. This leads to the discussion of the computer as a laboratory. Five different means are addressed as to how the computer serves as a laboratory.

Integrating the Functions of Earned Value and Cost Estimating

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WG 28 – DECISION ANALYSIS – AGENDA

Chair: LTC Jack M. Kloeber, Jr., USA, AFIT
Co-Chairs: LTCol Lee Lehmkuhl, USAFA
Dan Dassow, The Boeing Company
Mark Robershotte, Pacific Northwest National Laboratory
Advisor: Terry Bresnick, Innovative Decision Analysis
Room: 332

Tuesday, 1030-1200
Working Group Introduction
LTC Jack M. Kloeber, Jr., US Army, Air Force Institute of Technology & Mr. Terry Bresnick, Innovative Decision Analysis

Selecting an Appropriate Decision Analysis Process
Mr. S. Matt Vance & Mr. Gary W. Gill, The Boeing Company

The National Reconnaissance Office Representative Program Value Model – Work-in-Progress
Mr. James L. Huttinger & Roland A. Saenz, Booz, Allen & Hamilton Inc.

Value Focused Thinking for Small Organizations
Major Allan R. Cassady, USAF, Air Force Space Battlelab

Tuesday, 1330-1500
Bosnia Force Structure Analysis (Troop to Task)
Mr. Karsten Engelmann & COL W. Forrest Crain, US Army, Center for Army Analysis

Current Operations in Bosnia
Mr. Karsten Engelmann & COL W. Forrest Crain, US Army, Center for Army Analysis

Bosnia Benchmark Assessment-Interim Update
Major Rick Holdren, TRADOC Analysis Center & Mr. Karsten Engelmann, Center for Army Analysis

Strategic Mission Implementation: A Value-Focused Approach
Dr. James K. Lowe, Lt Col Steven F. Baker & Lt Col Steve Green, HQ USAFA/DFM

Wednesday, 0830-1000
Utility Assessment for Air Force Space Command's Long Range Plan
Mr. Don Olynick, ANSER Corporation

Unexpected Benefits from Air Force Space Command's Space and Missile Optimization Analysis (SAMOA)
Mr. Michael Tedeschi, HQ Space Warfare Center

Maximizing Return on Investment: Refining Air Combat Command's Modernization Planning Process
Mr. David M. Hickman, HQ ACC SAS & Ms. Lisa Jean Moya, HQ ACC/DRMA

Aerospace Integrated Investment Study (ASIIS) Decision Support Model
Major Tim Gooley & Lt Col Milt Johnson, HQ AFSCPC/XPA, Lt Col Lee J. Lehmkuhl & Mr. Mike Tedeschi, HQ Space Warfare Center, Mr. Tom Delacruz, Scitor Corp, Ms. Patti Hickman, Mr. Bill Todd, & Ms. Lisa Moya, HQ ACC/DRMA

Wednesday, 1030-1200
A Value Focused Approach to Determining the Top Ten Hazards in Army Aviation
Captain Brian K. Sperling, Air Force Institute of Technology

Evaluating On-Orbit Servicing Alternatives for GPS
1Lt Adam Wallen, Captain Gregg Leisman, Lt Col Stuart Kramer & Major William Murdock, Air Force Institute of Technology

Use of Multiple Criteria Decision Analysis in the Marine Corps Advanced Amphibious Assault Vehicle (AAAV) Program
Mr. David V. Strimling & Dr. James M. Eridon, General Dynamics Land Systems, & Mr. Russell H. Bittle, Jr., General Dynamics Amphibious Systems

Wednesday, 1330-1500
A Hybrid, Interactive, Multiple Attribute, Exploratory (HIMAX) Approach to Force Evaluation for Army After Next
Mr. John D. Pinder, Doctoral Fellow, RAND Graduate School

A Graph Theoretic Architecture for Dual Control Decision Making in Multisensor Systems
Dr. Dennis Buede & Paulo Costa, George Mason University, Dept. of Systems Engineering

Modeling to Optimize Restoration Technology & Investments (MORTI)
Ms. Linda A. Coblentz, Center for Army Analysis

Thursday, 0830-1000
COMPOSITE GROUP F.. Room 144

Thursday, 1030-1200
Contractual Risk Allocation Decision Problem for Privatized Nuclear Waste Cleanup at Hanford, WA
LTC (Ret.) Mark A. Robershotte, Pacific Northwest National Laboratory

A Bayesian Decision Model for Battle Damage Assessment
Captain Dan Franzen, Major Raymond Hill & Lt Col Greg McIntyre, Air Force Institute of Technology, Dept. of Operational Sciences

A Bayesian Belief Network Approach to Analyzing Indicators and Warning Data
Mr. Marty Krizan, NSA D Group, Dr. Dennis M. Buede, Decision Logistics, & Mr. Terry Bresnick, Innovative Decision Analysis

Thursday, 1330-1500
Fuzzy-Genetic Decision Optimization for Tactical Course of Action Development
Major Robert H. Kewley, Jr., US Military Academy, Dept. of Systems Engineering & Mark J. Embrechts, Rensselaer Polytechnic Institute

Quality Function Deployment from an Operations Research Perspective
Lt Eve M. Burke, Air Force Institute of Technology, Dept. of Operational Sciences

Simulation-Based Acquisition (SBA) Decision Analysis Support
Col Kenneth C. Konwin, USAF, DMSO & Mr. Thomas S. Nelson, ANSER

WG 28 – DECISION ANALYSIS – ABSTRACTS

Tuesday, 1030-1200
Working Group Introduction

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Selecting an Appropriate Decision Analysis Process

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The purpose of this presentation is to convey the concept that there are different types of Decision Analysis (DA) processes, and each is appropriate for certain applications. The material contained herein represents lessons learned from DA applications at Boeing and heritage McDonnell Douglas since 1991. The language and examples are tailored toward military applications, but the principles are universal to commercial and business applications as well.

This presentation focuses on Multi-Attribute Utility processes, where some set of (possibly conflicting) objectives are used to prioritize competing solutions or alternatives. Other situations may be better handled with tools such as decision trees or influence diagrams.

The National Reconnaissance Office Representative Program Value Model – Work-In-Progress

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The "Work-in-Progress" presentation discussed the National Reconnaissance Office's (NRO) Liaison Officer (LNO) and Theater Support Representative (TSR) program value model. The problem was viewed from an economical perspective with two separate and distinct components. The first, to determine the highest pay-off locations to deploy LNO/TSRs – a site selection cost-effectiveness problem. The second issue, to select and evaluate, on an ongoing basis, the staff to fill the LNO/TSR positions. From a decision analysis perspective, these issues require different evaluation criteria and warrant building independent but related multi-attribute utility models. The briefing will include the final hierarchical taxonomy of both models; the set of evaluation criteria and corresponding quality metrics; V&V procedures; and candidate results.

Value Focused Thinking for Small Organizations

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The Air Force Space Battlelab experience proves rigorous decision analysis tools are practical for small organizations. Composed of less than 25 people with various operational experiences, the battlelab is effectively using Value Focused Thinking for improved decision making and resource allocation. The battlelab is dedicated to demonstrating the military utility of innovative ideas. These ideas are refined into low cost, rapid initiatives to demonstrate improvements to Air Force core competencies. The battlelab's legacy approach for decision making lacked objectivity and traceability. The Air Force Space Battlelab adopted Value Focused Thinking to develop a decision support tool. To keep the model manageable for the battlelab, the model is simplified by combining core competency tasks with a bottom-up approach. This focuses the model on Air Force corporate values while maintaining ease of use. The scoring method also reduces complexity by comparing initiatives only to the mission area impacted. While limited to only twenty measures of merit, the model has effectively supported resource allocation and decision making. Using the value model, two ongoing initiatives were eliminated and new initiatives are tailored to increase their value to the warfighter. Although the model is streamlined, scores remain consistent when initiatives are re-scored. The briefing includes a demonstration of an automated scoring system using an Access database. The methods used by the Space Battlelab can help other small organizations improve their decision making.

Tuesday, 1330-1500
Bosnia Force Structure Analysis (Troop to Task)

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An analysis of the current Troop to Task for the U.S. led Multi-National Division-North (MND(N)) was conducted using two approaches. The first approach consisted of developing an optimal force structure based on an established force cap or level. This approach developed an optimal force structure to that force cap level based upon force and type unit capabilities and the mission priorities for peace operations as defined in SACEUR, Commander Stabilization Force (COMSFOR) and the MND(N) Campaign Plan. Expert evaluations of unit capabilities to perform various tactical tasks required by the current operations, developed unit values and "costs" based upon how many soldiers in each unit (because this counted against the force cap). Then the tasks were weighted in accordance with the commander's priorities and using an additive value technique, computed weighted scores for the various force alternatives to develop preferred force alternatives. In parallel, we applied the "cost" and the benefit values to develop a Pareto frontier to identify the relative goodness of each alternative. In the second approach, a task to troop analysis without a force cap limitation was conducted. Here we identified those tasks that are required to be performed and then built mission task organized force (MTOF) type simultancity stacks to meet the requirement. It came as no surprise that the two approaches produced two different answers. The difference between the force structures developed by these two approaches represents the risk associated with a force cap-limited force.

Current Operations in Bosnia

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The U.S. led Multi-National Division-North (MND(N)) is one of the subordinate commands of the NATO-led Stabilization Force (SFOR). SFOR's responsibility is to help ensure that a peaceful, secure environment exists to allow the components of the General Framework, Agreement for Peace (GFAP) to be implemented. One element of the GFAP is the return of displaced persons and refugees (DPREs). One key location for DPREs returns is the contentious town of Breko. MND(N) supported the return of DPREs to Breko through the allocation of physical resources, and through analysis. While returning the DPREs, the Office of the High Representative (OHR) wanted to achieve several objectives:

1. Verify the legitimacy of claims to property,
2. Provide for the maximum return as quickly as possible,
3. Do not reward ethnic cleansing.

All three of these objectives combine to make the return of thousands of individuals a difficult process. MND(N) assisted in solving this problem by applying an informatics, or information-based, approach. Key components of information were collected and analyzed. This information was then provided to the decision-maker to determine the rate and process of return most suited to the three objectives stated by the OHR. This paper discusses the processes by which the information approach was conducted, as well as additional aspects of the DPREs process.

Bosnia Benchmark Assessment-Interim Update

MAJ Rick Holdren (TRAC), Mr. Karsten Engelmann (CAA)
A joint TRADOC Analysis Center (TRAC) and CAA presentation submitted by:
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The Benchmark Assessment is a process by which the NATO-led Stabilization Force (SFOR) assesses the progress the nation of Bosnia and Herzegovina has made towards implementing the General Framework, Agreement for Peace (GFAP). There are ten criteria by which progress is measured on a semi-annual basis. These criteria are broken down into various objectives, benchmarks based on those objectives, and specific questions to evaluate each of the benchmarks. An expert-assessment of each question was executed, and a weighting scheme applied to determine the final criteria scores. The purpose of the interim report was to update the critical, military-related, criteria to be briefed at NATO's 50th anniversary, in Washington D.C. This paper discussed the processes by which the Benchmark Assessment is conducted, as well as the additional aspects of the interim report.

Strategic Mission Implementation: A Value-Focused Approach

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The contemporary focus on performance and mission-oriented results is forcing managers to reassess the validity of traditional decision processes; in many cases, these analytical approaches do not provide adequate information for decision-makers. The approach described in this paper offers a performance-based decision and budgeting process that objectively orders alternatives according to established mission criteria. Using Value Focused Thinking, the US Air Force Academy has been able to allocate over $1 million of equipment funding without the divisive claims of departmental inequity. Additionally, the model offers an objective rubric for assessing how well aligned the organization's decisions are relative to its stated mission. Finally, the method incorporates the dynamic fiscal environment and provides the flexibility not only to prioritize initial budget allocation, but to also address year-end budget fall-out funds. As a result, Air Force Academy has made significant strides toward implementing a results-oriented budgeting and management system.

<u>*Wednesday, 0830-1000*</u>
Utility Assessment for Air Force Space Command's Long Range Plan

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Measuring how well you do your job can be very difficult in terms of what to measure, how to measure it, and the usefulness or utility of the information assessed. However, Air Force Space Command (AFSPC) is doing this as part of their Integrated Planning Process (IPP). AFSPC began by identifying the tasks they are assigned based on direction from Air Staff, DoD, and other levels of national guidance. They then quantified the accomplishment of these tasks employing utility and decision analysis tools to derive a military utility score for all current and future systems over a 25 year time horizon.

This presentation builds on the AFSPC work in progress, briefed at last years MORSS, to address how the military utility of current programs and future concepts (including non-material solutions, sustainment of current programs, etc.) are evaluated. Initially, workshops were scheduled to develop a candidate list of measures to evaluate task performance appropriate for each of the 33 AFSPC tasks. Along with a definition of each measure, the group (Mission Area Teams) also identified the appropriate type of measure to use (histogram, straight or curved

line, "s" shaped curve, etc.), units of measurement, and the range of values (i.e. the minimum and maximum utility points) for each measure. Next, a single dimensional value function was developed for each of the 201 task measures, which were then used to evaluate each current program and future concept through the year 2025. The results were then aggregated to compile one score for each program as an input to the next phase of the IPP process, the optimization routine. Details of the process as well as some lessons learned will be presented in this briefing.

Unexpected Benefits from Air Force Space Command's Space and Missile Optimization Analysis (SAMOA)

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In 1997 SAMOA's focus was on the investment analysis for Air Force Space Commands (AFSPC) Modernization Planning Process. Procedural changes and the change of emphasis from deficiency based to needs based planning, within AFSPC's Integrated Planning Process (IPP), prompted some pleasant surprises in 1998-99. AFSPC supports planning with 5 Mission Area Teams (MATs): Force Applications, Space Support, Space Control, Space Force Enhancement and Mission Support. They work through a 2 year cycle to produce integrated inputs to the Strategic Master Plan (SMP), the foundation to the AFSPC Mission Needs Statements (MNA), Concept Requirements Documents (CRD), Operational Requirements Documents (ORD) and Program Objective Memorandum (POM). The SAMOA process was to focus on the end of the IPP, the Integrated Investment Analysis (IIA). It was discovered that the analytical tools required to build the IIA helped the MATs through every step of the process. The IIA Strategy-to-Task hierarchy became central to the Mission Area Analysis. Mission Needs were addressed by weighting the STT hierarchy (creating a value model), assessing current capabilities and comparing them to objectives on a Single dimension Value Function for each measure under each task. Concepts were refined through assessment against the value model and finally an optimization analysis, considering cost, utility and launch constraints was performed. This discussion will walk through the steps of developing the value model and describe the process that allowed the spin-off to Mission Area and Needs Assessment. The investment analysis will be briefly discussed. A key focus of the discussion will be on lessons learned.

Maximizing Return on Investment: Refining Air Combat Command's Modernization Planning Process

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Air Combat Command spends over seven billion dollars annually on the modernization and procurement of weapons systems. The Modernization Planning Process (MPP) provides two products in order to aid in the decision of where dollars are spent. The first is a set of Mission Area Plans giving a 25 year fiscally unconstrained outlook for each mission area's needs, priorities, and systems to buy and / or improve. The second is a list of system procurements, which are optimized by military worth, technical risk, and acquisition, ownership, and shared costs at various funding levels.

The current process is complex. It relies on subjective scoring to determine the military necessity of developing potential future systems and making improvements to current systems (Needs). The current process also uses subjective scoring techniques to determine the military worth of technologies or hardware solutions to identified needs (Solutions). A serious issue is the questionable tie-in with the POM process. The lack of coordination and cooperation with planners and programmers results in a product that has not been used extensively to support the POM.

The refinement effort attempts to use multi-objective decision analysis techniques to correct shortfalls in the current process. The goal is to conduct a parallel effort with the current process that will validate improvements and gain support from the planners and programmers.

There are three major components of this study. The first is the refinement of the linkage between national strategy and the military worth of Solutions. We have reduced six hierarchical levels that terminated at a subjective evaluation of system worth to three levels which terminate at system attributes or measures of effectiveness. The second effort is to develop measures of effectiveness that can be used to objectively (either quantitatively or qualitatively) evaluate Solutions. The third piece of analysis is to develop a value model that will allow the determination of each Solution's military worth.

The conceived refinement provides a robust, traceable, and expandable process that will allow easier understanding and use by planners and programmers. It has its roots in facts and quantitative data and will allow users to more easily document the rationale for decisions and solutions sets.

Aerospace Integrated Investment Study (ASIIS) Decision Support Model

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ASIIS is an ACC and AFSPC effort to create a common framework and proof of concept that can be applied to aerospace modernization decisions. This includes the development of an integrated evaluation framework, common cost standards/guidelines and a common optimization model. The one-year effort is managed jointly by ACC/DRM and AFSPC/XPX. Study results should provide a significant step forward in presenting an integrated Aerospace modernization picture for use by the MAJCOM's, Airstaff and OSD.

One of the Key aspects of ASIIS is to develop a common analytical framework and decision support model that will be used to evaluate the combat capability of both air and space systems. Therefore, a common value model and corresponding set of measures are being developed to support air and space combat capability evaluations. We will highlight the issues of developing a common value model for this large, complex problem.

Wednesday, 1030-1200
A Value Focused Approach To Determining The Top Ten Hazards In Army Aviation

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The United States Army Safety Center (USASC) is challenged with identifying the most severe hazards in Army Aviation. This research utilizes value-focused thinking and multiattribute preference theory concepts to produce a decision analysis model designed to aid decision-makers in their analysis process. The value model is based on the Army's Risk Management doctrinal manual (FM 100-14) and has been tailored specifically for aviation-related accidents and hazards. The model determines and rank orders the severity and risk for 65 categories of accidents and 24 existing hazards. A thorough analysis of the relationship between the probability and severity of accidents and the risk of individual hazards was conducted. Understanding this relationship is instrumental in developing risk reduction controls. Hence, the information in this report was used to make recommendations to the USASC for developing controls to decrease hazard/accident severity and probability. The model provides decision-makers with a decision analysis methodology that is consistent with Army doctrine and the values of the current chain of command at the Army Safety Center. Furthermore the model can be adjusted for different leadership levels or situations. Use of this model can reduce the inherent risks in Army Aviation and therefore protect the military force as a whole.

Evaluating On-orbit Servicing Alternatives for GPS

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Satellites are the only major Air Force systems with no maintenance, routine repair, or upgrade capability. The result is expensive satellites and a heavy reliance on access to space. Satellites are designed to have maximum capability and then must be completely replaced when they fail or become obsolete. At the same time, satellite design is maturing and design life is getting longer making it more likely that satellites become obsolete long before they stop working. This situation has motivated the Global Positioning System (GPS) Joint Program Office to consider alternatives to its current mode of operations in an effort to quickly meet new requirements while minimizing cost. One possibility is to devise a means of working on satellites while they are on orbit, much as we can now work on terrestrial systems.

This research is a thorough decision analysis of on-orbit servicing architectures using robotic servicers for satellite repair and upgrade. This approach involved defining the problem framework, elaborating the value model, establishing value functions and assessing weights for each measure. The alternative generation portion of the approach developed different system architectures. Finally, the process used decision analysis to evaluate the alternative architectures in the context of the user's goals, and it identified the best alternative.

Use Of Multiple Criteria Decision Analysis in the Marine Corps Advanced Amphibious Assault Vehicle (AAAV) Program

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Multiple Criteria Decision Analysis (MCDA) was an integral part of concept definition for the Marine Corps AAAV program. Two levels of trade studies were performed: whole system and subsystem/component trades. Whole system trades determined the "best" balance of AAAV "core capability" performance requirements, cost, and weight. Subsystem/component level trades selected specific technologies to meet the performance requirements defined for each "core capability" in the whole system trades.

Whole system trades began with a mission area analysis that included definition of threat, user/source requirements, and operational & organizational concept(s). Low, moderate, and high target performance levels were then identified for system "core capabilities". Using a Design of Experiments (DOE) approach, functional relationships between the "core capability" target performance level requirements and combat effectiveness, cost, and weight were developed for use in a Multi Criteria Mathematical Programming (MCMP) model. The MCMP model was used to generate a set of non-dominated candidates that were then evaluated using MCDA to select the "best" alternative(s) as defined by "core capability" performance levels.

Subsystem/component trades were conducted based on the "core capability" performance level requirements selected in the whole system trades. Each "core capability's" level helped further expand/focus its technology search and evaluation criteria. The set of candidates, now defined by real technologies, was then evaluated using MCDA to select the "best" alternative(s).

This paper will describe the analysis process used for the AAAV whole system and subsystem/component trades.

Wednesday, 1330-1500

A Hybrid, Interactive, Multiple Attribute, Exploratory (HIMAX) Approach to Force Evaluation for Army After Next

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As the dawn of 21st Century approaches, the United States Army is, within its Army After Next (AAN) program, looking ahead to the year 2025. Projecting forward from present conditions, it envisions a future that is characterized by strategic uncertainty and regional instability. The greatest challenges in such an environment would stem from the frequency, diversity, complexity, and novelty—rather than the intensity—of regional conflicts. AAN planners are investigating a variety of rapidly deployable strike force options that are intended to meet these challenges. This type of force would need to be more capable than a modern heavy armored force, yet as transportable and self-sustaining as a contemporary light airborne infantry force. To achieve this exacting standard such a force must include new types of lightweight fighting vehicles that use advanced technology—either on board, or in other elements of the force—to augment their protection and firepower. In addition, this force must be organized around a concept of operations that exploits synergistic interactions among vehicles, weapons and sensors to increase its overall effectiveness. Thus, one of the key problems facing AAN planners is to decide what essential characteristics these new vehicles should have, and what type of operational concepts should govern their use.

This presentation describes a novel approach that is being developed to tackle the difficult force evaluation problem facing AAN. This new hybrid, interactive, multiple attribute, exploratory (HIMAX) approach interactively combines expert assessment with multiple attribute decision theory, combat simulation, and exploratory modeling to evaluate alternative force options. The HIMAX approach is ideal for evaluating future force options because it can: (1) capture synergistic operational interactions; (2) consider a range of mission scenarios and force options; (3) explicitly illustrate the impact of uncertainty in force characteristics and expert assessments; and (4) combine multiple objectives to assess overall force effectiveness. In general, the application of HIMAX to a specific problem involves six steps: preparation, generation, evaluation, exploration, interaction and prioritization. This methodology will be illustrated in the context of an analysis of AAN light strike force options. Some preliminary findings and recommendations derived from this analysis will also be discussed. These recommendations will primarily address the nature and composition of an AAN light strike force, but may also involve near-term decisions on how to allocate scarce research and development resources.

The specific methodology developed for this analysis will, necessarily, be customized to the particular problem facing AAN. Nonetheless, the HIMAX approach should be applicable to a wide range of similar force evaluation problems. Indeed, with appropriate modifications, the HIMAX approach might also be useful in other areas, such as strategic planning for space exploration.

A Graph Theoretic Architecture for Dual Control Decision Making in Multisensor Systems

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This paper develops a theory for combining decision analysis and Bayesian networks for the real-time, dual control analysis of complex systems. This combination of decision analysis and Bayesian networks is called Dynamic Decision Networks. This architecture is consistent with parallel processing architectures. Finally this theory is being applied to the management of sensor resources for multisensor data fusion systems.

Previous efforts to automate routine sensor management decisions have been largely unsuccessful because there have been no real-time decision structures with sufficient complexity to model the problem, with sufficient long-sightedness to consider the far-reaching impact of sensor decisions, and with sufficient flexibility to cope with pilot's requirements and mission objectives, both of which change over the course of the mission. However, recent breakthroughs in decision analysis and Bayesian networks provide for a new information/decision architecture called "Dynamic Decision Networks" (DDNs), which are designed specifically to solve the problem of optimizing information gathering processes in complex stochastic scenarios such as the fighter/attack aircraft encounters.

A DDN is a set of interconnected influence diagrams and Bayesian networks. Influence diagrams are a decision analytic and graphical construct for representing a decision problem in terms of decision, uncertainties and values, and the probabilistic and informational interactions among them. Bayesian networks are inference engines that model complex interdependent stochastic processes. In the present application, the DDN will consist of an influence diagram for each stage of the mission, each of which addresses the options available to the pilot and the options for sensor allocation. For each influence diagram there will be a Bayesian network that maintains the current uncertainty on all relevant random variables, based upon sensor and pilot reports.

Modeling to Optimize Restoration Technology & Investments (MORTI)

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The Defense Planning Guidance and US Army goal is to have remedy-in-place for all environmental restoration sites by FY 2014. MORTI developed and applied a methodology to aid the Assistant Chief of Staff for Installation Management (ACSIM) and major Army commands (MACOMs) in prioritizing funds for major commands for environmental restoration projects. An integer program (IP) was developed by the Center for Army Analysis (CAA) to help prioritize site/phases and to examine different priority schemes. The objective functions of the IP are to prioritize risk (environmental) reduction and prioritize MACOM closeout subject to budget constraints, phase staggering, and starting all site/phase. MORTI is currently being used to develop and evaluate environmental restoration strategies to support ACSIM in the POM build.

Thursday, 0830-1000
COMPOSITE GROUP F.. Room 144

Thursday, 1030-1200
Contractual Risk Allocation Decision Problem for Privatized Nuclear Waste Cleanup at Hanford, WA

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The Hanford Site in Southeastern Washington State has the largest concentration of radioactive waste in the DOE complex. Presently, approximately 54 million gallons of waste are stored in 177 underground storage tanks.

The Hanford Tank Waste Remediation privatization concept was adopted as a way to use the technologies, efficiencies, and discipline of private industry to help accomplish the mission of remediating the tank waste. The allocation of risk between private and government agencies was very complex and the concept of risk allocation became a critical component of the negotiations with the private sector. Risk allocation was a major concern because the success of the privatization initiative depended upon the ability to obtain private financing.

In an effort to understand the effects of risk on total program cost, government staff developed a mathematical model of the relationships among the elements of risk in privatization contracting. Risk allocation was defined within the terms and conditions of the privatization contract by assigning responsibilities for specific cost, schedule, and performance elements to the parties to the contract.

This paper describes the modeling process used for selected risks in the contract. The risk allocation model takes subjective probability and cost impact estimates from subject matter experts and uses a Monte Carlo simulation process, based on the commercially available @*Risk* software, to generate results. The model was used as a decision analytic/support tool to assist the DOE negotiating team in defining the terms and conditions of a multi-billion dollar privatization contract.

A Bayesian Decision Model for Battle Damage Assessment

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Battle damage assessment (BDA) is critical to success in any air campaign. However, Desert Storm highlighted numerous deficiencies in the BDA process, and operations since Desert Storm continue to point out weaknesses. We present a review of the Phase I BDA decision, or physical damage assessment, and model the decision process using a Bayesian belief network. Through subject matter expert (i.e., the targeteers) elicitation sessions, imagery was found to be critically important to the BDA process yet this information is generally not retained.

This use of "perfect information" is delineated in the BDA process models. We proposed a methodology based on Bayesian belief networks for incorporating this perfect information. We demonstrate the Bayesian belief network's capability to update conditional probability distributions using data generated in real world operations. This capability allows the network's conditional distributions to evolve, increasing model accuracy and reducing uncertainty in the decision.

A Bayesian Belief Network Approach to Analyzing Indicators and Warning Data

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This paper describes the results of a project to explore multi-dimensional statistical analysis tools for the purpose of data mining. Our ability to sift large volumes of data and quickly arrive at an actionable conclusion is increasingly challenged by an ever-decreasing work force both in terms of numbers and experience. State-of-the-art statistical analysis tools can offer some relief.

The project focused on the use of Bayesian belief networks to find patterns in data. The project explored the use of two COTS computer software applications: "Netica" from Norsys, and "Belief Network Power Constructor" (BNPC) which is freeware available from the Internet. The Bayesian approach yields a probabilistic network wherein each node/variable contains a conditional probability distribution relative to other nodes/variables.

Our findings are that belief networks can contribute substantially to the discovery of patterns in data and to the formulation of hypotheses that are basis for actions, in our case, the redirection of assets. The software reviewed for this task provided good visualization through the use of "belief bars" that automatically adjust with changes in conditional probability. Netica's belief bars provide the user with immediate feedback on the posterior probability of a variable in response to changes in other variables. The combination of the belief network derived from Bayesian theory and the multi-dimensional visualization provided by Netica combined to form a powerful analytic tool set that can assist decision makers.

<u>*Thursday, 1330-1500*</u>
Fuzzy-Genetic Decision Optimization for Tactical Course of Action Development

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Fuzzy-genetic decision optimization (FGDO) solves difficult optimization problems which require concurrent optimization of multiple objective criteria. It has three modules. The first module is a model which converts the inputs of the decision problem to outputs. In this case, a combat model produces battle results (outputs) for various defensive positioning plans (inputs). The second module is a fuzzy inference system which converts the simulation outputs into an overall preference value. The user specifies his or her battle outcome preferences using natural language through a graphical user interface. The system then generates a Sugeno fuzzy inference system which converts any battle outcome to a single preference value between zero and one. The third module, a genetic algorithm, is the engine which searches the area of operations for a population of courses of action which maximize the planner's preferences as determined by the outputs of the combat simulation model and the fuzzy preference model. For this particular problem, the user defines a two dimensional area of operations in which to search for defensive positions. The genetic algorithm varies the x and y coordinates of unit locations within this space searching for a near optimal course of action against the given set of enemy courses of action. The genetic algorithm produces several significantly different courses of action for further evaluation and selection. Test results show an ability to quickly find a number of different high-performance courses of action in several test scenarios. These results may be combined with human tactical analysis to generate the final plan.

Quality Function Deployment from an Operations Research Perspective

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The methodology of Quality Function Deployment (QFD) is compared to operations analysis standards. Of special concern is how Air Combat Command (ACC) uses QFD for the Modernization Planning Process (MPP). ACC digresses from the traditional use of QFD for incorporating quality into manufacturing processes to use it as a planning tool. ACC's goal in implementing QFD is to incorporate the demands of the Air Force mission into the modernization planning effort. ACC's use of QFD to identify and quantify current deficiencies and quantify the value of alternative future solutions has led to the investigation of inconsistencies with QFD, both generally and with how ACC employs it. In short, this thesis looks to improve ACC's current method for optimizing combat capability through both near-term and far-term modifications.

Simulation Based Acquisition (SBA) Decision Analysis Support

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A Joint Task Force on Simulation Based Acquisition (SBA) Task was chartered by the Acquisition Council of the Executive Council on Modeling and Simulation (EXCIMS) to develop an SBA Roadmap. A necessary pillar of that effort was the use of a decision aid that would systematically allow both the Task Force and a user community Coalition to identify, decompose and prioritize the essential elements of the multi-architecture Simulation Based Acquisition environment. The objective of this presentation will be to document an advanced, hybrid Quality Function Deployment (QFD) protocol used to elicit key elements, identify preferences, and focus recommendations made in the Simulation Based Acquisition (SBA) Roadmap development effort.

The representation in the user community Coalition involved was specifically designed to bring together the broad acquisition knowledge, specific technical specialties and unique organizational requirements that are considered fundamental to identify key SBA criteria. Throughout the process, information developed through different data collection mechanisms was compared for continuity of output and sensitivity to variations in Coalition voting patterns.

Illuminating trends and high leverage goals, strategies, attributes, and actions were identified. Rank order comparatives across various Government and industry communities were established to investigate the robustness of the "Coalition-as-a-whole" need versus unique "sector" needs. Link analysis between levels of element decomposition was conducted along with the development of cross correlation insights between the final rank ordered actions.

Results provided the basis to quantify the need and make reasonable difficult decisions on actionable activities that were recommended to the Acquisition Council membership.

WG 29 – MODELING, SIMULATION AND WARGAMING – AGENDA

Chair: Mr. Michael W. Garrambone, Veridian Engineering
Co-Chairs: Major Kenneth Dzierzanowski, USA, TRAC-WSMR
Major Leroy A. "Jack" Jackson, USA, TRAC-MTRY
Mr. Joseph L. Mason, Veridian Engineering
Major Philip B. Oglesby, USAF, Air Mobility Command
Captain Todd E. Combs, USAF, Air Force Wargaming Institute
LtCol. William A. Sawyers, USMC, J-8, Warfighting Analysis Division
LCDR Aasgeir Gangsaas, Naval Analyst, J-8, Warfighting Analysis Division
Advisor: Dr. Bruce W. Fowler, Technical Director Advanced Systems Concepts Office, AMCOM
Room: 369

Tuesday, 1030-1200; WARGAMES AND EXERCISES I
Wargaming to Support Senior Leader Decision Making
LTC Michael C. Wilmer, The Joint Staff, J8, Studies Analysis and Gaming Division

Use of Decision Support Systems in Gaming at the US Army War College
Major Michael Bridges, US Army War College

Air Force Participation in Title X Wargaming, FY 1998
Mr. John Noss, Senior Systems Analyst (STI), HQ USAF, Directorate for Command and Control

Alternate Presentations

Lessons Learned from Regional Political-Military Gaming
LTC Ralph R. Rhea, Russia, Europe and Gaming Officer, The Joint Staff, J8, Studies Analysis and Gaming

Tuesday Lunch Session Day 1, 1200-1300; WARGAMES AND EXERCISES II
Simulation In Support Of Mission Planning
Mr. Curtis L. Blais and Mr. William M. Garrabrants, VisiCom

The Role of Theater Ballistic Missile Defense in Global Engagement '98
Mr. Michael H. Griffin, Project Engineer/Analyst, Modern Technology Solutions Inc.

Wargaming with an Analytic Model – How THUNDER was used in Global 98
Major Timothy J McIlhenny, Chief Wargaming Branch, Air Force Studies and Analyses
Mr. David Lee, S3I

Tuesday Lunch Special Session Day 1, 1300-1330; LANCHESTER PROCESSES
Knowledge-Enhanced Lanchester Processes
Jerome Bracken and Walter Perry, The RAND Corporation

Tuesday, 1330-1500, GIANTS OF ATTRITION MODELING
Overview and Directions of Aggregated-Force Models
Dr. James G. Taylor, Naval Post Graduate School

Developing The Bonder-Farrell Equations: Historical Perspectives and Lessons
Dr. Seth Bonder, Vector Research, Incorporated

The Genesis of Phase Aggregations
Dr. Bruce W. Fowler, Technical Director, Advanced Systems Concepts Office, USA Aviation & Missile Command

Alternate Presentations

Requirements and Alternatives for the Next Generation Mission Model
Mr. Bruce Merrill, GS-14, Chief, Analysis Division, Air Force Material Command

Wednesday, 0830-1000; KNOCK DOWN DRAG OUT ISSUES
Battle of Khafji Revisited
LTC Peter J. Palmer, US Army, Naval War College, Lt. Col. David J. Scott, US Air Force, LTC John A. Toolan, US Marine Corps

What Happens When the Lights Go Out? The Problem of Causality in Strategic Effects Modeling
Mr. Joseph L. Mason, Veridian Engineering

Don't Panic: The Importance of Irony in Wargames
Dr. Peter P. Perla and Dr. Ed McGrady, Center for Naval Analyses

Alternate Presentations

Why Most Combat Models Should be Stochastic: Tales of When the Average Won't Do
Thomas W. Lucas, Associate Professor, Operations Research Department, Naval Post Graduate School

Can the Army M&S Management Be Improved?
Ms. Lounell D. Southard, GS-14, Brigade Models & Simulation, US Army TRAC-WSMR

Wednesday, 1030-1200: MODELING, SIMULATION, and WARGAMING EDUCATION
Directions in Modeling, Virtual Environments, and Simulation. (MOVES curriculum and research directions for the MOVES Research Center)
Prof. Mike Zyda, Modeling, Virtual Environments, and Simulation Academic Group (MOVES), Naval Post Graduate School

Modeling, Simulation and Analysis Education at the Air Force Institute of Technology
Col. John Andrew, USAF, Department of Operational Sciences, Air Force Institute of Technology
Lt. Col. Glenn Bailey, USAF, Department of Operational Sciences, Air Force Institute of Technology
Dr. James W. Chrissis, Department of Operational Sciences, Air Force Institute of Technology

USAF Prime Warrior Wargaming and Exercise Course
Captain Todd E. Combs, Chief, Operational Analysis Division, Air Force Wargaming Institute

ALMC Support to Modeling and Simulation Education
Mr. Dennis Fuller, US Army Logistics Management College, Department of Decisions Sciences
Dr. William Crocoll, US Army Logistics Management College, Department of Decisions Sciences

Wednesday Lunch Session Day 2, 1200-1300, R&D and EXPERIMENTS
An Examination of the Model-Experiment-Model (MEM) Process in Advanced Warfighting Experiments (AWEs) and Joint Experimentation
Major Kenneth Dzierzanowski, USA, U.S. Army TRADOC Analysis Center-White Sands Missile Range

Focusing Modeling and Simulation at Missile R&D Engineering Center: From Our Heritage to the Future)
Dr. Jeff Cerny, Advanced Systems Concepts Office, Aviation & Missile Command
Mr. Scott Callender, Quality Research

JMEM/Air-to-Surface Weaponeering System (JAWS)
Ms. Carolyn E. Holland, Chief, Air-to-Surface Weapons Analysis Branch

Wednesday, 1330-1500 : ALGORITHMS and TOOLS
Operations Planner: Strategy Cell Assistant
Major Douglas E. Fuller, Chief Combat Analysis and Wargaming, AF/XOOC, CHECKMATE

Protecting the High Ground: Injecting Space Superiority into Modeling and Simulation
Capt James B. Clegern, USAF, Advanced Aerospace Concepts and Space Warfare, Space Warfare Center
Capt Jonathan W. Thompson, USAF, Advanced Aerospace Concepts and Space Warfare, Space Warfare Center

Applying Operational Synthesis to Maneuver Warfare Questions
Dr. Gary E. Horne, CNA Representative, Marine Corps Combat Development Command
Capt. Brian L. Widdowson, MCCDC Studies & Analysis Division (C45)

Alternate Presentations

GLobal Architecture Combat Identification Effectiveness Requirements (GLACIER) Tool
Thomas Donohue, Air Force Research Laboratory
Jon Wollam, Veridian Engineering

An Object-Oriented Architecture and Software Approach for a PC Desktop Simulation of Aggregated Forces Using Differential Equation Models of Combat)
Robert L. Youmans, Senior Systems Analyst, Teledyne Brown Engineering

Thursday, 0830-1000; MODELING OF HUMAN FACTORS

From Rifleman to Warrior System: The Evolution of the Individual Dismounted Combatant

Mr. Victor Middleton, Simulation Technologies, Inc. and Mr. Robert T. McIntyre, III, Simulation Technologies, Inc.

Data Manipulation Techniques For Collection Of Skill And Ability Data For Human Performance Models In The Army Command And Control Domain

Mr. Sam E. Middlebrooks, GS14, Operations Research Analyst, U.S. Army Research Laboratory, Human Research and Engineering Directorate

Developing Realistic Human Behavior Simulations to Support Individual Clothing and Equipment Research and Development Using Commercial Software Development Kits

Mr. John A. O'Keefe IV, US Army Natick Laboratory, US Army Soldier Biological Chemical Command
Mr. Robert T. McIntyre, III, STI
Mr. David Zhu, The Motion Factory
Mr. Victor Middleton, Consultant

Modeling Military Behaviors for the 21st Century

Lt. Col. Allen S. Olson (USMC), Marine Liaison Officer for Combat XXI, US Army TRAC-WSMR

Alternate Presentations

Behavioral Validation of Information-driven Combat Models

Mr. Dorian Buitrago, The Aerospace Corporation
Mr. Robert Weber, The Aerospace Corporation

Thursday, 1030-1200

COMPOSITE GROUP G .... Room 144

Thursday Lunch Session Day 3, 1200-1300, SPACE AND LOGISTICS

Space Modeling and Simulation

Mr. Martin Solomon, GS-13, Space Superiority Analyst, Air Force Studies and Analyses, AFSAA/SAAS

Showing the Military Utility of a Space Maneuvering Vehicle in a Campaign Level Context

Capt. James R. Hunter, Lead, Future Space Vehicle & Weapon Development
Capt. Charles Galbreath, , Space Systems Analyst, SMC/XR, Systems Engineering & Integration Branch
Capt. Eric Frisco, Space Systems Analyst, SMC/XR, Systems Engineering & Integration Branch

Simulation Tools for the Warfighter: JRSO&I Applications

LCDR Steven D., SC, USN, Joint Transportation Officer Military Management Traffic Command

Alternate Presentations

C-17 Airdrop Simulation

Captain Scott Fox, USAF, Air Force Institute of Technology
Lt. Col. T. Glenn Bailey, USAF, Air Force Institute of Technology
LTC William B. Carlton, USA, Air Force Institute of Technology

Thursday, 1330-1500, THE ENVIRONMENT IN MODELING SIMULATION AND WARGAMING

JOINT SESSION WITH WG 11 .... Room 342

Toward a Common Synthetic Natural Environment

Mr. Clark D. Stevens, WARSIM, STRICOM

Atmospheric Effects and Impacts for High and Low-Resolution Warfare Models

Dr. Richard Shirkey, Army Research Laboratory

Putting Weather into Combat Simulation

Lt. Col. Frank Zawada AND Lt. Mike J. Currie, Air Force Research Laboratory

The Effects of Vegetation on Dismounted Infantry Operations

Mr. Danny C. Champion, US Army, TRAC-WSMR

Alternate Presentations

Modeling Atmospheric Effects on Missile Warning in the Missile Defense Space Tool
Capt. F. Anthony Eckel, USAF, Air Force Weather Agency Liaison to the Space Warfare Center

JWARS Synthetic Natural Environment
Mr. Gerald DePasquale, JWARS

WG 29 – MODELING, SIMULATION, AND WARGAMING - ABSTRACTS

Tuesday, 1030-1200, WARGAMES AND EXERCISES
Wargaming to Support Senior Leader Decision Making

LTC Michael C. Wilmer
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Wargaming is a frequently overlooked tool in the analyst's kit bag. However, it can be very valuable for providing a qualitative approach to examining complex problems. Using gaming to bring senior decision-makers directly into the analytical process is an effective way of assimilating diverse information, developing unconstrained approaches to problem-solving, challenging parochial positions, generating new policy options, and promoting common ownership of insights and recommendations.

The Joint Staff's Studies, Analysis, and Gaming Division (SAGD) has, since the early 1960s, used wargames to support analytical efforts on a wide range of political-military issues. We employ a variety of tools and techniques in assisting the senior leadership of the Department of Defense with gaining insights and perspectives on some of the most complex, sensitive, and intractable issues facing the Department. These issues range in scope from strategic to operational problems as well as wide-ranging solutions from investment in specific military capabilities through diplomatic negotiations to the implications of the specific use of force. Using gaming techniques we bring the senior leaders of the Organization of the Secretary of Defense (OSD), the Joint Staff, the Commanders in Chief, and the Services directly into the analysis process.

This presentation will focus on the historical role of our organization and the methods we employ to assist senior leaders in confronting complex policy issues, reexamining their own perspectives, and exploring potential solutions to complex policy problems.

Use of Decision Support Systems in Gaming at the US Army War College

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The Strategic Crisis Exercise (SCE) is designed to provide Army War College students with an opportunity to integrate and apply the knowledge acquired through the USAWC curriculum during the academic year through a series of crisis scenarios. Students, in a role of interagency staff, DoD commands, or theater level commands are immersed in a world of simultaneous crises each requiring strategic level actions. Analysts at the Center of Strategic Leadership have developed several decision support tools that aid both the student's and controller's information gathering data display, game control, and data collection.

Air Force Participation in Title X Wargaming, FY 1998

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The Air Force is actively involved in Title X wargaming, including its own Global Engagement (10-14 years into the future) and Aerospace Future Capabilities Wargame (20-25 years out) series, as well as participation in both Navy Global and the Army After Next series. This presentation focuses on Global Engagement and the opportunity it provides to explore evolving operational concepts in a non-threatening environment. The process through which concepts that emerge from wargaming are further examined through research, experimentation, and exercises is also explored. With increasing demands on the analytical community to support wargaming assessment processes, the Air Force is finding that current analysis tools are stretched to fill roles for which they were not originally intended. Examples include highly time-compressed evaluation of alternatives and interfaces with other specialized models/tools. Additionally, military science has yet to capture conceptually the fundamentals needed to properly value the theater-wide impact of aerospace forces at the operational and strategic levels of war, and ensure proper representation through models, simulations, and analytical tools. Some of these challenges and current resolutions will be described.

Alternate Presentations:

Lessons Learned from Regional Political-Military Gaming

LTC Ralph R. Rhea
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The Joint Staff's Studies, Analysis and Gaming Division has gamed several aspects of operational issues in national security for policy-makers with in the US Government. The seminar gaming methodology provides a flexible and cost effective method for examining complex problems, bringing consensus on policy amongst diverse organizations, de-conflicting strategic planning and rehearsing in-place or evolving inter-agency plans and procedures.

Political-military gaming provides a qualitative review of an issue, not a scientifically based quantitative review. The game's value often involves bring regional and functional experts and higher-ranking policy experts from the inter-agency community to quickly get to the core issues of a problem. Often the gaming methodology achieves levels of understanding and consensus much faster than normal staffing procedures. A few examples of qualitative games include:

- Recommendation of policies to guide US participation in particular peace operations
- Validation of an inter-cabinet level procedure for handling non-combatant evacuations
- Examination of possible political-military options for several possible futures in troubled regions
- Rehearsal of inter-cabinet plans for an evolving emergency overseas

The purpose of this MORS presentation is to provide real-world examples of political-military gaming with the Joint Staff and the Office of the Secretary of Defense as well as our lessons learned about the strengths and weaknesses of the discipline.

Tuesday Lunch Session Day 1, 1200-1300: WARGAMES AND EXERCISES II
Simulation In Support Of Mission Planning

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There has been an understanding by all military services that simulation systems provide an effective means to train combat units and their command structure to prepare them for eventual combat situations. Less well understood is application of simulation to support the command staff mission planning process. The Marine Air-Ground Task Force (MAGTF) Tactical Warfare Simulation ((MTWS) is a combat simulation system designed to train tactical commanders and their staffs. Insights into the potential of the application of simulation to mission planning were gained in a major Joint-level exercise conducted in 1998. For that exercise, an MTWS suite was employed in the future operations planning cell. A second MTWS suite supported the overall exercise conduct for senior staff training. This paper provides and overview of the application of MTWS to support mission planning in a major staff exercise, and describes the lessons learned from this exercise that will provide a basis for continued investigations in 1999.

The Role of Theater Ballistic Missile Defense in Global Engagement '98

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Last November, the Air Force held its Global Engagement 98 wargame. Focused on a operational level conflict with regional threat in 2008, the wargame, designed by the Air Force Wargaming Institute and RAND, sought to highlight the new Air Expeditionary Force (AEF) concept in a no-plan scenario. The wargame consisted of three simultaneous games with the same starting point, each with its own blue, red, and white panels. Each panel was staffed with the appropriate mix of retired Commanders in Chief (CINCs), current CINC staffs, professional assessors, country-specific experts, and modelers. Additionally, a game control cell provided overall management, a senior advisory panel struggled with National Command Authority decisions, and a request for information cell contained a host of system experts for reference. The conflict was waged on the ground, at sea, and in the air.

One of the key components of the threat was its large number of theater ballistic missiles. Employment these weapons was especially important within the context of the no-plan scenario as the threat often sought to keep US forces from deployment. Theater ballistic missile defenses (TBMD) played a decisive role in the outcome of each game. Most of the TBMD family of systems were presumed fielded to some extent, although none were deployed to the region at the outset of the wargame. Consequently, the impact of the TBMD systems on the AEF concept was substantial. This briefing touches on the overall game design, the specific role of theater ballistic missile defense, the pre-game analysis, the different challenges for TBMD and the resulting strategies, and the lessons learned both for the warfighter and the analytic community.

Wargaming with an Analytic Model – How THUNDER was used in Global 98

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THUNDER, the Air Force's premier campaign level model was used an assessment tool in the Navy's Title X Wargame, Global 98. Thunder output data was used to provide baseline data for the air and ground campaign and was used to track munitions inventories. Using a complex campaign model in a dynamic and fast moving environment provides unique challenges. This paper describes the process used to develop THUNDER for use in a quick turn environment, describes the tolls. Developed to quickly access THUNDER out put data, gives lessons learned for those desiring quick turnaround times and describes future plans to further improve turn time

Tuesday Lunch Special Session Day 1, 1300-1330; LANCHESTER PROCESSES
Knowledge-Enhanced Lanchester Processes

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The Lanchester attrition processes are perhaps the best known models of combat. They were developed by F. W. Lanchester just prior to World War I and were first published in his now famous book: *Aircraft in Warfare: The Dawn of the Fourth Arm (1916).* Lanchester distinguishes two forms of warfare: ancient and modern. The former is characterized by his linear law and the latter by his square law. In this paper we discuss both processes and present a third, information-enhanced variant we refer to as the Lanchester mixed law. This third law is an attempt to assess the implication of information superiority on ground combat in a way other than by the use of game-theoretic concepts. Unit effectiveness, force survivability, and force size as well as force structure may change as a result of better information. The Lanchester laws provide a useful set of models to examine these changes.

Tuesday, 1330-1500: GIANTS OF ATTRITION MODELING
Overview and Directions of Aggregated-Force Models

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This presentation gives an overview of the historical development of aggregated-force combat models, from ATLAS and the Bonder IUA to JWARS and AWARS. Future directions for both model development and also model applications are briefly indicated. Although model architecture and different battlefield functional processes are considered, the presentation's main focus is on aggregated-force attrition and opposed-force rates of advance. The theoretical and scientific foundations of the major aggregated-force attrition methodologies are reviewed, particularly the different approaches (i.e. stand-alone-analytical-model and hierarchy-of-models approaches) for determining numerical values for single-weapon-system-type kill rates for Lanchester-type models. Current problem areas (particularly lack of adequate documentation of basic model methodologies and its impact on development and use of model standards for the management of model development) are discussed. Impact of basic model-methodology shortfall on current analysis interests such as joint warfare, information operations/information warfare (IO/IW), C4ISR, electronic warfare and countermeasures, special operations/operations other than war (SO/OOTW).

Developing The Bonder-Farrell Equations: Historical Perspectives and Lessons

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The "Bonder-Farrell" equations are used in many of today's models of combat at the small unit engagement level to joint theater-level campaigns. The original equations were developed in the early 1960s and enhanced/expanded through the mid-1970s. This talk will describe some of the historical motivation for the developments and present some "lessons learned" for combat modelers, analysts, and the profession.

The Genesis of Phase Aggregations

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Phase Aggregation (PA) is a modeling methodology akin to System Dynamics based on the idea of aggregating at the combat process/subprocess level. While not limited to engagement modeling, an apt comparison with Lanchester Attrition Theory (LAT). LAT would aggregate all of the subprocesses of combat attrition in two attrition rate coefficients/functions and two attrition differential equations (Homogeneous form). PA would aggregate each of the *N* subprocesses into *2N* differential equations with the appropriate number of coefficients/functions, each representing a subprocess, to form a complete set of equations. As such, it provides a level of representation intermediary between LAT and platform/entity (P/E) level modeling. PA retains an easily comprehensible mathematical representation like LAT and unlike P/E. The price is greater overhead than LAT, but, again, less than P/E. In this presentation, we describe the basics of PA and trace its early development from field experiment inspiration through its current use in analysis. This presentation is a precursor to an educational class to be presented at 2MAS in the fall of 1999

Alternate Presentations:

Requirements and Alternatives for the Next Generation Mission Model

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We simulate war at every level from one-on-one engagements through campaigns. Recently, the military OR community began to transition this modeling from the venerable constructive models to the new object-oriented Joint models--the J-Triad of JMASS, JWARS and JSIMS. Unfortunately, the J-Triad does not cover the mission-level modeling now performed by the legacy models Suppressor, EADSIM and SWEG. As support for the older models disappear, what should replace them? The Next Generation Mission Model (NGMM) Alternatives Study faces this question. This paper discusses current and future mission model needs, and then assesses possible ways to satisfy them.

Wednesday, 0830-1000, KNOCK DOWN DRAG OUT ISSUES
Battle of Khafji Revisited

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General Bernard Trainor has called the Battle of Khafji the defining moment of Desert Storm. General Charles Link has stated we must reexamine how we spend our defense dollars to restructure our future forces due to Khafji. Three former USAF Chiefs of Staff all recognized Khafji as a maker of airpower's ability to leverage sensors and new weapons to gain the advantage over enemy maneuver forces.

This study examines Khafji to see if the ability of airpower to exploit the ground maneuvers elements exists and if it does decisively win the battle. To adequately examine the full scope of the battle, a joint team of Air War College officers was formed.

The study examines the ability of airpower to single-handedly decide the outcome of a battle. It is about finding the Iraqi intent. It is about assessing the Command, Control, Communications, Computers, Intelligence, Reconnaissance, and Surveillance during the battle and analyzing how it controlled the battle space. It appraises the Battle Damage Assessment and how it failed to correctly assess the destruction on the battlefield, both physical and functional. And it looks at our emerging Air Force Doctrine as seen through the eyes of this single battle. This study will look at these areas and analyses them in the context of Khafji and whether airpower can decisively win the battle.

What Happens When the Lights Go Out? The Problem of Causality in Strategic Effects Modeling

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Air power advocates have suggested that traditional "attrition" models do not capture the strategic "effects" of modern warfare. Col. John Warden contends that the increased ability of precision-guided munitions to hit critical targets has revolutionized warfare. He argues that precision targeting of all levels of an adversary's economic infrastructure and leadership can produce a desired strategic outcome. What is the link, however, between destroying critical targets and influencing the political will of a government? How can an analyst model the causal link between strategic bombing and the outcome of a war?

This paper will examine the problem of defining and quantifying the cause and effect links between strategic bombing and the outcome of a theatre-level scenario. The most recent air campaign in Iraq reinforces the relevance of answering the question of how strategic air power influences the outcome of a conflict. The findings are based on a year of research into the historical effects of strategic bombing on the political, economic, and military dimensions of World War II in Europe. This effort by the U. S. Air Force's Air University and CHECKMATE to model the strategic effects of air warfare not only suggested plausible ways to determine cause and effect links but also raised important and difficult problems for the wargaming, modeling and simulation community to solve.

Don't Panic: The Importance of Irony in Wargames

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Humans are messy. They don't do what you expect. They figure out ways to accomplish what they want to accomplish, whether anyone wants them to accomplish it or not. They are motivated by things that do not necessarily look good in training manuals or on the pages of the Post. However what people do is probably the most important of the realities that you try to capture through gaming. Unless you as a game sponsor are prepared to confront some to the creative and darker realities of human nature you will not be able to fully capture "human factors" in your games. To capture these "human factors" you need three things: honesty, a gamer's approach, and perhaps most importantly, the courage to believe your own game results.

You need to be honest about your systems, and people, in order to have a meaningfully real game. Gamers do this all the time. Few commercial games ignore panic. Soldiers under combat will do all kinds of things that are not necessarily consistent with doctrine or the manuals. Honesty is often achieved by gamers through their almost intuitive understanding of the irony of combat and human confrontations in general. People make unexpected choices. I you don't deal with players initiatives in honest and interesting ways; if players feel they should be able to do something, and they can't, you just lost your players along with any hope to realistically simulate large scale "human factors". After all, the players are your most important "human factors". Likewise, as most gamers know, you learn the most form the unexpected. People often win by doing something outside the rules, and seeing how they break the rules may tell you something important.

But breaking rules and honest representation of messy, controversial, areas is often where military and civilian professional gaming breaks down. Games are done for a purpose. Few want to expose that purpose to the vagaries of the unexpected, much less the potential controversy that could come from including messy factors in gaming. That is why gamers and bureaucrats will always be opposed: gamers understand the irony of the real world, while bureaucrats would prefer to keep it out. In this presentation we call attention to what we see as the ironic problems being faced today and recommend realistic solutions which will benefit both the wargame sponsor's interests as well as the skill and inventiveness of wargame developers.

Alternate Presentations

Why Most Combat Models Should be Stochastic: Tales of When the Average Won't Do

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A continuing debate in the defense analysis community is whether combat simulations should (generally) be deterministic or stochastic. This paper argues that the nature of combat, along with fundamental mathematical principles, implies that most combat models should be stochastic. Although significant costs are associated with stochastic models, the resulting benefits will usually far exceed the costs. For a given input set, stochastic models generate a sample of possible outcomes rather than a single result. Furthermore, deterministic approximations to stochastic elements almost always generate biases in outcomes, which might foster poor decision-making. To help focus an all-too-often abstract debate, this paper considers the spectrum of arguments for and against deterministic combat models. The emphasis is on real-world examples that illustrate that outputs of deterministic combat models tend to be systematically biased. The examples cover the critical combat elements of attrition, detection, timelines, tracking, data fusion, and queues.

Can the Army M&S Management Be Improved?

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The theme of the 67th MORS, "Focusing Military Operations Research: from our Heritage to the Future" is especially true in the evolution of models and simulations. Because of the increased dependence on M&S due both to the increased fidelity and decreased funding for field tests and training, the proliferation of Models and Simulations in the Army necessitated reorganizing M&S Management in 1996. The primary results of reorganization were establishment of the Army Model and Simulation Office as the centralized office for M&S management in the Army and the formation of three domains: Advanced Concepts and Requirements (ACR), Research, Development, and Acquisition (RDA), and Training, Exercises, and Military Operations (TEMO). The Army M&S Management encompasses documents governing the M&S management (to include DoD regulations) and the personnel actually responsible for managing M&S.

This paper presents an overview of the current Army M&S structure, a brief summary of the current Army M&S documents relating specifically to the management of the system, and an assessment of how well the Army M&S system is working. Data provided are obtained from surveying Army M&S managers in the three domains (ACR, RDA, and TEMO) concerning:

- Experience
- Extent of familiarity with M&S documents and personnel
- Perceptions of AMSO, the website and the Army Standards Process
- Resources expended on M&S management tasks
- Information/education sources
- Overall assessment of Army M&S

The conclusions and recommendations provided to senior Army leadership are presented.

Wednesday, 1030-1200: MODELING, SIMULATION, and WARGAMING EDUCATION

Directions in Modeling, Virtual Environments, and Simulation. (MOVES curriculum and research directions for the MOVES Research Center)

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The Naval Postgraduate School has spent the last two years developing a new degree program called the Modeling, Virtual Environments and Simulation (MOVES) curriculum. That curriculum has turned into an Academic Group, a department-like structure, and a research center. We discuss the composition of that curriculum and the directions for the MOVES Research Center.

Modeling, Simulation and Analysis Education at the Air Force Institute of Technology

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The Air Force Institute of Technology provides graduate education at the Master's and Ph.D. levels in a broad range of Engineering, Applied Science and Management areas. The mission of the Department of Operational Sciences is to support Air Force initiatives in all areas of modeling, simulation and analysis through educational delivery, AF-focused research, and consulting.

This presentation provides an overview of the AFIT Master's and Ph.D. programs, focusing on their modeling, simulation and analysis attributes. The Air Force relevance and focus of the Operations Research and Operational Analysis programs are emphasized. Current research and consulting efforts supporting the USAF mission are highlighted.

USAF Prime Warrior Wargaming and Exercise Course

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It has been over one year that the Prime Warrior Course has been in existence. During this time this Chief of Staff of the Air Force initiative to prepare Air Force participants for joint wargames, analyses, and exercises has developed into a much sought after course to attend. . The course was developed under the auspices of the Air Force XOC, Air Combat Command (ACC) and the Air Force Air Education and Training Command (AETC) and was designed and constructed by the USAF Wargaming Institute, Maxwell AFB, AL with support from Veridian Engineering at Air University's College of Aerospace Doctrine, Research, and Education (CADRE). The course contains all the foundation material on Operations Research, Modeling and Simulation, and Air Force/Joint Doctrine & Operations needed to understand and employ the variety of Joint Service Training and Analysis models used to portray the Services in Joint military wargames and exercises. Attendees will find the presentation to be both enlightening and entertaining which focuses on the lessons learned in preparing and teaching this course to an audience of such diverse military ranks and operational experience. The presentation talks to the learning issues, student demographics, controversy between Services, and the use of models of combat "in motion". Count on getting the warfighter's as well as analytical/training and education perspective.

ALMC Support to Modeling and Simulation Education

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This presentation will discuss various educational programs and products provided by the US Army's Logistics Management College in support of Operations Research education. It will discuss curriculum offered for the Operation Research Systems Analysis--Military Applications Course I and II (ORSA MAC I & II), Decision Sciences Courses, and a number of Costing Analysis courses for program managers, logisticians and engineers. The presentation will highlight the DoD sponsored ORSA Continuing Education Program (CEP) which provides a large variety profession military educational short courses on key and emerging special interest topics. The briefing is designed to provide a short overview of a number of interesting and valuable educational opportunities for military and civilian M&S professionals.

Wednesday Lunch Session Day 2, 1200-1300; R&D and EXPERIMENTS
An Examination of the Model-Experiment-Model (MEM) Process in Advanced Warfighting Experiments (AWEs) and Joint Experimentation

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This presentation examines the use of the Model-Experiment-Model process in Advanced Warfighting Experiments and Joint Experimentation. Lessons learned from the U.S. Army's Training and Doctrine Command (TRADOC) Analysis Center (TRAC) support of the MEM methodology in AWEs will be explored. Also, emerging observations will be made of the MEM approach as followed in Joint Experimentation.

The reality of 1999 is the renewed emphasis on Jointness. Jointness is combined with the Revolution in Military Affairs that is not only transforming technological capabilities, but our organizational structure, doctrine, leadership, and training requirements. Conducting an experiment, to include the use of AWEs, is one way that the Department of Defense is defining what organizational, doctrinal, and cultural changes are necessary to take advantage of the rapidly evolving environment.

An important lesson learned from AWEs is the success of the MEM process. Models and simulations are used in the first and last "M" to provide insights, develop future requirements, and explore advanced concepts. The MEM process is a proven winner. One goal of this presentation is to educate the OR analyst and avoid the expense in time and money of relearning old lessons.

In consonance with the MORS theme of "Focusing Military Operations Research: From our Heritage to the Future," AWEs and the use of the MEM process have and will provide insights into what will be the structure and role of the 21st century military.

Focusing Modeling and Simulation at Missile R&D Engineering Center: From Our Heritage to the Future)

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JMEM/Air-to-Surface Weaponeering System (JAWS)

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The primary goal of the Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME) is to provide Joint Service authenticated non-nuclear munitions effectiveness information for operational commanders, weaponeers, analysts, weapon system designers, testers, trainers, logisticians and DoD targeteers and planners. In support of this effort the Joint Munitions Effectiveness Manuals (JMEM) Air-to-Surface (AS) Working Group developed the JMEM/AS Weaponeering System (JAWS) CD-ROM product. It operates in Microsoft Windows on PCs. This presentation and demonstration will focus on JAWS version 2.0.

JAWS is a single source for air-to-surface analysis and weaponeering and target vulnerability. This CD-ROM hypertext document includes all JMEM/AS manuals, available effectiveness data and the methodologies/programs to generate effectiveness. JAWS includes Weapon Effectiveness, Selection, and Requirements (Basic JMEM/AS); Delivery Accuracy; Target Vulnerability; Weapon Characteristics; Radar and Visual Deliveries; Risk Estimates for Friendly Troops; Target Acquisition; Weaponeering Guide; Buildings and Hardened Structures; Tomahawk Weaponeering (Conventional), U/RGM-109C Block III and U/RGM-109D Land Attack; Conventional Air-Launched Cruise Missile Systems Description and Effectiveness; WINJMEM (Windows automated weaponeering program); Windows PC Effects (Penetration and Cratering Effects program); JSWM (Joint Smart Weapons Method), JAT (JMEM/AS Trajectory program); TAM (Target Acquisition Program); GAU-8 Gun method; Sensor-Fuzed Weapons (SFW) Lookup Program; Hard-Target Lookup Program; and the Target Vulnerability Data Access Program (TVDAP). JAWS provides rapid weaponeering and analysis using precalculated table look-up solutions or WINJMEM and associated programs to provide individual (Open-End) or large batch file calculations. An online help manual is provided.

Wednesday, 1330-1500 : ALGORITHMS and TOOLS
Operations Planner: Strategy Cell Assistant

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AF/XOOC, CHECKMATE, has acquired a PC-based tool that provides a strategy-to-task process for quickly and easily creating Master Air Attack Plans (MAAP) in the strategy cell of an Air Operations Center (AOC). This process starts at the National Level and logically develops objectives, measures of merit, and priorities for the each level of command down to the JFACC. Tasks are then developed as required to attain those objectives. Each task is then prioritized into a Joint Prioritized Integrated Task List. Assigning targets to these tasks produces the Joint Prioritized Integrated Target List (JPITL) that is used by the strategy cell to communicate the JFACC's air scheme of maneuver to the MAAP cell. The MAAP cell then produces a MAAP that is given to Combat Operations to produce and execute the Air Tasking Order (ATO). Operations Planner (OP) allows this process to be easily automated, manipulated, and archived. OP allows the production of the JPITL and MAAP. Embedded inside OP is SABSEL data to assist an experienced strategist in assigning limited aircraft and other assets to targets. Targets can be imported from the MIDB or added manually. Aircraft and Weapons can be added and assigned against targets. Targets are assigned to tasks using text- or map-based queries of the MIDB. Exports from Operations Planner can be imported to OPUS, and EADSIM for high fidelity routing and attrition analysis. Operations Planner's utility in rapid production of plans for current operations and exercises was the driver for its production for CHECKMATE. The presentation will consist of a demo of Operations Planner at the unclassified level.

Protecting the High Ground: Injecting Space Superiority into Modeling and Simulation

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Space superiority is a key feature of the Air Force Core Competencies. The proposed Space Operations Vehicle (SOV), Space Maneuvering Vehicle (SMV), and Common Aero Vehicle (CAV) are new systems requiring innovative methods to help achieve and keep Space superiority. This study explores some of the counter-space and space force projection implications of these systems using established wargame campaign models, simulations, and analysis (MS&A) tools. Our methodology will be to evaluate the SOV/SMV/CAV and build campaign model scenarios using current system characteristics, then compare campaign results with various numbers and types of weapons, plus various employment options. The study will focus on two main areas:

1. The SOVs on-demand single-stage-to-orbit lift capability and orbital deployment, plus implications of the SOV/SMVs orbital maneuvering capability and specialized payloads.
2. Exploration of SOV/SMV/CAV employment options, vulnerabilities, and countermeasures for incorporation into current and New Vector Models and future wargame Space play.

As the Air Force evolves into a Space and Air Force, space will become the next battlefield to dominate and protect. By building highly accurate Space models and tactics today, we can smooth the entry of these systems into the future warfighting force.

Applying Operational Synthesis to Maneuver Warfare Questions

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To begin to get at answers to maneuver warfare questions we are focused on explorations involving distillations of the essence of combat, visualization of the appropriate data, and understanding combat evolutions. This process of "Operational Synthesis" is a complement to traditional Operations Analysis—it supports the study of asymmetries, risks, and potentials through the use, inter alia, of agent-based distillations.

We are using agent-based models in particular for three reasons. One, they can assess the impact of often immeasurably small differences in initial conditions and intermediate interactions. Second, because tactics and doctrine need not be hard-wired into agent-based models, they exhibit emergent behavior such as discovering "tactics" and "asymmetries." They also hint at the risks and potentials associated with scenarios. Thirdly, if simulations are to be used to understand the complex nature of warfare it is essential that they be run many times—the Spartan nature of distillations enables this understanding.

In our presentation we will discuss results from millions of simulation runs obtained via supercomputing power. We will present the application of our Data Farming meta-technique in the context of questions related to maneuver warfare. In particular, we have developed a family of scenarios referred to as an Attrition Maneuver Yardstick because it serves as a tool to use in the process of beginning to understand how we might explore these questions.

Alternate Presentations

GLobal Architecture Combat Identification Effectiveness Requirements (GLACIER) Tool

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The constructive and deterministic GLobal Architecture Combat Identification Effectiveness Requirements (GLACIER) tool V1.0 was created to support the AFRL Air to Ground (A/G) CID Requirements Study being sponsored by The Air Force Combat Identification Integration Management Team (CID IMT) and HQ ACC/DRAI. GLACIER determines operational effectiveness of a sensor system-of-systems within the mission areas of Suppression of Enemy Air Defense (SEAD), Attack Operations (AO), Close Air Support (CAS) and Interdiction. It determines the expected number of desired and undesired (friend or foe) target kills based upon probability of target identification, sensor fusion, and probability of destruction. Sensor characteristics, operational doctrine and rules of engagement, architecture features, and mission area features are considerations accounted for in the tool.

A GLACIER run consists of a fixed-wing delivery aircraft loaded with air-to-ground weapons and an accompanying sensor suite flying a scripted route toward a fixed target set. The sensor suites may consist of visual, procedural, interrogation and reply (IFF), Non-Cooperative Target Identification (NCTI), or target identification broadcast. His on-board sensors are fused with information from off-board nodes such as a forward air controller (FAC), a Rivet-Joint surveillance aircraft, an unmanned airborne vehicle (UAV), a ground station which receives information from any of the above or from a space-borne system, or any other target identification source. Correlation is considered perfect at this time. The weapon's circular error probable (CEP) at target is then determined from the relative targeting accuracy (RTA) of these combined sensors. The probability of target destruction is found via a Joint Munitions Effectiveness Manual (JMEM) look-up. Fixed-wing attrition is also input and used in determining the probability aircraft reaching its weapon release point.

An Object-Oriented Architecture and Software Approach for a PC Desktop Simulation of Aggregated Forces Using Differential Equation Models of Combat)

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The availability of high performance desktop computers has provided an opportunity to greatly expand the use of simulation and analysis. The complexity and type of existing military force-on-force simulations begs for a quick-reaction, simpler tool to study force and C3I issues of aggregated forces. Mathematical models of combat based on differential equations such a Lanchester's models, as well as other models of combat, still have applicability, and can be used to study operational issues. These models, when coupled with modern Object-Oriented software techniques, and the availability and performance of PC platforms, allow significant analyses to be performed on desktop computers. We have developed an Object-Oriented software architecture and design that is a big step toward the delivery of such a simulation tool. The legacy simulation ELAN provides the mathematical models as a starting point. This PC-ELAN tool can potentially fill a niche by providing analytically rigorous force-on-force analysis, using desktop PC's, by taking advantage of modern software development techniques.

Thursday, 0830-1000; MODELING OF HUMAN FACTORS

From Rifleman to Warrior System: The Evolution of the Individual Dismounted Combatant

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Prior to the '90s, analysis of the individual soldier was focused primarily on the concept of the individual as one element in a unit's ability to mass firepower on an enemy. Equipment for the individual was developed as separate items or "eaches," and analysis of form and function concentrated on specific item requirements. The concept of the soldier as a system, developed about 10 years ago, recognized the need to look at integrated function of the "eaches." The downsizing of the military that occurred concurrent with this development increased the need to analyze what the individual combatant does and how well research and development supports acquisition of systems to help him achieve his mission. An emphasis on joint capabilities has further evolved the soldier system to the warrior system.

This paper traces the development of modeling and simulation tools intended to support such analysis, and ends with a look at the issues confronting continued development and application of those tools.

Data Manipulation Techniques For Collection Of Skill And Ability Data For Human Performance Models In The Army Command And Control Domain

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The Human Research and Engineering Directorate of the Army Research laboratory has developed a series of computer models that simulate human performance of commanders and their staffs in a battalion level Army tactical operations center. These computer models incorporate a taxonomy developed by Edwin Fleishman that identifies 52 physical and mental skills and abilities that can be used to describe human operational activities in any general work situation. The models use a task network analysis scheme to represent cognitive and physical tasks being performed by the operators in the TOC during combat activities by applying skill demand activities tied to the taxonomy. Numerical data for each operator related to the skill and ability matrix is used to calculate workload and utilization rates for the operator in real time as the model executes. Derivation of this numerical data is an exhaustive process that uses a computer based survey instrument to collect the skill and ability matrix information for the matrix of 50 skills and abilities, for 24 operators in the TOC with up to 15 survey respondents being queried for each operator position. This report documents the process of data capture for five top level job categories and the translation of that data into 32 functional task categories that are used in the computer workload models.

Developing Realistic Human Behavior Simulations to Support Individual Clothing and Equipment Research and Development Using Commercial Software Development Kits

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The need for robust, believable simulations of human reactive behavior in simulations used to support the design, evaluation, and acquisition of individual soldier clothing and equipment has been recognized for at least the last decade. Most past attempts to meet this requirement have fallen short of the desired autonomous, reactive simulation of the reactive behavior of individuals as well as groups of humans.

Many of the previous attempts relied heavily on human operators planning and controlling the actions of each simulated entity. This was necessary to overcome the limitations of existing algorithms that could both simulate typical human reasoning processes and still control multiple individuals in a real time or faster simulation/model.

Recently the developers of commercial computer games have overcome some of these limitations. The products of their efforts have been captured in commercially available software development kits (SDKs), which can be used to develop simulation engines to control the behaviors of simulated individuals and groups of individuals.

Initial efforts have been undertaken to link these commercial behavioral SDKs to existing high-resolution simulations of individual physiological behavior, performance, and survival. This paper will discuss these initial efforts and provide preliminary review of their findings.

Modeling Military Behaviors for the 21st Century

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Generating a realistic representation of behaviors is perhaps the greatest challenge in developing combat simulations which reflect human-like responses in implementing tactics, techniques and procedures (TTPs) within the virtual environment. In the past, most simulations have represented human behavior by hard coding. One notable exception to this rule is CASTFOREM, a model that attempts to portray decision making within some situationally dependent context through decision tables. COMBAT^{XXI}, the successor model to CASTFOREM, will attempt to extend this process to a new level by utilizing an inference engine working within an Object Oriented Programming (OOP) environment.

Since battlefield TTPs are never static, neither should simulated combat behaviors be static. Starting from a set of *primitive* behaviors, it is possible to compose higher level behaviors that are appropriate to various battlefield, equipment, and time frame parameters. The tightly-coupled inference engine and simulation engine combine to work on a set of objects, and they in turn are driven by a graphical user interface (GUI) which allows for the composition of those objects. Although it is not expected to create a perfect solution to the behaviors problem, it is expected that this infrastructure and the processes utilized in COMBAT^{XXI} will be state-of-art, and will carry the modeling of military combat simulation well into the 21st century. This paper presents an overview of the COMBAT^{XXI} behavior simulation architecture and discusses problems both faced and overcome in its implementation.

Alternate Presentations

Behavioral Validation of Information-driven Combat Models

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The validation question takes on a different focus for combat models used to explore relative utility of various weapons, sensors, information networks and tactics for the 2010-planning horizon. Reference to empirical data from test ranges or live combat simulation is not meaningful for future combat scenarios involving weapons and sensors which have not yet been developed and tactical doctrine which is still hypothetical. Comparison to other models or intelligence sources is likewise infeasible given that the state of research of combat phenomena from an information perspective is in its infancy and DoD models have just begun to address C4ISR variables.

This study follows a bottom-up theoretical approach based on C.J. Ancker's two axioms of combat presented in "A Proposed Foundation for a Theory of Combat" in the MORS "Warfare Modeling" handbook and other published work on salvo fire engagement. We use a Markov process approach to compare the results for engagements of both homogeneous and heterogeneous units of sensors and shooters with the outcomes of the same engagements as simulated by a time step, object-oriented Monte Carlo combat model which explicitly plays the effects of C4ISR.

Thursday, 1030-1200
COMPOSITE GROUP G .... Room 144

Thursday Lunch Session Day 3, 1200-1300, SPACE AND LOGISTICS
Space Modeling and Simulation

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This briefing discusses the current capabilities and requirements of Space Modeling and Simulation (M&S). The M&S process is defined, and the benefits of M&S are explained. The Space M&S goal, challenges, current status, and roadmap are presented. The Air Force Studies and Analyses Agency's Space M&S mission, customers, uses, needs, measures and analyses are described. Space Integrated Product Team questions are enumerated.

Showing the Military Utility of a Space Maneuvering Vehicle in a Campaign Level Context

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The Space Maneuvering Vehicle (SMV) has the potential for revolutionizing military affairs as we know it. It is a multi-mission support platform all four space mission areas: Space Support, Space Force Application, Space Force Enhancement, and Space Control. But before the acquisition decision is made, how do we prove that an SMV provides any additional worth to the war fighter on top of the forecasted space capability as a quantitative check to the US taxpayer? As directed by Air Force Space Command, SMCXR has undergone a rigorous qualitative analysis of the what makes an SMV unique and how it might support the campaign as well as operations other than war. Using a four pronged approach of qualitative analysis, quantitative analysis, cost effectiveness analysis, and technical risk assessment, we attempt to show what worth an SMV is to campaign level outcomes and cost requirements to achieve those outcomes. Using aggregated measures of effectiveness on the campaign we back out SMV architectures necessary to achieve the required level of effectiveness and associated cost and technology risks. The methodologies and results to date will be presented.

Simulation Tools for the Warfighter: JRSO&I Applications

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There are a number of modeling and simulation tools available today that assist the Joint Services and DoD planners in transportation logistics. Two of these tools, the Enhanced Logistics Intra-theater Support Tool (ELIST) and Port Simulator (PORTSIM) will be discussed here. Both ELIST and PORTSIM have been used by Joint Staffs and warfighters in the field to evaluate Joint Reception, Staging, Onward movement, and Integration (JRSO&I); this includes the force projection of units through ports, and forward movement ashore to the tactical assembly areas in theater.

However, despite their success and utility to joint planners, these simulation tools have not yet been significantly utilized by the Navy/Marine Corps team; this is an opportunity. These tools can be of great use to Navy/Marine Corps decision-makers in the planning and execution of the "Expeditionary Logistics" vision.

ELIST is a modeling and simulation tool that evaluates the transportation feasibility of a movement plan. It "flows" forces and equipment over a theater's transportation infrastructure and determines whether infrastructure and transportation assets can support the warfighting commanders' required force delivery dates. In other words, ELIST simulates the deployment of forces within a theater of operations. PORTSIM simulates port operations and determines port throughput at the item level of detail. It also identifies system and infrastructure constraints and port specific clearance profiles.

This paper provides an overview of ELIST and PORTSIM and some of the models' functionality. The intent is to summarize the utility these tools have to the Joint Services and DoD planners in transportation logistics, while highlighting the potential for future use. Two sample scenarios focusing on the JRSO&I of U.S. Marine Corps forces in S. Korea are discussed and an analysis on port throughput, closure, asset usage, and routes illustrate some of the ways these tools are used in JRSO&I and other areas of logistics.

Alternate Presentations

C-17 Airdrop Simulation

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We developed an object-oriented simulation that models the airdrop mission of the newest U.S. transport aircraft, the C-17 Globemaster III. The simulation, written in MODSIM III, is based on three object types that represent the C-17, the paratroopers, and the wake vortices generated by the aircraft's wing tips. The aircraft object provides the required aerodynamic constants for simulating the wake vortices off each wing tip; the wake vortex object includes both a position algorithm and a vortex decay model; and the paratrooper object implements a 6-degree of freedom trajectory model. The simulation outputs include complete trajectory information for all paratrooper objects, and identifies the maximum radial velocity and velocity gradients encountered by each paratrooper during their decent. We demonstrate the model with two case studies. First, we create a "Risk Assessment Tool for the Ground Commander." This tool quantifies the risk associated with paratrooper/vortex encounters in various formations with a quantitative measure, the potential encounter rate (PER). The PER is directly related to the aircraft formation, where the separation between elements significantly affects a contingency or combat scenario. Second, we provide a visualization of the simulation results on a Silicon Graphics Onxy2 Visualization Supercomputer in a 3D virtual environment, and demonstrate its use as an interactive tool for mission planning and prototyping of new aircraft formations or tactics.

Thursday, 1330-1500, JOINT SESSION WITH WG 11, THE ENVIRONMENT IN MS&W...***Room 342***
Toward a Common Synthetic Natural Environment

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Currently, vast resources are expended for each simulation in the development of highly specialized Synthetic Natural Environments (SNE). The result is a duplication of capabilities in similar but disparate representations complicating the correlation problem. A correlated SNE capable of representing a broad range of effects models and environmental content at varying levels resolution is needed.

Simulations such as Modular Semi-Automated Forces (ModSAF), Close Combat Tactical Trainer (CCTT), Warfighter Simulation (WARSIM) and Joint Simulation System (JSIMS) will be required to interoperate with each other and with C4I systems in the Digital Capstone Exercise and subsequent training exercises. At STRICOM, the WARSIM/JSIMS Synthetic Natural Environment (SNE) team is working closely with the Synthetic Theatre of War (STOW) program to provide a single, seamlessly integrated representation of the land, sea, air, and space, designed for reuse in other simulations and with consideration to interoperability with other systems. Related efforts supporting the goals of reuse include: DARPA's Advanced Simulation Technology Thrust (ASTT), JSIMS Terrain Generation Process, and Synthetic Environment Data Representation and Interchange Specification (SEDRIS. These efforts would extend the JSIMS Common Data Model (JCDM), the cornerstone of this process, to include the representation required in CCTT and OneSAF. This will in turn facilitate the development of correlated multi-resolution terrain databases, reducing cost and facilitating interoperability between simulations and with C4I systems. Other factors facilitating development of a common SNE to be addressed include; technological advances in computing resources and open systems architectures, advancements in Software Engineering methodologies, acquisition reform and associated Integrated Design Teams (IDT), and advances in the quality and correlated coverage of NIMA source data. This presentation will discuss STRICOM's development of a common database generation process under Technology Base funding and development of a strategy for a multi-resolution representation of terrain and environmental effects models and services under the DARPA ASTT program.

Atmospheric Effects and Impacts for High- and Low-Resolution Warfare Models

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The natural environment is an important factor in determining the outcome of real battles. However determining weather effects and impacts in warfare models frequently imposes a large computational cost. Low-resolution warfare models cannot afford to include physics-based calculations that are computationally burdensome for individual platforms and systems; while some high-resolution warfare models do include such computations, it is usually on a limited basis. This paper discusses proposed Atmospheric Standards being put forth under the auspices of the Army Modeling and Simulation Office that are useful for high and low-resolution modeling. The proposed Standards models include: a smoke obscuration model (COMBIC) currently used in CASTFOREM and elsewhere, an atmospheric sensor "noise" (path radiance) model (SGR), an attenuation model for haze, fog, rain and snow (XSCALE), and a climatological model (CLIMAT). Also, for low-resolution modeling, a completely new approach is presented that includes weather at an appropriate level of fidelity. This approach is based on the use of the doctrine-based Integrated Weather Effects Decision Aid model (IWEDA) tied with ACQUIRE, a range performance model for target acquisition systems. Thus, for given sensors, target and background types, probabilities of acquisition under various weather conditions can be tied directly to doctrine-based results resulting in weather penalties that are not computationally burdensome. The viability of this methodology is being examined using a beta version of AWARS.

Putting Weather into Combat Simulation

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Progress has been made in putting weather and effects into warming and simulations. However many of the models that are currently used in wargames and for assessing military effectiveness either account for weather poorly or not at all. Previous work by Air Force Research Laboratory (AFRL) achieved success in putting realistic weather and weather effects into a aircraft-weapon allocation model used to support campaign analysis. Results were used to demonstrate military utility for the joint departmental National Polar Orbiting Environmental Satellite System (NPOESS). Since then AFRL has taken the knowledge learned and is currently attempting to put realistic weather and weather effects into the Air Warfare Simulation (AWSIM) which is part of the CINC's ALSP Training Confederation. This will be a report the approach taken to integrate weather to effect air-to-ground sorties in AWSIM and how it was demonstrated in Blue Flag Exercises, one of the AF's premier training efforts.

The Effects of Vegetation on Dismounted Infantry Operations

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Prediction of realistic Line-of-Sight (LOS) conditions has always been an essential aspect of combat simulations. The representation of LOS in areas with surface features (vegetation) has never been extensively examined. However, recent advances in weapons systems, combat simulators, and the evolving mission requirements of the modern Army have demonstrated the need for a more precise understanding of how vegetation impacts LOS prediction. TRAC-WSMR and TEC recognize this problem and have developed a study to: (1) identify geotypical feature density zones; (2) document typical LOS within each with a field collection effort and; (3) predict future LOS performance. The study will: (1) facilitate the selection of a standard algorithm for LOS which performs effectively in varied feature densities and (2) provide recommendations on how to improve the play of surface features in combat models.

Alternate Presentations

Modeling Atmospheric Effects on Missile Warning in the Missile Defense Space Tool

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The atmosphere can absorb and scatter infrared (IR) energy emitted by a missile thus reducing the effectiveness of space based IR sensors. This paper presents the details of how atmospheric effects on missile warning are modeled in the Missile Defense Space Tool (MDST). The MDST is a medium fidelity model that simulates the ability of the DSP and SBIRS systems to detect enemy missile launches. It is the primary missile warning tool currently used at joint and USAF exercises such as Blue Flag, Roving Sands and Ulchi Focus Lens. To make MDST a realistic representation of missile warning, it is critical that it contains pragmatic atmospheric effects algorithms. This realism leads to more effective training for the warfighter.

To emulate the atmospheric effects on missile warning, two distinctly separate algorithms are applied in conjunction. This strategy is based on the fact that the principal influence on a sensor's inability to detect a missile is the interference of clouds. Therefore, the primary algorithm stochastically determines whether or not a cloud free line of site exists between a sensor and a missile based on a time varying cloud field. The secondary routine handles clear sky atmospheric transmissivity with the use of look-up tables built from the Moderate Resolution Transmissivity Model (MODTRAN) using fixed atmospheric profiles.

JWARS Synthetic Natural Environment

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This presentation describes how JWARS has leveraged several technologies and software to meet Synthetic Natural Environment requirements. The JWARS Coordinate System is an object-oriented encapsulation of the Global Coordinate System (GCS). JWARS Terrain is simulated using a set of reusable Compact Terrain Data Bases (CTDBs) and software libraries. The JWARS Movement Infrastructure is generated from CTDBs and algorithms contained in the NATO Reference Mobility Model (NRMM). JWARS Weather Scenarios are generated using a reusable Weather Scenario Generator (WSG). [WSG draws environmental information from the Master Environment Library (MEL), a virtual warehouse of Atmosphere, Ocean, and Space models and data.] JWARS solar & lunar phenomena and ephemeristic calculations are simulated using an adaptation of Solar Lunar Almanac Core (SLAC) system. JWARS is currently considering reuse of the Integrated Weather Effects Decision Aid (IWEDA) to generate weather effects on systems from JWARS Weather Scenarios. The JWARS SNE is a classic example of technology transfer and software reuse.

WG 30 – REVOLUTION IN MILITARY AFFAIRS – AGENDA

Chair: Scott Orton, ANSER
Co-Chairs: Jim Ackert, ANSER
Alex Metrovich, ANSER
Advisor: Frank Paparozzi
Room: 367

Tuesday, 1030-1200
Air Force Partnerships and Alliances Creating Opportunities for the Future
eborah Westphal, SMC/XR, Dr. Gregory S. Parnell and Richard Szafranski, TOFFLER Associates.

Utility Assessment for Air Force Space Command's Long Range Plan
Don Olynick, Civ, Operations Research Analyst, ANSER Corporation

Tuesday 1330-1500
SBIRS Military Utility Evaluation
Mr. Damon Lum, Senior Analyst, System Simulation Solutions, Inc., SWC/AE

Showing the Military Utility of a Space Maneuvering Vehicle in a Campaign Level Context
James R. Hunter, Capt, Lead, Future Space Vehicle & Weapon Development, Charles Galbreath, Capt, Space Systems Analyst, Eric Frisco, Capt, Space Systems Analyst,SMC/XR

Wednesday 0830-1000
Directed Energy Applications for Tactical Airborne Combat (DE ATAC) Study
Leslee E. Washer, Maj, Deputy Analysis of Alternatives Division, Office of Aerospace Studies

Analysis of the Expeditionary Aerospace Forces
Major Robert A. Morris and Major Eric A. Beene, AFSAA/SAAC

Wednesday 1030-1200
Operational Synthesis and the RMA
Dr. Alfred G. Brandstein, Chief Scientist, Marine Corps Combat Development Command and Dr. Gary E. Horne, CNA Representative Marine Corps Combat Development Command

A Better Way to Model Warfare for Analysis of Command and Control: Agent-based Modeling of War as a Complex Adaptive System (CAS)
Geoffrey Maron, Capt USAF, Battle Management Command & Control, Air Force Studies and Analyses Agency (AFSAA/SAAB)

Wednesday 1330-1500
Improved Military Long Range Planning Via An OODA Loop Construct
John M. (Chip) Yarger, Civ, Senior Systems Engineer, ANSER Corporation

Campaign Level Analysis of Space Based Laser Ancillary Missions
James R. Hunter, Capt, Lead, Future Space Vehicle & Weapon Development, Charles Galbreath, Capt, Space Systems Analyst, Eric Frisco, Capt, Space Systems Analyst, SMC/XR

Thursday, 0830 - 1000
Winner of the 1999 Hollis Award – ***Developing a Multiple Criteria Decision Model (MCDM) for the Design and Maintenance of a Baja Competition Vehicle***
Cadet Richard Thomas, United States Military Academy

Gaming Information
Walter Perry, John Gordon, Jerome Bracken and Richard Darilek, The RAND Corporation

Thursday, 1030-1200
COMPOSITE GROUP G .... Room 144

WG 30 – REVOLUTION IN MILITARY AFFAIRS – ABSTRACTS

Tuesday, 1030-1200

Air Force Partnerships and Alliances Creating Opportunities for the Future

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The strengths of aerospace power that enable or contribute to the accomplishment of US national security interests include access, adaptability, energy maneuver, persistence, perspective, precision, range, and speed. These strengths incorporate complementary air and space characteristics that, when combined, result in new and better methods of achieving aerospace superiority. However, to develop these strengths, the Air Force must stay competitive in an ever-changing environment. Real-world stresses, such as budgetary constraints, reductions is personnel and rapid technology maturation rates challenge the Air Force and threaten its ability to achieve defined goals for the future. Any one of these stresses would require a reframing of many Air Force processes. All three are occurring simultaneously.

The Air Force must now discover other models to accomplish the task at hand creatively. The Air Force also will need to assess its current corporate operations management processes and investigate commercial enterprises to determine innovative options for accomplishing critical Air Force operations in the 21st century. To fully exploit the opportunities open to the Air Force, we believe that the Air Force must have an ability to conceive, shape, and sustain a variety of strategic partnerships and alliances. The questions become: Can the Air Force leverage partnerships and strategic alliances to improve the efficiency of their operations management? Is the Air Force capable of taking advantage of opportunities when they are presented? Will they be able to recognize and act quickly enough to be able to take advantage of an opportunity when it presents itself? What changes will be needed internal to the Air Force for opportunities to be created, identified and exploited? This paper elaborates these questions, refines them through the application of business practices, and identifies the particular risks to the USAF.

Utility Assessment for Air Force Space Command's Long Range Plan

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Measuring how well you do your job can be very difficult in terms of what to measure, how to measure it, and the usefulness or utility of the information assessed. However, Air Force Space Command (AFSPC) is doing this as part of their Integrated Planning Process (IPP). AFSPC began by identifying the tasks they are assigned based on direction from Air Staff, DoD, and other levels of national guidance. They then quantified the accomplishment of these tasks employing utility and decision analysis tools to derive a military utility score for all current and future systems over a 25 year time horizon.

This presentation builds on the AFSPC work in progress, briefed at last years MORSS, to address how the military utility of current programs and future concepts (including non-material solutions, sustainment of current programs, etc.) are evaluated. Initially, workshops were scheduled to develop a candidate list of measures to evaluate task performance appropriate for each of the 33 AFSPC tasks. Along with a definition of each measure, the group (Mission Area Teams) also identified the appropriate type of measure to use (histogram, straight or curved line, "s"shaped curve, etc.), units of measurement, and the range of values (i.e the minimum and maximum utility points) for each measure. Next, a single dimensional value function was developed for each of the 201 task measures, which were then used to evaluate each current program and future concept through the year 2025. The results were then aggregated to compile one score for each program as an input to the next phase of the IPP process, the optimization routine. Details of the process as well as some lesson learned will be presented in this briefing.

Tuesday 1330-1500

SBIRS Military Utility Evaluation

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HQ SWC/AE conducted this study of the Space Based Infrared System (SBIRS) at the request of HQ AFSPC/DRF/XPA and HQ USSPACECOM/J5R. The Defense Support Program (DSP) is being replaced by the SBIRS program as the answer to the evolving tactical ballistic missile threat and the need in future conflicts to perform the added missions of missile defense, technical intelligence, and battlespace characterization. The SBIRS program consists of two elements: SBIRS High and SBIRS Low. The SBIRS High element features a mix of geosynchronous earth orbit satellites, highly elliptical orbit satellites, and a new consolidated ground processing station. SBIRS High will incrementally replace the existing DSP infrastructure over the FY99-FY03 timeframe, with initial satellite launches in 2002. The SBIRS Low element consists of low earth orbit satellites and faces a deployment decision in 2000. Both SBIRS High and DSP detect and report strategic and tactical missile launches. This study focused on SBIRS High and DSP capabilities to assist in Theater Missile Defense. Computer simulation runs were made for SBIRS High and DSP using each system's performance data. The Air Force's legacy campaign model, THUNDER, generated 20 days of combat results for analysis. The resulting comparative analysis determined the relative military utility for SBIRS High versus DSP.

Showing the Military Utility of a Space Maneuvering Vehicle in a Campaign Level Context

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Charles Galbreath, Capt, Space Systems Analyst
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Approved abstract unavailable at printing.

<u>*Wednesday 0830-1000*</u>
Directed Energy Applications for Tactical Airborne Combat (DE ATAC) Study

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What if you went to war and all you had to bring was your aircraft and fuel? No bombs. No bullets. A fantasy? General Ronald Fogleman, Retired, leads the ongoing Air Force Research Lab DE ATAC study to identify and evaluate promising airborne tactical applications of directed energy technology to pinpoint future investment strategies for technology development and demonstrations. A tantalizing peek at possible 21st century Air Force capabilities.

Analysis of the Expeditionary Aerospace Forces

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In response to reduced AF budgets and higher operations tempos caused by higher overseas commitments, in August 1998 the CSAF directed the standup of the Aerospace Expeditionary Force (AEF) to occur by 1 October 1999. On 23 September 98, MGen Donald Cook in coordination with BGen Ben Robinson appointed AFSAA to "collect information and direct analyses as required" to support Expeditionary Aerospace Force (EAF) and AEF implementation. Since that time, the AFSAA team has organized an "Analysis Flight Plan" to meet all of the challenges this broad tasking brings about. Using the AF/XOPE Implementation Task Plan as the initial guide, AFSAA developed nine areas for in-depth study, consisting of the following: EAF Seminar Wargame, Low Density/High Demand Analysis, Expeditionary Location Feasibility, Battlelab Assessment, FDO Analysis, Split Operations, EAF Historical Research, EAF Scenario Development, and Deconflicting Competitive Sourcing and Privitization Impacts on EAF. This presentation discusses the EAF Concept, the prioritizing of analysis requirements, some of the methods and techniques employed, the lessons learned, and the future requirements for analysis.

<u>*Wednesday 1030-1200*</u>
Operational Synthesis and the RMA

Dr. Alfred G. Brandstein, Chief Scientist
Marine Corps Combat Development Command
Dr. Gary E. Horne, CNA Representative
Marine Corps Combat Development Command

The process of "Operational Synthesis" is a complement to traditional Operational Analysis. As currently practiced, Operational Analysis includes the process of breaking down a system into component parts, understanding the parts and then reassembling them. But in order to produce the details, the richness of the system is often lost. Operational Synthesis strives to understand the richness of the whole, but often forsakes the detail. In this presentation we outline our view on the tenets of what we call the *Real* RMA and how Operational Synthesis may help develop necessary support to decision-makers in the changing world environment and advancing technology of the 21st century.

In confronting the analytical challenges of the Real RMA, the United States Marine Corps has embarked on a multi-disciplinary method of inquiry with the ultimate goal of producing better maneuver warriors. In this presentation, we will describe our efforts to use new models and techniques to expand our intuition, integrate results into the USMC Combat Development System, and help develop better combat models and interpret them. While we focus on Operational Synthesis, efforts in this area alone can not fully answer our questions. It is our contention that the merging of Operational Synthesis and Operational Analysis will produce the Operations Research framework to support the 21st Century warfighting decision-maker.

A Better Way to Model Warfare for Analysis of Command and Control: Agent-based Modeling of War as a Complex Adaptive System (CAS)

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Current combat models are inadequate for modeling strategic and non-linear effects. Most current models were constructed in a reductionist manner based on linear equations. This approach yielded attrition oriented models that do not capture the complexity inherent in warfare. While effects of many methods of warfare are inaccurately represented in attrition based models, methods dependent on non-linear effects suffer the greatest misrepresentation. The inaccurate representation of Marine forces prompted the Marine Corps into a pursuit of CAS modeling techniques for maneuver warfare. A similar recognized weakness in current campaign level models is the inability to represent the non-linear and strategic effects air power can have when applied to enemy centers of gravity. Air power brings more to a campaign that just the killing power of its munitions, but with current models, air power is played as a weapon delivery system only.

The "New Sciences" of Complexity and Chaos provide a new framework with which to analyze systems. We are exploring the modeling of war as a complex adaptive system with an agent-based model and investigating the force multiplying effects of C2. Agent-based models are intended to capture the complexity inherent in a system by capitalizing on simple primitives of the system. The primitives of a system are those system properties, components, and interactions that drive system behavior. Oftentimes, a relatively complicated system can be accurately represented with a collection of simple primitives. A more accurate representation of war will allow the examination of non-linear and strategic effects. Agent-based models may increase our ability to analyze the strategic effects of air power, information war, terrorism, C2 warfare, space power, nuclear weapons, and psychological operations.

Wednesday 1030-1200

Improved Military Long Range Planning Via An OODA Loop Construct

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Two key challenges for military long range planning are: 1) the integration between long range plans prepared across multiple military organizations (e.g., AF MAJCOMs and CINCs' and Services' planning staffs); and 2) to better support national security goals within the less predictable, technologically proliferating post-Cold-War global security environment. This "work-in-progress" briefing explores the use of the Observe – Orient – Decide – Act (OODA) loop as the military activity "design construct", within a qualitative value model, to facilitate addressing both these challenges.

Military long range planning usually begins with top-level planning guidance (such as National Security Strategy, National Military Strategy, Joint Vision 2010, the various CINCs' and Services vision documents, etc.) and focuses "downward" on mission / task / investment details. Both the USAF Modernization Planning Process and AFSPC Integrated Planning Process are based on defining the Strategy to Task hierarchy of operational and support tasks to be performed by the forces being planned for. This briefing discusses the OODA loop's "downward" application for both: 1) defining operational / support tasks; as well as 2) effectively integrating the interactions between tasks of multiple organizations.

The briefing then examines the same OODA construct's even more far-reaching, "upward" implications for military long range planning by applying it to explore potential improvements in military strategy and doctrine in order to better meet the post-Cold-War needs of the civilian political leadership.

Campaign Level Analysis of Space Based Laser Ancillary Missions

James R. Hunter, Capt, Lead, Future Space Vehicle & Weapon Development
Charles Galbreath, Capt, Space Systems Analyst
Eric Frisco, Capt, Space Systems Analyst
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Having a weapon system in space for NMD and TMD can provide a significant advantage against opponents who rely on TBMs for their main offensive. However, what value can this weapon system add when it is not performing its primary mission? SMC/XR set out to provide a military worth assessment of ancillary missions of the SBL in the hopes of quantitatively demonstrating the greatest benefit of having an SBL when employed against an adversary that does not use TBMs or has had its TBM threat countered. This presentation will focus on the methodologies employed in playing an SBL's ancillary missions in a campaign using a Quick Reaction Analysis (QRA) modeling paradigm and the outcomes for that campaign.

<u>Thursday, 0830 - 1000</u>
Winner of the 1999 Hollis Award – ***Developing a Multiple Criteria Decision Model (MCDM) for the Design and Maintenance of a Baja Competition Vehicle***

Cadet Richard Thomas
United States Military Academy
West Point, NY 10996

In a previous course I took in Mechanical Engineering at West Point, a design team selected a set of "best" components with which to build a Baja competition vehicle. This selection was generally based on their individual component performance parameters in consideration of total budget limits, although in some cases where a subjective tie in performance assessment occurred, it was broken arbitrarily. The limitation of this design methodology was two-fold. First, it did not consider component, assembly, and maintenance (life-cycle repair and replacement) costs (including labor). And secondly, a tradeoff analysis was not performed that would identify sets of "near optimal" designs in light of these considerations.

We propose a multi-period design optimization model based on goal programming that seeks to identify a set of "best solutions" under the criteria of minimizing overall costs while maximizing component performance under both recreational and sport use conditions. We also demonstrate a novel degradation of component performance over the operational period that explicitly recognizes the complete operating environment in light of maintenance actions. Our computational experience in attempting to create a user-friendly, spreadsheet implementation will also be discussed..

Gaming Information
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Approved abstract unavailble at printing.

WG 31 - COMPUTING ADVANCES IN MILITARY OPERATIONS RESEARCH

Chair: Pamela Blechinger TRADOC Analysis Center – Fort Leavenworth
Co-Chairs: Camillus (Dave) Hoffman, TRADOC Analysis Center – White Sands Missile Range
Shirley Pratt, TRADOC Analysis Center - Monterey
MAJ Paul Warhola, OSD (PA&E) JWARS
Advisor: MAJ William Murphy, TRADOC Analysis Center - Monterey
Room: 365

Tuesday, 1030-1200
Modeling Military Behavior Using JESS (The Java Expert System Shell)
Camillus W. D. Hoffman, TRADOC Analysis Center-White Sands Missile Range

ModSAF's CSS Representation: Its Current State and Suggested Improvements
MAJ Mark M. Lee, TRADOC Analysis Center-Ft. Lee

OneSAF Testbed Baseline (OTB) is not OneSAF
Major J. Scott Billie, HQ US Army Training and Doctrine Command-DCSSA

Tuesday, 1330-1500:
Planning and Executing Data Collection and Analysis for HLA federations.
Paul B. Perkinson, Director of Software Engineering, Virtual Technology Corporation

Autonomous Agent Data Collection and Analysis Tool – Remote Data Collection from Distributed HLA Experiments
Neal T. Lovell, Operations Manager, Quality Research Incorporated

Analysis Federate in the Joint Advanced Distributed Simulation Joint Test Force (JADS JTF) Electronic Warfare (EW) Phase II
MAJ Murphy, US Army TRADOC Analysis Center – Monterey

Wednesday, 0830-1000
DoD M&S VV&A Recommended Practices Guide
Susan D. Solick, TRADOC Analysis Center, Fort Leavenworth, KS

Conceptual Model Descriptions
Dr. Dale K. Pace, The Johns Hopkins University Applied Physics Laboratory (JHU/APL

Common Threat Representation in Simulation, Analysis, and Testing of Integrated Ship Defense
Richard Reading, Principal Engineer, Litton PRC

Wednesday 1030-1200
Digital Leaders Reaction Course
Michael J. Tavares, TRADOC Analysis Center, Fort Leavenworth, KS 66027

Intelligent Automation of Critical Decision Information for Synthetic Environments
William J. Gerber, Research Fellow, STRICOM PM-WARSIM

Developing a Modern Simulation from a Legacy Model
MAJ Gerald M. Pearman, US Army TRADOC Analysis Center – Monterey

Wednesday, 1330-1500
Improving the Performance of HLA Applications By Multi-threading RTI Services Using the Proxy Design Pattern
Robert L. Youmans, Senior Systems Analyst, Teledyne Brown Engineering

ASESS HLA Interface Implementation to Support Execution in Multiple Federations
Ms. Callie M. Hill, Engineer, Teledyne Brown Engineering

Thursday, 0830-1000
Simulation and Modeling for Acquisition, Requirements, and Training (SMART)
Ms. Diane Scharein, C, M&S Division, DCSCD, HQ TRADOC-Fort Monroe

So You Want to Develop a New Model or Simulation for the Army
Ms Leslie Lampella, Senior Operations Research Analyst, HQ US Army Training and Doctrine Command

Using Modeling and Simulation to Reduce Cost of USMC Anti-Tank Missile Testing
Ms. Sara McAffery, The MITRE Corporation

Thursday, 1030-1200
COMPOSITE GROUP G .... **Room 144**

Thursday, 1330-1500
SWIM – Web Based Scenario Editor Bringing Weather to the Synthetic Battlefield
Paul D. West, Instructor and Director,Combat Simulation Laboratory, United States Military Academy

OLAP/Web Technology, Presenting Data for Decision Support
William Branley, Software Engineer, Kinetic Technologies, Inc.

Simulation Marginal Analysis
F. Michael Slay, Research Fellow, Logistics Management Institute

WG 31 - COMPUTING ADVANCES IN MILITARY OPERATIONS RESEARCH - ABSTRACTS

Tuesday, 1030-1200
Modeling Military Behavior Using JESS (The Java Expert System Shell)

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Some current simulation models used to portray military operations rely on decision tables to represent human behavior. These decision tables allow tactics, techniques, and procedures (TTPs) to be portrayed within the simulation. However, they lack flexibility, allow only a limited number of outcomes and can be difficult for a user to understand. Due to the limitations of decision tables some developers have written simulation models using AI (Artificial Intelligence) languages. While the decision making process is enhanced in these simulations, the core simulation is difficult to develop and maintain. Additionally, simulation models written in AI languages often suffer from a lack of computational performance when compared with models written in conventional languages. Other developers have attempted to take advantage of both a conventional language and an expert system by linking the two together. Linking a simulation written in a conventional language with an expert system shell has proven to be quite cumbersome. JESS (The Java Expert System Shell) overcomes many of the challenges associated with the linking of the core simulation and the expert system. Jess can be tightly coupled to a simulation written in the powerful, highly portable Java language.

A small military simulation model was written using Java and JESS to explore their potential use in the COMBAT XXI model. COMBAT XXI is the successor model to CASTFOREM and will attempt to utilize an inference engine working within an Object Oriented Programming (OOP) environment.

ModSAF's CSS Representation: Its Current State and Suggested Improvements

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This paper describes the Combat Service Support (CSS) representation in the Modular Semi-Automated Forces (ModSAF) simulation. TRAC-LEE enhanced the baseline representation in conjunction with functional experts from the Combined Arms Support Command (CASCOM). With functional guidance from CASCOM TRAC-LEE developed representation of a FXXI Forward Support Company (FSC). While supporting CASCOM in a simulation exercise (SIMEX) with exploratory analysis of a future US Army Strike Force, TRAC-LEE added further CSS enhancements. With experience gained in these activities, TRAC-LEE continues to add CSS representation and has suggestions for further improvements.

OneSAF Testbed Baseline (OTB) is not OneSAF

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One Semi-Automated Forces (OneSAF) is defined as a composable next generation Computer Generated Force (CGF) that can represent a full range of operations, systems, and control process (TTP) from entity up to battalion level, with variable level of fidelity that supports all M&S domain (ACR, RDA, TEMO) applications with an emphasis on human-in-the loop and no human in-the-loop. The program is being developed using a parallel design process broken down into the OneSAF Testbed Baseline (OTB) and the OneSAF Objective System (OOS). As this is a somewhat new development approach, there has been some confusion throughout the M&S community with regards to deliverable products. The OTB is not the final version of the OneSAF simulation. The OTB is using ModSAF v 4.0 as a baseline with ModSAF v 5.0 improvements to being incorporated. Using a series of build and version releases, the OTB will incorporated new functionality and technology. Build releases will be send out to selected testbed sites as part of the verification and validation (V&V) process. The objective is to port proven functionality into the final OOS. The OOS is a parallel development effort to build a new architecture for the OneSAF simulation. Current simulation architectures do not support future requirements such as training the digitized force. The new architecture will concentrate on operational concepts such as Composability, Scalability, Interoperability, and HLA compliance. Again the objective will be to leverage as much OTB materiel as possible.

Tuesday, 1330-1500:
Planning and Executing Data Collection and Analysis for HLA federations.

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This paper provides a federation independent Data Collection and Analysis (DC&A) roadmap for users interested in automated analysis tools for High Level Architecture (HLA)-compliant models and simulations. The cost of designing, integrating, and executing distributed simulations makes reliable collection essential to supporting analysis. This paper draws on the experiences and lessons learned building and executing DC&A for both large and small scale HLA federations in support of the Defense Advanced Research Projects Agency (DARPA) Advanced Distributed Simulation (ADS) Program and the Defense Modeling and Simulation Office (DMSO). The lessons learned performing DC&A on large-scale federations closely mimic the experiences gained performing DC&A on small-scale federations. The important technical concepts an analyst must be aware of in order to successfully plan and execute DC&A for any HLA federation are discussed. The lessons learned include the importance of incorporating analysis goals early in the federation development effort, the significance and challenges of performing analysis during federation execution, and the value of the HLA as a DC&A environment. This paper introduces the DMSO sponsored Data Collection Tool (DCT), an HLA federation runtime tool than can be used to collect data and perform analysis for any federation. The DCT enables collection and analysis during the execution of a federation so that results can be reported and analyzed in near real-time rather than waiting until completion of a simulation run. Specific examples of the types of analysis performed using the DCT are discussed including examples of analysis displays as well as the use of commercial desktop software, such as Microsoft Access and Excel.

Autonomous Agent Data Collection and Analysis Tool – Remote Data Collection from Distributed HLA Experiments

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The emergence of High Level Architecture (HLA) as the standard for simulation interoperability has created the need to develop software tools and techniques that operate in an evolutionary new environment. Data collection and analysis are fundamental components for all modeling and simulation (M&S) activities. While HLA seeks to improve interoperability for large scale distributed simulations through the use of new technology, the data collection and analysis requirements present a unique set of problems and limitations. This project applies the emerging technologies of autonomous software agents to problems associated with data collection, synthesis, and analysis in HLA. These agents will make use of the "remote programming" paradigm - transmitting a program to a remote machine or server where the program is executed one or many times. The use of autonomous agents in data collection will allow adaptive, distributed, and coordinated data retrieval across the entire fabric of a widely distributed simulation experiment causing minimal interference with the virtual world.

A full explanation of the capabilities of the tool and how it was developed will be covered as will some examples of how this technology can save analysis costs in large scale widely distributed HLA experiments.

Analysis Federate in the Joint Advanced Distributed Simulation Joint Test Force (JADS JTF) Electronic Warfare (EW) Phase II Test

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The U.S. Army TRADOC Analysis Center in Monterey developed a general purpose Analysis Federate data collection, analysis, and visualization tool that is composable across High Level Architecture (HLA) federations that use various different Federation Object Model (FOM) representations. The Analysis Federate was integrated into the Joint Advanced Distributed Simulation Joint Test Force (JADS JTF) Electronic Warfare Phase II Test to provide a comprehensive data collection, analysis, and visualization solution. This capability complimented the other JADS data monitoring and analysis tools, improved situational awareness, and enhanced the overall effectiveness of the test.

The Analysis Federate implementation fully complied with the JADS FOM and the JADS Interface Control Document (ICD). It provided test visualization and analysis functionality while operating within in the strict EW Phase II Test performance specifications that restricted network latency to a maximum of 70 milliseconds. The entire set of analysis algorithms that was developed for the EW Phase II Test was incorporated directly into the Analysis Federate.

The Analysis Federate uses Tapestry Solution's Vision XXI Graphical User Interface (GUI) technology to implement the required data analysis and visualization functionality. This allowed the Analysis Federate to provide real-time displays of both the raw experimental data and the calculated Measures of Performance (MOPs). It also archived the data to provide a post-exercise analysis and visualization capability.

Wednesday, 0830-1000

DoD M&S VV&A Recommended Practices Guide

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In 1996, the DoD Modeling and Simulation Office issued the DoD Verification, Validation and Accreditation (VV&A) Recommended Practices Guide . This guide provides background and information on principles, processes, and techniques that are recommended for use in DoD VV&A efforts. Between 1996 and 1998, DMSO solicited feedback on this document to determine appropriate ways to increase its utility. Two major recommendations resulted:

- reorganize the document so the individual reader can more easily find the specific information he or she needs; and,
- provide more detailed information on how to select appropriate techniques.

To address these concerns, the current DMSO VV&A team has elected to develop the RPG as a web-based reference guide and as a series of focused handbooks. This innovative approach allows each reader to access the type of information and level of detail most appropriate for his or her purpose. In addition, it provides a structure that can easily be modified to include new information. This presentation will discuss innovative aspects of this approach and provide a preview of the resulting document.

Conceptual Model Descriptions

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The variety of simulation conceptual models provide application domain context for simulation requirements, the linkage between simulation requirements and simulation specifications, and the ideas for representation of elements within a simulation. Evaluation of a simulation's conceptual models is the only basis for assessing simulation appropriateness for application of a situation for which it has not been tested explicitly. All judgments of simulation capabilities to interpolate or extrapolate beyond those conditions specifically tested must be based upon evaluation of simulation conceptual models. Conceptual models may be implementation independent or may include some aspects of implementation. The formats employed in describing conceptual models have an impact on both conceptual validation and simulation development. When different descriptive formats are used for the various conceptual models of a simulation, potential for introduction of error is increased with every transformation from one descriptive format to another. This paper discusses potential impact on conceptual validation and simulation development of conceptual model descriptive format and proposes an approach to description of the conceptual models of elements within a simulation that both facilitates conceptual validation and enhances simulation development. Conceptual model issues of special importance for distributed simulation are given particular attention in this paper.

Common Threat Representation in Simulation, Analysis, and Testing of Integrated Ship Defense

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The Navy's Program Executive Office, Theater Surface Combatants has applied the High Level Architecture to create an engineering-level simulation Federation for Integrated Ship Defense (ISD). The Federation includes both tactical combat system code-in-the-loop and high fidelity physics-based models, in a network-distributed environment. For the first time, it achieves full fidelity detect-to-engage ISD simulation integrating both hardkill and electronic warfare (EW) elements.

A crucial component of the ISD Federation is the use of threat anti-ship cruise missile representations seen commonly by all ISD elements. Threat behavior is reactive to the operational environment imposed by the set of all the ISD simulations. This establishes a single, continuous battle timeline and is the lynchpin of integrated hardkill/EW engagement. For example, during defensive missile fly-out, the missile sees threat trajectory changes caused by ship signature fluctuations or electronic countermeasures. The ability to quantify the synergistic impact of multiple ship defense elements grants new access to problem domains (e.g., performance assessment, tactics development) and complex scenarios that were previously unattainable. Interactions with battle group and joint theater operational simulations (e.g., EADSIM) are more tenable.

Use of common threat representation permits efficient scenario reconfiguration, to allow insertion of any: full fidelity threat models, conceptual threat models, test target models, or direct playback of test data. Thus, a direct interchange can be made between operational and test scenarios, and live fire test data can be interwoven with engineering simulation. This closes the loop around the design/development, operational testing, and training communities, and builds in the ability to perform effective validation of ISD simulation results.

Wednesday 1030-1200
Digital Leaders Reaction Course

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Key ingredients in this experiment were the significant advances in hardware/software technologies dealing with Advanced Distributed Simulations successfully using High Level Architecture and Distributed Interactive Simulations concurrently. In short, the Eagle simulation was used to populate the ABCS databases and drive an interactive Digital Leaders Reaction Course. The ABCS systems included the Maneuver Control System (MCS), the All Source Analysis System (ASAS), the Army Field Artillery Tactical Data System (AFATDS), and a UAV feed.

The TRADOC Analysis Center (TRAC) and The MITRE Corporation provided scenario, simulation, and other technical support for the Army Experiment 5 (AE5) Digital Training Experiment (DTE) and a DLRC exercise with the 1st Brigade 4th Infantry Division TAC CP at Fort Leavenworth, Kansas, during the period March through September 1998.

The mission of the TRAC/MITRE team was to develop and provide scenarios, simulations, and simulation-to-Army Battle Command System (ABCS) software interfaces sufficient to drive a proof of principle demonstration. The principle of using automated interfaces and simulations with automated command and control features in a prototype Digital Leader Reaction Course (DLRC) was proven and demonstrated in July 1998 and implemented with the the 1st Brigade 4th Infantry Division TAC CP in September 1998.

The TRAC/MITRE team participated in pre–DTE preparatory activities, training and preparing the MCS and AFATDS users in the use of the interfaces and applications, and conducting multiple iterations of the vignettes to enhance their tactical decision making skills. Specific activities included scenario development, simulation support, simulation to ABCS interface support, after action review system support, and hardware/software support.

If the facilities are sufficient we will also demonstrate these capabilities at the end of the presentation.

Intelligent Automation of Critical Decision Information for Synthetic Environments

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Abstract: In training exercises for commanders using a constructive battlefield simulation, human operators observe the battle simulation on computer monitors and manually synthesize the reports that are sent to the commander and his/her staff. These reports are filtered, based upon the commander's requests for specific, critical information, to avoid overwhelming the commander with data. A meta-expert system, the Intelligent Simulation of the Battlefield (ISB) is under development for assisting military commanders with training for managing battlefield information and decision making. Janus, a battlefield simulation widely used for command and control training, is being used to provide the input for a commander's Maneuver Control System (MCS) and the Intelligence Officer's All Source Analysis System (ASAS). The reporting of filtered information from Janus to MCS/ASAS will be automated to replace the human operators. That automation will be provided by the Simulation Information Filtering Tool (SIFT) / Intelligent Simulation Reporting Agent (ISRA) / S2 Autonomous Agent (S2A2) programs. SIFT/ISRA/S2A2 will allow a commander to specify his/her critical information requirements through a graphical interface. The SIFT/ISRA/S2A2 program will then encode messages for status of friendly forces, detections of opposing forces (OPFOR), assessments of OPFOR probable Courses of Action, and/or other critical information as requested by the commander being trained. Finally, it will send the encoded messages in standard formats to the command and control systems or even observer/controller workstations. This technology has great impact on information management, stimulation of command and control systems and after-action review for both Army and joint tactical operations.

Developing a Modern Simulation from a Legacy Model

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The Army Training and Doctrine Command (TRADOC) Analysis Center (TRAC) in Monterey, California is re-hosting the Janus legacy simulation with modern technologies. The project will re-host Janus on a personal computer (PC) running Windows NT. The project will also apply advanced technologies such as making the new simulation High Level Architecture (HLA) compliant, incorporating a modern architecture, re-writing source code in C++, using state-of-the-art graphical user interfaces, and implementing a modular terrain component. When complete the simulation, called HLA Warrior, will provide valuable lessons to developers of future Army military simulations such as OneSAF, WARSIM and Combat XXI.

This presentation will initially address the benefits of HLA Warrior's modern architecture. Three specific benefits include rapid prototyping, dynamically defined objects, and attaching object observers. Rapid prototyping shortens development times and reduces overall project costs. The ability to dynamically define objects allows the user to define object behaviors at runtime, significantly enhancing model flexibility. The architecture also supports attaching passive object observers for monitoring an object's state, a concept analogous to humans observing their environment and reacting to changes.

The presentation will also address HLA Warrior verification and validation efforts. Verification will be accomplished primarily through extensive source code testing. To facilitate error detection, code writers will incrementally develop and debug code in modules, isolating specific functionality. Validation will be accomplished primarily through subject matter experts assessing model face validity. A model is said to have high face validity if model results seem reasonable to people knowledgeable of the system under study.

Wednesday, 1330-1500
Improving the Performance of HLA Applications By Multi-threading RTI Services Using the Proxy Design Pattern

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In single threaded HLA applications, CPU utilization is shared between processing by the simulation problem domain and processing by the RTI during the Tick() call. For high performance applications, such as 3D graphics, where there is very little unused CPU capacity, we observed a sharp decrease in performance (measured as the display frame rate) for relatively small object counts (5-10 objects). We believe this performance loss is due to a competition between the RTI processing and the graphics processing, in a non-linear manner. As the entity count increases, the graphics requires more CPU time to render more objects, and therefore performs proportionately fewer Tick() calls. But, the RTI also needs increased CPU time to handle more objects, and takes longer in each Tick call, since it is called less frequently. These two processes compete, in a manner analogous to thermal runaway. We saw frame rate go from 20 to 5 frames per sec, with the addition of the RTI services. Our solution consists of using the Proxy design pattern to allow all RTI services to run in a single thread, separate from the main application thread. The Tick() rate is adjusted to a rate that can be maintained separately from the application load. The interdependence between the two processes is thus removed, and the frame rate returned to 20 frames per sec. We believe this situation occurs regardless of whether or not there are multiple cpus available. RTI services are posted from the application thread to the proxy thread using messages, with some messages blocking to return data when required. This solution is straightforward to implement and provides significant improvement in performance when compared to the single-thread approach to calling Tick().

ASESS HLA Interface Implementation to Support Execution in Multiple Federations

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To maximize simulation reuse, the ability to participate in multiple federations should be considered when establishing High Level Architecture functionality (HLA) within a simulation. The HLA interface should be instantiated as a separate layer to the maximum extent possible to minimize interaction within the simulation itself. Additionally, because a simulation may fulfill distinct roles in multiple federations with significantly different Federation Object Models (FOMs), the ability to select which HLA interface layer to execute should be incorporated into the simulation architecture. The Advanced Sub-system, Element and System Simulation (ASESS) provides the capability to select the HLA interface executed at run-time. This functionality supports interoperability through distinct FOMs. To date, ASESS has been used as both a stand-alone tool and in two different federations. In one federation, ASESS simulated multi-stage missiles. In the other, ASESS simulated satellite platforms and their organic sensors looking into a ground combat battlefield modeled in MODSAF, a DIS compliant simulation. Current tasks now require that ASESS fulfill two different roles in a third federation developed by another company with an existing well-defined FOM.

The ASESS object-oriented, building block architecture consists of a hierarchy of model types populated with multiple implementations of the same function to model unique physical characteristics or fidelity levels. The HLA interface is also treated as a model type. This provides encapsulation of HLA functionality and allows the user to choose which interface model to execute. This paper will discuss the implementation of HLA within ASESS to support

Thursday, 0830-1000
Simulation and Modeling for Acquisition, Requirements, and Training (SMART)

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During the requirements determination process, TRADOC defines the Key Performance Parameters (KPP) and the training requirements. As simulation tools are utilized and system code begins formation, the M&S Domains work together to develop software that can be passed through the development cycles and ultimately form the basis for the desired product. Keeping in mind the KPP and what kind of training tools will be required for the finished system. As a system is being developed through the normal acquisition cycle, M&S are used by all of the players along the way.

Each player needs different functionality from his/her tools:

- The battle labs, for example, need extreme flexibility in reconfigurable software to explore new concepts across the full range of DTLOMS.
- The research labs need detailed physical models to assess design features.
- Analytical agencies use aggregate level simulations to assess capabilities and potential tradeoffs.
- Once a system reaches the test/experimentation phase, detailed and data intensive tools are needed to properly assess performance.
- Experimenters and trainers need visual tools whereby user reactions can be triggered and resulting responses can be evaluated.

The Challenge: To identify what must pass from one player to the next. What building blocks need to be added to the core prototype as it grows? What should go into the Simulation Support Plan (SSP)? How do players work together to make this happen?

So You Want to Develop a New Model or Simulation for the Army

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There was once a time you could develop a concept for a model, build it, and then present it to the Army Model and Simulation (M&S) Community as a new tool some one could use. In a resource constrained environment, the old laissez faire model and simulation development process is no longer accepted. The M&S community was directed to focus its efforts by integrating efforts across the Army and promoting reusability.

An M&S developer needs to be aware of the current management structure in the M&S community and the regulations pertaining to M&S. The fundamental objective for the M&S community is to develop "World-class M&S that meet the needs of the Total Force." This objective is supported by a guiding principle "Develop efficiently." While there might be many interesting M&S that could be developed, a new effort should support the Army Vision for M&S and a domain's roadmap for the future. There is documentation required to start development of a new model or simulation or to make major changes to an existing model. Using, as appropriate to the level of effort, either the "traditional" Mission Needs Statement (MNS) and Operational Requirements Document (ORD) or the Model and Simulation Requirements Document (MSRD), the proponent defines his requirement. Associated with the requirements documentation is the Army's Requirements Integration and Approval Process. Additionally, the Army Standards Category Coordinators are developing a repository of standards which provide a source of information for M&S developers and fosters reuse.

Using Modeling and Simulation to Reduce Cost of USMC Anti-Tank Missile Testing

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Modeling and Simulation (M&S) has been used historically within the USMC to support training. The USMC is using M&S to support Developmental Test (DT) and Operational Test (OT) of the Predator Short Range Assault Weapon (SRAW). Using a verified and validated M&S system significantly reduces the cost of thoroughly exercising weapon systems to mitigate risk. The USMC developed:

1. a prototype model of the Predator SRAW, and
2. a simulation environment that can be used to generate additional data for DT and OT

The Predator SRAW M&S System enables real-time testing using production representative components, custom interface software and a COTS object-oriented simulation environment. Predator Guidance and Control Unit (GCU) software has been rehosted for software-in-the-loop (SITL) testing and GCU hardware has been integrated for hardware-in-the-loop (HITL) testing. Using a shared memory interface for component integration, the system successfully runs at a 1000 Hz rate for real-time performance. Testing focuses on verifying missile probability of hit and probability of kill

The actual cost of a test firing of the Predator SRAW ranges from $20K during OT to as much as $50K in support of DT. 103 missile firings are planned to support formal OT. Even so, a single firing may not support a rigorous statistical analysis. The M&S System gives the USMC the ability to supplement data from real shots and thus gain confidence in the statistical validity of test firings and determine a more accurate probability of hit and probability of kill. This system will allow the USMC to achieve statistically valid tests, overcome real world constraints and gain an unbiased measure of lethality.

Thursday, 1030-1200
COMPOSITE GROUP G .... **Room 144**

Thursday, 1330-1500
SWIM – Web Based Scenario Editor Bringing Weather to the Synthetic Battlefield

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Weather is often more difficult to capture in simulation than it is to predict in real life. Nearly infinite combinations of scenario location, time, and season preclude the establishment of a comprehensive library of ready-made, simulation-specific datasets. Yet scenario developers need accurate and timely weather data that is easy and quick to integrate.

The Simulation-Weather Integration Module (SWIM) fills that need for users of Janus, a major Army constructive combat simulation. SWIM is a web-based scenario editing tool, written in Java, that typically brings users 20 to 40 years of historical data from 2511 weather reporting stations worldwide. Source data is extracted from the International Station Meteorology Climate Survey compiled by the Navy, Air Force, and Department of Commerce. Scenario developers compare existing scenario weather data with SWIM's suggestions and can select or enter specific parameters for customized studies.

Developed for the Army's Cold Regions Research and Engineering Laboratory (CRREL) to study cold weather effects in simulation, SWIM extends its utility for all climates and regions of the world. It allows rapid baseline and what-if weather scenarios critical for trainers and analysts. Environmental effects on detection, mobility, people and equipment can be studied with confidence in the data source. SWIM suggests "typical" conditions based on the scenario location, month, and time of day. While currently aimed at a predominantly Army ground simulation, SWIM design techniques can be applied to Joint and future Joint (OneSAF) simulations to provide an accurate environment for a broad range of simulations.

OLAP/Web Technology, Presenting Data for Decision Support

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Approved abstract unavailable at printing.

Simulation Marginal Analysis

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Simulation and marginal analysis are commonly used techniques – but not together. Marginal analysis is a popular way to solve many problems in operations research. Simulation can be used on a much broader range of problems, but only to assess solutions – not to generate them. Unfortunately, the inaccuracy inherent in simulation interferes with marginal analysis, where small incremental changes are compared based on their marginal cost/benefit impact. These incremental benefits are overwhelmed by simulation's natural variability, absent a prohibitively large (and slow) number of replications. We have discovered a way to make to make simulation fast and accurate enough to work with marginal analysis. This permits generating solutions for the vast range of problems which cannot modeled analytically but can be simulated.

We will explain the new technique and demonstrate an inventory optimization model embodiment. This model effectively solves some of the classic unsolved problems in inventory theory.

WG 32 – SOCIAL SCIENCES METHODS – AGENDA

Chair: Mr. Hugh Dempsey, TRADOC ODCSR
Cochair: Denise Aleva, US Air Force Research Lab, WPAFB
Cochair: Dr. Alfred G. Brandstein, USMC CDC
Cochair: Mr. Frank Mahncke, Joint Warfare Analysis Center
Cochair: Dr. Franklin L. Moses, USARI
Cochair: Dick Steinberg, Schafer Corporation
Jr. Cochair: CPT Christopher Boyle
Advisor: Dr. Jock Grynovicki, USARL HRED
Room: 366

Tuesday, 1030-1200
Analysis and Classification of Multivariate Critical Decision Events: Cognitive Engineering of the Military Decision-Making Process
Dr. Jock O. Grynovicki, Mr. Michael Golden, Dr. Dennis Leedom, Mr. Kragg Kysor, Dr. Thomas Cook, Dr. Madeline Swann, US Army Research Laboratory, Human Research and Engineering Directorate

Salient Dimensions of Battlefield Complexity: Implications for Cognitive Engineering of the Digital Battlefield
Dr. Thomas Cook, Dr. Dennis Leedom, Mr. Mike Golden, Dr. Jock Grynovicki, Army Research Laboratory, Human Research and Engineering Directorate

Simulated Command Entities for Wargame 2000
Dr. Michael Lyons, MITRE, Joint National Test Facility

Tuesday, 1330-1500
Soldier Confidence of Automation in Command and Control Systems
Chris Grounds, Schafer Corporation; Annette Ensing, Greg Gray, THAAD Project Office

Maximizing System Performance by Using Command and Control Displays
Dick Steinberg, Schafer Corporation; Steve Armstrong, STA Corporation; Bobby Ford, THAAD Project Office

Alert Message Development and Display for Military C^2 Systems
William C. Brewer, Litton Systems, Inc., Data Systems Division

Wednesday, 0830-1000
Analyses of Weight, Body-fat, and Physical Fitness Testing Standards, for Active Duty Male Marines, with Proposed Alternatives
MAJ Bill Inserra, USMCDC, Studies & Analysis Division, Analysis BR, C 451

Getting More out of the Simulation Research Dollar: Lessons Learned from Experimental Psychology
Patricia A. Lakinsmith, Ph.D., Monterey Technologies, Inc.

Requirements Assessment for Individual Combatant Systems
Ms. Dawn Pogue, Mr. John D'Errico, Simulation Technologies, Inc.

Wednesday, 1030-1200
The prediction and control of skill retention for computer applications
Douglas Macpherson, Army Research Institute

Determining Principles and Strategies for Training Digital Skills
Douglas Dressel, Douglas Macpherson, Allison Auffrey, US Army Research Institute for the Behavioral and Social Sciences

Taking the Ethical Pulse of the Army
LTC Greg Dardis, US Military Academy; LTC David H. Olwell, Naval Postgraduate School (OR-OL)

Wednesday, 1330-1500
Action Research to Improve Government Organizational Performance: Case Studies in the Application of Strategic Management
CPT Frank Sturek, United States Military Academy

Cognitively-based, Task-Oriented Intelligent Information Management Technologies
Bruce G. Coury, Wayne W. Zachary, CHI Systems, Inc.

Criteria Driven Management Analysis – An Alternative Methodology for Organizational Studies
Pauline P. Cason, DBA, Science Applications International Corporation

Thursday, 0830-1000
Forecasting International Conflict through System Stability: Framing the International System as a General System
Michael L. Haxton, Joint Warfare Analysis Center

Lessons Learned from Regional Political-Military Gaming
LTC Ralph R. Rhea, The Joint Staff, J8, Studies Analysis and Gaming Division

Identifying Effective Practices for Technology Transition
William A. Lucas, Ph.D., Sloan School of Management, Massachusetts Institute of Technology; MAJ Michael D. Phillips, Ph.D., ARL and USMA Mathematical Sciences Center of Excellence; MAJ Kirk Benson, Department of Mathematical Sciences, United States Military Academy

Thursday, 1030-1200
COMPOSITE GROUP G .... Room 144

Thursday, 1330-1500
Maximizing the Utility of Simulation In Support Of Analysis: Lessons Learned from STOW 98
Mr. Robert J. Graebener, IDA; Mr. Stephen Kasputis, VisiTech, L.C.

Skill-based MOPS and MOEs for Individual-Team Performance
Dr. Herbert Bell, US Air Force Research Laboratory; Dr. Franklin L. Moses, US Army Research Institute for the Behavioral & Social Sciences

Developing Realistic Human Behavior Simulations to Support Individual Clothing and Equipment Research and Development Using Commercial Software Development Kits
Mr. John A. O'Keefe IV, US Army Natick SBCCOM; Mr. Robert T. McIntyre III, STI; Mr. David Zhu, The Motion Factory; Mr. Victor Middleton, Consultant US Army Soldier Biological Chemical Command

Alternate Papers

Engineering Economics Applied to Capital Investments
Dr. Fairly Vanover, TRADOC Analysis Center (TRAC) Fort Lee

Data Manipulation Techniques for Collection of Skill and Ability Data for Human Performance Models in the Army Command and Control Domain
Sam E. Middlebrooks, U.S. Army Research Laboratory, Human Research and Engineering Directorate

A Better Way to Model Warfare for Analysis of Command and Control: Agent-based Modeling of War as a Complex Adaptive System (CAS)
Geoffrey Maron, Capt USAF, Battle Management Command & Control, Air Force Studies and Analyses Agency

WG 32 – SOCIAL SCIENCES METHODS – ABSTRACTS

Tuesday, 1030-1200
Analysis and Classification of Multivariate Critical Decision Events: Cognitive Engineering of the Military Decision-Making Process

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The U.S. Army Research Laboratory (ARL) has undertaken a 5-year research program aimed at better understanding the distributed military decision-making process, at the Brigade level and above, as the process is shaped by time, stress, team structure, staff experience, and the introduction of digitization technology. From key battle staff commanders during several U.S. Army experiments, critical decision events were quantified using response data from two ARL structured survey instruments called the "Decision Maker Self-Report Profile" (Golden et al., 1999) and "The Critical Decision Inventory" (Leedom et al., 1998). We analyzed the commander's multivariate critical decision patterns by segmentation, characterization, classification of the data with discriminant analysis, and exploratory investigation of structures in the highly dimensioned data set by multidimensional scaling (MDS). Future efforts will enable us to identify variables and explore concepts that represent elemental "building blocks" from which each commander can construct a mental image of the battle space and effectively execute command and control. Preliminary findings reveal that the strategy used by experienced commanders differs from those with less experienced field grade officers.

Salient Dimensions of Battlefield Complexity: Implications for Cognitive Engineering of the Digital Battlefield

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War is a complex phenomenon, and decision making is essential to the conduct of war. The dynamics and complexities associated with modern military engagements, from peace keeping to major regional conflict, demand that the information associated with such environments be carefully selected, framed and presented to facilitate effective decision making at all levels. We hypothesized that the dimensions represented by the military acronym METT-TC (Mission, Enemy, Troops, Terrain and weather, Time available, and Civilian considerations), attributes associated with information technology (IT), and the impact of the local physical environment (LPE) provide a framework from which to organize and represent the salient dimensions of the battlefield. The U.S. Army's Crusader Concept Experimentation Program 3 (CEP 3) was selected as an ideal arena in which to conduct a preliminary investigation of METT-TC, IT and LPE dimensions and their associations with representative Battle Command decisions. Subjects were five field grade officers permanently assigned to a U.S. Army combat unit. During a 2-week experiment period, 24 decisions were isolated and documented across three phases of combat operations . Importantly, decision makers reported high levels of both "Significance" and "Understanding" for the majority of the dimensions represented by METT-TC, IT, and LPE, except for "Civilian Considerations" which were not present in the experimental scenarios. Significant differences according to decision types were observed. In summary, METT-TC, IT, and LPE dimensions as indicators of environmental complexity in combat situations appear to have high face and external validity. Further research is indicated to assess the internal validity and reliability of the measures and to assess the implications for "Cognitive Engineering of the Digital Battlefield".

Simulated Command Entities for Wargame 2000

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Wargame 2000, under the sponsorship of the Ballistic Missile Defense Organization, is a real-time, interactive, discrete event, human-in-the-loop simulation for command and control in air and missile defense applications. The Wargame 2000 System provides a simulated combat environment in which warfighting commanders, their staffs, and the acquisition community can examine air and missile defense concepts of operation, doctrine, tactics, techniques and procedures as an integral part of larger combat environments through the use of human-in-control experiments. WG2K is under development at the Joint National Test Facility with an initial demonstration of game capability for national missile defense in early 1999.

In national missile defense wargames, actual battle staff personnel from North American Aerospace Defense Command man positions in a command center which is an integral part of the Wargame 2000 composition. This man-in-the-loop activity is required to evaluate the accuracy and timeliness of decisions made by the battle managers and is a driver for the simulation to run in real-time. However, for the theater air and missile defense context, Wargame 2000 is also required to simulate the decision-making by the battle staff. Such computed generated agents or command entities should model human behavior to provide realistic C2 decisions, based on adaptive and rational cognitive processes, and to compute these behaviors for scaleable combat performance. This paper addresses design considerations for command entities in Wargame 2000, using lessons from the Synthetic Theater of War and research results from behavior modeling through the application of control mechanisms for goal-driven actions.

<u>*Tuesday, 1330-1500*</u>
Soldier Confidence of Automation in Command and Control Systems

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The role of the soldier has changed as the level of automation increases in command and control systems. Modern soldiers are now functioning as supervisory monitors rather than playing an active role in operations. This can create problems with system performance. Past research has shown that as the level of automation in a system increases, the situation awareness of the soldier-in-the-loop decreases. Without a good system understanding and sufficient awareness of the current situation, two behaviors can occur: a propensity for the operator to blindly follow the behavior of the system as well as any recommendations of the automation (over-reliance), or a propensity for the operator to

erroneously intervene, thereby degrading system performance (under-reliance). Seven operators from National Missile Defense and sixteen operators from Theater Missile Defense took part in interviews related to determining their preferred level of soldier-automation interaction and preferred task allocation between soldier and automation. Both sets of operators preferred a supervisory control relationship ("Give me recommendations, but I want the final decision."). Likewise, both groups preferred to perform tasks requiring decisions based on risk, or where they felt the computer could not possibly take all variables into account (e.g., monitor and assess political conditions). They felt appropriate tasks for the computer involved repetitive tasks (e.g., system status monitoring), or tasks involving complex calculations (e.g., threat engagement based on recommended firing doctrines).

Maximizing System Performance by Using Command and Control Displays

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In emerging Missile Defense (MD) Command and Control (C2) systems and concepts, the user typically acts as a manager by exception while the majority of system activity is computer automated. While direct interaction of the user with the system is minimal, an inaccurate action by the user can have catastrophic consequences. Additionally, many of the decisions MD C2 commanders are required to make are based on uncertainty in measured track data and predicted future enemy course of actions. In each of these cases, critical decisions are being made based upon probabilistic or uncertain data. Depending on the degree of uncertainty, the action taken by a military commander is greatly affected. While a tremendous amount of money is being invested in government contracts to improve the precision of the data measured by sensors and the accuracy of intelligence data, this does not eliminate the problem. Research performed for the U.S. Army's Theater High Area Altitude Area Defense Interceptor (THAAD), the THAAD Radar, and the National Missile Defense have tested concepts with operators for displaying the ambiguity of data for real-time displays in a manner which minimizes operator perception errors.

As advances in information systems have made more information available to warfighters during real-time operations. Typical design interactions with C2 users have revealed an insatiable appetite for data on a display. However, this research for Missile Defense systems found that more information does not guarantee better user performance. It is essential to display information in a manner that will augment the battle commander's decision-making capability without information overload. Display designs must be based upon the need to satisfy the command and control purposes rather than a firehose of information that degrades operator performance. There is clearly a strong need for advanced Human Computer Interaction (HCI) methods to minimize risk of erroneous personnel actions. The THAAD BMC3, THAAD Radar, and NMD C2 display systems have been using empirical based testing to define critical data required by operators to optimize C2 display decision making. Empirical evidence for designing C2 displays based on a purpose centered rather than information driven design methodology was found.

Alert Message Development and Display for Military C^2 Systems

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The development of alert messages varies from many other elements of code development, in that a text message is sent directly on the operator's display. Because humans cannot receive and process information as efficiently as a computer, it is imperative that only required information be displayed in this manner. Information that an operator does not need to do the job becomes clutter on the display that requires both time and cognitive resources, reducing system effectiveness. Alert displays in military command and control (C^2) systems, however, frequently rely on an *alert queue* that displays brief messages in a chronological list. In practice, system operators often delete a large number of accumulated messages without ever reading many of them. This behavior indicates that messages are either too numerous, not sufficiently meaningful, are poorly organized and displayed, or all three. To address the needs of the operator, information must be strictly limited, directed to the task at hand, grouped according to "natural" categories, and presented in a comprehensible, consistent, and informative manner. To this end, an alert message definition, structure and composition guidelines are proposed to assist systems engineers and software developers in the identification, classification, development, and display of alert messages.

<u>*Wednesday, 0830-1000*</u>

Analyses of Weight, Body-fat, and Physical Fitness Testing Standards, for Active Duty Male Marines, with Proposed Alternatives

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The Marine Corps utilizes a three-event Physical Fitness Test (PFT) comprised of a 3-mile run, sit-ups, and pull-ups to assess the level of physical fitness of individual Marines. This study uses newly collected data from the Marine Corps to analyze the current weight and body-fat standards and compare them with proposed alternatives. The research investigates whether the current standards can be slightly relaxed without resulting in significant decreases in physical fitness performance. The results showed that alternative weight and body-fat limits could be justified without resulting in significant decreases in physical performance. Weight is not a good indicator of body-fat, as a result, substantially more Marines exceed the 18 percent body-fat standard than the Marine Corps is aware of. Additionally, this study investigates the validity of pull-ups as an indicator of muscular strength and endurance. The analysis compares the performance scores for two types of pull-ups (the dead-hang and kip methods) with other physical performance events that require upper body strength and muscular endurance. The study presents proposed scoring alternatives for the pull-up event based on an analytical comparison of performance distributions for the run and sit-up events, in order to level the equality for all three PFT events. The analysis indicates that pull-ups are not necessarily an efficient measure of upper-body strength and muscular endurance; the research thus proposes more efficient alternatives. Additionally, a new 3-profile PFT alternative comprised of aerobic, muscular, and body-fat profiles is presented as an improved measure of assessing the physical fitness of individual Marines.

Getting More out of the Simulation Research Dollar: Lessons Learned from Experimental Psychology

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Full-mission simulation can be a cost-effective method of obtaining design feedback early in the system development cycle. Full mission simulation can assess the effectiveness of a future combat system, and gives system developers valuable feedback during the early stages of design, when changes can still be made at a relatively lower cost than later in the development process. Full mission simulation can provide data on operator reaction time and errors (useful to user interface designers) and team effectiveness on a realistic future battlefield. While low level, part-task testing can provide feedback on menu structure effectiveness, switch location, map features, subsystem response times, function allocation, etc., full mission simulation is essential for high-level system concept validation, and for addressing human factors issues that emerge from human interaction with new, complex systems.

Full mission simulation has its drawbacks, however. Often the variability associated with tactically correct, realistic missions prevents the experimental control necessary to obtain reliable, statistically significant data. Objective data such as number of threats killed, mission completion time, etc. fail to show the expected benefits. Subjective data obtained under these conditions are often more meaningful than the objective data collected by the simulator.

This paper presents a research methodology developed at a US Army research and development facility that produces stable, valid data from full mission simulation. Most of the concepts presented are based on classic experimental psychology. Guidelines are given for experiment design, scenario design, metric selection, and data analysis for studies of complex systems in full mission simulation.

Requirements Assessment for Individual Combatant Systems

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Approved abstract unavailable at printing.

Wednesday, 1030-1200

The prediction and control of skill retention for computer applications

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Windows ™ applications are supposed to be intuitive and easy to learn, yet many people seem unable to retain sufficient skill to utilize them adequately, especially if the tasks are infrequently performed. This presentation demonstrates application of the ARI Skill Retention Model to several Windows ™ tasks to identify the reasons for the problems. The model estimates the utilization/retraining cycle required for

any percentage of the users to retain proficiency. In addition, the model suggests application modifications that will increase the retention of the application, thereby decreasing retraining requirement and increasing the suitability of the application for occasional use.
Superficially, the model is easy to apply. It requires subject matter experts to answer ten questions. The interpretation of some questions is subtler than the wording indicates. For instance, the interpretation of some questions can depend on the skill of the user and on experiential differences between the user and the SME. Such Windows ™ tasks as copying and their associated help screens will be used to illustrate the model's strengths and weaknesses.

Appropriate attendees are life cycle/personnel systems modelers and applications developers as well as personnel concerned with applications evaluation, applications training, and long term operations/skill maintenance.

Determining Principles and Strategies for Training Digital Skills

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The Army is equipping units with a wide variety of digital technologies and command systems that increasingly demand information-age skills. There is a need to know how best to train and sustain the digital skills required by soldiers who will operate and maintain these systems. A first step is to determine the training principles and strategies that maximize the acquisition, transfer, generalization, and retention of digital skills.

The presentation will report about progress in determining what is known or what is promising in the area of digital skill acquisition, retention, and transfer for military application. It will review what is known (a) from the literature and from the field, (b) from searches of various electronic databases and web sites, and (c) from surveys of soldiers both in schools and in units.

Taking the Ethical Pulse of the Army

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FM22-100 proposes the Ethical Climate Assessment Survey, a tool for leaders to use to assess their units. The scale for interpreting the score has no empirical basis. This paper details a scheme for collecting and analyzing data about ethical climate scores through an ongoing blinded collection process. We claim two major policy benefits. First, leaders would have a valid set of benchmarks to compare their units against. Second, statistical analysis of the reports would provide the Army leadership with an accurate description of the ethical status quo in the Army with early warning of shifts in the status quo -- for either better or worse.

Wednesday, 1330-1500

Action Research to Improve Government Organizational Performance: Case Studies in the Application of Strategic Management

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Traditional or positive science research practices are not practical for solving real-world problems in organizations. The dynamic forces outside the laboratory will not allow the control required for more traditional research methods. To truly define the problem of an organization, collect the data, and test solutions; the researcher must "engage" the real-world problem and get involved with the subject (the organization). He must become an Action Researcher.

The Government Performance and Results Act of 1993 (GPRA) energized federal agencies to understand performance-based management. Specifically, federal organizations had to learn how to develop and implement a strategic plan. Strategic planning expertise is currently not in abundance in government organizations, and as a result consultants and academicians have been employed to help solve this critical organizational problem.

The Office of the Assistant Secretary of the Army for Financial Management and Comptroller (ASA FM&C) is currently developing a strategic plan for implementation, and the Army's Office for Competitive Sourcing and Privatization (CS&P) developed a strategic plan for implementing a performance oriented competitive sourcing and privatization program. This study describes the use of Action Research for defining each organization's problem, collecting data, and testing solutions. Also, each organization's application of strategic management will be described using a case study methodology to share lessons learned and methods for applying strategic management in government organizations.

Cognitively-based, Task-Oriented Intelligent Information Management Technologies

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Information technology is being developed to aid tactical decision makers that has the potential to present a blizzard of highly processed and distributed data and information. Many layers of processing, filtering and information integration exist between tactical decision makers and the source of the information, with relevant information spread across many sensor and information processing systems, data fusion and assessment systems, and data repositories.

Problems of interpretation of the tactical situation arise because of the difficulties associated with understanding such a complex information space, and the inherent uncertainties and limitations in the available information. The problem is compounded by the unique characteristics of the user interfaces for each of the underlying information technologies, and the difficulty associated with getting to information embedded in and obscured by the application.

Our response has been to develop cognitively-based, task-oriented technologies that aid in the management of tactical information. The focus has been on intelligent user interface technologies that will enhance tactical situation awareness and reduce the burden of interaction with complex systems. Our goal has been to develop technologies that access task-relevant information, present that information in a comprehensible form, and direct the user's attention to information critical to the situation and the decision making task. In this paper, we first present our view of intelligent user interfaces, and describe what we believe is needed to allow command decision makers to understand, manipulate and manage a complex tactical information space.

We will then describe in more detail the basis for our approach, and explain how cognitive engineering (and the use of cognitive task analysis and cognitive modeling techniques) have become the foundation for our technology development effort. We will show, by reference to a number of previous and ongoing projects in command and control, how we have developed cognitive agent technology and embedded that technology in a set of tools for building cognitive agents called iGEN™.

We will discuss how our cognitive agent technology is being used as part of intelligent user interface development efforts, and show how such technologies enhance the effectiveness of the tactical decision making process. Our presentation will consider specifically the value in intelligent user interface design and development to capture, represent and use the human decision maker's knowledge about tasks, processes, and organizational relationships that make up command and control. Thus, rather than focusing on low-level human-computer interaction knowledge, we have concentrated on intelligent associates that operate at a higher level to aid human command-and-control personnel carry out their goals and task requirements.

The paper will conclude with a discussion of a number of key research issues of importance to use, and our plans for future research and development.

Criteria Driven Management Analysis – An Alternative Methodology for Organizational Studies

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CDMA is a structured technique that allows a group, such as an A-76 Working Group, to determine an overall approach to organizational structure that best meets the needs of their particular environment. It takes a very subjective decision problem and quantifies it in a manner that withstands the scrutiny of auditors, adversaries or simply the higher level management officials who wish to assure that the best decision has been reached. The technique was developed by the author and a study group under her leadership. The technique has been tested through successful use in three separate A-76 studies. This presentation will demonstrate the technique, discuss its strengths and weaknesses and how it may be combined with other OR techniques. It lends objectivity to an area of that has frequently been subject to intuitive decision making

Thursday, 0830-1000
Forecasting International Conflict through System Stability: Framing the International System as a General System

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In this study, we build on three areas of research: Expected Utility models of conflict, General Systems Theory, and Social Network representations of organizational networks. This study has three primary goals: The first is to show the value of representing international systems of organizations as thermodynamic systems. The second is to determine whether the framework of using expected utility calculations to gauge system stability provides a valid means of modeling the onset and progress of conflict. And the third is to determine whether the Social Network Analysis concepts of flow and connectedness provide meaningful indications of the ability of organizations to resolve differences nonviolently. The results suggest this approach is indeed valid; the dissimilarity of response patterns to other actors in the system provides a good measure of policy orientation and preference orderings; and finally, the social network analysis metrics can provide valuable input to help estimate the prospects for nonviolent conflict resolution. The results provide clear indication that the framework of modeling the international system in terms of system stability theory provides strong predictive accuracies, accounting for as high as 75% of militarized disputes and 69% of the non-disput4es from 1988 to 1992. These accuracies are achieved despite using data with obvious and considerable holes, and an incomplete specification of the models involved.

Lessons Learned from Regional Political-Military Gaming

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The Joint Staff's Studies, Analysis and Gaming Division has gamed several aspects of operational issues in national security for policy-makers with in the US Government. The seminar gaming methodology provides a flexible and cost effective method for examining complex problems, bringing consensus on policy amongst diverse organizations, de-conflicting strategic planning and rehearsing in-place or evolving inter-agency plans and procedures.

The Joint Staff has learned some lessons in gaming such complex problems. Political-military gaming provides a qualitative review of an issue, not a scientifically based quantitative review. The game's value often involves bring regional and functional experts and higher-ranking policy experts from the inter-agency community to quickly get to the core issues of a problem. Often the gaming methodology achieves levels of understanding and consensus much faster than normal staffing procedures. A few examples of qualitative games include:

- Recommendation of policies to guide US participation in particular peace operations
- Validation of an inter-cabinet level procedure for handling non-combatant evacuations
- Examination of possible political-military options for several possible futures in troubled regions
- Rehearsal of inter-cabinet plans for an evolving emergency overseas

The purpose of this MORS presentation is to provide real-world examples of political-military gaming with the Joint Staff and the Office of the Secretary of Defense as well as our lessons learned about the strengths and weaknesses of the discipline.

Identifying Effective Practices for Technology Transition

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In a traditional weapon system development, technology is developed in a research laboratory and is selected for use when there is an acceptable risk and a clear need. Usually, increased performance and reduced costs are motivating factors. Understanding how advanced technologies can be developed and transitioned from a laboratory environment into a weapon system is the subject of this research. Specifically, the primary research focus is to identify technology transition barriers and new methodologies/strategies for dealing with these barriers. Implementing the outcomes of this research could result in improved processes, procedures and practices for the transition of advanced technology into Army weapon systems, providing the potential for saving millions of dollars on future advanced technology transition and insertion. The central research design, however, is based on in-depth case studies and extensive case data collected by a questionnaire-like instrument that is being administered to multiple companies in the Aerospace Industry. This paper is an effort to provide a statistical analysis concerning the validity of the survey instrument and the reliability of the information. This research is being conducted in conjunction with the International Center for Research on the Management of Technology (ICRMOT), Sloan School of Management, MIT of which the Army Research Laboratory is a supporting member organization.

Thursday, 1030-1200
COMPOSITE GROUP G .... **Room 144**

Thursday, 1330-1500
Maximizing the Utility of Simulation In Support Of Analysis: Lessons Learned from STOW 98

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Today's analyst is facing a new world when it comes to providing simulation support to the joint warfighter. That new world requires the adaptation of tried and true analytical techniques to a rapidly changing environment with the awareness that today's commanders have less time to absorb complex interactions and issues before making decision that have long reaching affects, from force protection to industrial production. This presentation will draw on the findings and observations provided by the Synthetic Theater of War Advanced Concept Technology Demonstration (STOW ACTD) currently in its last year of funding with USACOM as operational sponsor. A general framework for complex decision making, developed to frame the assessment effort of the September 1998 event, will be discussed along with the investigative process necessary to successfully operate in today's and tomorrow's turbulent world of joint experimentation and analysis. Identification of the critical steps associated with the scientific approach to analysis will be merged with the organizational awareness and understanding of stakeholder as well as user requirements necessary to provide the warfighter with the information necessary to make timely and more accurate decisions.

Skill-based MOPS and MOEs for Individual-Team Performance

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A major training deficiency in today's military is the lack of effective skill-based Measures of Performance (MOPs) or Measures of Effectiveness (MOEs). Their importance escalates when unexpected deployments and the use of ad hoc teams require rapid training. To refresh their skills and learn to work together quickly, individuals depend on appropriate feedback. Traditionally, feedback emphasizes mission outcomes to gauge performance: bombs, bullets, probability of kill, and combat exchange ratios. Such measures have limited training value because they provide little to no diagnostic or prescriptive feedback essential for training. The current presentation describes how to develop appropriate skill-based MOPs and MOEs, what's available to begin, what's needed, and some data about what difference it can make in training. The approach depends on using job skills and mission-driven contexts as the basis for measurement. What's needed are observation-based objective measures such as timeliness and accuracy based on standards. Initial work will be presented about objective process measures and about leadership measures of team effectiveness. The importance for training of these new kinds of MOPs and MOEs will be documented.

Developing Realistic Human Behavior Simulations to Support Individual Clothing and Equipment Research and Development Using Commercial Software Development Kits

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The need for robust, believable simulations of human reactive behavior in simulations used to support the design, evaluation, and acquisition of individual soldier clothing and equipment has been recognized for at least the last decade. Most past attempts to meet this requirement have fallen short of the desired autonomous, reactive simulation of the reactive behavior of individuals as well as groups of humans. Many of the previous attempts relied heavily on human operators planning and controlling the actions of each simulated entity. This was necessary to overcome the limitations of existing algorithms that could both simulate typical human reasoning processes and still control multiple individuals in a real time or faster simulation/model.
Recently the developers of commercial computer games have overcome some of these limitations. The products of their efforts have been captured in commercially available software development kits (SDKs), which can be used to develop simulation engines to control the behaviors of simulated individuals and groups of individuals.

Initial efforts have been undertaken to link these commercial behavioral SDKs to existing high-resolution simulations of individual physiological behavior, performance, and survival. This paper will discuss these initial efforts and provide preliminary review of their findings.

WG 32 – SOCIAL SCIENCE METHODS – Alternates

Engineering Economics Applied to Capital Investments

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Engineering Economics is used to assess the value of a given project and justify it from an economic standpoint. With the rapid pace of technological change increasing the complexity and elevating the cost and utility of technological resources such as training and information technology systems, the justification of these resources has become of monumental importance to constrained corporate and Department of Defense (DOD) budgets. Because of this complexity and the precipitous curve with which high technology systems are acquired, inadequate investment justification processes often lead to decision making that accept bad systems and reject good systems. Classic Economic Production Theory focuses on production functions where inputs are dependent on each other to produce an output. This presentation offers a methodology based on an extension of classic Microeconomics to production functions with two-variable inputs where either input can produce some quantity of output independently, but neither input can produce the required quantity of output alone. The mathematical equations for independent production functions may be derived from historical data by using Regression Analysis curve fitting. From these equations the three-dimensional production surface can be determined and bounded by the production constraints. The isoquant may then be determined which describes the combinations of the variables that will give the required production. From historical data, isocost curves may then be defined for combinations of system alternatives that achieve the required production. The tangency of the isocost curves to the isoquant identify the most cost effective combination of alternatives that achieve the required production. Applications for this methodology may be for justifying the cost savings and payback period for various systems that must be used together to produce the required output, e.g., an aircraft trainer and an aircraft simulator.

Data Manipulation Techniques for Collection of Skill and Ability Data for Human Performance Models in the Army Command and Control Domain

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The Human Research and Engineering Directorate of the Army Research Laboratory has developed a series of computer models that simulate human performance of commanders and their staffs in a battalion level Army tactical operations center. These computer models incorporate taxonomy developed by Edwin Fleishman that identifies 52 physical and mental skills and abilities that can be used to describe human operational activities in any general work situation. The models use a task network analysis scheme to represent cognitive and physical tasks being performed by the operators in the TOC during combat activities by applying skill demand activities tied to the taxonomy. Numerical data for each operator related to the skill and ability matrix is used to calculate workload and utilization rates for the operator in real time as the model executes. Derivation of this numerical data is an exhaustive process that uses a computer based survey instrument to collect the skill and ability matrix information for the matrix of 50 skills and abilities, for 24 operators in the TOC with up to 15 survey respondents being queried for each operator position.

This report documents the process of data capture for five top level job categories and the translation of that data into 32 functional task categories that are used in the computer workload models.

A Better Way to Model Warfare for Analysis of Command and Control: Agent-based Modeling of War as a Complex Adaptive System (CAS)

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Current combat models are inadequate for modeling strategic and non-linear effects. Most current models were constructed in a reductionist manner based on linear equations. This approach yielded attrition oriented models that do not capture the complexity inherent in warfare. While effects of many methods of warfare are inaccurately represented in attrition based models, methods dependent on non-linear effects suffer the greatest misrepresentation. The inaccurate representation of Marine forces prompted the Marine Corps into a pursuit of CAS modeling techniques for maneuver warfare. A similar recognized weakness in current campaign level models is the inability to represent the non-linear and strategic effects air power can have when applied to enemy centers of gravity. Air power brings more to a campaign than just the killing power of its munitions, but with current models, air power is played as a weapon delivery system only.

The "New Sciences" of Complexity and Chaos provide a new framework with which to analyze systems. We are exploring the modeling of war as a complex adaptive system with an agent-based model and investigating the force multiplying effects of C2. Agent-based models are intended to capture the complexity inherent in a system by capitalizing on simple primitives of the system. The primitives of a system are those system properties, components, and interactions that drive system behavior. Oftentimes, a relatively complicated system can be accurately represented with a collection of simple primitives. A more accurate representation of war will allow the examination of non-linear and strategic effects. Agent-based models may increase our ability to analyze the strategic effects of air power, information war, terrorism, C2 warfare, space power, nuclear weapons, and psychological operations.

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(as of 22 May 1999)

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Shelton Benny Richard - Tec-Masters Inc
Shiels Douglas - IDA
Shukiar Herbert J - RAND
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Sivakumaran Nagalingam S. - SPARTA, Inc.
Slay F Michael - Logistics Management Institute
Smallwood Dennis - USMA

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Zorn Capt Wayne L - AFIWC/SAVA
Zouris James M - Naval Health Research Center

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67TH MORSS AGENDA
UNITED STATES MILITARY ACADEMY, WEST POINT, NY

Monday, 21 June 1999		
1300	1700	"Friendly Fire Shootdown Over Northern Iraq" Woodcliff Hilton Auditorium
Tuesday, 22 June 1999		
0700	0830	Registration
0715	0815	Composite Group/Working Group Chairs/Co-Chairs Warm-up
0830	1000	**PLENARY SESSION:** Keynote Speaker: LTG **Randall L. Rigby**, Deputy Commanding General, US Army TRADOC
1030	1200	First Working Group **Session (#1)** COMPOSITE GROUP **A** SESSION
1215	1315	**Tutorials**
1330	1500	Second Working Group Session (#2) COMPOSITE GROUP **B** SESSION
1530	1700	**SPECIAL SESSION I** • "Theories of Combat" • Rist and Barchi Prize Paper Presentations and Awards • Junior/Senior Analysts Session #1
1715	1900	Mixer/**Prize Paper Displays (Barchi and Rist Prizes)**
Wednesday, 23 June 1999		
0700	0800	Town Hall Meeting (CG/WG Chairs)/Editors' Breakfast
0830	1000	Third Working Group **Session (#3)** COMPOSITE GROUP **C** SESSION
1030	1200	Fourth Working Group **Session (#4)** COMPOSITE GROUP **D** SESSION
1215	1315	**Tutorials**
1330	1500	Fifth Working Group **Session (#5)** COMPOSITE GROUP **E** SESSION
1530	1700	**SPECIAL SESSION II** • Military OR Heritage • Mini-Symposium Report: *C4ISR in 2010* • Mini-Symposium and Workshop Report: *Joint Experimentation* • Junior/Senior Analysts Session #2
1900	2200	MORS Barbecue at the Woodcliff Lake Hilton
Thursday, 24 June 1999		
0830	1000	Sixth Working Group **Session (#6)** COMPOSITE GROUP **F** SESSION
1030	1200	Seventh Working Group **Session (#7)** COMPOSITE GROUP **G** SESSION
1215	1315	**Tutorials**
1330	1500	Eighth Working Group **Session (#8)**
1530	1700	Composite Group/Working Group Chairs/Co-Chairs Wrap-up
1530	1700	**SPECIAL SESSION III** • The Innovation Process: Warfighting Advantage or Achilles' Heel • Mini-Symposium Report: *C4ISR in 2010 and SIMVAL 99* • Education Colloquium Session