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Military Operations Research Society (MORS)
Trip Report
Executive Summary

- **Meeting Purpose**

The annual meeting of MORS provides a forum to discuss the Operations Research requirements and analysis necessary for the DOD. A paper on a Confidence Assessment process for Modeling & Simulation was prepared and presented at this conference. The conference was held at the US Air Force Academy in Colorado Springs, CO.

- **Participants**

The MORS conference was attended by representatives of all military Services, Federally Funded Research & Defense Agencies (FFRDC), National Labs, and numerous contractors supporting the DOD. Mr. Daniel C. Holtzman, Vanguard Research Inc. attended and presented a paper on M&S Confidence Assessment.

- **Agenda**

See Attached.

- **Discussion**

The Presentation on the BMDO Confidence Assessment process went very well. There was a lot of discussion and request for information from the audience.

- **Conclusions**

This is a worthwhile conference for BMDO to be involved in, not just from the Modeling and Simulation aspect but from the larger BMDO picture.

- **Actions Required**

Their were requests for more detailed data regarding the CA process. BMDO should make this material available to the other DOD agencies and the military services.

This document has been approved for public release and sale; its distribution is unlimited.

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ABSTRACTS

[redacted]

62nd MORS SYMPOSIUM
Exploring New Horizons:
Matching Requirements, Opportunities and Resources

US Air Force Academy
Colorado Springs, CO
7 - 9 June 1994

Sponsored by:
The Deputy Under Secretary of the Army
(Operations Research)

The Director, Assessment Division
Office of the Chief of Naval Operations

Director of Modeling, Simulation and Analysis
Deputy Chief of Staff, Plans and Operations
Headquarters, USAF

Commanding General
Marine Corps Combat Development Command

The Director for Force Structures, Resource and Assessment
The Joint Staff

Director, Program Analysis and Evaluation
Office Secretary of Defense

Under the contractual sponsorship of:
The Office of Naval Research

Military Operations Research Society, Inc.
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Alexandria, Virginia 22304
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Schedule for the 62nd MORSS

Tuesday, 7 June 1994		
0700	0830	Registration
0715	0815	WG Chairs/CoChairs Warm-Up
0830	1000	Plenary Session
1030	1200	Special Sessions I
1200	1330	Tutorials/Lunch
1330	1500	1st WG Session/CG's II/IV
1530	1700	2nd WG Session/CG's I/II
1715	1900	Mixer
Wednesday, 8 June 1994		
0700	0800	Town Hall Mtg WG/CG Chairs
0830	1000	3rd WG Session/CG III
1030	1200	Special Sessions II
1200	1330	Tutorials/Lunch
1330	1500	4th WG Session
1530	1700	5th WG Session
1830	2100	Western Barbecue
Thursday, 9 June 1994		
0830	1000	6th WG Session
1030	1200	7th WG Session/CG's II/V/VI
1200	1330	Tutorials/Lunch
1330	1500	8th WG Session/CG's II/III
1500	1530	WG Chairs/CoChairs Wrap-Up
1530	1700	9th WG Session

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This publication contains titles of presentations made at the 62nd MORS Symposium (62nd MORSS), along with names, addresses, phone and fax numbers of authors and abstracts, if available. Abstracts published in this book had to be Unclassified and Approved for Public Release. Some abstracts are missing because they were not cleared for public release. Some are missing because they had not been submitted at the time of publication.

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ABSTRACTS

62nd MORS SYMPOSIUM
Expanding Horizons: Matching Requirements, Opportunities and Resources

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This is the first Book of Abstracts produced by the Military Operations Research Society in conjunction with a MORS Symposium. The MORS Staff and Board of Directors is continuously seeking ways to make MORS and the Symposia more responsive to the needs of our members. We have long known that the information exchange at a symposium is invaluable. We understand that the ability to quickly follow-up on information received there, or to further a contact made with an author of a particular presentation is desirable.

We decided that one way to make the information at the symposium more valuable would be to publish the names and addresses of the authors, along with the abstracts of their presentations, if available. We hope that you find the information in this document of use to you.

Abstracts published in this book had to be Unclassified and Approved for Public Release. Some abstracts are missing because they were not cleared for public release. Some are missing because they had not been submitted at the time of publication.

Putting this book together took an enormous amount of time and effort on the part of the Working Group Chairs, who submitted the abstracts for their Working Group on disk and hard copy and who followed up with all their authors to insure public releasability. The staff thanks them for their hard work. Without them, this book would not have been possible. Thanks also go to Cynthia Kee-LaFreniere, who took what was submitted on disk and patiently reformatted it into WordPerfect®, making all the working groups as consistent with one another as was possible.

Since MORS is publishing this book of abstracts, we will not be publishing a proceedings from this Symposium. Papers will be collected from Special Session presenters and from Best Working Group Paper presenters, assembled and submitted to DTIC for distribution to those who wish to request it. This process will probably take about 6-9 months after the Symposium.

As always, we appreciate input from our members. If you have comments about this Book of Abstracts, please call or write me at the MORS office.

Natalie S. Addison
Associate Executive Director
and Publisher

62nd MORSS Special Sessions, Prize Papers, Tutorials and Composite Groups

See 62nd Final Program for Abstracts.

SPECIAL SESSIONS
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Mini-Symposium Report: Simulation Data and Its Management (SIMDATAM)

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Mini-Symposium Report: "How Much Testing Is Enough?"

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Efficiency and Economy in Military Operations Research

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Heritage Session – 50 Years of MORS

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Distributed Interactive Simulation (DIS) in Support of Acquisition

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Junior/Senior Analyst Session

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An Analysis of Peacekeeping Operations: Peacekeeping and the New World Order

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PRIZE PAPERS SESSION
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RIST PRIZE PAPER

Battlefield Combat Identification System Near Term (BCIS-NT) Cost and Operational Effectiveness Analysis (COEA)

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BARCHI PRIZE PAPER

Constrained System Optimization and Capability Based Analysis

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TUTORIALS
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An Overview of AirLand Combat Modeling and Simulation

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Better, Cheaper, and Tighter Results Using Modern Experimental Design

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Presentation Techniques for Operations Research Analysts

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VV&A: Philosophy, Management Approaches, Methods, and Tools

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Designing, Testing, and Evaluating Command, Control, Communications, Computers, and Intelligence (C4I) Systems

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How to Run a Winning Working Group

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COMPOSITE GROUP SESSIONS

STRATEGIC – Working Groups 1, 3, 4
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Arms Control, Disarmament and Nonproliferation Treaties and Agreements: An Update
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Status/Update of the Nuclear Posture Review (NPR)

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Navy Joint Mission Area/Support Area Assessments

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The Joint Littoral Warfare Mission

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Carrier Battle Group Effectiveness in Support of the Naval Expeditionary Warfare Concept

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Measures of Effectiveness: Quantitative Tool for Decision Making

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AIRLAND CONTINGENCY OPERATIONS -- Working Groups 2, 7, 8, 9, 10, 11, 12, 13, 14
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Modeling and Simulation in the Warfighting Headquarters

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Joint Warfare Implications of the Near-Simultaneous Major Contingencies: Programming and Policy Analysis in OSD

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SPACE/C3I -- Working Groups 15, 16, 17, 18
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SALIENT PROBLEMS IN THEATER MISSILE ENGAGEMENTS -- ARE WE ON THE ROAD TO AN EFFECTIVE DEFENSE CAPABILITY?

Command and Control: The Key to Successful Theater Missile Defense (TMD) Operations

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Operational Contributions of Space Systems to Theater Missile Engagements

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RESEARCH AND DEVELOPMENT – Working Groups 19, 20, 21, 22, 23
Chair: James Bexfield, IDA
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Panel Topic: Implications of Modeling and Simulation Management on Military Analysis

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RESOURCES AND RECONSTITUTION – Working Groups 24, 25, 26, 27, 28, 29
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Defense Market Behavior

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62nd MORSS Working Group Abstracts

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Reengineering Nuclear War Planning

On taking office this past January, President Clinton issued a challenge to come up with a plan to reinvent government. In November 1992, I sent out a similar tasker: to reinvent USSTRATCOM's Strategic War Planning System (SWPS).

SWPS is the process by which USSTRATCOM creates our nation's nuclear war plan, the Single Integrated Operational Plan (SIOP). As you can well imagine, this plan has been in a tremendous state of flux over the last few years due to the breakup of the Soviet Union. That's the challenge, keeping the plan current; because the SIOP is so complex it historically takes up to 18 months to build, deconflict, disseminate, and prepare for execution.

In order to overcome the challenges associated with the new world order, I directed the creation of the Strategic Planning Study Group (SPSG). Its charter: reinvent the SWPS. The SPSG consisted of 11 officers and several civilians from across the entire USSTRATCOM staff. The team was assisted by individuals and organizations throughout USSTRATCOM and also received invaluable inputs from OSD, the Joint Staff, combat-ready units, the national laboratories, and companies from within the software industry.

The team began its mission by defining the requirements of all customers of the SIOP. Then, they carefully evaluated the existing process to see how well SWPS meets those requirements. Finally, the SPSG developed a set of options and pared them down to a single proposal:

1. Create a new process called the "Living SIOP" in which the war plan is continuously updated
2. Replace the current network-style data base with a relational system
3. Transition those parts of our infrastructure that are vendor-specific to a more open systems infrastructure
4. Change the application tools to accomplish many of the current processes in parallel versus the existing time-consuming, serial methods.

USSTRATCOM will realize significant gains from this study. We'll be able to develop a complete SIOP in 6 months, be more responsive to crisis planning situations, and enhance our interoperability with regional CINCs. Perhaps most importantly in these days of fiscal constraints, we'll be able to make all these changes within a declining budget, save $20 million annually, and reduce the number of personnel required to create the SIOP.

We've met the challenge issued by President Clinton. As a result of our efforts, we'll have a far-improved process for creating and maintaining our nation's strategic war plans.

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Counterproliferation: Strategy and Force Structure Implications

On January 3, 1993, Presidents Bush and Yeltsin signed the START II agreement that--if adhered to--will play an important role in reducing the U.S. and Former Soviet Union's nuclear arsenals from over 20,000 warheads at the beginning of this decade to approximately 3,500 by the year 2003. This is encouraging news that should be welcomed by all, because it reduces the likelihood of first strike and further lowers the prospects of a superpower nuclear war. But START II, regardless of all its good features, will not end the nuclear age. This points to the need to address a fundamental question that has been set aside rather than debated in a well thoughtout and objective forum: What is the role and future requirement for nuclear deterrence in U.S. national security?

Detracting from this debate is a certain euphoria that has emerged with the disintegration of the Soviet Union, breakthroughs in arms control talks, and the performance of U.S. conventional military forces in the Persian Gulf War. These events have encouraged wishful thinking by some military strategists who are beginning to take the view that nuclear weapons are obsolete. Another factor has been the shrinking defense budget. This has caused congress and DoD to put nuclear systems on the chopping block in an effort to retain conventional capabilities and to encourage arms control activities. These views pose a grave risk to our national security posture, because their premise is faulty. Granted, the U.S. does not need the large nuclear arsenals of the past, but we must not let the pendulum swing to the other extreme--as it appears to be headed. Such a dramatic change would be reasonable if nuclear weapons were obsolete or could be eliminated entirely, but neither is the case. The technologies are here; people will continue to use them to their advantage; and

from a planner's viewpoint, it would be foolish to think otherwise.

An adverse trend has already been established, and unless checked, it will erode our ability to design and build nuclear weapons to meet our future deterrent needs. It also will affect the ability of our military to maintain and employ nuclear weapons should future threats to our security make such actions necessary. Some welcome this as a step towards arms control, but it does not track with reality. This is not to argue against arms control, but it does suggest that caution is needed. First, history has shown that arms control agreements often fall short of expectations. World War II is an example. Second, arms control talks and non-proliferation activities have not halted the spread of nuclear weapons. The number of countries with nuclear weapons has grown from 5 to 12 in spite of the Non-Proliferation Treaty. Belarus, Britain, China, France, Kazakhstan, Russia, Ukraine, and the United States have nuclear weapons with regional and global implications, India, Israel, Pakistan and South Africa's weapons pose a limited international risk but raise major regional concerns. In addition, Iraq, Iran, Libya, and North Korea are in the market for nuclear weapons, and if the credibility of our nuclear deterrent comes into question, allies like Germany and Japan could at some point in the future follow suit. Thus, as the nuclear club gets larger, the potential for nuclear conflict increases.

The basic framework for the proposed paper acknowledges two types of potential nuclear threats--global and regional. The existing national security strategy plays down global threats because of successes in the arms control arena and disintegration of the Soviet Union. Clearly, we are no longer faced with a monolithic threat, and warning time has increased; but the global nuclear threat has not gone away, the threat of its use has only diminished. Fortunately, our current strategic systems will be an adequate deterrent against this threat for some time, but this will not always be the case. Someday the force will have to be modernized. This means that we must assure stewardship of the existing stockpile and preserve a crucial science and technology base for modernization or reconstitution, if needed.

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Proliferation Response Modeling, Simulation, and Analysis: A Decision Analysis Aid for Policy Development, Planning, and Requirements Definition

In this program computer-based decision making tools for assessing targeting options for countering the nuclear-weapon-building process are being developed and applied. In the modeling and simulations, calculated mission effectiveness and collateral effects are combined into a composite score with treatment of uncertainties. The current application of the model is focused on the nuclear fuel cycle in a single country and on military strike options.

Counterproliferation responses are generally those active measures undertaken to counter the procurement or building of weapons of mass destruction or to counter the weapons themselves to deny enemy or terrorist use. In this program we focus on the former and are developing analytic decision-making tools for assessing targeting options against the nuclear-weapon-building process. These tools can be useful in counterproliferation planning and policy development, and can help identify information and technology needs. The goal is to put weapon-building knowledge from the DOE into a DoD targeting and mission planning perspective, and to provide a more objective and traceable decision-making process.

In the analysis of pertinent response options there are several steps that lead to ranking of the weapon/targeting options. The first step is a vulnerability analysis of the weapon-building process to identify vulnerabilities such as choke points and time-critical processes that become the potential targets. In general, we look for and identify the targets that, if "taken out," would put the proliferant out of the weapon-building business for the longest period of time, but other criteria are included also. (The vulnerability analysis in this program is based on the Los Alamos Angelfire work on nuclear fuel cycle vulnerabilities.) The next step is to identify the appropriate weapons and then apply the weapons to the targets in a simulation model, currently the conventional targeting evaluation model (CTEM). The next step is to evaluate the effectiveness of the strike according to preselected criteria, the principal criterion being the amount of time the weapon-building process is delayed. Next collateral effects, such as radioactive material dispersal, are quantified and combined with the effectiveness into a composite score. Next, targeting errors are included by repeating the whole process in a Monte Carlo fashion starting with draws from weapon circular error probability (CEP) distributions. Thus, the result is a range of scores for each option that can then be ranked with respect to the others. All of these steps are included in the modeling and simulation.

The first application of the model will address a portion of one country's nuclear fuel cycle, the reprocessing facilities, and military strike options with conventional munitions. Effectiveness will be measured in terms of the time delay to achieving a weapon, and calculated population dose from radionuclide dispersal will be the collateral effect considered. Later possibilities include modeling the entire weapon-building

process, developing a discrete-event simulation model that would like to red teaming exercises, adding biological and chemical weapons, expanding beyond conventional strike options to covert and other actions, and quantification of the impacts of additional intelligence information and technology enhancements.

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Proliferation Interdiction Effectiveness Analysis

Proliferation Interdiction Effectiveness Analysis establishes a methodology for analyzing possible future crisis scenarios involving a proliferant, by identifying critical nodes or paths in nuclear fuel cycle processes and/or facilities and assessing the potential consequences of interdicting a facility or part of a facility. The methodology begins with information requirements from intelligence and process engineering sources, moves to critical path analyses of the process, and ends with an analysis of the environmental, socioeconomic and political and retaliative consequences of action. The actual decisions on targeting would be made by the responsible military organization.

Critical pathway methodology is being used to analyze how pathways might shift when an option is removed and how the removal of options impacts both time and resources needed to develop nuclear weapons capabilities. Information on source terms and damage assessment permit the use of models for environmental consequence analyses. LLNL's Atmospheric Release Advisory Capability (ARAC) is one of the environmental tools used to model airborne releases. Among the economic consequences to be evaluated are the costs of replacement of a facility, the potential loss of trade and the cost of the mission. Political and retaliative consequences are more qualitative and rely on expert judgment. The methodology is an iterative one, requiring the participation of a multi-disciplinary team and progress made to date will be shown.

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Strategic Futures

The Strategic Futures process is a systematic approach to correlating future strategic mission requirements with science and technology opportunities. The objective is to define USSTRATCOM's future mission needs, and link them to acquisition community research and development (R&D) efforts. The Strategic Futures process is intended to complement and support the existing service-unique programs (e.g., the Air Force's Technology Master Plan development and the Navy's Mission Area Assessments, Roundtables and investment strategy development). Strategic Futures can also support USSTRATCOM's participation in the formulation of OSD's Advanced Concept Technology Demonstration (ACTD) program.

The Strategic Futures process includes the following steps in a "strategy to tasks" approach:
(1) Definition and prioritization of USSTRATCOM's future mission needs;
(2) Identification of technologies to meet needs;
(3) Design, development and conduct of seminar planning games;

(a) Definition, coordination and Strategic Advisory Group review of scenarios for the planning games;

(b) Development of technology toolboxes, including technology descriptions and effectiveness ssessments for supporting the missions and tasks defined for the scenarios;
(4) Analysis support for defining needs, developing technology toolboxes, designing and conducting planning games, and identifying leading technologies.
(5) Integration of game and analysis results, and coordination of USSTRATCOM needs and technology solutions with technology providers to identify enabling technology programs, and to influence investment strategies and acquisition planning.

SF2 is expected to yield both qualitative and quantitative results. Pre-game planning, game conduct and post-game analyses will inevitably lead to deeper understanding of potential threats, shortfalls in meeting those threats, and the acquisition process that must be constructively engaged to produce real solutions. Tangible results will include scenario selection methods, scenario albums, technology toolboxes, and prioritized lists of USSTRATCOM's future mission needs and candidate S&T programs (including potential ACTD sponsorship) to meet those needs. Results will be provided to organizations interested in future strategic mission needs and technologies for addressing those needs.

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The Role of Emerging Technologies in the Proliferation of Weapons of Mass Destruction

Technology is advancing more rapidly than the U.S. ability to comprehend and plan for its effect on regional military force balances. Many of the technologies that are commercially available today have a latent strategic potential which may be unrecognized or not fully understood by U.S. decision makers, and which may be put to use by determined proliferators in ways detrimental to U.S. security interests.

One of the most notable and highly publicized cases of a civilian oriented technology freely available in the commercial marketplace which may pose serious security problems for the United States is the Global Positioning System (GPS). In the hands of a hostile power with ballistic missile capability, GPS technology could increase the accuracy and lethality of missile systems by an order of magnitude, magnifying incentives for aggression and providing important battlefield advantages in the event of conflict. Information processing technologies may also contribute to the rapid enhancement of a nation's warfighting capabilities. The capabilities found in yesterday's "supercomputers" are accessible in today's laptops. Other on-the-horizon technologies may convey similar military advantages to an aggressor, and may proliferate faster than our ability to cope with their unintended consequences.

This paper will identify and assess the availability of emerging commercial technologies with strategic potential, the implications of transfer of these technologies to Nth countries, and the range of plausable counter-proliferation strategies that can be enacted to combat the effects of these transfers. It will be argued that dealing with the strategic potential of emerging commercial technologies on a proactive, rather than a reactive, basis is both warranted and feasible.

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Security Risk Assessment

The security of U.S. nuclear weapon stockpile is of paramount importance. The security record for the stockpile has been perfect, and to our knowledge there has been no attempt to take possession of a U.S. weapon. However, recently there has been an increase in the number of terrorist attacks directed against U.S. interests. It is possible that a terrorist attack could be directed against a U.S. nuclear storage site.

We recently made a crude estimate of the probability of success for a terrorist team to obtain at least temporary access to a U.S. nuclear weapon. We found that the probability of a success may be comparable to that of an accidental nuclear detonation. Therefore, the national importance of security and use of control is comparable to that of nuclear safety.

We are currently assessing the probabilities of a terrorist team's ability to gain access to a nuclear weapon in U.S. custody within the United States and to enable the weapon. We have developed a methodology that marries classical decision theory with interactive high-resolution simulations. Our progress to date will be described.

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Stockpile Life Study -- A History of Care and Feeding

The U.S. nuclear weapons program is undergoing a period of great turmoil. The stockpile is being greatly reduced, the production complex is in a state of transition and the country is in the midst of a nuclear test moratorium. Given this situation, how long can the nuclear weapons remaining in the stockpile last? What are the implications for the reliability and maintenance of the remaining stockpile? This study attempts to address these issues by examining the historical record for nuclear weapons, the defect data that have been recorded mainly through the Stockpile Evaluation Program (aka, QART), and the data on changes that have been made to the stockpile.

On the order of 70,000 nuclear weapons have been built and full systems tests have been conducted on roughly 20% of them. This study reveals that 257 "actionable" defect types have been uncovered through the test program and other activities related to stockpiled weapons. Changes to weapons in the stockpile have been made to correct about one-third of these defect types, and also to implement new safety features and to improve operations and maintenance. Comparison of the rate of defects and changes to date for weapons expected to remain in the stockpile well into the next century do not differ substantially from the historical trend, thus allowing a reasonable projection of the workload that can be expected from finding and fixing defects of the future.

Perhaps the most important aspect of this study is that it sheds some light on the Stockpile Evaluation Program and on the process of making changes to the stockpile which is often transparent or at least obscure to most in the military.

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TheRelative Overall Merit Assessment (ROMA) Model – An Approach to Comparing Warhead Candidates

The evaluation of numerous Mk4A and Mk5A candidates for the Navy-DOE SLBM Phase 2 warhead feasibility study involved tradeoffs between competing attributes such as surety, weapon effectiveness, vulnerability, production and logistics, engineering characteristics, and physics evaluation. The ROMA model was developed and used to combine figures of merit (FOMs) for each of the candidate warheads. The results of the ROMA analyses were used in the Phase 2 indicate the best warhead alternatives for further consideration.

ROMA is a spreadsheet model that combines analytic and subjective inputs from the Phase 2 technical working groups. The methodology uses relatives values for the various FOMs and normalizes them at several levels. It assigns weighting coefficients to each of the FOMs that correspond to their assessed importance in overall value. Members of the System Performance and Effectiveness Technical Working Group (SPETWG) were polled for their preferences to establish the weighting and tradeoff measures.

This 45 to 60 minute briefing describes ROMA by using illustrative candidates, input numbers, and findings, based upon the approach used in the SLBM Phase 2. The briefing concludes with a discussion of the model's attributes.

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Effects of High Power Radio Frequency Weapons on an Integrated Air Defense System (IADS)

As technology marches forward its advances are quickly integrated into most nation's military arsenals. With the continuing development of more advanced electronic equipment and the growing dependence upon computers, especially in time-critical situations, any weapon with potential to disrupt or permanently damage these components bears scrutiny. Since an IADS is a complex, highly interconnected system of communications networks, electronic equipment, and computers, it is interesting to see the effects on the overall system by targeting selected components. Several Radio Frequency (RF) weapons which are potentially deadly against certain types of electronics and computers are now in a conceptual design phase.

This paper discusses the effects of employing certain RF weapons against a "Soviet-type" IADS, and how overall effectiveness of the system is changed. The paper contains work completed at HQ Strategic Air Command in 1992, and shows how lessons learned from this study are being currently applied. For example, the paper shows how field test results are used as input into computer models. The present efforts works closely with the US Strategic Command (USSTRATCOM). USSTRATCOM planners are using the results of the study in their "real-life" planning process.

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The Counterproliferation Role of Ballistic Missile Defense

The Clinton Administration has elevated the importance of counterproliferation in U.S. foreign policy. The recently-announced Defense Counterproliferation Initiative (DCI) represents an official recognition that despite efforts to prevent it, proliferation may still occur. Therefore, as the Secretary of Defense has stated, "we are adding the task for protection to the task of prevention."

The DCI does four important things. First, it acknowledges for the first time, at senior policy levels, a direct role for ballistic missile defense (BMD) in the counterproliferation mission. Second, by focusing specifically on the role of theater missile defense (TMD), it highlights the importance placed on defending U.S. troops and regional allies against ballistic missile attack. Third, as an explicit part of U.S. counterproliferation objectives, it increases the prospects for Congressional support and funding for the TMD program. Finally, it provides impetus to a restructuring of the defense acquisition process in order to insure that appropriate theater missile defense capabilities are acquired.

Unfortunately, the DCI falls short in two major respects. It fails to articulate the comprehensive role that TMD can play across the counterproliferation policy spectrum. And it discounts the importance and relevance of a national missile defense to counterproliferation.

This paper will identify and evaluate the linkages between BMD and proliferation, focusing on ways that theater missile defense might complement current U.S strategy. It will be argued that BMD can play a unique dual counterproliferation role. By having a dissuasive effect, it would enhance U.S. non-proliferation objectives. And the defense capability it provides would offer protection from determined states that refuse to be deterred in their quest for weapons of mass destruction. Either way, ballistic missile defenses lessen the attraction and raise the cost of competing in the ballistic missile arena.

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Cost-Benefit Analysis of Treaty Confidence-Building Measures

Provisions for verifying adherence to the Chemical Weapons Convention have given rise to concern that their benefits may not be worth the cost. Further concern has also been expressed that similar provisions might become the verification standard for future international arms control agreements and treaties.

To address these concerns we are developing a systematic approach for determining the value of treaty verification means. Our approach utilizes multi-attribute utility theory to trade off costs with benefits. These costs are both direct and indirect. Direct costs associated with verification can include on-sight inspections, national technical means, technology R&D and manufacture, and the like. Included with indirect costs are less-easily quantifiable factors such as military and political losses associated with missed detection of violations and false accusations, as well as loss of sensitive and/or proprietary information associated with on-sight inspection of both government and commercial facilities. Treaty benefits are realized through reduced risk and cost avoidance.

Our approach provides an integrated philosophy for arms control treaty verification across the various defense concerns, including nuclear, chemical, biological, conventional, and missile delivery.

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Counterproliferation/Silver Book

The U.S. civilian leadership,-including the President, Secretary of State, and Secretary of Defense, has articulated the national commitment to counter the proliferation of weapons of mass destruction (WMD). Military options are a key part of this counterproliferation effort.

The USSTRATCOM initiative called SILVER BOOK consolidates present-day military options against nations known to proliferate weapons of mass destruction. The concept will assign appropriate responsibility and accountability for WMD. It will focus national resources on WMD as a world-wide problem, provide a decision tool for the National Command Authority, provide a planning tool for other CINCs, and preserve the unity of command for the CINCs executing military options.

The Counterproliferation/Silver Book briefing will present the logic behind the concept of the Silver Book and will use an illustrative example to demonstrate the methodology used to develop the Silver Book against a fictitious target.

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Deterring Regional Adversaries

With the Cold over, U.S. national security strategy has shifted away from its focus on the former Soviet Union and toward possible U.S. regional involvements. As a consequence, virtually all the fundamental elements of U.S. strategy, developed during the Cold war with the Soviet Union, have to be reevaluated as to their applicability to regional adversaries. Among these fundamentals is the role of deterrence was the heart of U.S. strategy for countering the Soviets, both because war with the Soviets was unacceptably dangerous. Much of what is called "deterrence theory" was developed specifically for this function. Therefore, regional strategy requires revisiting basic questions about deterrence. Should the United States base its regional strategy on deterrence? Can regional adversaries be deterred and, if so, by what? What resources can and should the United States devote to that objective?

This Draft report represents an attempt to come to grips with these fundamental questions. As such, it should be of interest to policy makers, strategists, and military planners interested in the conceptual requirements for effective deterrence, as well as the operational and force structure implications that emerge should the United States make regional deterrence one of the pillars of its national military strategy. As an

application of these concepts, a companion report (Dean Wilkering and Kenneth Watman, Deterring Nuclear Threats From Regional Adversaries, DRR-544/2-A/AF) addresses the specific question of strategies for deterring nuclear attacks against the United States or U.S. allies by regional nuclear powers. This second report should be of interest to policy makers interested in U.S. counterproliferation policy.

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Strategic Retaliation and Theater Missile Defenses

The purpose of this paper is to provide a first order examination of the potential impact of a Russian theater missile defense on the nuclear retaliatory capabilities of the United States. Various strategic defense and offense options are considered, assuming that theater missile defenses are allowed to be deployed in each homeland. Other agendas are addressed which would either limit the effectiveness of theater missile defenses when used against strategic missiles, or ban the deployment of such defenses in the homelands of Russia or the United States. A basic assumption is that the terms of the START II Treaty will have taken full effect.

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Unified Perspective
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Doctrine Development Service Perspective
Absract not available.

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TMD Tactics, Techniques and Procedures
Abstract not available.

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Modeling Stability in the New International Environment
Abstracts not available.

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Cooperative Development of Ballistic Missile Defense
Abstract not available.

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Implications of Boost/Ascent Phase Intercept Systems for Arms Stability
Abstract not available.

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An Overlooked Priority: Passive Defense Contributions to Counterproliferation
Abstract not available.

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Array TBMD Concept of Operations

The United States Army Air Defense Artillery School (USAADASCH) developed the operational requirements for Patriot Advanced Capability-3 (PAC-3), Theater High Altitude Area Defense (THAAD), and Corps Surface-to-Air Missile (Corps SAM). Along with the individual system requirements, an operational concept was developed for employing the systems in a tiered defense. The presentation proposed, herein, begins with a brief description of these systems, explains the rationale for a tiered defense, defines the concept for a defensive enclave, describes firing doctrine considerations, and concludes with an overview of engagement and force operations command and control.

The defensive enclave is composed of a task organized Battalion-sized force along with the command and control structure needed to effectively execute the defense. The task force is normally composed of a Patriot battalion with six fire units and a THAAD battery. The task force provides preferential defense for critical assets. THAAD provides the "upper tier" of the defense and Patriot the "lower tier". Defense planning is centralized at the battalion headquarters while engagement authority is decentralized to the batteries. The defense planning process develops the rule sets and parameters used by the batteries to execute a decentralized but coordinated battle. Near real time information exchanged between THAAD and Patriot within the enclave includes positional track data, operational status, and engagement status. Cueing and alerting information is received from sources external to the enclave, via the Joint Tactical Information Distribution System and from Patriot and the Commander's Tactical Terminal/Hybrid. In turn, track data from THAAD and from Patriot is provided to the theater. Additional information provided to the theater from THAAD and Patriot, includes predicted ground impact point and predicted launch point, to support attack operations and passive defense.

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Navy TBMD Concept of Operations
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Theater Missile Defense BMC4I Operational Concepts
Abstract not available.

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Dynamic Realtime Target Classification
Abstract not available.

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The Role of UOES in System Development/Acquisition
Abstract not available.

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UOES Analyses
Abstract not available.

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UOES Contingency Operations Planning
Abstract not available.

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UOES as an Innovative Acquisition Approach for TMD
Abstract not available.

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Analysis of a Multi-Layered Theater Air Defense (TAD) Capability
Abstract not available.

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Joint Air Operations
Abstract not available.

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Distributed Air Defense/Missile Defense
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PATRIOT Advanced Capability Level 3 (PAC-3) Cost and Operational Effectiveness Analysis
Abstract not available.

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Theater Interoperability
Abstract not available.

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Joint TMD Interoperability Certification
Abstract not available.

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Army TMD Interoperability Testing
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Implications of Theater Interoperability
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TMD Interoperability at What Price?
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Gold Pan: A Theater Missile Defense Demonstration
Abstract not available.

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Addressing BM/C3 Issues on the Extended Air Defense Test Bed

The Extended Air Defense Test Bed (GADTB) is a newly developed, medium to high fidelity, theater-level simulation capability that will model the Extended Air Defense (EAD) Environment. The EADTB is sponsored by the Ballistic Missile Defense Organization (BMDO) and has been developed by the United State Army Space and Strategic Defense Command Test Bed Product

Office, in Huntsville, Alabama. EADTB provides the analyst with a flexible modeling capability to represent varying EAD concepts in a Theater environment. The EADTB will have an initial operating capability in April 1994 and the BMC3 Experiment is planned from Summer, 1994 to early Fall, 1995. The BMDO has defined an initial Experiment to be executed on EADSTB which will provide information on the evolving EADTB capabilities to model BMC3, and insights into the Theater Missile Defense (TMD) BMC3 Architecture. Several BMC3 issues have been identified and these include: criteria and alternatives for the reporting process for early warning data dissemination; value added of combining TMD sensor data; insights into the TMD Architecture communication design capabilities; and, performance sensitivities to the engagement planning process and to the modular deployment of Theater Missile Defenses. This paper will discuss the BMC3 Issues, EADTB capabilities, development of the Experiment plan and design on the EADTB, and the Experiment schedule.

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Theater Air Command and Control Simulation Facility (TACCSF)

The Theater Air Command and Control Simulation Facility (TACCSF), located at Kirkland AFB, New Mexico, is the world's largest operator-in-the-loop air defense simulation facility. The facility was developed by the Office of the Secretary of Defense, Air Force, and Army over a 18-year period, at a total cost in excess of $200 million, to address specific air defense and command and control issues.

The facility is a national asset operated by the Air Force (TACCSF), with Army participation, and is a resource available for use by any US or Allied agency. Typical applications which the facility supports include, but are not limited to:

- Development and refinement of new system requirements, concepts, tactics, plans, and procedures
- Systems integration/interoperability
- Planning, scoping, and rehearsing live operations
- Extending the results of live operations into larger scenarios

The TACCSF simulates air defense functions such as tracking, identification, weapons allocation and control, and kill assessment for all execution levels of integrated Army/Air Force air defense. The TACCSF includes the following components: a control and reporting center (CRC), control and reporting posts (CRP) represented by models of the German Air Defense Ground Environment (GEADGE) and Modular Control Equipment (MCE), the E-3 AWACS, E-8A Joint Surveillance Target Attack Radar System (J-STARS), RC-135 Cobra Ball, Airborne Laser, F-15E, F-15Cs, an Army air defense brigade (AN/TSQ-73), PATRIOT air defense battalion with six fire units, a HAWK battalion with eight fire units, and unattended ground sensors. Effects of inputs from a Special Information System (SIS) are modeled as is the information flow from the Rivet Joint/TIBS, a Sector Operations Center (SOC) and Wing Operations Center (WOC).

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Theater Missile Defense Test Design

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Counter Proliferation Overview

Abstract not available.

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US Army Deep Operation Coordination Center (DOCC) Counterforce Concept

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The Counterproliferation Role of Ballistic Missile Defense

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Army Tactical Missile System Cost and OpPerational Efffectiveness Analysis
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A Practical Approach to Validating Existing Models and Simulations For Use in Ballistic Missile Defense

Given that many Models and Simulations (M&S) are often reused for purposes other than they were designed. How does one attempt to validate old M&S for the new intended purpose? This is the basic question that the Ballistic Missile Defense Organization's (BMDO) National Test Bed (NTB) program was concerned with when it initiated the Analytical Tool Box Program (ATB). The ATB program provides two CA services to its customers, M&S catalog, and a Confidence Assessment process. It is the CA process that is the focus of this paper.

The ATB Confidence Assessment process is a methodology for building confidence in the results of M&S for a specific intended use. The process has been developed in three phases and culminates in a head-to-head analysis capability of two o or more models or simulations. This paper outlines the process, defines the three phases and the head-to-head capability and provides a high-level overview of the program.

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Modeling the Effects of Deployment Limitations on TMD Capability
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Modeling TMD in Combined Arms/Joint Task Force Operations
Abstract not available.

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New Evaluations of Defense Effectiveness
Abstract not available.

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Communications Architecture for TMD BM/C3I
Abstract not available.

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Arms Control Compliance: Information Value of Verification Measures

Decision analysis concepts involving the value of additional information were introduced by the US delegation to a group of technical experts charged with evaluating and prioritizing various verification measures proposed for the Biological Weapons Convention (BWC). This is an area of increasing concern given the proliferation of biological technology and weapons, especially among rogue countries, and the specter of horrific consequences if a possibly mercurial leader were to employ BW.

Three of the 21 verification measures considered by the experts group in Geneva were evaluated: 1) searches of unclassified databases of BW-related publications; 2) use of commercial satellites to detect and identify facilities possibly associated with BW production or storage; and 3) use of on-site inspections by trained

personnel, possibly supplemented with analytical equipment, at facilities suspected of illicit BW involvement.

Using realistic sensitivities and selectivities for those measures, together with representative prior probabilities of cheating, we demonstrated that it will be very difficult for any of the three measures to produce posterior probabilities of violation high enough to prompt a charge of non-compliance.

Even when the three verification measures are considered collectively -- perhaps as part of a sequential screening process where more refined, more intrusive, and more costly measures are employed sequentially -- the cumulative effects of the measures may not have sufficient diagnosticity or discriminability to produce posterior probabilities of violation sufficiently conclusive to warrant diplomatic or military responses.

Despite such analyses casting doubt on the efficacy of BWC verification measures, together with some nations' desires to promote verification measures for largely political purposes, the US experts were successful in persuading other delegations to adopt a decision analytic approach as an evaluation tool.

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Optimal Selection of Proliferation Targets

The Template Targeting Methodology (TTM) is a software tool for selecting targets and weapons for attacking facilities in third-world weapons-of-mass-destruction (WMD) programs. TTM is an extension of the Chemical Weapons and Nuclear Capabilities Acquisition Process models (CWCAP and NCAP respectively) developed for the intelligence community to determine the status of WMD programs. While the current scope of CWCAP and NCAP does not address overt military action against proliferation targets, TTM is intended to fill that gap by providing a systematic means of to select both targets and weapons to impede a proliferant's progress toward a deliverable chemical or nuclear weapon, or to compromise his warfighting capability if such weapons are already stockpiled. TTM could also be expanded to include targeting biological or missile facilities.

Like CAP, TTM implementation is based on a template (or network flow) representing all the technological paths that a proliferant can pursue to obtain an operational weapons system. Country specific data is entered for each activity in the template (i.e. what is the intent to undertake this activity? how far along is it? how vulnerable is it? etc.) and serves as a template "overlay" for that country. Template elements may then be "filtered" and displayed for a given country so that, for example, all activities that are underway and susceptible to further collection are highlighted on the template. WMD program status may be evaluated by calculating the time-to-complete and intent for all paths leading up to milestones within the template. Critical paths (e.g., fastest or most likely) may then be highlighted along with filtered elements. Optimal selection of targets and attack options is accomplished by maximizing the expected delay a WMD program would suffer as a result of an attack on facilities supporting the WMD program. Collateral effects are also accounted for in the optimization.

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Identifying Indicators of Illicit Chemical Weapons Production Under the Chemical Weapons Convention

The verification regime for the CWC will include on-site inspections for the purpose of determining the presence of Schedule 1 or 2 chemicals. Environmental samples will be taken at a perimeter around the facility and analyzed for their chemical content. In many cases, identification of degradation of prohibited chemicals could provide sufficient evidence of an agent's presence. This paper will present the results of work sponsored by the Defense Nuclear Agency to 1) model the production of selected Schedule 1 chemicals, 2) model the downwind transport and soil deposition of the production effluents, 3) assess the evidential significance of specific degradation products, 4) evaluate the ability to treaty-accepted inspection equipment and procedures to detect postulated concentrations of degradation products in soil samples, 5) collate and analyze available physical and chemical properties and environmental pathways data for CWC Schedule 1 chemicals and their degradation products to assist DNA in developing a research and development effort to collect missing data and resolve inconsistencies in published information.

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Cost-Benefit Analysis of Treaty Confidence-Building Measures

Provisions for verifying adherence to the Chemical Weapons Convention have given rise to

concern that their benefits may not be worth the cost. Further concern has also been expressed that similar provisions might become the verification standard for future international arms control agreements and treaties.

To address these concerns we are developing a systematic approach for determining the value of treaty verification means. Our approach utilizes multi-attribute utility theory to trade off costs with benefits. These costs are both direct and indirect. Direct costs associated with verification can include on-site inspections, national technical means, technology R&D and manufacture, and the like. Included with indirect costs are less-easily quantifiable factors such as military and political losses associated with missed detection of violations and false accusations, as well as loss of sensitive and/or proprietary information associated with on-site inspection of both governmental and commercial facilities. Treaty benefits are realized through reduced risk and cost avoidance.

Our approach provides an integrated philosophy for arms control treaty verification across the various defense concerns, including nuclear, chemical, biological, conventional, and missile delivery.

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Some Implications of Alternative World Futures for Arms Control and Regional Stability

The United States is facing the need to define its role in power arrangements that will evolve in the future. Whatever power arrangement this turns out to be, the US role (political, military, and economic) will aim at supporting regional stability. Arms control will be one component of US policies that support the achievement of US national strategy in the regional context.

World Futures represent the conditions that define strategic concepts and strategies to achieve regional security, and a variety of geopolitical futures is possible. One possible power arrangement was described by President Bush as the "New World Order." Other possibilities include neo-isolationism, a balance of power among several nation or multi-national "poles" and the unilateral exercise of predominant US power. Each alternative world future is defined to some extent by the level of US involvement , at the same time that it establishes requirements for US force size and structure.

This paper will describe roles for the United States in alternative world futures and suggest implications for future trends in strategic, conventional, CW and BW arms control. The policy-technology interface will play a central role, as different world futures imply alternative defining strategic concepts and strategies which, in turn, imply the availability of and reliance on differing technologies. The process also works in reverse, in which case the supply of technologies provides the push to alternative strategic concepts and strategies.

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Using the Continuous Solution Provided by the Arsenal Exchange Model (AEM) to Find Integer Solutions of the Missile Allocation Problem

AEM is used to find continuous of the missile allocation problem. Realistically, an integer number of weapons are assigned to an integer number of targets. The research investigates deriving good feasible integer based on the continuous solution provided by AEM. The ability to do analysis based on integer solutions becomes more important as the number of weapons and targets decrease.

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The DNA Hazard Prediction Program

The Defensclear Agency (DNA) is developing an operational forecasting system capable of predicting the dispersal of hazardous materials released into the atmosphere for virtually any scenario. Such scenarios may be associated with the use of nuclear, biological or chemical weapons or may derive from release of hazardous materials from facilities or targets which store, produce, or use nuclear, biological, or chemical materials. The program includes both research into the basic physical phenomena and development of efficient computational models. All models developed are being integrated into a flexible and responsive predictive system that supports both mission planning and emergency response. The major technical thrusts include characterizing the release of hazardous materials, accurately representing the wind fields and weather and the associated transport of materials through the atmosphere and appropriately formalizing the expected effects on military and civilian personnel in terms that have operational significance.

Characterizing the source is a very complex process. The release of hazardous material may result from weapons that have been used or intercepted, from military or terrorist strikes on weapons production or storage facilities or on industrial facilities or even from accidents. This portion of DNA's program includes

experiments, hydrocode simulations and release source model development. The source terms generated are used to initialize an atmospheric transport calculation.

Accurate prediction of atmospheric transport requires high resolution of the local wind fields and weather. DNA is attacking this challenge by both applying current high resolution nested atmospheric simulations and by developing a new multi-scale integrated simulation tool. Both approaches are focused on forecasting capabilities to enable real-time response to emergency scenarios. Multiple vapor, aerosol and large particle transport tools are being applied and evaluated to transport the hazardous materials through wind and weather.

To be useful the patterns of flow and dispersal must be evaluated in terms of their effects on both military force sand non-combatants in an area of concern. The transported environments must be merged with extensive nuisance, incapacitation and lethality databases and population data to generate casualty assessments and to evaluate potential actions in mitigation. DNA is adapting tools developed for nuclear cloud fallout effects to these more general problems.

An example case where some of these tools are applied is a hypothetical attack on a nuclear power plant. This paper will walk through this example from the hazard release characterization, to the evaluation and application of historical winds to aid in developing emergency plans, and finally to the definition of hazardous footprints associated with the transport of the released radioactive materials.

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ABM Impact on the SIOP: Cost/Benefit Trade-Offs

USSTRATCOM was asked by CJCS for our thoughts on the impact on USSTRATCOM's mission if the Russians deployed a theater ballistic missile defense system similar to the US Theater High Altitude Air Defense (THAAD). While a first order evaluation might show a drop in damage expectancy (DE), we feel that a narrow interpretation of these results would overlook other characteristics brought by defensive systems to the nuclear deterrence and stablility relationship. Assessing only the COST of a Russian THAAD-like capability ignores the BENEFIT side of the equstion. We want to understand both elements of the equation.

Examining the risks to US strategic forces by the deployment of Russian THAAD-like ballistic missile defense system, we review methodologies for analysis to assess the impact of a Russian THAAD-like system on a START II laydown (at an aggregate level and more detailed model).

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Strategic Retaliation and Theater Missile Defenses

The purpose of this paper is to provide a first order examination of the potential impact of a Russian theater missile defense on the nuclear retaliatory capabilities of the United States. Various strategic defense and offense options are considered, assuming that theater missile defenses are allowed to be deployed in each homeland. Other agendas are addressed which would either limit the effectiveness of theater missile defenses when used against strategic missiles, or ban the deployment of such defenses in the homelands of Russia or the United States. A basic assumption is that the terms of the START II Treaty will have taken full effect.

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Proliferation Indicators – An Interim Report

That concern over the proliferation of nuclear, chemical and biological weapons has grown since the end of the Cold War is no surprise. Various elements of the Government continue to try to prevent proliferation by implementing a variety of export control programs; the Defense Department has initiated a counter-proliferation program to deal with proliferation if it cannot be prevented; and the Intelligence Community is giving increased attention to discovering and assessing proliferation programs wherever they may occur. Each of these major types of activities relies, to varying degrees, on identifying and detecting various indicators that accompany an active program whereby a state (or even a non-state) seeks to develop or acquire weapons of mass destruction and/or the means to deliver them.

This internal study identifies a series of potential indicators of proliferant activity in the areas of nuclear weapons -- particularly the weaponization of nuclear devices, as contrasted to the production of special fissile materials -- and of ballistic missiles. The potential for each of several general methods for detecting and for assessing proliferation programs is evaluated -- at several stages during their progression from simply a "gleam in someone's eye" to actual deployment and subsequent retirement of such weapons and missiles. From that assessment, one could then match certain available or proposed technologies to indicators with the greatest potential for helping to address proliferation.

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Counterproliferation: Developing the Tools

With the passing of the Cold War and the restraints of the bipolar Superpower framework, the US finds itself in an international environment characterized by long dormant regional power struggles whose leaders increasingly look to weapons of mass destruction (WMB) as a lever to guarantee objectives. Though US objectives of a free, independent and economically prosperous nation are unaltered, the threat to these goals has changed. While WMD are not new for the US military, what is new is the wealth of technology available to counter WMD and the potential possession of WMD by a wide range of actors whose motivations and risk tolerance differ greatly form past adversaries, potentially rendering them less susceptible to deterrence and more likely to employ WMD. The greatest leverage to execute the counterproliferation of WMD is offered through the aerospace medium with its capability for rapid and flexible surveillance, strike, and assessment. The paper will discuss the changing international environment and the emerging threat, the factor effecting our instruments of national power, and how the US might best manage a response. Finally, the paper will develop current USAF actions to facilitate an effective military to counter WMD.

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Conventional Armed Forces in Europe (CFE) Treaty Elements, Issues and Measures of Effectiveness

Since the signing of the Treaty on Conventional Armed Forces in Europe, or CFE, in Paris on 19 November 1990, the pace of political change it punctuated has hardly subsided. The 34 nations convened there under the auspices of the Conference on Security and Cooperation in Europe, or CSCE, have swollen to 52; the 22 original parties to the CFE Treaty, signatories of either the erstwhile Treaty of Warsaw or the North Atlantic Treaty, are now 30. The unprecedented reduction of conventional armaments in the region from the Atlantic Ocean to the Ural Mountains agreed there is proceeding, but not without lingering difficulties and challenges.

The CFE Treaty itself is a highly complex undertaking of twenty-three articles and associated protocols, with the full English text running to some 110 pages. Associated reports, notifications, and information exchanges to date already yield ample new metaphors for our concept of an 'information explosion.' This overview is a self-conscious effort to distill and simplify the central aspects of the Treaty and associated documents, focusing on aggregate equipment and manpower limits, holdings, liabilities, and sites. It updates and expands on a pamphlet originally composed at the US Army Concepts Analysis Agency in June 1991, whose tables and graphs also appeared in S. Hrg. 102-288, The CFE Treaty, pp. 301-314, and a subsequent update compiled at the US Arms Control and Disarmament Agency in March 1993.

The analytical task this effort represents is a familiar one: seeking adequate measures of effectiveness that economically convey the main thrust of the phenomenon observed. Trading off simplicity against precision, impact against detail, concept against comprehensiveness are at the heart of scientific inquiry, and adequate oversight of a major arms limitation treaty should certainly meet the standard. Reviewing and discussing means and measures employed in this pursuit should thus be of interest to analysts as well as policy makers.

The evident premise of this work remains the old but still operative bromide that holds a picture to be worth a thousand words. The object is to portray in a handful of graphics and accompanying narrative the key features of the CFE regime, providing the reader a quick survey and reference, as well as an update on issues of continuing interest as the Treaty is implemented. The data presented draw on reports rendered under the Treaty's Protocol on Notification and Exchange of Information, including data exchanged at signature on 19 November 1990, with corrections rendered up to 90 days thereafter; 'entry-into-force' data compiled as of 15 July 1992 in connection with provisional application of the Treaty; and the two succeeding annual information exchanges conducted thus far, with data as of 1 January 1993 and 1 January 1994.

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Decision Analysis to Support Development of a Counterproliferation Acquisition Strategy

The Defense Nuclear Agency (DNA) was tasked by the Office of the Secretary of Defense (OSD) to identify and prioritize counterproliferation (CP) issues as part of a wider DOD effort to develop a CP acquisition strategy. Specifically, our objective was to identify key requirements, incremental to conventional warfighting capabilities, to counter the proliferation of weapons of mass destruction (WMD). We developed a model to

represent alternative requirements using Expert Choice, a computer-based decision support tool that implements the well-established Analytic Hierarchy Process. Requirements were expressed in terms of four functional areas: counterforce, active defense, passive defense, and C3I. Expert Choice's primary utility was in structuring the decision making process in terms of these functional areas. In our preliminary efforts, we found that the application of Expert Choice methodology also provided an efficient forum for group discussion of CP issues. Follow-on efforts focused on an active defense acquisition strategy that included prioritization of programs in light of their value added to counterproliferation objectives.

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Global Security Forecast
Abstract not available.

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Assessing Future Military Competitors

History tells us that new competitors will arise in the coming decades to challenge the present military dominance of the United States. The competitors of greatest concern will be those select few that are able to innovate and exploit existing and emerging technologies to gain disproportionate military leverage. Such innovation may result in a Revolution in Military Affairs (RMA) -- a profound change in the nature or conduct of warfare which renders some of our own military methods and systems obsolete. The critical national security issue for the United States today is how we best position ourselves to anticipate and deal with this future military competition.

The problem of trying to anticipate a future that is very different from the present is one which the intelligence community is not well configured to handle. We cannot hope to accurately predict a future which offers so many technological options. However we may be able to gain valuable insight into the nature of the competition -- both near and long term -- through analysis of empirical indicators of ongoing competition and of the capacity of possible adversaries to be particularly innovative over the next several decades.

In addition to a new methodology, we must also consider major modifications to our traditional methods of intelligence collection, analysis, and dissemination. In particular, human intelligence sources may supplant our primary Cold War systems as the primary means of discerning the nature of our future competition. Permanent Red Teams will offer us more insightful analysis of how the competition will respond, while expanded and innovative means of intelligence dissemination will be necessary to facilitate our own successful innovation to meet the future threat.

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Space, Reconnaissance-Strike-Defense Complexes (RSDCs) and Information War
Abstract not available.

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Three Perspectives on the Revolution in Military Affairs
Abstract not available.

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Long-Range Precision Strike
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Deterrence

Abstract not available.

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Theater Missile Defense
Abstract not available.

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Stealth at Sea
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Service Perspectives on the Revolution in Military Affairs
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Industry Perspectives on the Revolution in Military Affairs
Abstract not available.

WG 5 -- Expeditionary Warfare/Poweer Projection Ashore

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Integrated Theater Engagement Model (ITEM)
Abstract not available.

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US Central Command Strike Warfare Analysis Using the ITEM Simulation

Several times in the last decade the United States has conducted strikes of a limited scope against a belligerent state. As a combat command, a unified command must be prepared to conduct quick analysis of various courses of action in contingency situations where force projection is considered. The utility of modeling and simulation of joint warfare for analysis has direct application in contingency planning.

A simulation tool used by the USCENTCOM Combat Analysis Group for modelling power projection ashore is the Integrated Theater Engagement Model (ITEM). It is an easily manipulated joint model that allows air, ground, and naval combat simulation. It provides an analytic tool to simulate expeditionary warfare and force projection, and aids in resource and course of action decisions.

The briefing will cover the background of the ITEM model and give a sample force projection analysis. The analysis will be a comparison between ground-based and carrier-based air assets in-place against targets whose destruction is necessary to open a sea-lane contiguous to a belligerent state.

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Ship to Shore Fire Support System
Abstract not available.

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USN SSM Sizing Trends with Improving Third World SAG CAP Capabilities
Abstract not available.

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Modeling and Simulation for Expeditionary Warfare

The Chief of Naval Operations has focused the "...From the Sea" strategy on four key operational capabilities.

(1) Command, control, communications, computers, intelligence, and surveillance (C4I/Surveillance)
(2) Battlespace dominance
(3) Power projection of joint forces, and
(4) Force sustainment

Within this strategy the Expeditionary Warfare Division (N85) must understand and analyze broad but related warfare areas: amphibious warfare, shallow water anti-diesel submarine warfare, mine and anti-mine warfare (to include surf, land, deep and shallow water mines), naval special warfare, riverine warfare, and maritime prepositioning forces. Expeditionary warfare is complex but can be made more understandable using computer models and simulations to document and analyze solutions to specific problems. Modeling and simulation provides a scientific approach with a documented, repeatable audit trail to:

- establish requirements,
- identify appropriate force mixes,
- evaluate concepts and alternatives,
- assess sustainability,
- determine weapon system specifications,
- provide training, and provide decision aid support to the deployed commander.

This paper discusses requirements for modeling and simulation and how modeling and simulation can be applied to better understand the problems and issues of expeditionary warfare. Attributes of models used to simulate specific warfare areas are discussed and why it si desired to have a federation of models that work synergistically. The paper also emphasizes compliance with the common operating environment and the Navy's modeling and simulation master plan.

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Tomahawk Terminal Fratricide

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Close Air Support Issues

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Relative Cost Effectiveness of Combinations of Suppression of Enemy Air Defenses, Standoff Jamming, Onboard Countermeasures, and Standoff Weapons in a 2010 Scenario

Abstract not available.

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Sandtrap: A Post-Strike Migsweep Tactic

Abstract not available.

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Advanced Technology for Precision Strike Planning

A top-down functional analysis of the needs of a force level air strike planner is performed. These areas include definition, assessment, planning and execution. Opportunities for the application of advanced technology are examined in the areas of target analysis, inter-dependent platform routing, options selection and resource allocation,and visualization and evaluation of competing plans. An end to end system for the assessment and planning phases is described. Operations research approaches to the target analysis, allocation and routing areas are also delineated. High-end computer graphics for visualization, target analysis and preview/evaluation functions is examined. To test the concept, a complex training scenario was used. The results are presented.

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Nearshore Oceanographic Forecasting During Logistics-Over-the-Shore Operations

Amphibious landings and Logistics Over the Shore (LOTS) operations require accurate wave information. Selection of a LOTS site requires that historical wave data, usually available only by hindcast, be used to choose the most favorable time and location. During the LOTS operation, the Commander in Chief (CINC) requires accurate forecasts of waves, water levels and currents in order to optimize the selection of lighterage vessels and to maximize the throughput of supplies within the environmental constraints. Engineers at the US Army Engineer Waterways Experiment Station (WES), Coastal Engineering Research Center (CERC) have developed a real-time system that may be used by the CINC to forecast the above environmental factors using a small computer in the field. The present system, demonstrated on a work station, but targeted for a high end personal computer, accesses weather forecasts from the Fleet Numerical Oceanographic Center (FNOC) and calculates waves at the site of interest using a second generation spectral wave model. Waves are propagated to the site using an appropriate refraction/diffraction model over the nearshore bathymetry. Water levels and currents are calculated using a finite element Advanced CIRCulation model (ADCIRC). The calculations are updated every 12 hours to provide a continuous 72 hour forecast of local ocean conditions. Graphical User Interfaces (GUIS) have been designed to ease the application of the technology for the field personnel.

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Training and Leader Development Simulation for Mounted Warfighting

The experience I have gained form working the Combined Arms Training Strategies (CATS) over the past several years has provided insights into how simulation could evolve into the future from the user's perspective. Specifically, CATS provides an architecture which ties training standards/proficiency gates, resource requirements, and simulation and simulators together. By tying the resources, standards, simulation and simulators together, CATS becomes a tool which the defense community may focus and bound training analyses, determine the essential elements of analysis, perform sensitivity analyses and produce a product which is timely and relevant to acquisition cycle. The merging of simulation and combat systems, especially C3J, into a single combat rehearsal system allows us to plan, rehearse and respond to a contingency and develop our material/training/ combat requirements simultaneously.

WG 6 – LITTORAL WARFARE AND REGIONAL SEA CONTROL
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The Joint Littoral Warfare Environment

Joint Littoral Warfare will be conducted in a very rich and complex environment which will evolve substantially over the next half century. In planning the forces of tomorrow, it is essential that this evolution be anticipated. The environment of a Joint Mission Area may be characterized as consisting of two major component: (1) The Physical Environment (meteorology, oceanography, topography), (2) The Geo-Political Environment (geo-economic context, geo-political, legal context). The premise of this paper is summarized as follows: (1) In Joint Littoral Warfare; the weather, terrain, and aquatic environments have such significant impact on military operations as to deserve consideration as a third active participant in any potential conflict. (2) The global and regional geo-political environments are predictable up to two at least generations in the future (40-50 years). This paper summarizes the "Working Fiction" developed for use in the Joint Littoral Warfare Strategic Planning Process being demonstrated in FY 1994.

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Countering U.S. Military Strategy

The development of a long term threat representation for a rising middle income regional power has become one of the central challenges in force planning for the Post- Cold War Period. This briefing focuses on an approach to force planning for those regional powers whose ambitions may bring them into conflict with the United States and its allies. The under-lying premises of this approach may be summarized as follows: 1. The Persian Gulf War (1990-91) was the public announcement that a "Revolution in Military Affairs" (RMA) had taken place. This RMA was a significant and shocking as the RMA epitomized by the Franco-Prussian War (1870-71). 2. A Theoretically Clever Opponent is capable of studying and understanding the Western Style of Coalition Warfare

and U.S. Military Strategy and of identifying identifying generic strengths and exploitable weaknesses in coalition strategy and doctrine. 3. A determined and patient TCO is capable of planning and developing a resource contrained military capability over time which can allow that regional power to realize its regional ambitions while raising the price of U.S. intervention to substantial if not prohibitive levels. The thesis of this effort is that the geo-economic and geo-political evolution of a region up to two generations into the future is predictable and that the national goals and aspirations of a major regional power are definable both qualitatively and quantatively. Given this information, it is possible to chart an economically feasible range of paths (acquisition strategies) that would allow a TCO to develop the military capability to realize at least a limited set of his ambitions.

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Navy Force Structure Analysis

There are two different approaches to determine the size of the Navy - warfighting requirements and forward presence requirements. This paper will discuss the rules, policies, and methodologies the Department of the Navy uses to calculate the number of ships required in the force structure to support one forward deployed ship. This methodology has been utilized by the Navy staff, the Joint Staff, and the Congressional Research Service.

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Surface Combatant Battle Force Mix Study

This presentation provides a methodology for an analysis of the number of Surface Combatants required in the Force 2001 POM Strategy Wargame scenario using a force of surface combatants with capabilities equal to a DDG-51 and then using a mix of DDG-51 equivalents, DD-963 and FFG-7 surface combatants. The Force 2001 Scenario provides a basis for Naval warfare tasks which are used to define Naval Task force Groups. The levels of threat to Naval forces during various phases of the campaign are used to determine combatant types and numbers. The results make use of single ship parametric analysis employing spread sheet models to develop SAM sector coverage relative to a defended point against threat aircraft, anti-ship cruise missiles, and tactical ballistic missiles; and for Undersea Warfare coverage against threat submarines. A set of baseline results is provided as an example of the steps in the methodology. This work was accomplished by The Jophns Hopkins University Applied Physics Laboratory and the Naval Surface Warfare Center for the Plans, Programs, and Requirements Branch of the Surface Warfare Division, Chief of Naval Operations, N86.

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Fleet Marine Force Module Enhancement Study

The FMF Module Enhancement Study was conducted to demonstrate that the Maritime Prepositioning Ship squadrons (MPSRons) can effectively support priority force modules. This report documents the results of that study. It shows that the MPSRons ship loads can be reconfigured to provide operational flexibility, improved deployability, sufficient sustainment, and back-up plans to further support those modules. It also shows that the time lines for arrival of the T-AVB meet force-module time requirements, and it documents the stand-up and operation of a humanitarian-assistance force module during an exercise with one MPS ship.

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Surface Combatants in a Littoral Environment: Changing Requirements

U.S. Navy surface combatants, notably the AEGIS fleet, were designed for optimal performance in an open ocean ("blue water") environment. Systems were designed to operate synergistically with friendly ships and aircraft within battle groups. Designs were developed for maximum firepower against massive long range cruise missile attacks and for effective deep water antisubmarine warfare. The change of mission emphasis to littoral warfare and regional sea control will require significant changes be made to surface ship design. Ships must be able to do effective strike warfare and surface gun fire support and to avoid minefields. They must be able to defend amphibious groups against low, fast cruise missiles, tactical ballistic missiles, and diesel submarines. This paper describes antiair warfare analysis done to support a series of studies conducted at the Dahlgren Division of the Naval Surface Warfare

Center which has examined alternatives for advanced AEGIS baselines and othe roptions for a 21st century surface combatant. The analysis includes examination of the effects on system performance of alternative multi-function radars, cuing sensors, and short range missile systems. The primary measure of effectiveness is probability of raid annihilation.

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The Number of Moving Search Platforms Equal in Detection Performance to a Distributed (Fixed) Sensor Field

Both moving platforms (ships) and distributed sensor fields have potential application in area search for littoral conflicts of the future. This analysis presents a parametric solution to the operations analysis question of "How many surface ships (moving search platforms) are equivalent in expected detection performance to one distributed field against an acoustic target of given characteristics?" The enhanced search speed due to the potential motion of both searcher and target is accounted for in the parametric solution as an elliptical integral. The parameters of the moving searcher(s) and the distributed field used in this analysis are: total search area, time to detect at a specific probability of detection, number of field sensors, median detection range of an individual field sensor, expected speed of a target within the field, the moving platform(s) search speed, and the median detection range of the moving platform(s).

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Low Profile Vessel Threat Detection in a Littoral Warfare Low Intensity Conflict

Low Profile Vessel (LPV) and Low Profile Semi Submersible (LPSS) radar, infra red, and acoustic detection test results are presented. The tests were conducted in the Joint Task Force Four (JTF40 Area of Operation (AOR) during 1993 by operational forces and research and development activities. The LPV and LPSS are typical of the small, non-steel hull, maritime drug trafficking vessels encountered by JTF4 in the Drug War. It is noted that indigenous wooden or fiberglass hull vessels like the LPV and LPSS are not unique to the Drug War. They are common threat for most "From the Sea", Littoral Warfare, Low Intensity Conflicts, especially where the enemy has no substantial "Steel Navy".

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Deployable Surveillance Requirements for Littoral ASW

In recent years defense policy emphasis has moved from strategic to regional concerns where flexibility and responsiveness are significantly more important. This change coupled with the recent rapid technological advances in electronics and communications invites a new look at the way ASW surveillance is conducted. This paper reviews analysis to determine the requirements for a deployable ASW surveillance system designed specifically for operations in regional conflicts in littoral waters. Issues examined include: what are the likely types of missions and objectives, and how do they and the ROE change from peacetime to crisis to conflict; expected goals and operating behavior of the enemy; environment; ensuing surveillance system requirements. The paper includes analysis using the Sea Control Analysis Tool (SCAT), a McDonnell Douglas developed high fidelity ASW simulation. The simulation is used to examine the effects of communications timelate on the ability of air platforms to reacquire and prosecute contacts, the effectiveness of fields versus barriers, and the force multiplier effects of distributed surveillance for SSN operations.

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Analysis of the ASW Combat System for the Next Generation Surface Combatant

The next surface combatant will be expected to perform multiple missions, by itself and in support of a force. Wherever it goes, it must be capable of defending itself while supporting the defense of any protected units. A draft Mission Needs Statement (MNS) has been written that states in concrete terms what the Next Generation Surface Combatant must be capable of doing. These requirements must be matched against candidates for the ASW combat system for this combatant. These candidates consist of various sensor options (including acoustic and non-acoustic) both onboard and offboard as well as self-defense systems. The study consisted of analyzing various combinations of these component systems with respect to how well they satisfied the MNS.

This presentation will focus on the background and methodology employed in this study beginning with a brief overview of its history and a short look at the requirements in the MNS and continuing through the selection of system alternatives, scenarios, and environments. We will examine the large number of cases involved in this analysis concluding with a discussion of the challenge involved in selecting a way to present the results clearly and concisely. A look at a sample of the results for this study is included.

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Wingship Alternate Missions Analysis

Under a congressionally mandated study, ARPA is investigating the military utility of a wingship, also known as a wing in ground effect (WIG) vehicle or as an Ekranoplan. The primary mission is considered to be the transoceanic shipment of cargo. Several alternate missions can be considered, and this paper discusses these, including: Amphibious Lift - Trans Oceanic, Amphibious Lift - Ship to Shore, Amphibious Lift - Special Operations Forces, Airborne Shallow Water ASW, Airborne Shallow Water Mine Countermeasures, and Cooperative Engagement Concept Ordnance Carrier.

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Operational Assessment of Counter-Drug Intelligence

Interdiction operations based on intelligence cues have been gaining importance, with both increasing sophistication and aintelligence sensors, and reductions in OPTEMPO budgets. In past counter-drug operations, steady-state patrols were conducted across broad areas of the Caribbean and eastern Pacific transit zone. This required a large interdiction force to cover the 900+ miles of south american coastline. Steady-state patrols are more thorough, but expensive due to their asset requirements. Surveillance based on intelligence cues could potentially save millions of OPTEMPO dollars by only requiring a force postured to operate when cued. Because cues vary so greatly in accuracy, timeliness, and comprehensiveness, operational assets should only be deployed in those cases with the greatest probability of success. This paper quantifies the intelligence cues of smuggling activities presented to operational forces over a 6-month period to determine the correlation between intelligence cuing and interdiction success. Quantification of intelligence cues is not simplistic. The dynamic interaction between intelligence and collection/analysis and smuggler modus operandi, result in unique pattern of cues. These patterns were compared to the final outcome of the activity to determine their level of correlation. The correlation considered such variables as mode of transport, geographical location, smuggling entity, degree of smuggler coordination, INTEL-analyst confidence, and intelligence sources.

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Naval Operational Modeling of Mine Countermeasures

The Fleet Operational Simulation Project (FOSP) is bringing the Center for Naval Analyses into the state-of-the-art in analysis modeling. The general project objectives are: to measure the impact of change (e.g., tactics) on fleet operations; to develop and integrate a state of the art simulation facility; to use the facility for analysis, planning, and evaluation. The first task of the project involved Mine Counter-Measures (MCM) modeling of mine sweeping and mine hunting. The computer hardware consists of several networked SGI Indigo units and an Onyx/8 Reality Engine workstation. The latest software sensor models execute and interact with the Simulation Toolkit and Generation Environment (STAGE) battle manager product. We present the preliminary results and status of this ground-breaking project. Three scenarios are defined - Persian Gulf, and Major Regional Contingencies (MRC) East and West - and used as a baseline for future man-in-the-loop simulations. The Total Mine Simulation System (TMSS) models the important mine-ship interaction. Features of the modeling approach, expecially the strengths and limitations, are described.

WG 7 -- Nuclear Chemical Biological Defense

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OMEGA: Modeling Chem/Bio Releases with Complex Terrain and Multiscale Weather
Part I - Weather

The Operational Multiscale Environment model with Grid Adaptivity (OMEGA) is a new atmospheric

simulation system that merges state-of-the-art computational fluid dynamics techniques with a comprehensive non-hydrostatic equation set. OMEGA is based upon an unstructured triangular prism grid that permits a horizontal grid resolution ranging from 100 km down to 1 km and a vertical resolution from a few tens of meters in the boundary layer to 1 km in the free troposphere.

OMEGA represents a significant advance in the field of weather prediction. Current operational forecast models are scale-specific and have a limit to their resolution caused by their fixed rectangular grid structure. OMEGA, on the other hand, is naturally scale spanning and its unstructured grid permits the addition of grid elements at any point in space and time. This means that OMEGA can readily adapt its grid to fixed surface or terrain features, or dynamic features in the evolving weather pattern. In addition, OMEGA can provide enhanced grid resolution in localized regions such as urban areas with significant sources of pollution.

An additional advance in OMEGA is the inclusion of an embedded aerosol transport algorithm (see the companion paper in this conference). This permits the simulation at high resolution of the transport and diffusion of either grid based aerosols or of Lagrangian parcels.

The flexible grid adaptivity of OMEGA provides it with an important advantage over previous models. It permits the resolution of orographic and land/water boundary features improving the fine scale meteorological simulation and, in turn, the simulation of the aerosol transport. This flexibility of resolution and the coupling of the aerosol algorithm creates a unique tool for a variety of applications and scales.

In this paper, we will present an overview of the atmospheric simulation capabilities of OMEGA. We will discuss both its numerical techniques and its physics. This will set the stage for the companion paper in which we discuss the formulation of the aerosol transport model in OMEGA and its application to air quality problems.

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OMEGA: Modeling Chem/Bio Releases with Complex Terrain and Multiscale Weather Part II - Hazards

The Operational Multiscale Environment model with Grid Adaptivity (OMEGA) is a new atmospheric simulation system that merges state-of-the-art computational fluid dynamics techniques with a comprehensive non-hydrostatic equation set (see our companion paper *High Resolution Atmospheric Simulation using OMEGA* for a discussion of OMEGA) The grid resolution for the atmospheric simulations performed using OMEGA ranges from 100 km down to 1 km. OMEGA also contains an embedded aerosol transport algorithm that permits the simulation at high resolution of the transport and diffusion of either grid-based aerosols or of Lagrangian parcels.

The coupling of a very high resolution (1 km) atmospheric simulation tool with an aerosol transport and diffusion model creates a flexible tool for a variety of applications. Among these is aerosol transport in complex terrain and near land/water boundaries - in fact anywhere that microscale features could have a significant impact on the local meteorology, which in turn affects the transport and diffusion of aerosols.

In this paper, we will present an overview of the aerosol transport and diffusion model included in OMEGA; both its physical basis as well as its implementation on the adaptive unstructured grid that forms the basis of OMEGA. We will then discuss the application of this aerosol transport capability to air quality problems including the extension of the OMEGA formulation to treat scavenging and wet deposition as well as atmospheric chemistry issues.

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DIS as an Aide to US Military Chemical/Biological Doctrine Development

The U.S. Military doctrine development for dealing with chemical and biological agents introduced onto the battlefield can be aided by the use of Distributed Interactive Simulation (DIS). The utility of DIS has been demonstrated as a training tool and vehicle for doctrine development for combined arms missions. The introduction of hostile environments into the synthetic battlefield can create a more realistic battlefield for soldiers to train and commanders to develop doctrine and tactics.

The U.S. Army Edgewood, Research, Development and Engineering Center (ERDEC) is developing a suite of chemical/biological agent dispersion DIS applications that will allow the injection of these agents into synthetic environments. Early development has centered around theater ballistic missile engagements. Use of these weapons with chemical and biological agents is, by many accounts, a real possibility at present and a certainty in the future. The ability to predict and portray the spread of the agents released by these weapons or released after an intercept will allow command and control system developers plan for such

contingencies. Parametric analyses of chem/bio dispersion scenarios show that the effects of these agents on the battlefield or on civilian areas are entirely case dependent. DIS is a natural vehicle then for the evaluation of these effects.

At present, no capability to inject chem/bio agents into the DIS battlefield exists. ERDEC is an active participant in evolving DIS standards development. The ERDEC DIS Technology program will demonstrate the spread of chem/bio agents following the intercept of a theater ballistic missile intercept by a hit-to-kill interceptor. This scenario will be demonstrated at the 16th Interservice/Industry Training Systems and Education Conference DIS Demonstration in November 1994. Also at this demonstration, ERDEC will operate a prototype FOX NBC Reconnaissance Vehicle simulator on the DIS battlefield. This paper discusses the specific architectures for both simulation applications. Also discussed are the modifications to the IEEE 1278 DIS protocol data units required to track chem/bio agents on the DIS battlefield. An overall joint service plan for portraying chemical and biological agent dispersion and effects for all scenarios is proposed.

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Battelle Manufacturing Signatures Methodology
Abstract not available.

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Detection Roles, Measures of Effectiveness and Analysis Techniques for Biological Agent Point Detector Requirement Assessment

Biological Agent Point Detector roles, operational requirements, and measures of effectiveness (MOE) have been analyzed for a variety of threat scenarios. operational requirements (threshold, sampling rate, sampling time, response time and error tolerance) were found to be sensitive to role, challenge, and MOE. The relative merits of selected MOEs, and techniques for determination of operational requirements in various, established point detector roles, will be addressed.

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Counter-Proliferation Treaty Verification
Abstract not available.

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XM21 Risk Reduction Program
Abstract not available.

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A Proposed Approach to Value Added Studies
Abstract not available.

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Lightweight Stand-off Chemical Agent Detector (LSCAD) Support
Abstract not available.

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The Effect of MOPP4 on M190 Howitzer Crew Performance
Abstract not available.

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A Methodology to Assess the Effects of Chemical and Biological Weapons in the Battlefield

Despite the dissolution of the USSR, the unprecedented victory of the Allied Forces during Desert Storm, and other continuing changes in the world, the proliferation of weapons of mass destruction (chemical and biological) is becoming one of the most serious security threats that the US will confront. The Third World nations without significant conventional military power are now able to develop chemical and biological warheads. As the possibility of US contingency forces becoming exposed to chemical and biological (CB) effects continues to grow, analytical tools are required to support the various elements of the DoD community as they address the issues of weapons of mass destruction (WMD). The JANUS interactive model is being developed into such a tool. JANUS is a two-sided model which is a high-resolution stochastic force-on-force simulation depicting the various combat systems operating in specified scenarios. TRAC-WSMR is currently in the process of improving the CB simulation capabilities of JANUS. This paper focuses on the methodology that is being used in this effort. The technical approach of this effort is to integrate existing methodologies for representing the effects of WMD and their unique effects on personnel performance and behavior in a constructive combat simulation. The main task will be to incorporate a chemical cloud transport and diffusion model into JANUS. This effort will produce a version of JANUS capable of portraying WMD and their effects on humans. Specifically, chemical/biological agent clouds, cloud travel, cloud dissipation, contamination levels, casualty effects, point detector capability, and effects of CB protective equipment on personnel performance will be incorporated into JANUS.

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Issue in Countering Proliferation: Biological Weapons Proliferation -- Aligning Goals with Resources

Abstract not available.

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Evaluations of Full-System Individual Protective Ensembles Against Vapor Simulatn Challenges

Abstract not available.

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Analysis of US Naval Biological DEFENSE Effectiveness 1990-2000

Abstract not available.

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Mounted Warfighting Training and Leader Development in Simulation

Department of Defense (DoD) needs to train and synchronize the total force to maximize the synergism of the total force's capability. However, DoD will be unable to train in the future as it has in the past. Environmental concerns, reduced budgets, higher training costs, more complex weapons systems requiring increased land and range requirements for training, will force us to reconsider how we train the total force. Training at the joint level with the integration of coalition forces heretofore executable only on a limited scale may be unexecutable in the future except in simulation.

Given Contingency Missions, the future CATS focuses on the integration of CBT/CS/CSS, Heavy/Light/SOF, Air Force/Navy/USMC and Allies. The simulation plan allows leaders and staffs to identify Courses-of-Action in response to the contingency, develop the METL and train it in the time available, design the correct force structure, train the courses of action, and evaluate units prior to deployment. Therefore, simulation, in the future, not only trains in

the traditional sense, it necessarily becomes a combat rehearsal system.

In the future and even now, time and space are the critical limitations on training. In the fourth dimension time and space are overcome - simulation provides additional time to the unit by saving the time required to prepare and move to the field. Further, in simulation STXs can be rerun and modified until the unit attains proficiency. This saves the time required to move the unit back to the start point and the brass on the ground and the ground torn up by acceleration or neutral steer does not give away the point along the course where actions occur. The maturation and miniaturization of our simulation will allow the force to embed the current TADSS capability in the weapons system. This will allow units to train in peace time using the same training devices as they train in war. When reconstituting crews and units, the devices the NCOs and officers used to train their units in peace time will be with the unit in time of war available for training and rehearsals.

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Modeling and Simulation Supporting the Soldier System

The rapidly changing world order in the post Soviet era poses many new and increasingly complex problems for both Army Materiel and Combat developers. The old paradigms are rapidly changing as the U.S. evolves to a primarily CONUS based, force projection army. The specter of Soviet tanks pouring through the Fulda Gap has been replaced by a myriad of new concerns ranging from instability in the Balkans to the intransigence of North Korea.

Amidst all this, we must note that the number of states possessing weapons of mass destruction is increasing. In particular, this increase is occurring in regions with a history of politically unstable leadership, much factional fighting, and little understanding or regard for current non proliferation treaty efforts.

Consequently, the U.S. must ensure that its fighting forces are prepared to face all contingencies on any battlefield. Moreover, as procurement dollars for expensive weapons platforms become increasingly scarcer, we must optimize the effectiveness of our most important platform, the individual combatant. To this end, the U.S. Army Natick Research, Development and Engineering Center is leading efforts in constructive modeling and simulation to estimate the benefits and operational costs of evolving Soldier System technologies.

Specifically, any proposed equipment must be designed to act in concert with other components of the Soldier System, to achieve the maximum gains possible from system synergism. Equally important, equipment developers must have some method of a priori demonstration of potential operational benefits, if they are to argue credibly for their share of scarce resources. It is the promise of quantifying this synergy and operational worth that Soldier System modeling offers.

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Gaming Counterproliferation

New technologies, coupled with new operational and organizational concepts, have the potential for revolutionizing the modern battlefield. The Office of Net Assessment has been examining such concepts in a well-structured series of analyses, seminars and war games. One such game, co-sponsored and funded by the Defense Nuclear Agency, examined such advanced concepts in the context of addressing a strong nuclear, biological and chemical warfare threat in a Third World context in the 2015 time frame. The "Advanced Military-Technical Concepts Game" was conducted 2-4 November 1993 at the Naval War College at Newport, Rhode Island. Players included operators from the services and technologists from OSD, agencies, laboratories and FFRDCs. The two-and-a-half day game featured nine "vignettes" which dealt with the toughest military problems of the overall scenario and a "tool box" of new systems that could be used to supplement those already programmed. In the game, the players had to resort to the "tool box" regularly and often in order to put pressure on the enemy from the start, to be ready to attack any delivery system that was detectable even momentarily, and to intercept any missiles early in their trajectory. Further, innovative means were needed to deal with deep underground facilities. Some of the more innovative and useful systems concepts will be described, as well as insights on an operational concept for countering WMD.

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The Integrated Unit Simulation System: Representation of the Combined threat in Simulation of Soldier Performance
Abstract not available.

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Modeling of CB Releases in an Urban Environment
Abstract not available.

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Residual Hazard Prediction of Desorbing Chemical Agent Vapors from Close-in Large Area Sources Using Boundary Layer Phenomena
Abstract not available.

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A Baysian Appoach to the Meta-Analysis of Army Field Test

The U.S. Army has conducted a number of operational tests in the last two decades to determine degradation in unit performance of certain combat tasks under the threat of enemy chemical weapons employment. In particular, the "Combined Arms in a Nuclear/Chemical Environment Force Development test and Experimentation" (CANE FDTE) program has conducted four tests to date that measured unit performance in a chemical warfare environment. The overall purpose of the CANE program has been to "provide measured data and determine how well combat and support units can perform their missions in extended operations where nuclear and chemical weapons are employed" *[Independent Evaluation Plan for a Combined Arms in a Nuclear/Chemical Environment Force Development Test and Experimentation (CANE FDTE),* Revision 1.5, October 1988]. In response to requests from other members of the Army community for performance degradation data, the U.S. Army Chemical School has now recognized the need to synthesize these results into a single range of degradation values to make the results more useful. These requests have come from a variety of sources, including combat modellers, combat developers, and trainers.

This paper presents the development of a methodology for obtaining a single range of estimates for the expected percent difference in performance of a task in chemical warfare conditions. The methodology incorporates all of the information available on human performance of combat tasks in a chemical environment, including the subjective judgments of military experts. Specifically, a probability distribution is obtained for the percent difference in unit task performance by aggregating both the field test results and the subjective assessments of military experts, as well as any other data from appropriate sources such as actual combat data or field exercise data.

The proposed methodology incorporates principles of meta-analysis and Bayesian statistical techniques to obtain the distribution. First, expert assessments are elicited to determine a prior distribution, representing the "prior knowledge," for the expected percent difference in performance of a particular combat task. Next, the field test results of unit performance of the task are treated as observational data and combined mathematically with the prior distribution to obtain a posterior distribution for the expected percent difference. This posterior distribution represents the synthesis of both subjective and experimental data, and provides the ability to not only give point estimates of the expected percent difference in performance, but also ranges and confidence intervals of the expected difference.

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Integrated Unit Support System: Metabolic Work Rate Methodology
Abstract not available.

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Theater Missile Defense Chemical Flight Experiments
Abstract not available.

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Analysis of a Comprehensive BW Defense Program Phase 1: The Biological Integrated Detector System (BIDS)
Abstract not available.

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Techniques for Estimation of USAF Ground Crew Protective Mask Effectiveness

The adequacy of current USAF Ground Crew protective mask against post-Warsaw Pact NATO Chemical-Biological warfare challenges was re-examined. Challenge characteristics (challenge levels and distributions) from recent NATO assessments and U.S. mask protection data (protection factors and distributions) were used for casualty prediction and for calculation of protection Improvement Factor requirements. Challenge values were derived from hundreds of attack simulation variants of selected NATO scenarios involving both chemical and biological agent-filled weapons. the methodologies used for these determinations are the subject of this presentation.

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An Overview of the Methodology used in the C-17 Cost and Operational Effectiveness Study

This overview will concentrate on the effectiveness portion of the methodology. It will include brief descriptions of the models used, the sources of key assumption and inputs, the study timeline, and a list of the sensitivities analyzed. It will not include study results, but will highlight the key role AMC played in performing the analysis.

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Refueling Operations Refinements Using Simulation and Modeling
Abstract not available.

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Simulation of Inland Waterways Traffic Systems as a Lines of Communication Component in OCONUS Sustainment Operations
Abstract not available.

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The Force Deployment Estimator (FDE) Model
Abstract not available.

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Airfield Resources Modeling
Abstract not available.

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Air Mobility and the Two MRC Scenario

Current national guidance states that the armed forces must be prepared to fight two near simultaneous Major Regional Contingencies. In order to successfully prosecute two wars, the nation needs the capability of delivering sufficient firepower to these theaters "in time". This presentation will show how AMC strategic mobility forces can make this monumental task possible. With the use of models such as Mobility Analysis Support System (MASS), Combined Mating and Ranging Planning System (CMARPS), and the Airlift Cycle Analysis Spreadsheet (ACAS) we will show the

capability to close forces at varying time intervals between MRC C days and illustrate potential limitations in a two MRC scenario.

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Capability Based Analysis

This paper presents an update of a new tool introduced last year that is being used by decision makers in the Air Force to aid in decisions about complex systems. Capability Based Analysis (CBA) integrates the use of response surface methodology with real-time analytical feedback, allowing decision makers to explore a wider array of options quickly, providing greater insight, and allowing fast what-ifs. This modeling approach has been used to aid decision makers at the highest levels in DOD. Examples of past uses include: C-17/airlift capability models in a two-theater (5 aircraft, utilization rates, crew ratios, and maximum on the ground (MOG)), maintenance manning levels of C-5 and C-141, determining the correct number of C-5s to assign to Altus AFB to meet training requirements, and a European Infrastructure analysis.

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A Multivariate Utility Analysis of the KC-135R Multipoint Air Refueling System

Abstract not available.

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LAM 94 Deployment Analysis

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Using National Bridge Inventory Data to Limit Passability on the National Highway Planning Network

Military Traffic Management Command, Transportation Engineering Agency (MTMCTEA) evaluates the impact of changes in equipment and force structure on the ability of the United States to project its armed forces around the globe. This mission focuses our attention on the interaction between transportation infrastructure (railways, highways, waterways and facilities) and the vehicles of our deploying units. MTMC works with the Federal Highway Administration, among others, to assure the national highways can support Defense requirements. Critical components of highway capability are the capacity and condition of the Nation's bridges. This paper describes the analytical methodology MTMCTEA employed to associate the physical restrictions of bridges in the FHWA National Bridge Inventory with the highway links in the National Highway Planning Network (NHPN) maintained by Oak Ridge National Laboratory, and the results of the effort. The resulting system is not intended to preempt or displace the authority of the States in permitting outsize and overweight traffic, including shaping our forces to make movement easier, and t identify -- at least to a first approximation -- where critical limitations may exist. The presentation includes a progress report on design and implementation of a force flow model in which movement is constrained by the physical capability of transport network links as derived in this effort.

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Proposal for a National Transportation Analysis Platform

The rapidly developing technology of geographic information systems (GIS) has reached a state of maturity in which many organizations, public and private, have invested substantial resources in hardware, software, and data to support GIS applications. Action is being taken to create standards for spatial data and to consolidate much geographic data available on a national level in a National Spatial Data Infrastructure. Consistent with these developments is creation of a National Transportation Analysis Platform to serve both as a data repository and analysis platform. Databases within the system, available in a client-server environment, would include transportation infrastructure characteristics and condition data, transport asset location and availability data, and economic factors. Analysis capabilities would take advantage of the evolving technology of model integration, which permits disparate analytical systems to feed each other data dynamically. This capability has been demonstrated in the US Transportation Command's Analysis of Mobility Platform (AMP) project. AMP

integrates several separate models and was successfully used to support an important military exercise in June 93. The presentation covers the overall architecture of the system, the agencies likely to use such a construct as their potential applications.

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The Mobility Paradox

The formation of the Air Mobility Command presents a variety of formidable and unique challenges. We view these challenges as windows of opportunity for new paradigms. The potential for constructive change continues to exist in both the airlift and the aerial refueling mission roles. Exploring new ways to exploit the full versatility of the airlift and tanker fleet makes analysis efforts at Air Mobility Command a daily adventure. This presentation attempts to investigate and summarize the challenges and opportunities of three key areas. First, the availability of en route infrastructure (basing and resourcing); second, the use of tanker aircraft in an airlift role; third, the aerial refueling of C-5s, C-141s, and C-17s to circumvent the need for a "lily-pad" approach to airlift.

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Mobilization and Deployment Model

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Modeling and Simulation of the Transportation Environment (MSTE)

MTMCTEA evaluates new weapon system compatibility with the existing transportability infrastructure, provides transportability criteria to concept developers, and oversees transportation testing of new systems. In an effort to influence design and reduce test failures, MTMCTEA is developing MSTE. MSTE will be linked to the ARPA Integrated Product and Process Development (IPDD) Simulation Program. This connection will permit MTMCTEA analyses of any weapon system played on the synthetic battlefield as well as support operational analyses of deployability.

MSTE uses computer-aided design and engineering (CAD/CAE) technology to simulate the physical restrictions and shock environment imposed by the defense and commercial transportation systems. This will allow the integration of transportation force data in the design of weapon systems. MSTE incorporates a structural analysis platform. This platform gives MSTE the capability to take dynamic load information from a simulation and apply the load to a structural member (in software) to determine the adequacy of a design. MSTE also includes a three dimensional (3D) analysis tool. In 3D, we can perform density loading of vehicles and systems in various transport modes (rail, air, and highway). Other analyses include lifting and tiedown configurations of systems for transport.

We have analyzed various weapons systems using MSET capabilities. For example, we have investigated the feasibility of loading six APACHE longbow helicopters into the C-5. We analyzed a Future Main Battle Tank (FMBT) concept using the developed phases of MSTE. Using MSTE, we provided assistance for many other programs such as the M1 Tank, Palletized Loading System (PLS), Armored Gun System (AGS), the 2-1/2-ton truck Extended Service Program (ESP), and a Marine Corps proposal for lifting 5-ton trucks.

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Estimating Airlift Capability

Abstract not avaialble.

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Impact of Input Assumptions on Model Results when Loading Airlift Aircraft

Abstract not available.

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Analyzing Theater Capabilities Using ELIST (the Enhanced Logistics Intra-Theater Support Tool

Abstract not available.

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Abstracts not available.

Current Worldwide Air-to-Air Missiles
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Pilot-in-the-Loop Threat Fighter Simulation
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Integrated Test of Fighter Technologies III
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Advanced Medium Range Air-to-Air Missile COEA Analysis
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Tactics Discovery Using Genetic Algorithms and Machine Learning
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Counter Precision Guided Munitions (PGMs) Analysis
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Precision Strike and Surveillance Architecture
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Time Value of Recce Information
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Setting Requirements for Probability of ID in Air-to- Air Combat
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Tactical/Environmental Decision Aids for Naval Strike Warfare
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The Mind of the Brawler Pilot
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Analysis of a Multi-Layer Theater Air Defense (TAD) Capability
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Operational Utility of the Joint Stand-Off Weapon (JSOW)
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A Concept for Verification, Validation, and Accreditation of Distributed Interactive Simulations

Historically, resources were often not programmed for the verification, validation, and accreditation (VV&A) of combat models and simulations (M&S). In these times of increasing missions and dwindling resources, the Department of Defense must ensure the effective and efficient use of its resources including its models and simulations. With the publication of Army regulation (AR) 5-11 and Department of the Army pamphlet (DA Pam) 5-11, a new emphasis has been placed on the VV&A of Army combat simulations. The Army must ensure that its M&S are credible to senior level decision makers.

The verification and validation of combat simulations is challenging. Accurate representation of physical and cognitive processes is difficult; real world data to validate these processes are often not available; and combat M&S tend to be large, complex code structures. Verification and validation of distributed interactive simulations (DIS) is more challenging. These confederations of simulations have all of the inherent verification and validation problems of the traditional closed-form M&S and their distributed interactive nature introduces new challenges. Multiple databases, visual components, and network interactions are just a few.

Distributed interactive simulations are in their infancy. Verification and validation must be an inherent part of a model's life-cycle, therefore, now is the time to address V&V of the synthetic battlefield.

This presentation will discuss unique requirements for VV&A of simulations in the DIS environment and a concept of how to fit V&V into M&S development cycles. The presenter will also discuss ongoing projects within the Army and other services and the efforts of the DIS Interoperability Standards V&V Working Group.

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Battlefield Combat Identification System – Near Term (BCIS-NT) Cost and Operational Effectiveness Analysis (COEA)

During Operation Desert Shield/Storm, the number of friendly fire casualties (24 percent) far exceeded the average amount in previous conflicts. As a result of these lessons learned, the Army Chief of Staff directed that a task force be formed to investigate and improve combat identification and that a combat identification device for ground-to-ground and air-to-ground (rotary wing only) platforms be developed and fielded by 1995.

In support of the BCIS-NT program, a General Officer Steering Commitee selected a MMW Q&A technology to meet requirements for the combat identification device based on a technology demonstration and analysis. Subsequently, HQDA required a a COEA be conducted to determine if a MMW BCIS could reduce fratricide without decreasing combat effectiveness. Five MMW systems were compared in the COEA: three had range resolution around the interrogated target while the remaining two relied solely on interrogating the entire beam width. Both 45 mil and 22 mil beam widths were investigated. The basic approach to the study was to conduct a technology review, followed by effectiveness (deterrmined from high resolution combat simulation results), training, and cost analyses.

The principal results of the study were as follows: any BCIS-NT alternative reduces direct fire fratricide; in a high-fratricide situation, BCIS can improve Blue combat effectiveness; non-ranging BCIS variants provide significant protection to the enemy by mididentifying Red vehicles as Blue; and, impact on training is minimal.

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DIS Management: The Functional Manager's Perspective

The DIS environment offers the Army the power of information technology to share and integrate knowledge on common synthetic battlefields. The essence of DIS is sophisticated integration of simulations and information resources to permit unencumbered information sharing, to generate knowledge, and to enhance innovation for systematically improving military capabilities. It can greatly reduce the acquisition life cycle, produce better analytical products, and through the technology provide for cost effective training devices and mission rehearsal capabilities. The presentation first outlines the Army's management structure for DIS. It then focuses on the Functional Manager's role.

TRADOC, as the Functional Manager for DIS for the Army, is responsible for developing the Army's Master Plan for DIS. The vision as detailed in the Master Plan shows the Army's priorities and strategy for DIS development for the next ten years. The presentation highlights the development of the Master

Plan. To achieve the DIS vision the Functional Manager must work with the Technical Manager to develop the capabilities required by the users and provide an environment in which to exercise these capabilities.

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Data Initiatives Within DOD for DIS

The world of combat studies is changing. New areas of study, such as operations other than war (OOTW) or joint operations, bring along new challenges. New categories of data are needed; knowing who has the data is one of the problems. With the growth of Distributive Interactive Simulations (DIS), concerns about interoperabiltiy between simulations and sharing of data between models are pervasive. For current as well as future modeling and study efforts, there remains concerns about communicating data needs without ambiguity, efficiently storing and rapidly accessing the huge amounts of data the models need, and defining the new types of data to maximize its usefulness beyond a single simulation or study.

Many of the Army and DOD efforts regarding nomenclature standardization, centralization of information, data sharing and data definitions will be discussed. Current status of data efforts supporting the DIS data standards and requirements will be presented.

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Aspects of Coalition Warfare in the 21st Century

The TRAC Scenario and Wargaming Center has developed many scenarios at the theater and corps level that involved coalition warfare in the 21st Century. Many of the lessons learned and insights gained from these scenarios point out trends that need to be considered in future planning.

This paper looks at the future from the perspective of a down sized force in the 21st Century. With the demise of the large Soviet threat of the 1980s, the US expects that a smaller force can accomplish future security missions. Coalition warfare and advanced technology are two ways of ensuring that a smaller force is capable of handling a major conflict. These two approaches run into conflict and, if proper forethought and analysis are not applied, could put us in an unfavorable situation in the future.

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The Palletized Load System (PLS) - An Analysis of PLS Cost Effective Uses

The Palletized Load System consists of a truck, trailer, and series of specialized flat racks or "sideless containers" which significantly reduces the handling of supplies and equipment which are loaded and transported by the system. As a result of this more efficient handling, the number of trucks required to haul the same amount of supplies is also reduced. A single driver, using the hydraulic system and hook built into the truck, can lift a PLS flat rack onto the bed of the truck or trailer in a matter of minutes. Other forms of loading require the use of material handling equipment (MHE) and additional personnel to perform the same mission in a much greater length of time.

In prior analyses, PLS was shown cost effective for the distribution of ammunition from the corps storage area forward and is currently being procured for that mission. The British version of the PLS was successfully used for the delivery of water and bulk petroleum in Saudi Arabia during the Gulf War. The primary purpose of this analysis was to determine if there are other applications for PLS, in addition to the distribution of ammunition, which are cost effective and should be considered for future United States Army use.

This paper provides some background information on the development of the study and the final approved results.

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Armored Vehicle Survivability Enhancement

This paper presents the results of a study which investigated ways to enhance the survival of a direct fire

armored vehicle, the Line-of-Sight Anti-Tank (LOSAT) weapon system. Various means of signature reduction, armor, and active and passive countermeasures against direct (ground and airborne) and indirect fire systems were applied to LOSAT. The effectiveness of these means were evaluated singly and in combination using European and Southwest Asian scenarios in the CASTFOREM simulation.

All means employed were to be achievable by 1996. Signature reduction represented passive modifications to the LOSAT so that the capability of direct fire target acquisition systems (visual and IR) were reduced in range, as represented by the Night Vision Electro-Optic Laboratory Search/Acquire algorithms; additionally the probability of acquisition by smart artillery munitions in the IR/radar bands was similarly reduced. Countermeasures were combinations of the Missile Warning Sensor, Radar Warning Receiver, Laser Warning Receiver, Directed Search, Self-protective Smoke Grenades, and the Short Stop anti-artillery system. Armor was added to protect areas of the LOSAT on the Bradley chassis, within cost and weight constraints. The results were that a bigger payoff was received by reducing the signature or adding countermeasures that adding armor, and the combination of signature reduction and countermeasures worked best of all. Simply put, it was best not to be seen. If seen and targeted, it was best not to be hit. If hit, the system was usually defeated.

The result of this study has direct application to the use of long range direct fire systems such as the LOSAT or other armored systems when the US land forces have neither the advantage of a forward position nor the time to acquire one, and are opposed by an advanced conventional threat.

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Tactical Wheeled Vehicles of the 24th ID Used in Operation Desert Storm

A basic problem for logisticians and Army planners is to determine what kind and how much equipment is needed to do a wartime mission. Prior to Operation Desert Storm (ODS), wartime equipment requirements were based on field exercises and national training center experience. Actual usage in ODS was significantly different than predicted usage. The best way to collect this type of information is to send data collectors out with the unit--which was not done during ODS. We did the next best thing--collect information from units once they returned to the United States.

We established several projects to collect mileage, deployment times, maintenance and logistics data. The project we wish to discuss is our effort to "reconstitute" the maintenance and readiness history of a division based on actual records. This division was the only one to bring back sufficient records and is the actual wartime collection of data on wheeled vehicles.

We will also discuss preliminary findings from other similar efforts (such as the special data collection done on vehicles sent to ODS, Kuwait and Somalia).

Our goals are to discuss results of this project and related efforts, and to emphasize the multidisciplinary team effort needed to develop and implement this complex series of projects.

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Close Combat Model Improvement Program (CC-MIP)

The constructive models in the US Army's inventory are lacking in the portrayal of the dismounted infantry soldier. TRAC-WSMR in conjunction with the USA Infantry School is working on correcting this problem via the Close Combat Model Improvement Program (CCMIP). This paper will address the current representation of the dismounted soldier in the CASTFOREM and Janus constructive models.

The Land Warrior Cost and Operational Effectiveness Analysis (COEA) and 21 Century Land Warrior (21CLW) Advanced Technology Demonstration (ATD) are two upcoming studies using these constructive models. These studies will be addressing new capabilities which will be analyzed with a new analytical tool, the soldier station. The soldier station will enhance CASTFOREM and Janus capabilities.

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Aviation Attack Battalion Study

The Aviation Attack Battalion Study (AABS) identifies the benefits and liabilities involved in replacing the OH-58C (Kiowa) with the AH-64A (Apache) as the

scout helicopter in the heavy division attack helicopter battalion. The AABS was conducted by the Production Analysis Directorate of the Training and Doctrine Command (TRADOC) Analysis Center (TRAC). TRAC was directed to conduct a study using force-on-force simulations to examine the impact of the proposed Aviation Restructure Initiative design of the attack helicopter battalion while considering the Army modernization objectives. The Aviation Restructure Initiative focuses on providing an aviation force that will support the new National Military Strategy for a continental United States-based force projection Army. During the Winter 93 Force Design Update held on 3 February 1993, the Chief of Staff, U.S. Army (CSA) approved ARI but asked that analytical support for the decision be provided. Performance, effectiveness and sustainability analysis were conducted.

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An Independent Verification and Validation of the Future Theater Level Model (FTLM) Conceptual Model

This paper describes work performed for the Joint Staff/J-8 in performing an independent verification and validation (V&V) study of the Future Theater Level Model (FTLM).

We subjected the conceptual design of the FTLM to those tests that we thought appropriate to its design stage, to its purpose as an analytical combat model, and to its capabilities as specified in the Mission Needs Statement. The conceptual design passed those tests. We recommend that its development be continued.

Because this recommendation is positive, we recommend increased attention in the areas of design of model input and output support and decision logic creation. We also recommend the institution of informal configuration management control. These steps are appropriate as the model moves to a more complex and costly stage of development. We further recommend continuation of the planned integration of independent verification and validation into the FTLM design and construction process.

The talk will briefly describe the FTLM (as it is conceived), the techniques used for V&V of a model concept, and the results of the work.

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Dealing with Threat Developments; Are We Asking the Right Questions?

The end of the Cold War has not necessarily made the world a safer place. The questions force and combat developers are wrestling with today are similar to those asked at the end of the two world wars. Unfortunately, we are in no better position today than our predecessors were after World Wars I and II to answer those questions. Our crystal ball is no less clouded than theirs.

The thrust of this paper is that we may be focusing our efforts on the wrong question. The principal threat question should be what, rather than who. Attacking the problem as a "what", the paper explains the differences between symmetrical and asymmetrical threats, gives a broad overview of world wide "whats", establishes and explains the possibility of encountering "technological surprise" and looks at ways to represent and evaluate complex data in a net assessment model.

The Threat Response to Operations Other Than War (OOTW)

The application of military power, regardless of the nature of the mission, is reactive in nature. To assist in understanding the threat to US OOTW roles and missions, this paper examines each of the OOTW categories described in FM-100-5 from a threat perspective. To fully understand the scope of this problem set, we must expand our vision of the "threat."

Threat options are discussed from both political and military perspectives in the more traditinal types of operations (Peace Keeping, Peace Enforcement). Additionally, threats to the successful accomplishment of more non-traditional military missions such as Humanitarian assistance are discussed. Threats from non-state actors and criminal elements are also examined.

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Operations Other Than War-Technology Insertion Impact Analysis

The purpose was to determine what impact the use of supplemental intelligence gathering equipment would have on force effectiveness during Operations Other Than War (OOTW). Reconnaissance and intelligence gathering activities become even more difficult during OOTW missions where the distinction between hostile factions and friendly forces becomes vague and difficult to identify. The supplemental intelligence gathering equipment consisted of three devices: an Unmanned Aerial Vehicle (UAV) Pointer system, the CrossBow remote sentry, and an Electronic Filmless Camera. Data were collected at the Joint Readiness Training Center (JRTC) during a five-day rotation. The data consisted of observer/controller reports and examination of the information flow from within the brigade. The traditional approach used in analysis is to compare an exercise using the new or experimental method with the same exercise without the new method or baseline. Constraints of the study precluded this type of design and forced a new approach. The approach developed was to collect data from the exercise for use in the wargaming model JANUS to model the supplemental equipment in a post-exercise analysis.

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Can your Survivability Analysis Survive

This paper examines the interaction among losses, loss exchange ratios, and final force ratio. It notes that losses are often controlled by tactical input to computer models. This tends to confound survivability and damage done to the enemy force. A suggestion is made to control for loss exchange ratios and total damage to the enemy force so that the real survivability among alternatives can be examined. The suggestion involves a combination of calculations and computer output.

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Louisiana Maneuvers (LAM) 94 Deployment Analysis

National Military Strategy (NMS) requires the Army possess capability to rapidly deploy and insert "first to fight" forces that are more deployable, lethal, tactically mobile, survivable, and sustainable than existing early entry forces. Conducting force projection requires the Army to introduce credible, lethal forces early. Accomplishing this task necessitates trade-offs in selection of forces, means of deployment, and force sustainment.

Previous Army studies evaluated a quick-response brigade
-size force (referred to as a 2K force) and a larger follow-on force (referred to as a 10K force) in terms of deployability, lethality, survivability, and sustainability. These studies provide the direction for the LAM 94 study.

This study analyzes the deployability of similar lightweight and middleweight forces. It uses a TRADOC operational scenario, 2001 force structures, 2006 threat force, and conventional units and weapons to determine the deployment requirements in time and assets for the forces to move to a contingency theater. It employs Military traffic Management Command, Transportation Engineering Agency's (MTMCTEA) Transportability Analysis Reports Generator model (TARGET*Plus) and Air Mobility Command's (AMC) Mobility Analysis Support System (MASS) model to predict unit movement requirements, strategic airlift requirements, and closure times.

A base run is analyzed, followed by exploratory runs using design-model-design concept. Force designs are changed to improve lethality, survivability, deployability, sustainability, and tactical mobility. The analysis produces two objective force designs, one lightweight and one middleweight. The results support additional combat model runs with each of the force designs only 75% deployed, and possibly only 50% deployed, to assess these force designs' ability to conduct opposed entry missions.

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Mounted Warfighting Training and Leader Development in Simulation

Department of Defense (DoD) needs to train and synchronize the total force to maximize the synergism of the total force's capability. However, DoD will be unable to train in the future as it has in the past. Environmental concerns, reduced budgets, higher training costs, more complex weapons systems requiring increased land and range requirements for training, will force us to reconsider how we train the total force. Training at the joint level with the integration of coalition

forces heretofore executable only on a limited scale may be unexecutable in the future except in simulation.

Given Contingency Missions, the future CATS focuses on the integration of CBT/CS/CSS, Heavy/Light/SOF, Air Force/Navy/USMC and Allies. The simulation plan allows leaders and staffs to identify Courses-of-Action in response to the contingency, develop the METL and train it in the time available, design the correct force structure, train the courses of action, and evaluate units prior to deployment. Therefore, simulation, in the future, not only trains in the traditional sense, it necessarily becomes a combat rehearsal system.

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Reconstitution Analysis of US Army Forces - 1999

The fall of the Berlin Wall in 1989 followed by the dissolution of the former Soviet Union necessitated a change in our National Military Strategy. The United States will rely on projecting military forces from within its continental boundaries to support two nearly-simultaneous Major Regional Conflicts (MRC) while concurrently supporting Lesser Regional Conflicts worldwide. With the likelihood of more Congressionally-mandated reductions in United States military end strength, the number of Active Duty Army units may decrease by 1999. Thereafter, if two MRCs occur nearly simultaneously, selected Army units may be required to deploy to one conflict, perform their mission (combat, combat support, combat service support), reconstitute and rapidly redeploy to a completely different part of the world for a second war. Analysis is needed to assess the tasks, requisite resources and strategic risk associated with the reconstitution of these selected Army units. This analysis will include a review of current Army doctrine supported by experience from field commanders from Operation Just Cause, Operation Desert Shield/Desert Storm, and selected others. Various situations will be examined ranging from both MRCs starting simultaneously to where one MRC begins several weeks after the end of the first MRC. Resulting ranges of more refined reconstitution times and the effects of shortages in units critical to reconstitution will be analyzed in combat modeling of TRADOC Theater Resolution Scenarios. Resulting risks (changes to combat losses) will be assessed.

Logistics Impact Analysis (LIA) for the Close Range Unmanned Aerial Vehicle (CR-UAV) Cost and Effectiveness Analysis (COEA)

The UAV Joint Program Office is developing a CR-UAV to support US Army and US Marine Corps (USMC) reconnaissance operations at the brigade echelon. The Department of Defense tasked the USMC to conduct a joint COEA in support of the CR-UAV program. This LIA is a comparatively analysis of possible logistics impacts caused by fielding a CR-UAV system. It only looks at the proposed systems to be fielded in the Army. It does not address manpower and personnel, or training issues associated with fielding a CR-UAV system.

The LIA will determine the comparative differences among the following three alternatives: 1)Base Case (BC), US Army force projected to 1999, but without UAV support at the brigade echelon; 2)Alternative 2, BC force with the CR-UAV system added to support the brigade; 3)Alternative 3, BC force with the Short Range UAV added to support the brigade. Measures of performance include the following characteristics: 1)Calculated reliability and maintainability; 2)Deployability; 3)Transportability; 4)Force structure impacts; 5)Initial stockages of class IX. The measure of effectiveness from a logistics point of view will be operational availability. Decision makers will complete an analytical hierarchy survey (pairwise comparison) which will be used to prioritized the attributes. Multiple attribute decision making techniques will be used to determine the best alternative froma logistics point of view.

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Force Facilitator For Operations Other Than War

In this post Soviet era, the US Armed Forces are finding themselves performing more missions in Operations Other Than War (OOTW). While these operations have many requirements that are common in traditional combat operations, OOTW do have unique aspects that impact force structure decisions. Currently, there are no tools to analyze force requirements for these types of operations.

The Force Facilitator For Operations Other Than War is an automated tool to assist staff officers to determine force structure requirements for OOTW. The tool will be IBM or compatible microcomputer based. The tool will be "mission and task driven," i.e., the type of mission will determine the specified and implied tasks that need to be accomplished. The requirements of these

tasks will be optimized with units' capabilities that match those tasks.

The purpose of this briefing is to provide a general overview of the tool, to review important lessons learned in the tool's development, and to demonstrate the tool's capability.

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The ABCA Scenario

Scenario and Wargaming Center has supported the American, British, Canadian, and Australian (ABCA) Quadripartite Working Group (QWG) with scenario efforts for more than two years. The scenarios are designed to assist the ABCA QWG develop concepts for standardization agreements and plans that allow those nations to cooperate in engagements ranging from Operations Other Than War to mid-intensity conventional battles.

This paper briefly describes the background of the most recent scenario effort, the scenario development criteria, the scenario overview, and some analytical issues that the scenario supports. The scenario provides a realistic, reasonable, and robust setting for examining the activities of rapidly deployed ABCA forces at brigade, division and corps level. It generates opportunities for analysis of doctrine, organization, equipment, and command and control issues across a spectrum of combat intensity.

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IEW Functional Area Model (FAM)

During the period 1988-1990, the Vector In Commander (VIC) modeling team located at the TRADOC Analysis Command, White Sands Missile Range, implemented requirements established by the U.S. Army Intelligence Center and School (USAICS), Fort Huachuca, to upgrade the intelligence electronic warfare (IEW) functional area. Model enhancements included better sensor representation, collection management of sensor assets, and processing and analysis of reports. The IEW functional area model provides the analyst a tool for studying the operational effectiveness of intelligence systems and processes within a combat situation. How closely the IEW functional area model approximates combat intelligence on the battlefield is examined. Typically, the effectiveness of the IEW during combat modeling is viewed in terms of timely maneuver actions taken in response to the perceived threat, and in terms of the accuracy and timeliness of the target acquisition information provided to the fire support assets. The relationships between IEW and other functional areas represented in the model are examined.

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Command and Control Vehicle (C2V) Cost and Operational Effectiveness Analysis (COEA) (Movement and Emplacement Characteristics)

A major deficiency noted from Operation Desert Storm was the inability of the current M577A2 command post to "keep pace" with the tempo of the battle. While this indicates the inadequacy of the current C41 system to apply the efficiencies of enhanced technology and automation, it also reflects upon the mobility capability of the current command posts. In fact, at the onset of the requirement analysis, the principle issue for the C2V was considered to be mobility.

The topic of this paper is to discuss a portion of the TRAC analysis, that is the technique used to determine the threshold and objective values of the mobility parameter and the respective performance for each of five C2V alternatives. As a result of the analysis, mobility was further refined to be comprised of two attributes: the ability to move; and the ability to physically emplace/displace the CP. Our methodology linked a TRADOC standard scenario, gaming run output of a combat simulation model, and results of a mobility assessment of the C2V alternatives conducted by the Waterways Experiment Station, (Vicksburg, MI). A simple algorithm of tactical decision rules was then used in a map exercise (MAPEX) to integrate the model runs and the mobility analysis within the context of the scenario to explore the threshold and objective values associated with the movement and emplacement characteristics.

Army Tactical Missile System (ATACMS) Cost and Operational Effectiveness Analysis (COEA)

The Army Tactical Missile System (ATACMS) Milestone IV Cost and Operational Effectiveness Analysis (COEA) was conducted to support acquisition decisions for the improved ATACMS. Specifically, the MS IV COEA supported the Army decision to approve or not approve engineering and manufacturing development of the improved ATACMS. The methodology used in conducting this COEA consisted of six interrelated parts: 1)target set analysis; 2)performance analysis; 3)effectiveness analysis; 4)theater and quantities analysis; 5)cost analysis; 6)cost and effectiveness analysis integration.

The study issues imposed by Department of Army and answered in the study were:

a. What are the contributions/benefits of Improved ATACMS (with APAM warhead) to joint precision strike operations against joint TMD targets (missiles, TELs, resupply vehicles, etc.), C3I sites, logistics sites (including FARPS), and lightly armored targets.

b. What procurement quantities of Improved ATACMS are necessary to meet warfighting and peacekeeping requirements?

c. What is the cost effectiveness of Improved ATACMS?

d. What is the sensitivity of alternatives to TLE?

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Counter Friendly Fire

During Operation Desert Storm 23.6% of the U.S. forces' deaths and 15.4% of the wounded were caused by fratricide or fire from other friendly forces. This study was conducted in two phases, the first phase was to determine the major causes of fratricide and to look across the Hughes product lines and within the research laboratories to determine what technologies exist or are on the drawing boards that can be brought to bear on this problem. The second phase was to perform a cost and operational effectiveness analysis on the concepts generated in Phase 1 to determine which was the most cost effective approach. Three primary candidates were evaluated, a coded laser interrogator and a modulated retroreflector; a coded laser interrogator and an RF transponder; and a MMW interrogator with a MMW transponder. These candidates were evaluated in a TRADOC approved scenario using the Hughes Antiarmor Requirements and Effectiveness Model (HAREM) in both clear and degraded conditions. HAREM is a high resolution combined arms combat simulation capable of representing up to 1000 combat systems along with its supporting artillery, helicopters, close air support, etc. Modeling methodologies and study results will be presented.

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Mobilization and Deployment Model

In the light of recent and ongoing Army force structure reductions and a shift to a force projection strategy, a clear need exists for a model which assists the staff in rapidly developing and evaluating alternatives for mobilizing and deploying Army forces.

The Combined Arms Command (CAC) at Fort Leavenworth, KS recently completed a study which established the methodology and data base requirements for a fast-running tool to enable the examination of Army problems associated with the Army force projection strategy. This paper summarizes the methodology which forms the basis for a Mobilization and Deployment Model (MODEM) which will be a personal computer-based model that assists force designers and operational and strategic operators and planners in the rapid development and simulation of mobilization and deployment of alternative contingency force packages to potential or actual worldwide trouble spots. This mobilization and deployment model will allow the user to:

- Select units for deploymen
- Examine mobilization requirements
- Build logistical sustainment packages
- Calculate movement/deployment times
- Estimate the build up of combat power over time relative to the threat.

The paper describes the model design with associated user input processes, data manipulation and output processes which contribute to the overall methodology to perform these operations. It describes the design functionalities of Data Base Update, Contingency Force Assembler/Mobilizer, Deployer, Combat Capability/COFM Estimator, and Review/Print Modules which allow the user to conduct contingency force analyses.

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Using Constructive Models Within Virtual Simulation Environments for Analysis: The Eagle/BDS-D Project

The presentation will describe the TRAC project to dynamically link the corps-level deterministic simulation, Eagle, with the virtual simulation, Battlefield Distributed Simulation-Developmental (BDS-D); focusing on the development of an interface between a constructive model and a virtual distributed simulation. Design and implementation of the interface will be described. A short video will demonstrate the interface. The presentation will also describe the potential applications of synthetic environments created by linking constructive and virtual simulations for analysis of weapon systems, concepts, doctrine, tactics, and force structures. A topic of discussion will also include insights into problems facing analysts working in this mixed simulation environment.

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Leveraging Distributed Interactive Simulations in Force XXI

America's 21st Century army, currently referred to as Force XXI, will evolve as the Department of the Army reexamines all echelons, all components and all activities of Today's Force. This assessment will examine the need to reengineer ourselves from the foxhole to the industrial base. Battle command and control will be intensively analyzed because information, intelligently used, can lead to responsive application of the right combat power to generate overwhelming lethality and to minimize casualties. The Army plans to use DIS and the power of information technology to share and integrate the distributed knowledge of the entire defense community on common synthetic battlefields to identify what military capabilities need to be developed, acquired, trained and maintained for Force XXI. The unencumbered sharing of knowledge will permit a leap to a higher level of integration and increased innovation across the domains of: research and concept exploration; doctrine and requirements generation; materiel development and acquisition; education and training; and battlefield planning; and execution. This presentation lays out the Army's concept for harnessing and leveraging DIS capabilities to improve advanced concept development; research, development and acquisition; and force redesign vital to Force XXI.

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Impact of Emerging Doctrine on Army Analysis

For the past forty-five years the US Army has focused its energy on a potential future conflict with the Soviet Union. This task was an immense one which has had an impact on virtually every aspect of our doctrine, training, organizational structure, leadership and equipment. Underpinning the many decisions made during this era has been a robust analytical mechanism which provided the critical insight needed by our senior leaders as they developed an Army which ultimately won the Cold War.

The Cold War, however, is over. The strategic environment has fundamentally changed. The threat is a new and diverse one. We have smaller forces which must be projected into a theater before they can confront an enemy. The force must not only be capable of fighting our nation's wars; it must be equally effective in operations other than war. New analytical challenges face us--many will require new methods. Once again the Army analysis community will be called upon to assist our senior leaders make the right decisions as we move into the future.

This paper will briefly examine the evolving role of Army analysis in meeting the demands of the post Cold War era. The paper will initially highlight the Cold War challenge and analytical efforts used to overcome it. The paper will then discuss emerging issues requiring near term study. Finally, the monograph will examine the evolving role and methods of Army analysis as we structure an Army for the 21st Century.

WG 11 -- Special Operations, Low Intensity Conflict

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SOFNET-JCM Interface Project

This is a program to develop and demonstrate a shared synthetic battlefield across a distributed communications network using Distributed Interactive Simulation (DIS) protocols between a high fidelity, virtual Special Operations Forces (SOF) Inter Simulation Network (SOFNET) aircraft simulation system, and a theater-level constructive simulation, the Joint Conflict Model (JCM). The principal goal is to allow CINC or JTF staffs and SOF aircrews to perform mission review and rehearsal coordination within the context of a wargame or real world event.

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SOF in the SEES Model

The Security Exercise Evaluation System (SEES) is a real-time, interactive, entity-level simulation that may be used to conduct protective force training and site security analysis. the Model-Test-Model process is used as a basis for running exercises to consider the validity of SEES as a simulation of airbase security operations. SOF uses includes determining the preferred mix of technology, tactics and manpower to provide effective detection, identification, assessment, delay, and response in preventing the direct or indirect penetration of limited and exclusion areas.

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Use of a Combat Model in a Humanitarian Assistance or Disaster Relief Scenario

The roles and missions of the US military are undergoing changes to cope with the new world order. Senior military commanders have expressed a pressing requirement for computer simulations to help train high level staffs in non-combat scenarios revolving around humanitarian assistance or disaster relief. The Joint Conflict Model has been used to demonstrate this idea. Off-the-shelf combat simulations with flexible databases, readily accessible to the user, allows users to develop training scenarios for humanitarian assistance or disaster relief missions. the new adversaries for these scenarios are famine and disease, rather than tanks and aircraft.

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Special Operations in the Joint Conflict Model (JCM)

More difficult than model development, perhaps, is determining the best applications of high resolution dynamic analysis. Although important advances are being made in simulation and modeling techniques, the "too-hard-to-do" box is still not empty. The intense data requirements for high resolution simulations will continue to be an issue as new equipment and force structure are developed. Parametric data development, however, will be only one of the obstacles to detailed combat modeling. Adequate representation of how new systems are incorporated into different force structures and doctrinal concepts will be far more challenging. The portrayal of SOF in the JCM as discrete elements of larger conflicts is a significant step.

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Special Operations Modeling & Analysis: New Requirements, New Approaches

In 1993, BDM demonstrated the utility of a new generation of modeling techniques in conducting special operations analysis. BDM is currently underway applying and expanding this modeling methodology to deal with a wider range of SOF issues. Objectives of this current effort include: Analysis of non-traditional military issues in low intensity conflict, including hostage rescue and civilian involvement in combat operations; combat effectiveness tradeoff studies of different insertion/extraction platforms, communications devices, special reconnaissance techniques, and weapons systems; sensitivity analysis of operations across different warfare environments and intensities; and recommendations for the incorporation of PSYOP and civil affairs in force-on-force modeling. This presentation will provide information on the current status of the METRIC model, as well as a summary of in-process analysis on scenario issues. Future analytical directions and model development plans will also be discussed.

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CA/PSYOP in Combat Models

Military operations in Panama, Southwest Asia, hurricane relief operations in Florida and humanitarian assistance missions in Somalia underscore the importance

of civil affairs missions and psychological operations. Inclusion of CA and PSYOP capabilities into high resolution and aggregate level models will enhance readiness of regional unified commands by allowing joint staffs to train to their regional missions with CA and PSYOP capabilities. The Joint Theater Level Simulation (JTLS) will be evaluated as a platform or testbed for the algorithms developed.

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The Applicability of SOF in Peace Operations

In attempting to educate special operations forces (SOF) to plan for the future, it becomes obvious that we are planning in an era of uncertainty. In the "new world disorder" that is emerging, SOF must be educated and prepared for "operations other than war" in addition to their standard role. What is the applicability of SOF in peace operations? This briefing attempts to define the current terms used in peace operations and propose the applicability of SOF in peace operations. The briefing focuses on the various environments and challenges the audience to identify indicators that the environment is shifting to a different level of violence. The assumption is made that the leaders must have knowledge of a shift in a timely manner so tactics can adapt in time to protect the force and accomplish the mission.

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Land/Air/Maritime Planning and Rehearsal (LAMPREY) Systems

This briefing will review automated computer technologies for mission planning, preview and mission rehearsal for SOF. It will discuss the original philosophy for the Special Operations Planning and Rehearsal System (SOFPARS), canceled for land and maritime components. The primary emphasis will be on planning and mission preview for ground and sea forces, which have challenging requirements and concepts over and above air forces. The first requirement is for high resolution data, meaning one meter and less. The second is for an automated process that follows joint, service and SOF doctrine. It is important to note that the objective is not simulation or modeling, rather it is automation of mission planning and development of mission preview/rehearsal capabilities. The paper will address issues for the integration of air-land-sea planning and rehearsal capabilities on the same system, which must be deployable and tied to common C3I channels.

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Disaster Preparedness Planning Program

Develop digitized mapping spatial and attribute databases designed to support installations disaster response missions. This program includes requirements definition, database design and content, cartographic issues and data collection for both installations and the surrounding geographic regions. The data collection effort will determine both sources and collection methods for spatial and attribute data. The project will deliver an integrated database planning package to selected joint installation and civilian community disaster planning exercises, as well as a prototype automated disaster planning tool.

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Vallidating Peacetime Operations

US CENTCOM has had the opportunity to conduct three successive "military operations other than war" within the past year and a half. Operations PROVIDE RELIEF (airlift of humanitarian relief supplies to Somalia), RESTORE HOPE (Humanitarian relief/security operations in Somalia), and U.S. support of UNOSOM II were all planned and executed by CENTCOM. The skills of the analytical community are needed to help operational personnel resolve these diverse new tasks which are full of uncertainty, ambiguity and risk. CENTCOM is currently assisting TRAC in developing a decision aid that will analyze the type and size of units required to perform operations other than war. An additional requirement exists to develop a logistics model to identify supplies and transportation assets necessary to support a given mission. The briefer will discuss planning for operations other than war from the perspective of the primary joint planner responsible for the operations mentioned above.

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Force Facilitator for Operations Other Than War

In this post-Soviet era, U.S. forces are finding themselves performing more missions in Operations Other Than War. While these operations have many requirements that are common with more traditional combat operations, they also have unique aspects that impact force structure decisions. Currently, there are no tools to analyze force structure requirements for these types of operations. The Force Facilitator is an automated tool to assist the staff officer to determine force structure requirements for operations other than war. This tool is IBM microcomput- based, and will be mission or task driven. The requirements for these tasks will be optimized with unit capability to accomplish these tasks. This briefing will provide an overview of the tool, review lessons learned in the development of the tool, and demonstrate its capability.

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Contingency Analysis Planning System (CAPS)

In today's political environment, a computer based tool that provides a reasonable representation of peacetime contingency operations is needed. This tool should provide a method, development path, and implementation plan for analytical contingency planning. Current government models provide pieces of the required method, but fall short of allowing the flexibility and breadth of scope necessary to provide insights into contingency alternatives in today's world. The integration of biased exponential algorithms in CAPS will allow joint analytical and planning communities to assess rapidly the implications on contingency operations. CAPS will give the planner a single tool to use for rapidly assessing alternative courses of action regarding specific contingency requirements.

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Modeling and Simulation Support for Special Operations Forces

The USEUCOM Office of analysis and Simulation implicitly models the impact of SOF operations within the context of a larger theater-level campaign. The changing political-military situation in the EUCOM AOR has increased the requirement for high resolution models to explicitly analyze SOF operations in support of planning, exercises and real operations. this presentation will describe current techniques used to implicitly model SOF operations. Recent modeling and simulation support to a SOF CPX will be discussed. The presentation will provide several requirements identified as critical to mission planning for armed conflict and peacekeeping operations.

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Oak Ridge Technologies to Support Tactical Military Operations

The DOE's facilities at Oak Ridge, including Oak Ridge National Laboratory, have been involved for a number of years in the development of technologies and system for use by the law enforcement, special operations and intelligence communities. Some of these technologies have applications to tactical military operations. To enhance tactical command and control, Oak Ridge has developed prototype miniature audio/video transmitting devices, using both infrared and radio frequency technology, in combination with a thin-film power source that can be used in many field applications where size, weight and power are critical. Also prototyped is a secure communications system relying on ultrasonic sound pressure. Oak Ridge has also worked on improving assault equipment with advanced materials, making lightweight shields, non-toxic custom ammunition, and lightweight scaling equipment.

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Military Organization and Functions of the Office of Assistant Secretary of Defense for Peacekeeping and Peace Enforcement

This briefing will discuss the reorganization within the Office of the Secretary of Defense that gave birth to the ODASD/PK-PE, as well as the missions, functions and organization within that office. additionally, the various Task Forces that have been established within OSD to handle ongoing peacekeeping operations as well as the various working groups that OASD Peacekeeping is chairing in an attempt to establish overarching peacekeeping/peace enforcement policy direction.

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Understanding TMD Requirements and Concepts through Wargaming

Acquisition of military systems is a lengthy and intensive process where the warfighter's original operational requirements sometimes get lost. Threat changes, budgetary constraints, fuzzy requirements, and emerging technologies often lead to delivered systems that are more products of the developer's vision rather than the operator's approved incremental acquisition plan that ultimately fulfills objective requirements.

Today advances in distributed simulation and virtual reality can improve that process by helping operators develop higher confidence requirements and concepts. Simulations provide operators a unique opportunity to place themselves into a pseudo environment that reflects their current operations requirements and operational concepts.

USSPACECOM and others are using the wargaming capabilities at the National Test Facility to resolve questions in the Capstone BMD and the BMD Concept of Operations. Besides a flexible facility, adaptable to a variety of needs, a host of tools is available to examine a variety of problems. The Advanced Real-time Gaming Universal Simulation (ARGUS) is the cornerstone simulation that feeds the wargaming environment. ARGUS is a two-sided, interactive gaming tool that provides realistic real-time simulation capabilities to exercise BMD architectures and current concepts of employment against any number of scenarios projected by operator. ARGUS' advanced distributed simulation capabilities provide an excellent opportunity to take advantage of external simulation facilities as well. The X-motif environment and the software driven communication capabilities provide operators the capability to explore man-machine interfaces that will support his decision processes and communication plans designed to support command and control requirements. This discussion describes the genesis of the wargaming capabilities at the NTF, their applications today, and the future opportunities wargaming will provide in resolving BMD issues.

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Corps Sam Effectiveness Against Cruise Missiles

Abstract not available.

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Growing Influence of the 3rd-Dimension on the Modern Battlefield

For centuries, military leaders studied terrain and its impact on warfare. Until the twentieth century, military terrain analysis and its associated doctrine focused on the ground and its corresponding effects. Many battles were won or lost because of local topographic conditions and the military leaders ability to assimilate the changing terrain. Alexander, Hannibal, Napoleon, and Lee were notable military leaders who understood terrain and used it to their advantage against their enemies. Terrain analysis for these leaders was, for the most part, a two dimensional problem. Slope, soil, and trafficability conditions were paramount. However, in the last century there has been a steady evolution in warfare. Modern warfare, through the introduction of advanced weaponry, requires contemporary commanders to prepare for war in all dimensions. How and why did this evolution take place? Also, why has the 3rd dimension gained so much prominence in such a relatively short period in the history of armed conflict? This presentation will address these questions and more as we ascertain the importance of the 3rd dimension in future warfare.

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The WPC Lethality Methodology

This paper describes the development of a new surface to air missile (SAM) engagement model and associated database for the air warfare simulation (AWSIM) at the Warrior Preparation Center (WPC). This project addressed many of the major weaknesses in the development and use of various weapons system models in campaign and theater level computer assisted exercises. The methodology is largely based upon procedures and techniques currently used by U.S. and NATO science and technology centers for hi-fidelity modeling, adapted to the WPC's theater/campaign level war simulations. The methodology describes a weapon's basic physical characteristics, provides a systematic means to quantitatively measure the human influence on both the weapon and the target, and finally it provides a means to show the impact of environmental factors such as velocity and spatial relationships between the shooter and target. The result is a more realistic reflection of the complex human, equipment and environmental interactions on the modern battlefield, rather than an equipment vs equipment result. A major portion of this work involved defining terms and establishing parameters used in the model. From this theoretical work, a set of useful and accurate mathematical tools were developed to assess and establish realistic weapons parameters and provide useful guidance to database and exercise planners. These tools also provided an accurate and measurable way to verify and validate the computer algorithms.

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ELAN as an Air Defense Tool*

The current world political situation has shifted the focus from global to theater defense. This redirection combined with limited funding and time has heightened the need for quick reaction force-on-force combat modeling to support inter/intra service tradeoff analyses needed for weapon systems acquisition. ELAN* is a medium resolution division level and below Joint Combat model which can be used to analyze AD systems with regard to weapon systems effectiveness, tactical techniques and procedures, and operational or organizational concepts. It's battle box has been expanded from a 20 km x 20 km area to a 100 km x 100 km box to allow for operational force effectiveness views of a theater or corps level fight for the ground and air elements.

DoD's emphasis on joint system acquisition programs requires the conduct of weapons tradeoffs across all the armed services and the functional areas such as air defense, armored system and fire support systems. The need for a joint operational effective combat model exists; ELAN*(Star - Sea Terrain AIR) satisfies this need. ELAN* currently models air-to-air, air-to-ground, ground-to-air, amphibious, naval and ground maneuver operations. DMA terrain data and AMSAA BRL weapons data are used to model terrain and weapon systems. The presentation will address the changing analysis needs for weapon systems acquisition and how ELAN* can support these needs.

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Analysis of a Multi-Layer Theater Air Defense (TAD) Capability

TAD is defense of a theater from theater ballistic missiles (TBMs), cruise missiles, air-to-surface missiles, and aircraft. This analysis focused on TBMs, but included the other TAD threats. Few capabilities exist today--primarily PATRIOT and, to a much lesser degree, Scud TEL I killer missions. Many potential systems on the horizon have different capabilities and significantly different costs. In light of the restricted defense budget, only the most cost effective mix of systems can afford to be developed, integrated, and fielded. This analysis was conducted to provide an objective cross-service assessment of current and projected TAD systems. The systems were employed within their specific layers, such a Attack Operations or Terminal Defense, to assess their capabilities. The model considered--by layer--the Pk of the systems, between-layer kill assessments, Buy-In and 15-year O&M costs, and a new concept called Blue Protection. Blue Protection is a measure of the potential damage negated by TAD capabilities. The results of the analysis were the costs and resulting Blue Protection from an enemy attack. These two measures of effectiveness were used to determine the cost effectiveness domain and provide decision makers with information on:

- How cost effective are the various system in term of Blue Protection?
- What is the short- and long-term impact of various solutions?

- What is the impact of various force structures on Blue Protection?

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Joint Air Defense Operations

The Joint Air Defense Operations/Joint Engagement Zone Joint Test Force JADO/JEZ JTF was chartered by OUSD DDDR&E (T&E) in October 1990 to investigate and evaluate the concept of joint air defense operations based on various hostile aircraft identification techniques and procedures. All four Services are actively participating in the Joint Test and Evaluation (JT&E) Program to operationally test and evaluate alternatives for implementing a JEZ.

The JEZ concept eliminates separate engagement zones. It also eliminates reliance on restrictive airspace control procedures to provide friendly ID through the application of Positive Hostile Identification (PHID) Rules of Engagement (ROE). The PHID ROE restricts engagements to those targets that have been positively identified to or by the operator as hostile. The PHID ROE is supported by Target Signature Systems (TSSs) which are physics-based hostile aircraft identification systems that can be used either in JEZ or FEZ/MEZ operations. A hostile ID can be obtained either directly from organic sources or indirectly from higher echelon. Hostile IDs can result from target attributes (i.e., visual ID or pint of origin) or by observance of a hostile act or intent.

The approved JADO /JEZ JT&E Test Design is based on a single and broad critical operational issue (COI): "When and how can the effectiveness of SAMs and fighters operating under JADO/JEZ with a PHID rule of engagement be significantly improved over the effectiveness with current tactics, techniques, and procedures (TTP)?"

This presentation provides emerging test results in terms of attrition, fratricide, survivability, and allocation of resources. The results of this first fully instrumented and documented air defense testing ever undertaken are providing the operational community and decision makers with valuable information on, and potential solutions to, air defense problems.

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Derivation of the Distributed Air/Missile Defense Concept

The U.S. Army is restructuring its doctrine, shifting toward contingency operations; and threat forces are modernizing to integrate new technologies into their air and missile weaponry. As a result, the battlefield of the future will be one in which widely dispersed, highly mobile forces will require equally dispersed, yet integrated, mobile air/theater missile defense systems to protect them from air and missile attack. A new system concept, identified as Distributed Air/Missile Defense, provides opportunities for that protection while maximizing the survivability of air/theater missile defenses so they can fight subsequent battles.

Distributed air/theater missile defense has four key features:

- Physically distribute BM/C3I elements and operations
- Three-dimensional, multi-function, netted sensors
- Autonomous, terminal homing seeker missiles
- A digital data communications/distribution system

Based on trade-off studies, implementation of this concept results in several opportunities for improved force effectiveness:

- Defense of much larger areas with far greater firepower.
- Significantly improved resource allocation and firepower concentration - providing Battalion-wide global engagement optimization.
- Reduced command centralization - minimizing decision reaction time, and attack saturation.
- Robust survivability - significantly complicating the threat's attack options.
- Facilitation of mission tailoring of tactical deployments.

This paper describes several of the effectiveness as well as cost trade-offs that were performed to derive this conceptual architecture and provides insights into why it is a candidate solution for future air/missile defense systems.

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A Measure of Effectiveness for Threat Reconnaissance UAVs

A measure of effectiveness for threat reconnaissance, surveillance, and target acquisition (RSTA) unmanned aerial vehicles (UAV) is required to project threat capabilities and match air defense counter-RSTA requirements. This paper proposes Area Search Rate as a useful measure for projecting threat UAV loiter altitudes, ranges, and reconnaissance effectiveness. The measure is easily computed from the technical and physical limitations of airborne passive imaging sensors, and operational variables, using the AQUIRE methodology from CECOM Center for Night Vision and Electro-Optics (C2NVEO). A relationship to Koopman's search width concept allows evaluation of UAV fleet effectiveness over wide areas. An example of an optimization of loiter altitude illustrates the measure's use.

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Setting Requirements for Probability of ID in Air-to-Air Combat - The Results of an Identification Probability Analysis

The motivation for the Identification Probability Analysis came from the user, Air Combat Command (ACC) who were tasked to answer questions concerning air-to-air target ID confidence and other probabilistic ID parameters. Traditionally, both the user community and the technology development community worked toward a 99% (or greater) confidence value for the sensor's ID. However, there has been no analysis or hard data to support such a number (or any number). For example, if a new ID technology could work three times as often at 97% for one third the cost of a 99% confidence ID system, which would a fighter pilot rather have? ACC needed sound data to begin to address probabilistic ID specifications to support future ID hardware and software development efforts, and there was none available.

The Non-Cooperative Target Identification (NCTI) Program Office at Wright Laboratory initiated the Identification Probability Analysis in response to this need. The objective off this analysis is to quantify the sensitivity of mission effectiveness to changes in ID performance. The item of highest interest is the effect on mission accomplishment and fratricide caused by reducing ID confidence. The computer simulation chosen for this analysis was the Situationally Interactive Combat Model (SICM). Several scenarios and Red/Blue force ratios were used to verify the robustness of the analysis performed and to avoid being mission specific. The product of this analysis is a database that combat ID decision makers can use to address key ID performance questions.

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Non-Monotonistic Results in a Stochastic Simulation

This presentation describes a stochastic simulation analysis being conducted for Wright Laboratory which tests the performance characteristics of an air-to-air combat ID system. This analysis specifically addresses three performance factors involving the ID of aircraft by other aircraft: ID range, the ID declaration rate, and the confidence level that the (declared) ID is correct. Some of these ID performance factor combinations produced counter-intuitive results. For example, we will describe cases where improved ID systems produced poorer mission effectiveness. This phenomena (non-monotonistic behavior) has been seen in some deterministic modeling results, with experts postulating everything from 'this won't happen in stochastic models' to 'the phenomena will be worse in stochastic simulations.' This briefing includes a discussion of the history of the phenomena, a description of this particular ID analysis, the stochastic model and simulation techniques used, non-monotonic observations in the results, efforts made to investigate the causes and cures, and conclusions based on experience to date. This briefing will be of prime interest to the modeling and simulation community, C3I attrition modelers, and combat analysts experiencing similar trends in their results.

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Contribution of Elevated Sensors to Theater Air Defense vs Low-Altitude Targets

The purpose of this Hughes study is to provide an objective assessment of the contribution of ground-based and elevated (airborne) sensors to successful engagement of low-altitude air threats by surface-based, theater air defense systems. Study focus is on the potential contribution of elevated sensor options to the defense mission as a function of various sensor types, platforms, threats, and associated ground-based system elements. Parameters such as the number of elevated and other organic sensors in the defense system, sensor detection range and altitude, threat types and numbers, and defense employment geometry are examined.

Overall scope of analysis includes:

- Review of potential theater defense laydowns (assets, sensors, C3, launchers, etc.) in Korea, SW Asia, and FRG scenario areas,
- Development of baseline line-of-sight (LOS) performance for the ground-based and elevated sensor platforms,
- Summary of LOS performance measures (MOP) for individual and combined sensor suites consisting of ground-based and elevated sensors vs low-altitude theater threats,
- Comparison of LOS MOP with engagement-related target track requirements,
- Assessment of the adequacy of candidate AD sensors to support minimum track requirements for successful threat engagement, and
- Relate findings to insights from earlier elevated sensor studies (SOTAS, PAVE MOVER, FAAD Masked Target Sensor).

Study results highlight the significant impact of terrain masking on sensor coverage, target acquisition and tracking performance, and overall defense effectiveness.

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Precision Strike in Support of Theater Air Defense

The four pillars of Theater Air Defense have been defined as Attack Operations, Passive Defense, Active Defense, and Battle Management/C3I.

The goal of "Attack Operations" is to destroy the theater air threats before they can be employed, or at least to disrupt their processes and reduce their effectiveness. The degree to which attack operations succeeds lessens the load on the other pillars of air defense.

"Precision Strike" can be considered as enabling technologies to effectively conduct attack operations, and can be utilized by each of the services employing their unique assets. The DDR&E Science & Technology Program has defined the Precision Strike Thrust as: "The desire for reduced casualties, economy of force, and fewer weapons platforms demands that we locate high-value, time-sensitive, fixed and mobile targets and then destroy them with a high degree of confidence within tactically useful timelines."
Hughes has undertaken an internal, corporate-sponsored study to assess the unique requirements of the Precision Strike mission.

The objective is to define an end-to-end functional architecture which will support the detection, targeting and engagement of time-critical ground targets, and to assess leveraging technologies to show the benefit of specific systems integrated within the architecture.

Hughes has defined a sensor-to-shooter architecture which incorporates wide-area surveillance, tactical reconnaissance, intelligence and planning, command and control, and weapon delivery, and has developed a spreadsheet analysis tool which can be used to assess system performance tradeoffs using relevant top-level measures of effectiveness.

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Patriot Advanced Capability Level 3 COEA

The TRADOC Analysis Center conducted the PAC-3 COEA in two phases. Phase I analyzed the PGP and initial PAC-3 Operational Requirements Document (ORD) requirements. It also determined that the PAC-2 missile and Guidance Enhanced Missile could not meet PAC-3 ORD requirements. The issues of battle management (BM); C3I; training; manpower; reliability, availability, and maintainability; procurement; force structure impacts; deployability; and mobility were also examined. Phase II examined the Multimode Missile (MMM) and the Extended Range Interceptor (ERINT) in greater detail against a more stressing threat. Its conclusions reinforced Phase I, with MMM providing greater battlespace and ERINT maintaining greater firepower. Phase II also examined the operational implications of several issues; among them were tactical ballistic missile (TBM) breakup, the Phase III radar, and the benefits of external cuing.

WG 13 -- Electronic Warfare and Countermeasures
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Abstracts not available.

Selecting an M&S Toolbox for EC Evaluation
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Integrating EC Evaluation Tools into J-MASS
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Towards a Focused and Coherent EC M&S Analytic Capability -- A Round Table Discussion with EC Analysts -- Maj Bill Behymer
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A J-MASS Waveform Threat Model for EC Analysis
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Advanced Concepts for Destructive SEAD
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ECCM Effectiveness for Track While SCAN Radars
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Capturing the Effects of ECM in Automated Mission Planning
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WG 14 -- Joint Campaign Analysis
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Battle Force Mix Study: A New Analytic Approach to Naval Campaign Analysis

Traditional methods of naval campaign analysis, designed primarily for scenarios involving open-ocean combat between superpowers often do not meet the needs of campaigns in the littoral environment. Operational conditions, casualty computation, force requirements and the definition of victory are drastically different. The basic question of the study is "How many surface combatants will be required to carry out the Navy's part of the Joint Requirements for a Win-hold-win strategy?" To support this, JHU/APL and the Naval Postgraduate School developed a new approach to campaign analysis. Results of this study were integrated with other analytic tools (such a as overseas deployment/forward presence model) to arrive at first order approximations of the numbers and characteristics of surface combatants to execute the mission.

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Current Analysis at a Warfighting Headquarters

An example of analytical support to mission planners "today." The HQ USEUCOM Deputy Director for Operations and a JTF Deputy Commander tasked the analysis of potential air campaign plans by contingency planners, specifically air-to-ground operations against enemy artillery positions, air bases, C2 nodes, depots, power grids and telecom targets. Since the contingency planners required responsive analyses, the TACWAR model was used. The analysis reinforced USEUCOM and JTF staff planning with quantitative estimates of the degradation of enemy ground targets and risk to US aircraft, as well as the risk to friendly ground forces. It examined several alternatives courses of action.

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Modeling and Simulation at a Warfighting Headquarters

Describes the process used by ECCS-AS to determine HQ USEUCOM modeling and simulation requirements, and discusses the prioritized requirements approved by the HQ USEUCOM Chief of Staff. Also the analysis support to both the headquarters and Joint Task Force staffs. Includes an example of how ECCS-AS has supported contingency plan development by performing comparative analyses of a limited conventional operation using a theater-level simulation and data base. USCENTCOM has agreed to actively participate.

Cpt H. F. Conley
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Requirements Determination by Analysis in a CINC

Presents the Combined Forces Command (CFC-Korea) CINC's Threat Distribution and discusses the methodology used to build it. The latest DPG specifies the Services use the Capabilities Based Munitions Requirements Process,abased on projected force structure and projected threat. Consequently the employment CINC's plan is essential. The means for incorporating the CINC concept of operations into the Pentagon's munitions determination process is the CINC's "Threat Distribution:" an allocation of targets from a common target base across the components which support the CINC. Because a unified command had never built a threat distribution, a new methodology was created. It had to capture the guidance in the JSCP, a DIA estimate of the outyear threat, and the theater OPLAN. The approach taken was two-tiered: it relied on theater doctrine for employment of forces and a computer simulation to assess the success of that doctrine. We used TACWAR, a theater level model, to play the scenario. TACWAR provided a gross measure of the relative capability of service components. We then applied JSCP projected force structures and theater doctrine to build the Threat Distribution. This was done for a baseline, single MRC and a dual MRC scenario. The final product was an allocation of 46 different target categories across service components, including ROK army and air force and US army, air force, navy and marine corps.

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Optimization of Aircraft Mission Apportionment in a TAC THUNDER Scenario Using RSM

Perhaps the most important input to the TAC THUNDER model is the user-specified apportionment of available aircraft. This allocation defines what percentage of each type will fly what missions. An optimal apportionment provides useful information to both the analyst and decision maker and a better understanding of how TAC THUNDER processes behave. This is important for V, V and A of the campaign model. In addition, campaign outcomes using an optimal allocation are important for showing no non-material solution exists as far as aircraft employment is concerned, a requirement by Congress to validate the requirement for new weapon systems. To compare different sets of available aircraft, it is necessary to find the maximizing apportionment for each set. This research uses an unclassified scenario to show how an analytical Response Surface Methodology (RSM) technique arrives at the relationship between aircraft apportionment and campaign outcome. RSM uses a steepest-gradient search of the constrained response surface. The results are illustrated with illuminated charts showing the various relationships between aircraft numbers and MOEs such as FLOT movement and attrition. Our results show close air support missions to be singularly effective in the illustrative scenario. Additional analysis is underway to measure the sensitivity of the response surface to increases in the opponent's effectiveness.

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Rick Munro
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Joint Warfare Analysis Using the ITEM Campaign Model

The Assessment Division of OPNAV (N-81) has been developing in-house campaign analysis capability to address aspects of the new world order and associated threats, especially as they affect naval warfare and the Navy in joint operations. The primary tool employed is the Integrate Theater Engagement Model (ITEM). A base case corresponds with an approved MRC. Various types of aircraft and weapons were installed in ITEM and comparisons made of sorties, length of campaign, weapons expended, cumulative damage and aircraft lost to ground and air defenses. The base case is summarized with information about the target set and major system characteristics. Other force mixes are compared using the principal MOEs. In addition, potential for joint use of ITEM is discussed. The use of the Mission Effectiveness Model (MEM) in the FY94 SECNAV War Game to illustrate theater ballistic missile defense is described.

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A Major Mideast Contingency Without Advanced U S Force Deployment

This analytical effort lays a foundation for subsequent issue analyses that will shed valuable insights into next generation aircraft and missile requirements. The work centers on the ability of Gulf Cooperation Council (GCC) forces or U.S>-led coalition forces (within the context of no advance U S deployments) to meet the initial campaign objective of stopping an invading, armor-heavy Iraqi thrust in Saudi Arabia short of Dhahran in the 2010 time frame. Analysis is at the theater level, emphasizing land and sea based air capabilities. Efforts examine the first ten days of a defensive campaign and three levels of GCC air capability to bracket GCC air effectiveness. Five cases of weaponeering and associated employment are examined to bound potential U. S. air power effectiveness and provide insights into the potential contributions of advanced munitions.

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Joint Military Net Assessment

Abstract not available.

WG 15 -- Command Control and Communications

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C2 Challenges for the 21st Century

Abstract not available.

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C3 Systems Evaluation & Acquisition As A Temporal Process

It is increasingly difficult to field a new C3 system, whether to replace an obsolete existing system or to provide automated support where it had heretofore been lacking. Port of this difficulty can be attributed to our C3 systems evaluation methods.

We have several existing C3 systems evaluation methodologies, but they lack a temporal dimension. Current methods essentially define the operational value to a C3 system as the amount that it will improve force effectiveness today. Lifecycle cost is determined by assuming that the system will be supported throughout it planned lifecycle and then abandoned, and the two are combined to make the acquisition decision.

In this paper, we propose a new evaluation framework based on viewing every C3 system acquisition as an evolutionary upgrade to an existing system. We treat C3 systems acquisition as a process that repeatedly chooses between sets of evolutionary upgrade paths. Each acquisition choice provides enhanced support to certain operational functions. It also enables certain future upgrade paths and blocks others, thus changing the set of choices available in the future. Recognizing this, our approach explicitly focuses on the discounted value and cost of future feasible upgrades, as well as the technology risks, in each acquisition decision. This approach enhances current evaluation methodologies by favoring acquisitions that lend themselves to future upgrades.

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Development of The Information Campaign Concept

Previous studies conducted by VRI demonstrated the large payoff for having a significant information advantage on the battlefield. TRADOC commissioned this pilot study to develop initial insights into strategies for conducting an "information campaign" to crate that advantage. The study involved in the development of methods to assess the payoff for disrupting information targets and an analysis to identify good "strategies" to attack the enemy and defend U.S. information networks

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Defining and Comparing Alternative C4 Architectures for the Army: Conceptual Approach

The Army is examining a wide range of possible C4 architectures to meet the challenges of future contingencies. One part of this effort is a top-down approach developed at RAND to both define and compare alternative C4 architectures. Starting with three

perceived trends in the information age, three alternative architectures are defined. These architectures are then compared according to a set of physical and information attributes. Due to the large size of the analysis space, a qualitative approach is first used to make a rough comparison between the candidate architectures and to reduce the size of the analysis space. Based on this approach, the size of the space was reduced by over 80 percent. If the quantitative analyses are completed in time for the conference, those results will be presented as well.

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System Boundaries Within the MCES Paradigm

MORS has long been interested in supportive of efforts to develop methodologies for measuring effectiveness in military systems. MORS has placed particular emphasis on measuring the contribution of C3 systems. This interest has been demonstrated through a series of MORS-hosted workshops and mini-symposia beginning as far back as 1985. Professor Sovereign, a seminal force in these workshops and on the faculty of the Navel Postgraduate School, provided an excellent, historical overview in a recent background paper for the MORS Mini-Symposium on Campaign-Level C4IEW Effectiveness held at Fort Leavenworth in October 1992. In his paper, Professor Sovereign reviewed the principal product that has resulted from the preceding MORS Workshops, namely the Modular Command and Control Evaluation Structure (MCES), and illustrated its application to a particular unmanned aerial vehicle (UAV) platform. This paper reviews the fundamentals within MCBS, examines its use of MCES in the UAV application and points the way to an improved use of the MCES.

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GCCS "Acquisition" Strategy

Abstract not available.

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An Analysis of JFACC Air Campaign Planning and Information Processing Tools?

The JFACC concept contributed to the success of the air campaign during Operation Desert Storm. However, the automation tools used during the war to help plan and coordinate the air campaign were found to have a number of shortfalls and limitations. Since then a number of new automation programs have been started to eliminate these limitations, while at the same time certain tactical reconnaissance assets may be eliminated.

This analysis investigates whether the current investment strategy in automation tools, communications systems, and reconnaissance systems is sufficiently balanced to optimally support the new JFACC concept. A parametric timeline analysis will be done of the ATO production and dissemination processes. The following elements will include in the analysis: attack aircraft fore structure, weapons types, numbers of strategic targets and strategic target types, tac recce force structure and tac recce data dissemination links, ATO dissemination links, and finally ATO and mission planning systems. Most of the these elements will be represented as nodes in a set of interacting Markoff processes.

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Joint Air Defense Operations C3I Data Links or "TADIL BABEL" (S/NOFORN)

Abstract not available.

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Planning and Conducting Air Campaigns Under Uncertainties: A Computerized Exercise Approach?

The overall purpose of this effort is to generate greater understanding of the process of air campaign planning at the strategic level as well as to emphasize the magnitude of the potential uncertainties involved in the planning and execution process through the use of computerized exercises. The system includes both formal written materials for browsing and cross-reference and an interactive planning exercise. The exercise focuses on identification and understanding of strategic target sets both in terms of individual targets and systems of targets with interrelationships. After building a degree of knowledge of these target systems, players plan and conduct a multi-day air campaign with specific objectives. These exercises are further complicated by uncertainty in the information presented to the players,

i.e., incomplete intelligence, bad weather. Specific attention is given to review and explanation of the actions taken over time with focus on how well a player manages the inherent uncertainities in the planning and conducting of effective Air Campaigns.

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Evaluating Database Consistency Management Approaches Using Simulation Modeling

There is a growing need within many military organizations to provide consistency management among distributed database systems in order to support interoperability and flexibility within tasking cycles. The goal of this research is to evaluate how existing consistency management algorithms perform in the tactical military environment. Although this research focuses on investigating existing database consistency management algorithms to determine their suitability for use in the strike warfare environment, many of the algorithms are also applicable to other military operations.

Within the military environment, different types of databases are needed to allow interoperability and mission planning for manned aircraft, delivery of cruise missiles, and ground strikes. These databases vary in purpose, including storage of track databases developed by correlation and tracking systems, storage of red and blue characteristics and performance data to aid in the correlation process, storage of intelligence data to support manned aircraft mission planning and ground maneuvers, and storage of cruise missile mission plans that are fed into the cruise missile when it is ready to be fired. It is important that the replicated data between the ashore and afloat nodes be consistent. However, the definition of consistency may vary from application to application, and may even depend upon whether the data in a given application is considered critical or not.

This research uses a high-level simulation model of the strike warfare environment to examine the various consistency management algorithms and assess their utility in that environment. Parameters to be investigated include: the level of data consistency among the replicated nodes and the time it takes to reach that level; the communications bandwidth requirements; and the currency of each of the databases. This briefing will describe interim results of this work.

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An Independent Verification and Validation of The Future Theater Level Model Conceptual Model

This discussion will briefly describe the Force Theater Level Model, the techniques used for V&V of a model concept, and the results of the work.

We subjected the conceptual design of the FTLM to those tests that we thought appropriate to its design stage, to its purpose as an analytical combat model, and to its capabilities as specified in requirement documents. The conceptual design passed those tests. We recommend that its development be continued, but that increased attention be paid in the areas of design of model input and output support and decision logic creation. We also recommend the institution of informal configuration management control. These steps are appropriate as the model moves to a more complex and costly stage of development.

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Integrating Distributed Interactive Simulations for Training and Military Operations

Abstract not available.

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Command and Control: The Key to Successful Theater Missile Defense (TMD) Operations

The purpose of this paper is to present an overview of an analysis of command and control system imperatives critical to the performance of effective Theater Missile Defense (TMD) Operations. Theater Missile Defense, in its developmental infancy, is on the threshold of operational turmoil and confusion as routine joint and combined operational interoperability becomes more the norm through an evolving force projection doctrine. The presentation begins with the supposition that TMD command and control will require a coordinated effort to address high payoff synergistic solutions through doctine, training, leader development, organizations, material, and soldiers (DTLOMS).

The discussion will provide a brief description of the current TMD concept of operations and significant roles. It will identify critical command and control issues whose resolution will have a positive collateral effect on numerous other issues. The discussion will analyze and suggest solutions in the areas of doctrine, command post roles and relationships, deep operations,

targeting, command post size and complexity, and TMD information requirements.

The summary will advance the notion that each participating element in the joint and combined TMD arena is unique in respect to its missions, organization capabilities, national goals, and strategies. TMD command and control procedures will have to be developed that will allow a smooth connectivity and nteroperability of any and all elements supporting a tactical operation.

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Analyzing Army Command and Control on the Move
Abstract not available.

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Matching Requirements, Opportunities and Resources: The Contribution of Space-Based Command and Control to Future Military Operations

This paper and presentation are based on an on-going study for the Joint Staff/J-5 (Space Policy) that is examining the extent to which space power (both friendly and hostile) will influence the implementation of national security strategy and the conduct of future military operations. Since the focus of Working Group 15 is on command, control, and communications, the paper and presentation will address the contribution of space-based command and control (C2) to future military operations.

In the context of an evolving strategic landscape, decision makers must clearly understand the capabilities of military space systems and their expected contribution to accomplishing national and military objectives. Just as the focus of this landscape is changing from the former Soviet Union to regional and nontraditional threats, the role of space power is also changing and is complicated by declining budgets and force reductions. While Operation *Desert Storm* highlighted the importance of space power in supporting conventional military operations, future joint and multinational operations will demand an increasing role for space systems, particularly in command and control, and including the possible exploitation of civil and commercial systems. This paper and presentation will identify expanding challenges posed by the evolving strategic landscape, and evolving requirements and opportunities, specifically external constraints and factors which will affect U.S. C2 in future operations. Four notional baselines for space support of C2 are offered to illustrate and identify the implications for carrying out national objectives. Selected C2 issues are addressed from insights learned from examining command and control of joint air operations. Finally, the paper and presentation offer some concluding observations and implications for further research.

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Deep Operations Coordination Cell Analysis

The U.S. military is limited in its ability to integrate, coordinate, and synchronize intelligence decision-making and attack means in real time to achieve maximum leverage over the enemy. It must streamline the command, control, communications, computer, and intelligence (C4I) process to maximize combat power. For critical deep attach operations (especially against opponent theater missiles), the process is "stubby pencil" and the "sensor-to-shooter" timeline is too long.

The need exists for an analysis to support decisions regarding configuration (manpower/user assessment) and sensor-to-shooter timeliness of the Deep Operations Coordination Cell (DOCC) and the testing and refinement of its ability to support deep operations. Analysis may be supported through simulations, demonstrations, and exercises. This effort will examine corps elements that are currently involved in planning, coordinating, synchronizing, and executing fire support and identifying requirements for detection of high payoff targets for deep operations.Thursday, 1030

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U.S. Army Deep Operations Coordination Cell (DOCC) Development
Abstract not available.

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Joint Force Sequencing: A Model For Assessing Joint/Allied Operations

Joint Force Sequencing addresses the time phasing of the deployment of U.S. military forces and systems

into an immature regional theater of operations. This paper addresses the implications of Joint Force Sequencing on U.S. Joint Task Force command and control and the partitioning and transition of command and control from an early operations shipboard environment through forcible insertion to sustained operations ashore. The paper proposes Joint Force Sequencing as a model for considering the various modes and states in which the Joint Force command and control system-of-sytems can exist. As an example, joint air operations are considered in further detail to highlight the significance of Joint Force Sequencing on the implementation of command and control in immature regional operations.

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A Multivariate Permutation Rank Order Test for Network Simulation Validation

Simulation is a widely accepted means of analyzing systems that are two complex to model analytically. Most communications systems fall into this category. But simulation credibility suffers when a continuing verification and validation program is not undertaken, thereby diluting the value of analyses that simulations support. The purpose of this research is to strengthen the link between experimentation and simulation, both of which should be utilized in evaluating communications systems' measures of performance.

A primary goal of any verification and validation process should be to enhance both the correctness of a simulation and the confidence placed in its results. One challenge is to develop a process that is at the same time feasible and compatible with an organization's needs, and can be applied to both existing simulations as well as new ones.

This paper describes a statistical test useful for the validation of simulations of (battlefield) communications networks. The method employs a multivariate nonparametric rank sum test with the aid of a randomization procedure to assess the significance of the defined test statistic. For illustrative purposes, the validation procedure is applied to a simulation that was developed to duplicate a configuration in which messages were passed over a communications network using the combination of the Tactical Fire Direction System (TACFIRE) protocol and Single Channel Ground and Airborne Radio System (SINCGARS) Combat Net Radios (CNR).

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Aggregation and Integration of Data Sources for C3 Evaluations

This paper focuses on the problem of integrating multiple sources of significantly different data types into a common data base for Command, Control and Communications (C3) test and evaluations. In the resource challenged environment of today's C3 evaluation, all sources of data must be utilized to support cost effective acquisitions. The analyst is often confronted with the problems of aggregating and integrating diverse sources of data such as questionnaire inputs, expert opinion, deficiency reports, manually collected system data, and automated digital data collection outputs. This paper describes the methods used to aggregate evaluation data from different sources on the Army Tactical Command and Control Systems (ATCCS) System Confidence Demonstration into one common data base for evaluation purposes.

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C2 Core Data Model "Application Prototype

This briefing describes the results of our examination of the C2 Core Data Model, which was distributed to the C2 community in September 1993 by the Defense Information Systems Agency's (DISA) Joint Interoperability and Engineering Organization (JIEO) for review and validation. The C2 Core Data Model is a direct technical transformation of the Army Tactical Command and Control Information System (ATCCIS) Battlefield generic Hub and was produced by a team from DISA/JIEO and the Army. The C2 Core Data Model provides the same functionality as the Battlefield Generic Hub Data Model and has been aligned with the DoD Data Model.

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Training and Leader Development Simulation Plan for Mounted Warfighting

This discussion is built upon experiences gained from working the Combined Arms Training Strategies (CATS) over the past several years. Specifically, I will provide insights into how simulation could evolve from the user's perspective. CATS provides an architecture which ties training standards/proficiency gates, resource

requirements, and simulation and simulators together. By tying the resources, standards, simulation and simulators together, CATS becomes a tool which the defense community may use to focus and bound training analyses, determine the essential elements of analysis, perform sensitivity analyses and produce a product which is timely and relevant to acquisition cycle. Further, the merging of simulation and combat systems, especially C3I into a single combat rehearsal system which allows us to plan rehearse and respond to a contingency and develop our materiel/training/combat requirements simultaneously.

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The Army Unit Resiliency Analysis (AURA) Component Level Modeling Sensitivity Analysis

This paper evaluates the sensitivity the Army Unit Resiliency Analysis (AURA) results to the level of component detail used in the performance of unit-level conventional ballistic vulnerability analyses. The AURA methodology is a large interconnected collection of analysis models which provides detailed evaluation of the capability of a military unit to perform its mission essential tasks. In recent years, AURA has been applied to the problem of analyzing the residual capability of a massed Corps Main Command Post following theater ballistic missile attack. Unit effectiveness has been analyzed in terms of the capability of each cell within the command post to communicate. To model the complex shielding of critical components, three dimensional unit-level target descriptions consisting of approximately 8000 target identification regions, describing approximately 30 vans and tents complete with communications equipment, personnel, and supporting generators emplaced around the periphery were necessary. Because the vulnerability of communications equipment is dependent upon the vulnerability of power cables, phone wires, junction boxes, signal cables, and the equipment providing connectivity to the network, these assets were also included in the target description. While this approach provided an accurate method of determining the damage to the unit, it significantly increased the time required to generate the target description and perform the requisite vulnerability analysis and unit-level capability analysis. In order to increase the efficiency of performing such an analysis without sacrificing accuracy, a sensitivity study of unit capability results to the level of component detailed utilized in the unit-level target description was conducted.

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Use of Simulation for Designing Large-Scale C3 Experiments

This paper discusses the use of discrete simulation for designing large-scale command and control experiments at the Army Tactical Command and Control System (ATCCS) Experimentation (AES). It describes the methods developed by the AES for evaluating the communications architecture, the experiment event list, and other experiment design issues.

WG 16 – Military Environmental Factors
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Environmental Effects for Distributed Interactive Systems.

Realistic simulation of dynamic virtual battlefield environments, their resident combatants, and the responses of virtual sensor systems, requires the use of high fidelity physics and engineering models. The current inability to incorporate high fidelity environmental effects is a major obstacle to the realism and utility of existing war fighting models and simulations. The Defense Modeling and Simulation Initiative of 1 May 1992 identified the creation of synthetic environments as a major goal. Accordingly, the Defense Modeling and Simulation Office (DMSO) has set objectives that promote joint service standards for physics based environmental effects in distributed modeling and simulation networks. Synthetic environments should provide to simulations, time and space varying information about the terrain, atmosphere, atmospheric backgrounds, oceans and near-space. This paper will describe the Environmental Effects for Distributed Interactive Simulations (E2DIS) program. This program shall incorporate appropriate fidelity physics of the environment and environmental effects seamlessly into distributed simulations using Distributed Interactive Simulation (DIS) standards.

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Responding to an Expanding Mission: Adapting Air Force Global Weather Central's Cloud Forecast Models to Theater Weather Support
Abstract not available.

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Environmental and Oceanographic Support Capabilities at the Naval Oceanographic Office
Abstract not available.

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Environmental Protection and Military Training -A Two-Way Benefit Stream.
Abstract not available.

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Using Stochastic Vehicle Mobility Predictions to Identify Speed-Controlling Factors
Abstract not available.

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Advanced Meteorological Modeling for Adjusting Extended Range Artillery

Many times the current doctrine of utilizing data from a dedicated meteorological station is not representative of the actual wind, temperature, and pressure effects experienced by unguided artillery projectiles. An enhanced procedure for adjusting artillery fire is required to compensate for the meteorological effects on extended long range artillery applications. Different algorithms were developed to select a best approximation in deriving a composite meteorological message from available balloon borne meteorological observations. The design allows a commander, whose dedicated meteorological station data may be 4 hours old, to use another station's data that may be 30 minutes old but 20 km away. Simulated results are tabulated for the evaluation of the following proposed algorithms: an algebraic objective analysis, an analytic successive approximation technique, and a physical performance three-dimensional hydrodynamic forecasting model. A trade-off analysis of artillery accuracy improvements is presented from algorithms using Z-80 computer processing to the state-of-the-art computer work station. Using a meteorological scenario that allows measured data every two hours, it is demonstrated that proposed algorithms can provide the artillery user with better than one hour old meteorological accuracy.

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A Mobile System for Battlefield Atmospheric Sounding
Abstract not available.

WG 17 -- OPERATIONAL CONTRIBUTION OF SPACE SYSTEMS

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Abstracts not available.

Space Systems Contribution to Naval Forces
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Air Force Space Command Mission Area Planning
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The Insertion of Space into the US Army's "Louisiana Maneuvers"
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Broad Area Imagery Requirements and Priorities of the Warfighter
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Status of NORAD/USSPACECOM Integrated Command and Control System (NUICCS) Analyst Technical Environment (NATE)
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Comparison of the Performance and Training Times of the Back Propagation and Conjugate Gradient Neural Networks
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Impact of Information on the Battlefield
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Modeling Global Positioning System Effects in the TLC/NLC Model
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A Methodology to Assess the Impact of the Global Positioning System on Air Combat Outcomes
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Weather Utility Simulation (WXSIM)
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Operational Performance Testing of Defense Support Program (DSP)
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WG 18 -- Operations Research and Intelligence
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Operations Research and Intelligence

The purpose of this paper is to present an overview of current operational research and intelligence considerations which affect our analysis of salient problems in theater missile engagements and effectiveness of defense capabilities. A central issue is how analytical tools can be used to bridge potential gaps between operational requirements and intelligence. In the face of major changes anticipated in the nature of theater operations and in corresponding intelligence needs to support such operations there is real danger of disconnects in the process of identifying the intelligence needed to support operations, obtaining that intelligence, and providing the intelligence where and when it is needed from an operational perspective. Operations research techniques and tools can be applied to address this problem and bridge the potential gap between operations and intelligence.

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An Algorithm for Generalized Assignment Problems with Multiple Prioritized Objective Criteria

A class of resource allocation problems deal with allocation of groups of resources to groups of tasks. Allocation problems of this type can often be formulated as binary programming problems with multiple optimization criteria. B. D. Lebedev developed an algorithm addressing solution of such problems for use by the former Soviet Armed Forces to determine the optimal allocation of artillery fire units to targets. This paper presents a

discussion of the Lebedev algorithm, an extension to the algorithm to deal with optimal allocation across multiple time increments, the reformulation of multiple objectives to a single objective, and possible application of the algorithm to problems other than artillery unit/target assignments.

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Computer Model of Russian Rocket Artillery Firing Scatterable Mines

This paper describes a computer implementation of an algorithm used to deliver anti-tank and anti-personnel mines by a Russian Multiple Rocket System. The program emulates the calculations described in Russian documents. The software can also calculate the number of mines in a given path, so that the potential effectiveness of the minefield can be assessed. A comparison of this algorithm with a similar algorithm from a western country is also presented.

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Applications of Opposing Force Employment Algorithms to Chemical Casualty Estimation

In order to make an informed estimate of friendly vulnerabilities to an opposing force's use of chemical weapons, an understanding of the threat employment doctrine is essential. The choice of aim points and adjustment for weather conditions has a significant impact on the possible expected casualties a friendly force may incur. Working closely with intelligence analysis from the Foreign Science and Technology Center, TRAC-WSMR, and the Missile and Space Intelligence Center, weapons characteristics and probable employment doctrine for foreign artillery and missiles has been described. Using this information, the Chemical Working Group of the Joint Technical Coordinating Group for Munitions Effectiveness is providing opposing force chemical weapons effectiveness information to include in vulnerability Joint Munitions Effectiveness Manuals (JMEM). Major Sees will explain the methodology and some possible benefits to JMEM users.

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Toward the Deterrence of Aggression: Modeling, Strategies, and Force Characteristics

The concepts underpinning the deterrence of aggression have changed considerably since the dissolution of the Soviet Union. Supporting the Strategic Deterrence Joint Mission Area Assessment chaired by the Chief of Naval Operations Strategic Submarine Branch (N871), The Johns Hopkins University/Applied Physics Laboratory performed basic theoretical development and analytical work expanding the framework of deterrence from "nuclear only" to a broader context. In two Warfare Analysis Laboratory Seminar Exercises (WALEX) the ideas were further explored and refined by representatives from a wide range of organizations, including members of the Chief of Naval Operations staff, the intelligence community, Navy and Marine Corps operational staffs and Joint staffs, and academic and analytical groups. From this work emerged a significantly different perspective on the use of conventional forces to deter a wide spectrum of aggression, from terrorist acts through major regional conflicts. This article presents some of the results of this work, including:

- A new analytical model of an aggressor's decision process;
- A revised definition of deterrence;
- Four strategies for pursuing deterrence objectives;
- A suggested process for selecting the appropriate deterrence strategy;
- Implications of deterrence "failures"; and
- Some commentary on the deterrence utility of forward deployed forces

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The Army Unit Resiliency Analysis (AURA) Component Level Modeling Sensitivity Analysis

The subject of this paper is the evaluation of the sensitivity of Army Unit Resiliency Analysis (AURA) results to the level of component detail utilized in the performance of unit-level conventional ballistic vulnerability analyses. The AURA methodology is a large interconnected collection of analysis models which provides detailed evaluation of the capability of a military unit to perform its mission essential tasks. In recent years, AURA has been applied to the problem of analyzing the residual capability of a massed Corps Main Command Post following theater ballistic missile attack. Unit effectiveness has been analyzed in terms of the capability of each cell within the command post to communicate. To model the complex shielding of critical components afforded by such

a massed complex of vehicles, three dimensional unit-level target descriptions consisting of approximately 8000 target identification regions, describing approximately 30 vans and tents complete with communications equipment, personnel, and supporting generators emplaced around the periphery were necessary. Because the vulnerability of communications equipment also depends upon the vulnerability of power cables, phone wires, junction boxes, signal cables, and the equipment providing connectivity to the network, these assets were also included in the target description. While this approach provided an accurate method of determining the damage to the unit, it significantly increased the time required to generate the target description and perform the requisite vulnerability analysis and unit-level capability analysis. In order to increase the efficiency of performing such an analysis without sacrificing accuracy, a sensitivity study of unit capability results to the level of component detailed utilized in the unit-level target description was conducted. Various statistical techniques were utilized to determine importance of including various components and combinations of components to overall evaluation of Corps Main Command Post vulnerability.

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Air Force Satellite Control Network (AFSCN): Automating the 24-Hour Schedule

Satellite range scheduling is a complex problem that involves scheduling satellite supports in which a satellite and a specific remote tracking station are assigned a time window during which they communicate with each other. As the number and complexity of satellite supports continue to increase, more pressure is placed on the current manual system to efficiently generate a schedule. The objective of this research was to develop a methodology that will automate the generation of the initial 24 hour schedule. The goal of the algorithm developed was to schedule as many conflict free supports as possible. A two phased approach was developed to schedule the supports. The first phase scheduled as many low altitude satellite supports as possible, while the second phase scheduled as many additional high altitude satellite supports as possible. For both phases, schedule generation and schedule improvement algorithms were developed. For low altitude satellites, the schedule generation algorithm applied a mixed integer program with a linking procedure, and the schedule improvement algorithm was a two satellite interchange procedure. For medium/high altitude satellites, the schedule generation algorithm was an insertion procedure and the schedule improvement algorithm was a three satellite interchange procedure.

A schedule was generated for six representative data sets with encouraging results. At least 91 percent of all satellite support requests were scheduled for each day. These results were comparable to results of the current range schedulers and a previous automation study. Based on the results reported, the methodology presented in this research effort seems to be a valid approach for automating the initial 24 hour schedule.

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Some OR Models for Constrained Personnel Resources at NSA

This presentation will articulate some recently completed and ongoing operations research modeling efforts applied to help the National Security Agency conduct its business in an environment of severely constrained personnel resources. Efforts to be discussed include: an integer programming model for the efficient scheduling of a security force; a Markov chain model of a civilian promotion program; and a comprehensive civilian pay model to forecast budget requirements as a function of hire, attrition, promotion, and pay schedule change scenarios.

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Text Processing Technologies to Assist SRBM Analysts

DIA is sponsoring a project to help SRBM analysts exploit unformatted textual message traffic more fully. For this purpose, DIA has contracted with BDM Federal, Inc. to develop and implement methodologies designed to increase analysts' capacity to review daily incoming messages and correlate related information from the body of messages which accumulate over time. The project will also integrate the processing of messages with parametric SRBM data which analysts access primarily in hardcopy "Handbooks" at the present time. The resulting *"Analyst's Assistant"* is intended to be a "force multiplier," enabling SRBM analysts to keep pace with the growing volume of message traffic — despite the current resource-constrained environment—by accessing textual and parametric data through more powerful automated tools.

The study approach, and principal processing techniques being developed by BDM, are based on a knowledge engineering methodology designed and prototyped under DARPA's Strategic Computing Program. This methodology provides for rapid development of machine-usable knowledge bases containing a deep

representation of the analyst's domain. The Analyst's Assistant is a knowledge-based application which performs advanced text processing and analysis functions, and is readily extensible to new analyst domains through the use of new knowledge bases (i.e., all domain expertise is contained in the knowledge base, not the software).

The principal functions of the *Analyst's Assistant* are the following:

(1) Text Visualization—A technique for reviewing sources in a module called "Graphical Browser" which depicts the contents of messages, and relationships between messages, in in-depth taxonomical, time-map (temporal), and message cluster graphics.

(2) Data Extraction—A process performed by the Rule-Based Analyzer/Extractor (RBA) module, which identifies and extracts related text fragments—and specific data items—from a collection of sources for research and analysis purposes;

(3) Data Base Generation—The automatic creation of formatted data base records containing specific items of information extracted from message text for storage and retrieval in a relational data base;

(4) Predictive Analysis—The use of a rule base—which integrates the domain taxonomy and time-maps by defining cause-and-effect relationships—in order to automatically identify activity patterns which domain experts normally interpret as indicators of significant developments, events, or milestones.

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Regional Intelligence and Situational Knowledge (RISK) Analysis

In an initial effort leading to a Senior Advisory Group (SAG) briefing, BDM successfully demonstrated the ability to model, analyze, and display significant elements of RISK concerns (situation awareness, intelligence collection and dissemination, C3 integrated with combat operations, etc.) in support of the Battle Command Initiative. In addition, BDM conducted initial analysis of two bounding cases of situation awareness and battle management; comparing a current U.S. capabilities baseline against a "perfect" awareness case. This analysis showed a high potential for improvements to both U.S. intelligence collection and battlefield communications. Preliminary analysis also indicated how the timeliness and resolution of intelligence and communications varied in different tactical phases of engagements involving numerous mission types. Finally, BDM was able to provide a quick assessment of how a Commander's decision-making process could impact on operational outcomes regardless of the quality of intelligence collection and dissemination.

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Methods for Ship Military Effectiveness Analysis

Ship design and technology selections can be based on complete systems analysis results if one is willing to perform military effectiveness. In the past, these selections have been based on ship size and performance analysis alone, but with improved techniques, comprehensive system analysis on ships can be performed. System analysis is most illuminating because it factors in threat, ship size, cost, weaponry, signatures, vulnerability, decoys/jamming, and availability. The purpose of this paper is to explore military effectiveness methodology, develop key relations and show some useful results. The techniques proposed can be used in elaborate computer models for in-depth studies or in simplified linear relations to gain understanding of the interrelation of the variables and result trends.

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US Coast Guard Patrol Boat Mission Analysis Study

This study examined the number of US Coast Guard Patrol Boat (PB) replacements required to meet current and future mission demands. The Coast Guard has major responsibilities in the area of Enforcement of Laws and Treaties (ELT), Alien Migrant Interdiction Operations, Recreational and Commercial Marine Safety, and protection of Marine Sanctuaries. Additionally, the service has significant responsibilities in Search and Rescue (SAR), Marine Environmental Protection/Response, and Military Readiness/Operations. The Coast Guard employs a multi-mission operational philosophy in which, for maximum efficiency, general purpose assets are expected to perform effectively in several mission areas, being subject to changing role emphasis and capable of easy adaptation, system modification/upgrade, accommodation of role-specific equipment, and incorporation of new technologies. The analysis was performed by simulating Coast Guard

operating tactics in key mission areas using the Naval Undersea Warfare Center's engagement simulation model, SIM II. This model provides a means to dynamically assess real-world applications of Coast Guard PB resources in mission-relevant tactical scenarios. The results of these simulations were mapped into a research allocation model programmed in GPSS. This model examined system effectiveness among several Coast Guard boats, taking into consideration availability of boats and priority of missions, and then determining the number of coastal patrol boats required to achieve mission demand levels. Also examined were the trade-offs and sensitivities among resource allocation alternatives under conditions of current capability, future demand projection, and alternative replacement performance.

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Information Warfare in Gaming and Simulation: A Critical Look at MOEs

The demise of the former Soviet Union, and the appearance of its newly crafted, non-threatening posture (or more properly, the self-destruction of many of its military capabilities and deployments) has changed many of the premises upon which military gaming and simulations depended. As the United States military moves forward to consider the nature of future war, one part of that examination includes the whole panoply of issues involved in what is being called "Information Warfare." Information Warfare is essentially maximizing the use of information to provide the commander "situation awareness" in the broadest sense, while simultaneously denying such overview of the battle space to the opponent. Traditionally, the impact of soft factors like "situation awareness," and the attendant means of achieving it and denying it to an enemy have been very difficult to model, and their representation in games and simulations has often relied upon limited human intervention - each could have been a game stopper if pushed very hard.

Nevertheless, with the current attention to information warfare and it elements and potential impacts, all computer gaming and simulation systems and the attendant games constructed using them, as well as most games being done by human players, don't accurately reflect the impacts of information warfare concepts and systems employed by either the United States or potential competitor nations or entities. *Current models/simulations and the like, as well as wargame red teams , are certainly not configured to assure any kind of reliable C2W/information warfare play from an opposition standpoint.* There may be a few areas in which this is done half well, there may be a few people who know what they are doing in games or the like, but there is no systematic consideration of what a true C2W/information warfare red team should look like, nor a set of models to support such a team, nor reliable MOEs to support such modeling and gaming - certainly not in the sense that red teams were finally designed to play the Soviets. If Information Warfare is, or can be, one of the determinants of warfare outcomes, and is possibly an instigator of a revolution in Military Affairs, it is critical that this shortfall be addressed. This paper suggests some criteria to use in developing suitable information warfare MOEs and a technique to improve gaming fidelity.

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The Airbase Bomber Study

Abstract not available.

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A Proposed Approach to Value Added Studies

The goal of the approach was to develop a method to quantify the benefit of items of chemical and biological defensive equipment to the user. The approach identified where in the process benefit analyses are, or should be, performed. It also identified methodologies and measures of effectiveness or performance that are utilized to perform these studies. The approach identified scenarios that may be used for chemical and biological assessments and where required, methodologies and measures to be used in performing the valued added study (benefits analysis).

The author requests participants of Working Group 19 to offer advice and comments directed towards improving the approach that will be presented.

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AFAS Operational Effectiveness Analysis

The advanced Field Artillery System (AFAS) is being promoted as the field artillery system of the future. The fire support capabilities of the AFAS are certainly superior to the capabilities of the currently fielded cannon systems. The AFAS has improved rate of fire, accuracy, mobility, and range. Also, it can fire a TOT of up to 8 rounds from a single gun. VRI is participating in an

analysis to determine whether the capabilities of the AFAS significantly improve the performance and survivability of the combined arms forces deployed into combat. The results of Force-on-Force simulations have been used to assess the impact of the AFAS upon war fighting capability. Throughout the analysis and subsequent briefings, it has been important to display Measures of Effectiveness (MOE) which not only illustrate the improved capability of the cannon but also illustrate the benefit the cannon provides to the other combat forces. Additionally, MOE were selected which show the impact of the cannon system upon deployment, personnel, and other peacetime resources, such as cost, since the impact of a new combat system extends beyond the battlefield.

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An Expert Systems Approach to Test Planning

The Automated Test Planning System (ATPS) is a rule-based expert system designed to aid staffs within the Office of the Secretary of Defense, Department of Defense agencies, and the military services in the test and evaluation planning process. The fielded system provides an intelligent system to aid in the review of Test and Evaluation Master Plans (TEMPs) and in an assessment of T&E program risk. Use of ATPS provides more consistent and higher quality review of TEMPs, reduced training time for inexperienced TEMP reviewers, and the "final exam" for field users to review TEMPs before submitting to Service headquarters and OSD for approval. The ATPS combines highly effective technologies, such as expert systems, hypertext, and editing capabilities, in a seamless environment and presents these capabilities through a friendly user interface that allows the user to focus on the task at hand, rather than on the quirks of a software program.

ATPS generates an Intelligent Checklist for TEMP review. The body of knowledge was developed from representatives of DoD testing organizations, existing paper checklists, and the DoD 5000-series directives and instructions. An intelligent TEMP Advisor was developed to provide the user with detailed information in support of the intelligent checklist. In addition, the ATPS accepts user input (TEMP review comments) and transfers those comments to an ASCII file which can then be read by common word processors for editing into a final report.

The second ATPS module, T&E Program Risk Assessment, was fielded in March 1994. The architecture of this module is also expert-systems-based with an intelligent interview to identify program risk indicators and explain the consequences of the identified risks. As part of the risk assessment, the system leads the user through a review of related requirements, threat, analysis, and test and evaluation documents to ensure the key parameter of each are properly coordinated, so that test results will provide the needed data for subsequent analysis and evaluation.

A third ATPS module, TEMP Build, is now under development and will be described in detail in this presentation. This module, with the help of databases available on TECNET and other resources, will assist the user in developing a TEMP.

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Test & Evaluation for Airborne Missiles
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Summary of Army Instrumentation, Targets, and Threat Simulator (ITTS) Lo ge Planning
Abstract not availab

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Joint Logistics Over the Shore Joint Test Directorate

The Evaluation: The Joint Logistics Over the Shore (JLOTS) Ocean Venture 93 (OV93) field test was perhaps the largest test ever conducted by the Joint Test and Evaluation community. *JLOTS* operations are for the delivery of supplies and equipment to forces in areas where port facilities are inadequate or non existent. OV93 examined the system throughput of cargo and included:

1) seven strategic sealift vessels (3 from the Ready Reserve Force);

2) participation of 62 military units from 4 services (totalling over 5,000 military and civilian;

3) deployment of 71 watercraft and unit equipment;

4) installation of an 810-foot elevated causeway, three 810-foot floating piers, and several miles of roadways;

5) unloading over 800 20 and 40-foot containers from a tactical auxiliary crane ship (T-ACS);

6) the roll off or lift off of over 750 wheeled and tracked vehicles;

7) seven types of lighters transporting cargo over 3.5 miles of open ocean;

8) automatic and manual documentation of all unloaded cargo.

The Technologies: The absolute magnitude of this joint test demanded early and continual planning as well as the incorporation of as many automated data collection and evaluation systems as possible. This multimedia presentation (35*mm* slides, overhead viewgraphs, video, GPS tracking of ships, an animated SLAM computer simulation, and an interactive CD-ROM) will mainly focus on the commercial off the shelf (COTS) technologies that were integrated and employed to collect, process, retrieve/store, analyze, display and report on data available during this evaluation. These technologies included:

1) The real time tracking of over 30 watercraft using the Global Positioning System and digital mapping software for accurate Time Space Position Information (TSPI) data.

2) A 22 station state of the art PC-based LAN was established at the field site to allow simultaneous data base access to test operators, analysts and report writers.

3) A windows compatible *multi* media relational data base was used to store all collected data (scanned documents, photos, video clips, sound bytes, and keyboard data).

4) A fully automated system that scanned and captured 7 separate RF test frequencies, digitized the voice data and stored it for later gisting and analysis.

5) A PC-based SLAM computer simulation was developed to provide post *test alternative* scenario analysis.

6) An interactive multi media CD-ROM is being developed as a legacy and will serve as the encyclopedia for all LOTS data. This is a first for this technology in the T&E community and could be the standard for future archiving and reporting.

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Model Aided Test and Evaluation

A new T&E approach is being developed that utilizes models to aid in the evaluation of test data for more efficient and optimal use of testing resources. The approach focuses on the progressive construction of more credible system models throughout the system life cycle. Model credibility, defined by quantified confidence requirements on important system measures of effectiveness, will be projected to lower level subsystems to determine the types of testing, test sizes, instrumentation characterization, and test processing methodology in the overall test plan. Optimized processing will combine information from first principles with all applicable test data to understand and build high confidence system models. The modeling will ideally be at the fundamental level (parameters independent of test conditions) to optimize (i.e. model-aid) the combination of data from all types of diverse tests.

The resulting models can then be used to predict system performance over operational conditions with high quantified confidence. Traceability of confidence through the model will delineate the critical areas of the system needing the most test resources. Top-down, integrated test planning, coordination, and system evaluation will enable optimum utilization of test assets from all stages of the system life cycle. Concurrent engineering will ensure that testability is built-in from the start and that data from all stages and levels of testing will be applicable and useable. The testing activities will be "bottom-up" with each participant (developer, OT&E, etc.) testing to satisfy its own and the top-down overall system requirements. A simple paradigm example will illustrate some of the new concepts.

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Test Sizing Driven by Performance Requirements Criteria
Abstract not available.

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Test Sizing, Confidence Limits, and Adaptive Testing for Weapon System Reliability

Missile testing programs exist to determine if a decrease in reliability or accuracy has occurred. The testing approach in the CJCS (Chairman, Joint Chiefs of Staff) guidelines is based on statistical methods. The testing guidelines for reliability estimation and change detection are based on confidence intervals and hypothesis testing, which were established in the statistical literature by Neyman and Pearson in 1932.

The statistical framework of the two types of risk is briefly reviewed. Five different approaches and their associated test sizes basesd on classical statistical methods are presented: Fisher's test, one-sample Neyman-Pearson hypothesis testing, two-sample Neyman-Pearson hypothesis testing, sequential testing, and double sampling. Graphs showing the sensitivity of the test sizing to varying the risks and reliability are given.

Several different methods for calculating the confidence limit for weapon system reliability on a series system are presented. A possible "adaptive" testing scheme is proposed which varies the number of missiles to be tested each year based on the previous year's results.

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Pre-Test Modeling of the Javelin Antitank System

The Army conducted an Initial Test and Evaluation (IOTE) of the Javelin Antitank system in the Fall of 1993. Prior to this test, a pre-test modeling analysis of the system was conducted at the Naval Postgraduate School, using the Janus high resolution combat model. An objective of this research was to compare the Javelin with the current system, the Dragon II, using appropriate measures of effectiveness and measures of performance that were identified in the Test Evaluation Plan (TEP).

Additionally, Janus was used to predict the outcome of various IOTE scenarios and hence make a guess as to the adequacy of those scenarios in capturing desired effectiveness/performance data. The data generated from the model were analyzed using graphical and nonparametric statistical techniques. The results highlight the benefits of using high resolution modeling prior to actual operational testing.

A recent Unmanned Aerial Vehicle (UAV)-Global Positioning System (GPS)- Real Time Tracking (RTT) evaluation involved the successful application of a methodology designed to excel in today's test & evaluation environment. During an eight-month program the Defense Evaluation Support Activity (DESA) was able to identify, manage and integrate elements of the T&E environment while providing the operational community better knowledge of the involved systems. Through the use of the UAV-GPS-RTT evaluation, this presentation discusses aspects of today's T&E environment, describes both an organizational structure and methodologies designed to anticipate and overcome environmental limitations, and provides the audience with a practical application of these methodologies.

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Today's Test & Evaluation Environment
Abstract not available.

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Environmental Effects for Distributed Interactive Simulation, Demo 1
Abstract not available.

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Higher Level Evaluations (Task Level OT&E)
Abstract not available.

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Mounted Warfighting Training and Leader Development in Simulation

Department of Defense (DoD) needs to train and synchronize the total force to maximize the synergism of the total force s capability. However, DoD will be unable to train in the future as it has in the past. Environmental concerns, reduced budgets, higher training costs, more complex weapons systems requiring increased land and range requirements for training, will force us to reconsider how we train the total force. Training at the joint level with the integration of coalition forces heretofore executable only on a limited scale may be unexecutable in the future except in simulation.

Given Contingency Missions, the future CATS focuses on the integration of CBT/CS/CSS, Heavy/Light/SOF, Air Force/Navy/USMC and Allies. The simulation plan allows leaders and staffs to identify Courses-of-Action in response to the contingency, develop the METL and train it in the time available, design the correct force structure, train the courses of action, and evaluate units prior to deployment. Therefore, simulation, in the future, not only trains in the traditional sense, it necessarily becomes a combat rehearsal system.

In the future and even now, time and space are the critical limitations on training. In the fourth dimension time and space are overcome - simulation provides additional time to the unit by saving the time required to prepare and move to the field. Further, in simulation STXs can be rerun and modified until the unit attains proficiency. This saves the time required to move the unit back to the start point and the brass on the ground and the ground torn up by acceleration or neutral steer does not give away the point along the course where actions occur. The maturation and miniaturization of our simulation will allow the force to embed the current TADSS capability in the weapons system. This will allow units to train in peace time using the same training devices as they train in war. When reconstituting crews and units, the devices the NCOs and officers used to train their units in peace time will be with the unit in time of war available for training and rehearsals.

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Mission Analysis and Reporting System (MARS)

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CSEAL: An Innovative Development, Test and Evaluation Environment

Abstract not availble.

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Database Development for Computer Simulations Using Test Data as Implemented for the Combat Analysis Sustainability Model

The database development for the Combat Analysis Sustainability Model (CASMO) involved a rigorous process for data collection, data processing, and the maintaining of an audit trail for the data. The effort was conducted by BDM under contract to the US Army Operational Evaluation Command. The audit trail was used to present and defend sources and accuracy of data for use in the simulaltion. The effort used an integrated data processing system, the principles of which are applicable for many simulation database development efforts, particularly when using test data for input.

The Combat Analysis Sustainability Model (CASMO) represents the maintenance, logistics, and transportation operations of the support base for an Army division in peacetime or combat. The model examines sustainability of major ground-based weapon systems in an operational environment. CASMO is driven by an input database which represents combat units, maintenance units, supply depots, mechanics, repair parts, transportation networks, and other factors. The model is written in the SIMSCRIPT II.5 simulation language and runs on a Sun workstation.

As part of the database development effort, BDM developed a top-down dendritic process for selecting repair parts. This process ensured that maintenance actions were represented in the model at the appropriate level of detail, as defined by the system Maintenance Allocation Chart (MAC). BDM completed a parts list for four Army weapon systems:

M1A1 Abrams Tank	692 parts
M109A3 Howitzer	426 parts
M2A2 Bradley Fighting Vehicle	333 parts
M3A2 Cavalry Fighting Vehicle	346 parts

The data were entered into several working databases, organized by the type of data. After entry of data, verification programs were run to ensure the integrity of the data. The final data processing program used the working databases to create a single data set in the format required by the model.

To assist in data validation, BDM developed three techniques that are applicable for test simulation database efforts: an audit trail to identify the source of each data item, a description of the algorithms and methodology used to convert raw data into the required model input, and a "score card" to track the status of data collection and the goodness of the data.

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A Multivariate Permutation Rank Order Test for Network Simulation Validation

Simulation is a widely accepted means of analyzing systems that are too complex to model analytically. Most communications systems fall into this category. But simulation credibility suffers when a continuing verification and validation program is not undertaken, thereby diluting the value of analyses that simulations support. A primary goal of any verification and validation process should be to enhance both the correctness of a simulation and the confidence placed in its results. One challenge is to develop a process that is at the same time feasible and compatible with an organization's needs, and can be applied to both existing simulations as well as new ones. Multivariate methods can be used to test the hypothesis of agreement between simulated predictions and empirical observations. This paper describes a statistical test useful for the validation of simulations of (battlefield) communications networks. The method employs a multivariate nonparametric rank sum test with the aid of a computer-intensive permutation procedure to assess the significance of the defined test statistic. For illustrative purposes, the validation procedure is applied to a simulation that was developed to duplicate a configuration tested in FY91 in which "messages" were passed over a communications network using the combination of the Tactical Fire Direction System (TACFIRE) protocol and Single-Channel Ground and Airborne Radio System (SINCGARS) Combat Net Radios (CNR). The purpose of this research is to strengthen the link between experimentation and simulation, both of which should be utilized in evaluating communications systems' measures of performance.

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The Threat/Intelligence Data Extraction System (TIDES)

Abstract not available.

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Reflections on the Practice of Design of Experiments at Elgin AFB, Florida

For the past three years, Sverdrup has encouraged the use of designed experiments in the diverse test programs ongoing at Eglin. Our Systems Effectiveness Center of Excellence has learned some useful lessons concerning:

- "post-test" design and analysis of data
- the behavior of various classes of response variables,
- the theory and practice of blocking and randomization,
- sequential experimentation and use of developmental data
- educating technical practitioners and
- educating clients

We began our efforts by collecting previous testing data with the goal of reanalyzing it with ANOVA and regression. To our dismay, the patterns of confounding and the lack of explanatory power in the predictors defeated our efforts at demonstrating the improvements in precision and efficiency latent in DOE techniques.

In consulting with a number of test programs, we document the difficulties in using information-poor response variables like proportions instead of the richer physical measurements often available at marginally greater expense and effort. We developed approaches that capture both the usual proportions as well as physical response variables to demonstrate the improved behavior of the linear models and greater process understanding.

In implementing designs, we have encountered a number of roadblocks to randomization that would usually have forced the model into a blocked or cross model. In some cases, we have implemented compromises that, while not strictly random, preserve the intent of preventing systematic bias from background variables.

In a recent EC test, we have been able to use the developmental data to develop appropriate models for

further testing, to include transforming (log and rank) the response variables and selecting combinations of predictors. Furthermore, we gain an estimate of error for selecting sample size and assessing the significance of effects in fractional designs. Finally, we are planning to incorporate DT&E data into our designs to fill in the baseline cells.

We are on our fourth series of technical education courses in DOE, having experimented with University contract courses, inhouse short courses, academic courses and seminars. It appears to us that much of the University classical design material, while important for mathematical statisticians, is unnecessary for practicing testers. We have found that the key to practical design and analysis of experiments is an unshakable foundation in ANOVA, especially the concepts of squared errors and contrasts. And, this material is difficult to transmit via lecture and academic homework, requiring a vested interest in a project of the student's own choosing. Without project experience, we find that students do not properly grasp the art of randomization in execution or the physical interpretation of the statistical results.

Finally, educating our clients in the benefits and limitations of DOE has proved to be a formidable challenge. So much of the test community has little statistical sophistication, and has been performing single-factor-at-a-time experiments with the "golden" 30 trials for so long, that DOE ideas appear to be a criticism of a career's work. Common questions we struggle with include:

- "If this is so good, why haven't I heard of this before?"
- "But we've never done it like that before."
- "Aren't these ideas new and unproven?"
- "Our problem is much too complicated for that!"

We have some success in answering these, and more so recently, as we have solid experience to demonstrate the benefits and pitfalls of DOE in trying to understand the real world through test.

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Standardization of Terms for Air Crew Training Devices: Training Requirements, Fidelity Requirements, and Test & Evaluation Terms

Operational testing of Aircrew Training Devices (ATDs) are conducted by several agencies depending on the stage of development of the ATD. Each test agency will develop a unique test plan, conduct the test, and draft a report tailored to the purpose of the test. This paper discusses the commonality of the different tests and that cooperation between the test agencies can produce efficiency and the ability to correlate test results. This paper secondarily shows how the relationship between training requirements and fidelity requirements should directly influence the evaluation criteria.

Current test agencies responsible for a specific phase of ATD development include: Aeronautical Systems Center - Developmental Test and Evaluation and Acceptance testing; Air Force Operational Test and Evaluation Center (AFOTEC) - Initial Operational Test and Evaluation and Qualification Operational Test and Evaluation; Major Command Test Squadrons - Follow On Test and Evaluation or Simulator Certification.

Elements common to each of the tests include the ATD's training requirements, the system contractor specifications, and the end user. Up till now, each phase of testing has a uniquely developed test plan with no intent of correlating to previous test efforts. Each test used similar sources for test development (e.g. the system training plan), but different evaluation criteria have evolved for each test agency. AFOTEC uses a six-level rating scale where Air Combat Command's test squadron (29 TSS) uses a four-level rating scale. AFOTEC uses a separate fidelity rating to determine the degree the ATD represents the real world system; the 29 TSS primarily tests the specific training requirements for the ATD relative to the mission at the ATD's location (any single training location will not use every one of an ATD's capabilities). Efficiencies for these tests can be realized by allowing the initial test preparation to serve as the model for follow-on tests, by allowing the results from previous tests to serve as the baseline for the performance of the ATD, and by standardizing evaluation criteria to directly reflect the System Training Plan relative to the trainer fidelity required for each training task.

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Virtual Reality – An Air Combat T&E Perspective

The exponential increase in the complexity of modern aircraft and aircraft systems has made it extremely difficult to assess the mission effectiveness of Naval aviation weapons systems against new threats. Flight testing has historically been the primary source of data on the effectiveness of our aircraft and weapons, but flight testing is expensive and limited in the questions it can answer. For this reason, the U.S. Naval Air Warfare Center has embarked on the development of a fully integrated, multi-spectral ground test facility called the Air Combat Environment Test and Evaluation Facility (ACETEF) which is capable of creating a "virtual" test

environment for testing advanced weapon systems. Four primary factors have driven the development of the ACETEF. First is test realism. Flight testing lacks operational realism in that it cannot create the test conditions for determining the operational utility of our weapons systems in the dense threat environment of real combat. Second is security. Flight testing is inherently a public event. Third is cost. Flight testing is expensive and compounded by the added risk of mishaps. And last, the limited combat situations of the past few years have documented the need to evaluate the interoperability of our systems. Navy, Marine, Army, Air Force, and allied forces must be able to communicate and interact. Through the use of a unique combination of simulation and simulation techniques the ACETEF permits man-in-the-loop ground testing of fully integrated aircraft and aircraft systems in a virtual environment that closely parallels actual combat, while remaining secure, safe and cost effective.

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Force Potency Analysis of RTCA Results
Abstract not available.

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Interoperability Testing in the DoD Open Systems Environment

As the Federal Government develops the National Information Infrastructure (NII) and the Department of Defense aligns under the DoD Information Infrastructure (DII) with a major thrust to use Commercial Off the Shelf (COTS) products, an assurance of interoperability is becoming increasingly important. The Joint Interoperability Test Center has defined and implemented a methodology which will provide a level of assurance of interoperability among products conformant to specific International Standards and Profiles while controlling the cost of testing.

The methodology, Department of Defense Open Systems Environment Interoperability Test Methodology (DoD OSITM), is based on testing a conformant product using interoperability tests developed for the Elements of Service specified in applicable International Standards and Profiles. The testing takes place among the products under Test (PUT) and one or more previously DoD OSITM tested products. The methodology also includes automated tools which assist the testing in the area of Static Analysis, Interoperability Test Case Selection, and post test results analysis.

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Data Collection Opportunities for OR Assessment of UGVs.
Abstract not available.

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TTCP Activities on Battlefield Assessment of UGVs
Abstract not available.

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Mobile Detection Assessment Response System
Abstract not available.

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Computer Assisted Teleoperated Vehicle
Abstract not available.

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Design of a Modular Teleoperated and Autonomous UGV Control System
Abstract not available.

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TUGV in the Janus (A) Combat Simulator

The purpose of this paper is to explain the mathematical model of the Tactical Unmanned Ground Vehicle (TUGV) in the Janus (A) Combat Simulator. The TUGV is a ground based wheeled reconnaissance platform, operated from a HMMWV at a range of 10 kilometers and with three sensors (optical, thermal and acoustic). The research effort presented in this paper incorporated a sound sensor capability in the TUGV model. The model was then tested in a series of scenarios, both offensive and defensive, with one of the Measures of Effectiveness being the number of detections. The paper will explain the TUGV prototype, explain the TUGV model by explaining the necessary modeling assumptions and constraints, and report the results of the tests of the TUGV in the scenario environment.

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An Empirically Based Assessment of UAV/UGV Interoperability
Abstract not available.

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Joint Acquisition Analysis: Lessons Learned

The paper focuses on the lessons learned from the conduct of the Close Range Unmanned Aerial Vehicle (CR-UAV) Cost and Operational Effectiveness Analysis (COEA). The CR-UAV COEA has a Marine Corps study director, has modeling and simulations support from the Army and reports to a Navy Oversight Board, Discussion will cover the organizations involved in providing direction and input to the analysis plan, conduct of the analysis, reporting procedures, and product approval. Particular emphasis will be placed on the different procedures used by the various services and agencies involved and how these differences were overcome. Insights into how future efforts should be conducted will be offered.

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Autonomous Lunar/MARS Micro-Rover: "MITy"
Abstract not available.

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The Evolution of the Unmanned Underwater Vehicles
Abstract not available.

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The Unmanned Underwater Vehicles - A Navy Force Multiplier
Abstract not available.

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Unmanned Vehicles Information Analysis Center Feasibility Study
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UAV C3I Measures of Effectiveness

The problem of assessing military systems, and, in particular, C3 systems, depends on our ability to

understand the relationship of system performance to its worth in terms of objectives, and to identify the contribution of decision making support to operational outcomes. In order to assess C3 systems, we must be able to model how likely the decision maker is to recognize the situation, how likely that person is to choose particular cources of action as a result of that recognition and when these events will take place. The problem of assessing system effectiveness is in being able to relate the systems' performance to the Top-Level Warfare Requirements (TLWR). This paper contends that utilities elicited at the system level are only consistent with utilities elicited at the higher level if they are related by the (possibly subjective) model of the causal dependence of the higher level outcomes on the low level attributes. This relationship is not known to have been derived previously and is believed to be a new result. The paper will also address a new perspective on utility functions as conditional probabilities or fuzzy relations on worth vaiables.

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UAV Payload Final Analysis and Execution Plan
Abstract not available.

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UAV Survivability Analysis
Abstract not available.

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UAV Operations Concept Development Using SUPPRESSOR Computer Simulations
Abstract not available.

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A Functional Performance Assessment as Performed within a UAV COEA
Abstract not availble.

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The Airbase Bomber Study

This examined the comparative merits of employing the Joint Direct Attack Munition (JDAM), an accurate guided munition, versus the use of the MK-82 and MK-84 unguided general purpose bombs against an air field target set. JDAM is a guidance unit attached to a standard ballistic warhead (MK-84/BLU-109) which enables the bomb to make midcourse trajectory corrections and autonomously guide the weapon to specific geodetic coordinates. It was expected that this guidance unit would enable a weapon with the ability to be employed under restricted ceiling/visibility conditions without sacrificing weapon accuracy. The airbase consisted of multiple targets of varying hardnesses found, and typically arranged, in common scenarios of the Southwest Asia (SWA) theater of operations. This study was co-chaired by Air Combat Command, Directorate of Conventional Munitions Requirements and AIR-526, Naval Warfare Analysis Division, where the primary concern of the analysis was to determine the comparative effort necessary to "destroy" the airbase. It was postulated that the effectiveness of the JDAM would be particularly beneficial to bombers because they were not originally optimized to be used in the conventional role. The study employed the B-2 Bomber as the principal delivery platform and incorporated the doctrinal employment of these weapon systems in a fixed scenario environment.

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A Bottom-Up Approach to Modeling Mission Effectiveness

This presentation provides an overview of the bottom-up modeling process used in the mission effectiveness analysis for the Navy's portion of the Joint Standoff Weapon (JSOW) Preplanned Product Improvement (P3I) Cost and Operational Effectiveness Analysis (COEA). The foundation of the approach was a scenario consisting of hostile ground based point area defense systems and a variety of targets of interest. Given the threat laydown and location of friendly assets, a combat experienced aviator developed realistic strike plans for attacking each target with the alternative weapons using the resources typically available aboard an aircraft carrier. JMEM methods were used to compute lethality for air launched weaponry against ground targets of interest given the delivery conditions called out in the strike plans. Pks for ground defenses against the attacking airborne vehicles were generated by RADGUNS(AAA) and ESAMS/MECA (SAMS) using the specific trajectories generated by BLUEMAX from the strike plans. Detection ranges for SAMs were derived from ALARM results. These one-on-one results were integrated in SUPPRESSOR with weapon and aircraft characteristics, threat laydown information, and tactics to model the complex interactions among the players for each strike. Mission level results were then derived from Monte Carlo runs of SUPPRESSOR. Rationale for choosing this approach as well as its strengths and weaknesses will be discussed, along with lessons learned. Details of the modeling approach and some helpful tools will be illustrated by examples.

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Test and Analysis Integration in the SADARM MS IIIA COEA

This presentation will be a case study addressing test and analysis integration work done in the SADARM MS IIIA COEA (the first COEA done by TRAC-SAC that formally addressed test and analysis integration). The presentation will begin by addressing: what was done and what was produced (planning, methodology development, model runs, documentation, etc.); why it was done (directives / guidance) and what the expected benefits were; and who did it (users, developers, COEA, and OT analysts). Then the extent to which the expected benefits were realized will be addressed. The presentation will conclude with lessons learned.

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THE COEA CART AND THE ACQUISITION HORSE
An Evaluation of the COEA Impact on Non-Major Program Acquisition and TEMP Traceability

For those of us fortunate to be involved with developing platforms, weapons and combat systems we are well aware of the far reaching thrust of the DOD 5000 series instructions. But no DODI 5000.2-M requirement has garnered more program management attention than has the Cost and Operational Effectiveness Analysis, or COEA for short. Since its debut in 1990, there has been confusion as to why it is required, who is responsible for generating it and who really benefits. Its stated purpose was to aid the Acquisition Executive (AE) select the most cost-effective approach to meeting an operational need. Comments from the non-major program trenches indicate that the COEA has become a major administrative burden on the Program Manager (PM) and of questionable value in its current form.

This paper evaluates two separate, but interrelated issues: the first being the utility of the COEA in directing six non-major Navy programs beyond Milestone I. The second is an assessment of the "traceability" of COEA MOE's down to the Test and Evaluation Master Plan (TEMP) with emphasis on MOE differences. The survey results show that the COEA has limited impact to directing a particular approach for these non-major acquisition programs. It also reinforces the notion that not all COA MOE's are suitable for direct incorporation into the ORD and TEMP. It is recommended that OSD reevaluate the utility of the COEA as it is currently implemented for programs beyond Milestone I and the MOE "traceability" doctrine.

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Unique Aspects of Conducting ACAT Level III and IV COEAs

This briefing provides a prototype method of conducting an Acquisition Category (ACAT) level III or IV Cost and Operational Effectiveness Analysis (COEA). Most regulations governing the conduct of COEAs speak mainly to ACAT level I or II programs with very little verbiage devoted towards how to conduct an ACAT level III or IV COEA. This presentation includes a description of "Level of Effort" used for ACAT III and IV COEAs. It provides suggestions on how much time should be devoted to conducting a particular COEA and an idea of the length of the report. It also provides some basic guidelines for the following questions. What type of COEA is required for a MS I/II or MS I/III and what questions should the analysis answer? Is there a need for a full blown COEA vice some lesser form of analysis? What constitutes a valid reason for requesting a waiver of a COEA? What is the difference in Non-Developmental Items (NDI), Developmental Items, Limited Procurement Urgent (LPU), Material Change (MC), Preplanned Product Improvement (P3I), and O&M Funded programs as they relate to the COEA needs.

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Joint Acquisition Analysis: Lessons Learned

The paper will focus on the lessons learned from the conduct of the Close-Range Unmanned Aerial Vehicle (CR-UAV) Cost and Operational Effectiveness Analysis (COEA). The CR-UAV COEA has a Marine Corps study director, has modeling and simulations support from the Army and reports to a Navy Oversight Board. Discussion will cover the organizations involved in providing direction and input to the analysis plan, conduct of the analysis, reporting procedures, and product approval. Particular emphasis will be placed on the different procedures used by the various services and agencies involved and how these differences were overcome. Insights into how future efforts should be conducted will be offered and tied in with the results from the Joint COEA Working Group recommendations.

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An Approach to Performing Joint COEAs

This presentation discusses issues of general concern relative to the conduct of Joint COEAs. These issues were identified through the initiation of dialogue among those individuals within the separate services who are responsible for COEA policy, procedures, and actions. A Joint COEA, in the context of this presentation, is one for which the JROC has determined that a development system is required and that development will be supported by two or more services. A Joint COEA process is proposed and discussed that addresses the identified issues. The proposed process supports the current established DoD guidance documents and continues to promote COEA product responsibility to the designated Lead Service. The process proposed establishes early coordination procedures among the participating services in order to resolve service differences early in the process and to delineate and assign study and analysis responsibilities.

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"3-Ms" MNS - MOEs - Models

USD(A), DOT&E, and ASD(PA&E) released a memorandum on 9 March 1992 that directed the acquisition community to ensure linkage among all the acquisition documents (MNS, ORD, COEA, TEMP and APB). Since the MNS occurs first, it is the cornerstone for defining concepts and systems that will meet user needs. The things that provide the actual linkage among the documents are the measures of effectiveness (MOEs) that we use in the analyses and include in the documents to measure how well or to what degree we perform the required tasks to fulfill the established mission needs from the MNS. These MOEs are inputs and outputs of the various models we u se in our analyses. These models are as simple as equations on the back of envelopes and as complicated as large computer simulations. This briefing relates the threee Ms (MNS - MOEs - Models) and suggests how this linkage can be accomplished.

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A Methodology for COEA Analyses: MOE Data Reduction and Interpretation

(U) MOE generation and analysis is a critical element of the COEA process. Analysis of complex weapon systems often requires tradeoffs between many conflicting MOEs. Appropriately weighing the merits of each of these MOEs across multiple competing alternatives is the key to successful analysis. This paper details the multivariate methodology developed at the Air Force Studies and Analyses Agency to formalize MOE analyses. The paper presents a rigorous framework using Factor Analysis to identify and eliminate MOE multicollinearity, identify predictor MOEs, determine the true dimensionality of the COEA decision space and interpret key factors which determine the effectiveness of the alternatives. By seeking to uncover the complex relationships within the MOEs, the methodology serves the dual purpose of data reduction and data interpretation. This greatly simplifies the task of displaying complicated data to the decision maker. This paper uses the recent Milstar Polar Adjunct COEA as a case study for proving this methodology by significantly reducing the number of MOEs for consideration while maintaining a high fidelity of representation and reproducibility. The results were readily understood and accepted by senior decision makers and the analysis shed light by illustrating unseen but extremely insightful relationships among key critical MOEs. The results of this analysis illustrate the power and broad applicability of multivariate analysis . Extensions of this form of analysis include IPL generation, POM analysis, weapon system effectiveness and test evaluations, and model/simulation output data reduction.

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Measures of Effectiveness: Quantitative Tool for Decision Making

A method is described by which qualitative judgments are translated into quantitative and traceable measures of effectiveness to provide guidance as to which of several alternatives best fulfills a need. With the defense budget continually shrinking and requirements becoming increasingly acute, decisions which result in system cost overruns and under performance become increasingly less tolerable. More and more, procurements will resemble the manner in which we make personal purchases. No longer will the process be one of determining the requirements and purchasing the system at whatever its cost. In the future, the budget will be more strictly set, and we will compromise cost and performance, purchasing *only as much of the system as our budget will allow.* The method, which is a combination of the Analytical Hierarchy Process and the use of "utility" curves, is illustrated through an example that evaluates many alternatives over several performance, interface, and programmatic parameters. The specific example illustrated concerns the Supersonic Sea Skimming Target program that is in the early stages of the Department of Defense acquisition decision and implementation phase.

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Battlefield Combat Identification System Near Term (BCIS-NT) Cost and Operational Effectiveness Analysis (COEA)

The problem of friendly fire casualties has been documented throughout history. However, during Operation Desert Shield/Storm the number of friendly fire casualties (24 percent) far exceeded the average amount in previous conflicts. As a result of lessons learned in Desert Storm (decreased visibility due to dust/smoke, misidentification of targets, etc.) the Army Chief of Staff directed that a task force be formed to investigate and improve combat identification. A major outcome of this task force was to pursue development of a combat identification device for ground-to-ground and sir-to-ground (rotary wing only) platforms that could be fielded by 1995.

In support of this BCIS-NT program, a General Officer Steering Committee selected a millimeter wave question and answer technology to meet requirements for the combat identification device based on a technology demonstration and analysis performed by the task force.

Subsequently, HQDA, DAMO-FD (study sponsor) required a cost and operational effectiveness analysis (COEA) be conducted to determine if a millimeter wave (MMW) BCIS could reduce fratricide without decreasing combat effectiveness. Five MMW systems were compared in the COEA: three had range resolution around the interrogated target while the remaining two relied solely on interrogating the entire beam width. Both 45 mil and 22 mil beam widths were investigated.

The basic approach to this study was to conduct a technology review, followed by an effectiveness analysis, a cost analysis, and a training impact analysis. The technology review compiled fratricide results from several sources, to include both historical accounts of battles and "simulated fratricide" occurring at the two Army training centers (Fort Irwin, CA and Grafenwohr, GE). Combat effectiveness was determined by using a noninteractive combat simulation (CASTFOREM) to study the effects of the five MMW BCIS on battle outcome. The cost analysis compared the costs of fielding different BCIS variants, and determined the variations in the costs of fielding one of them to one, two, and four divisions, with or without inclusion on rotary wing platforms. The training analysis consisted of a survey of the affected Army schools to determine BCIS impacts on the training subsystem.

The principal results of the study were as follows: any BCIS-NT alternative reduces direct fire fratricide; in a high fratricide situation, BCIS can improve Blue combat effectiveness; non-ranging BCIS variants provide significant protection to the enemy by misidentifying Red vehicles as Blue; and, impact on training is minimal.

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The Characteristics Approach and Multiattribute Evaluation: An Economic Perspective

"The test of maximum effectiveness
for a given budget seems much less likely
to mislead the unwary..."
Hitch & McKean [1965] p.167

In the absence of profit measures, decisions among alternative physical investments are typically based upon measures of effectiveness and costs. The development of reliable effectiveness indicators and the calculation of accurate life cycle costs dominates the literature. However, this paper addresses the decision criterion issue that faces decision makers once effectiveness and cost measures are developed. We examine two popular criteria used to compare alternatives: 1) Effectiveness/Cost ratios, and 2) Weighted Effectiveness-Cost measures. The first approach is based upon an economic optimization formulation, while the second criteria is based upon a pure utility formulation. The two criteria are virtually exclusive in that they do not produce consistent rankings of alternatives. The lesson is that the selection of an appropriate choice criterion depends on proper problem formulation.

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Assessing Cost and Effectiveness Through Force Allocation

To properly evaluate the effectiveness of a force structure composed of dissimilar aircraft, it is necessary to assign aircraft to the missions and targets for which each type of aircraft/weapon system is the most effective. To satisfy this need, the Force Allocation Model (FAM) was developed. It is an expected value model that is based upon a prioritizing algorithm; the highest priority is that combination of aircraft platform and target category that yields the largest target value killed per sortie (TVK), which is defined below:

TVK = (Target Value) x (Expected Kills Per Sortie)

The determination of target value is a subjective procedure that can differ significantly due to such factors as mission objectives and individual opinion. Therefore, one must be careful in assigning these values, keeping in mind the specific scenario and mission objectives, and utilizing a consistent method for target value determination. The expected kills per sortie number applies to one type of aircraft and weapon against a specific target category. Measures of effectiveness obtainable from FAM include target value killed per sortie, cost per sortie, total wartime cost, and conflict duration.

In the model, aircraft are allocated according to the prioritized list of aircraft/target combinations until there are no sorties for that aircraft type available for the day, or all targets of that particular target type have been destroyed. At this point, the number of targets killed, the target value killed, and the sorties flown are tabulated and then the next aircraft/target combination on the list is examined. In addition, the cost associated with each allocation is calculated which includes weapon cost and sortie cost. The program terminates when there are no enemy targets of any target category remaining; the time when this occurs marks the end of the campaign.

This model can be used in a number of ways for cost and effectiveness analyses. Initially, it was developed to determine the contribution of individual aircraft to the total force by analyzing their cost as a percentage of wartime cost and their target value killed relative to other aircraft platforms. However, subsequent projects have involved the effect on top level measures (such as wartime cost and conflict duration) by limiting the available inventory of certain weapons, initiating a surprise attack on the enemy, and evaluating guided weapons against specific targets. In addition, FAM is currently an unclassified model which makes it particularly useful for marketing purposes.

The paper will further illustrate the uses of FAM by providing sample analyses and will describe additional enhancements that will be implemented this year.

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Optimized Cost Benefit Impacts of Ballistic Casualty Reduction Equipment Design Criteria

This paper discusses an evaluative methodology for generating optimal ballistic casualty reduction design criteria to enhance the design of body armor. It allows one to generate a multi-dimensional matrix of casualty reduction data to run a search optima through. These results will provide a basis for maximizing casualty reduction to weight and casualty reduction to life cycle cost ratios over a range of body armor designated range of weights. Multi-criteria techniques using pairwise factor comparisons for relative weighting of factors are used to evaluate optimal design configurations. Sensitivity analysis is then used to emphasize the effects of the more heavily weighted factors.

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Combined Arms Training Strategies (CATS) as a Tool for Analysis

Department of Defense (DoD) needs to train and synchronize the total force to maximize the synergism of the total force's capability. However, DoD will be unable to train in the future as it has in the past. Environmental concerns, reduced budgets, higher training costs, more complex weapons systems requiring increased land and range requirements for training, will force us to reconsider how we train the total force. Training at the joint level with the integration of coalition forces heretofore executable only on a limited scale may be unexecutable in the future except in simulation.

Given Contingency Missions, the future CATS focuses on the integration of CBT/CS/CSS, Heavy/Light/SOF, Air Force/Navy/USMC and Allies. The simulation plan allows leaders and staffs to identify Courses-of-Action in response to the contingency, develop the METL and train it in the time available, design the correct force structure, train the courses of action, and evaluate units prior to deployment. Therefore, simulation, in the future, not only trains in the traditional sense, it necessarily becomes a combat rehearsal system.

In the future and even now, time and space are the critical limitations on training. In the fourth dimension time and space are overcome - simulation provides additional time to the unit by saving the time required to prepare and move to the field. Further, in simulation STXs can be rerun and modified until the unit attains proficiency. This saves the time required to move the unit back to the start point and the brass on the ground and the ground torn up by acceleration or neutral steer does not give away the point along the course where actions occur. The maturation and miniaturization of our simulation will allow the force to embed the current TADSS capability in the weapons system. This will allow units to train in peace time using the same training devices as they train in war. When reconstituting crews and units, the devices the NCOs and officers used to train their units in peace time will be with the unit in time of war available for training and rehearsals.

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The Virtual Interactive Target (VIT): Applications to Cost and Effectiveness Analysis

Distributed Interactive Simulation (DIS) is being touted as "the way DoD will prepare to fight for the next 30 years." (Dr. John J. Hamre, Senate Armed Services Committee Staff, 22 March 1993). DIS brings together, in a real-time virtual battlespace, every conceivable type of participant: simulators of widely varying vintage and levels of fidelity; actual aircraft, ships, vehicles, and

field equipment; and actual or simulated command and control centers. Proposed uses of DIS include training, testing, mission rehearsal, and system acquisition.

In December of 1993, Defense Nuclear Agency (DNA), in conjunction with the National Test Facility (NTF), demonstrated a prototype of a Virtual Interactive Target (VIT) which models realistic conventional weapons effects and target responses using the DIS paradigm. Impressive visualization of these effects is provided on a Silicon Graphics Onyx Workstation. The visualization is of such high quality that it could be used in war-gaming battle damage assessment. Other proposed uses of the VIT include examining operational effectiveness of conventional and unconventional weapons used to attack aircraft shelters and hardened underground targets. This paper proposes an iterative process to use the VIT in COEAs for such weapons systems.

The proposed iterative process is illustrated with a hypothetical case study, as DIS, the VIT, and weapons under consideration are not mature enough to have actually been used in experiments or simulations. Questions concerning whether DIS and the VIT are actually ready to be used as described in the hypothetical case are addressed. What are the advantages and disadvantages of using DIS? How reliable would the results, measures of effectiveness, and COEAs be? These and other issues are examined in the paper.

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Command and Control Vehicle (C2V) Requirements Analysis (Movement and Emplacement Characteristics)

A major deficiency noted from Operation Desert Storm was the inability of the current M577A2 command post to "keep pace" with the tempo of the battle. While this indicates the inadequacy of the current C4I system to apply the efficiencies of enhanced technology and automation, it also reflects upon the mobility capability of the current command posts. In fact, at the onset of the requirement analysis, the principle issue for the C2V was considered to be mobility.

This paper examines the techniques used to determine the threshold and objective values of the mobility parameter and the respective performance for each of five C2V alternatives. As a result of the analysis, mobility was further refined to be comprised of two attributes: the ability to move; and the ability to physically emplace/displace the CP. The methodology linked a TRADOC standard scenario with gaming output of a combat simulation model and the results of a mobility assessment of the C2V alternatives conducted by the Waterways Experimentation Station, Vicksburg, MS. A simple algorithm of tactical decision rules was then used in a map exercise (MAPEX) to integrate the model runs and the mobility analysis within the context of the scenario to explore the threshold and objective values associated with the movement and emplacement characteristics.

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Sensitivity Analysis of Key Performance Parameters for the USMC Medium Lift Alternative

The acquisition of a Medium Lift Alternative is a serious issue for amphibious operations. The MLR will fill a critical role left by the aging CH-46E and CH-53D. Throughout the COEA analysis, questions have arisen as to the need for certain requirements and the cost of achieving them. Specifically, high speed and high load capability were seen as primary requirements for the MLA. However, the need for these requirements has not been adequately demonstrated and the considerable cost of achieving them seen to be prohibitive. While the MLA program progressed through the COEA, OSD PA&E Land Forces division undertook a study to assess the MLA requirements and determine what the impact of these requirements is on the operational capability of the aircraft. The new national strategy could effectively increase the role of the medium lift helicopter in amphibious lift and special operations. The diversity of the role that the MLA plays impacts the modernization requirements in many ways. The specific requirements at issue are the speed, load and range capability. An additional issue is how the mix of heavy and medium lift aircraft affects the mission. The study investigates these requirements with respect to the diverse role set out for the MLA and assesses what the impact of the requirements is on the overall amphibious mission.

WG 23 -- Weapon System Acquisition
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Theater Air Command and Control Simulation Facility (TACCSF)

The Theater Air Command and Control Simulation Facility (TACCSF), located at Kirtland AFB, New Mexico, is the world's largest operator-in-the-loop air defense simulation facility. The facility was developed by the Office of the Secretary of Defense, Air Force, and Army over a 13-year period, at a total cost in excess of $200 million, to address specific air defense and command an control issues.

The facility is a national asset operated by the Air Force, with Army participation, and is a resource available for use by any US or Allied agency. Typical applications which the facility supports include, but are not limited to:

- Development and refinement of new system requirements, concepts, tactics, plans, and procedures
- Systems integration/interoperability
- Planning, scoping, and rehearsing live operations
- Extending the results of live operations into larger scenarios

Air Combat Command (ACC) has designated the TACCSF as the primary operator-in-the-loop simulation facility for theater missile defense (TMD) studies. The Air Force conducted a TMD test at the TACCSF in February 1993 to analyze timelines and accuracy of information flow and launch point determination for attack operations. More complex live-simulated mixed activities are scheduled for FY94. The TACCSF is currently linked to the National Test Facility (NTF) and the Advanced Research Projects Agency (ARPA) WARBREAKER Simulation Facility. Distributed Interactive Simulation (DIS) protocols are used to exchange information between the simulations. The TACCSF will soon be linked to other joint simulations to create the necessary architecture to conduct studies, rehearse live demonstrations and exercises, and train crews in this critical mission area.

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The Virtual Interactive Target (VIT): Applications to Weapon System Acquisition

Abstract not available.

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Joint System Acquisition Analysis: Lessons Learned

The paper will focus on the results of the Joint Cost and Operational Effectiveness (COEA) Working Group. Emphasis will be given to the different methods used by the Services to conduct COEAs and how those differences can be reconciled within a joint COEA. Responsibilities, taskings, and command relationships for joint COEAs will be covered. The paper will discuss procedures for initiating the COEA, approving study plans, and routing and approval of products. Additionally, lessons learned from the conduct of the Close-Range Unmanned Aerial Vehicle (CR-UAV) COEA will be presented. The CR-UAV COEA has a Marine Corps study director, modeling and simulations support from the Army, and reports to a Navy Oversight Board.

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Navy Joint Acquisition Initiative

In September 1992, the CNO Executive Steering Committee (ESC) undertook an initiative to examine the status of Navy Jointness and Interoperability with the other services. They established a Process Action Team (PAT) to develop a strategic vision for the Navy in Joint Acquisition. Ultimately reporting to the CNO, the PAT was comprised of not only OPNAV personnel, but also representatives from the Office of the Secretary of the Navy, the Marine Corps, Navy Systems Commands, the Army, and the Air Force. This paper discusses the results of the PAT. A plan was developed to institutionalize and leverage Joint Acquisition within the Navy and thereby obtain maximum warfighting capability at minimum cost. A force field analysis was utilized to illustrate the major contributors a well as the chief impediments to Joint Acquisition. When implemented, the approach will improve interoperability of systems for increased warfighting capability, reduce acquisition cost through shared RDT&E and production, and allow greater operating and support efficiencies.

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ELAN®: A Quick Reaction Force-on-Force Joint Tool

The current world political situation has shifted the focus from global to theater defense. This redirection, combined with limited funding and time, has heightened the need for quick-reaction force-on-force

combat modeling to support inter/intra service tradeoff analyses needed for weapon systems acquisition. The need for good joint combat force-on-force tools has never been greater. ELAN* is a medium-resolution division level and below Joint Combat model which can be used to analyze all major land, sea and air systems with regard to weapon systems effectiveness, tactical techniques and procedures, and operational or organizational concepts. Its battle box has been expanded from a 20KM x 20KM area to a 100KM x 100KM box to allow for operational force effectiveness views of a theater or corps level fight for the ground and air elements.

DOD's emphasis on joint system acquisition programs requires the conduct of weapons tradeoffs, not just within the Army, but across all the armed services and the functional areas such as air defense, armored system and fire support systems. The need for a joint operational effective combat model exists; ELAN* (STAR #209# Sea Terrain AiR) satisfies this need. ELAN* currently models air-to-air, air-to-ground, ground-to-air, amphibious, naval, and ground maneuver operations. DMA terrain data and AMSAA BRL weapons data are used to model terrain and weapon systems. Within weeks, a scenario can be created to represent any level of threat or evaluate the capabilities of a proposed weapon system tactic, force structure or operational plan. The presentation will address the changing analysis needs for weapon systems acquisition and how ELAN* can support these needs.

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The Air Base Bomber Study

Abstract not available.

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Supporting Acquisition Decisions Through Effective Experimental Design

Weapon Acquisition is a very expensive process, especially in today's cost reduction environment. Techniques must be used to conduct operational testing using a minimum of resources while not sacrificing the adequacy and credibility of the test. A coordinated use of a combat simulation and a design of experiment procedure, the Taguchi method, show promise as an acquisition strategy.

This research focused on the Javelin medium antitank system which just completed operational testing in the fall of 1993 and was intended to give the Project Manager's office information regarding the probable outcome of critical design characteristics prior to the test. Using the Taguchi method, many different design parameters were analyzed at several different levels of performance. The method reduced the number of trials required to obtain a desired level of statistical significance while still obtaining the necessary data for each parameter. Once the required number of trials were identified, the Janus combat model simulated the operational test trials.

Results suggest what weapon parameters are more critical to the specific measures of effectiveness of survivability, lethality, and engagement range. In a broader view, this tandem use of an experimental design technique and a combat simulation can provide acquisition managers insights on critical system parameters prior to actual testing.

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Moving Target Analysis

Abstract not available.

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Value Added Analysis for Army Equipment Modernization

This paper describes the Value Added Analysis methodology which was used as part of the US Army's Planning, Programming, Budgeting and Execution System to assist the Army leadership in evaluating and prioritizing competing weapon system alternatives during the process of building the Army budget. The Value Added Analysis concept uses a family of models to measure an alternative system's contribution to the program using a hierarchical assessment framework. A mathematical optimization model is then used to simultaneously determine an alternative's cost-benefit and to identify an optimal mix of weapon systems for inclusion in the Army budget.

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A Proposed Approach to Value Added Studies
Abstract not available.

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Better is Not Good Enough

Cost and Operational Effectiveness Analyses (COEAs) are performed in support of the Department of Defense (DoD) Acquisition Management Process. They assist DoD decision makers in determining whether a proposed new system should proceed from one acquisition phase to the next. Typically, COEAs show the benefits of a proposed new system over the existing system and produce improved versions of that system. On the other hand, little useful analysis reaches the Office of the Secretary of Defense to support the other two major DoD decision support processes, Requirements Generation, and Planning, Programming, and Budgeting. In particular, oftentimes during a Program Objective Memorandum review or budget review, the development or acquisition of a particular system is stretched or canceled for strictly fiscal reasons. There is no analytical assessment regarding the impact of the changes on the utility of that system and no analytical justification for that system taking the reduction rather than other systems. This paper discusses the need for more and broader analysis to support the three major DoD decision support processes.

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The Value of Air Defense Protection to the Force-on-Force Battle -- Distributed Approach
Abstract not available.

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Combat Indentification-Joint Acquisition Analysis

The joint combat identification program eclipses two major efforts under the auspices of the OSD directed study: the Navy Combat Aircraft Identification (CAI) COEA which addresses air-to-air and ground-to-air combat ID and the battlefield combat identification system (BCIS) which addresses ground-to-ground and air-to-ground combat ID.

As a result of fratricide occurring in Desert Storm, the Army initiated an accelerated program call the BCIS Near-term solution that would field a combat ID device by 1995. Results form the BCIS-NT COEA confirmed the selection of MMW Q&A device with range resolution around the target. Lessons learned from conducting this COEA include: how to develop a scenario that has plausible instances of fratricide, how to determine a realistic fratricide level but still have the ability to analytically assess ID device differences, how to set rules for preventing "unbelievable fratricide" without limiting the use of the scenario, ensuring that the ID device technology and weapon system acquisition system are compatible, determining what factors should be considered when modeling combat ID devices and what human factors should be considered when modeling combat identification.

The last subject of the presentation will be a synopsis of the lessons
learned by the Army in coordinating combat ID efforts with the Navy and the coalition forces.

WG 24 -- Soft Factors in Military Modeling and Analysis
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Mission Essential Task List (METL) Assessment Using A Linguistic Application of Fuzzy Set Theory

The U.S. Army uses *trained*, *requires practice*, and *untrained* to rate the extent to which a unit is proficient in combat tasks. The rating of *untrained* is rarely used because it connotes failure. Hence, proficiency is normally evaluated using the two remaining terms. Since quantitatively assessing training is methodologically difficult and would probably produce measures of questionable validity and precision, a qualitative approach is preferred by the user community. Their current approach is inadequate because it neither offers flexibility nor precision. This thesis proposed a

new rating method based on a linguistic application of fuzzy set theory. A new rating language on which to evaluate the specific doctrinal components of mission readiness was produced. A computer program which demonstrated that the doctrinal components could be systematically integrated to produce a quantitatively determined, yet linguistically expressed overall rating was written and tested. Recommendations for further research were made.

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The Effect of MOPP4 on Crew Performance for the M198 Howitzer

Abstract not available.

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The Etiology of Fratricide Events

Political guidance to the military departments in both the UK and the US, and elsewhere as well, stresses the always desirable objective of keeping one's own casualties to the barest possible minimum, consistent with other military objectives. As hitherto rare military operations associated with peacemaking, peacekeeping, and other humanitarian actions become more likely, concern for one's own casualty levels increases. The Gulf War demonstrates that casualties inflicted by one's own weapons become a subject of great interest when casualties inflicted by the enemy are reduced.

The subject of fratricide (also known as amicicide or friendly fire) is now one of high interest. Fratricide, by any name, is defined as casualties from weapons of one's own or allied forces, when the firing elements assumed they were engaging enemy. The definition excludes accidents occurring when enemy engagement was not contemplated. Study of the subject has been sparse and data are not easily obtained. The incidence is subject to consid4rable debate, partially because sound analysis has not yet been done. Regardless of the levels, however, fratricide has been with armies since armies were created. Technology steps are being taken to reduce the incidence of fratricide. It is unlikely that fratricide will be eliminated by the use of technological devices, some causal factors may be immune to technological "fixes."

A cooperative UK/US study is underway to determine the circumstances surrounding fratricidal events. Data are drawn from the Viet Nam, Gulf, Korean, and Falkland Islands Wars and actions. Data are also being sought from other sources such as the Grenada, Panama and Northern Ireland operations.

A preliminary typology is taken from Shrader, 1982 and consists of: ground-to-ground (direct fire), ground-to-ground (indirect fire), and air-to-ground. A further characterization of the data is drawn from Shrader, 1992 and consists of factors contributing to the event: terrain and climate, visibility, types of operations, size and pace of operations, technology, degree of attention, stress of combat, level of training, discipline and fire control, and coordination. (The latter five factors are judged by Shrader to be direct causes of fratricide.)

Data are primarily individual sets of casualty information consisting of descriptions of the circumstances surrounding the casualty such as tactical situation, terrain, force element, weapons and units involved, weather conditions, time of day, time of year, immediate events leading to the casualty, weapon causing the wound(s), nature of the wound(s), behavior of the soldier following the wounding (self-and witness-reported), and post-wounding data (treatment, evacuation, surgery, recovery, return to duty, or autopsy). Status of the work in progress and preliminary observations will be reported. Comments on approach and data sources will be appreciated.

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Monitoring Medical Signs in the Field

Abstract not available.

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Mounted Warfighting Training and Leader Development in Simulation

Department of Defense (DoD) needs to train and synchronize the total force to maximize the synergism of the total force's capability. However, DoD

will be unable to train in the future as it has in the past. Environmental concerns, reduced budgets, higher training costs, more complex weapons systems requiring increased land and range requirements for training, will force us to reconsider how we train the total force. Training at the joint level with the integration of coalition forces heretofore executable only on a limited scale may be unexecutable in the future except in simulation.

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The Task-Taxon-Task Performance Degradation Methodology: Preliminary Validation Effort
Abstract not available.

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Reserve Component Training Installation Facility Yearly Requirements Study (RCTIFYRS)

The Reserve Component Training Installation Facility Yearly Requirements Study (RCTIFYRS) was charged with the tasks of developing and demonstrating a set of practical and comprehensible tools of sufficient fidelity to evaluate the economic implications of the expansion of currently or potentially available training facilities or the closure of facilities oriented toward support the Army National Guard and Army Reserve peacetime training missions. The heart of the methodology uses a multi-criteria bin packing heuristic to match unit training requirements witht heresources available at potential training locations. The model's quick response time allows the generation of multiple cases, in order to test robustness, and provides for timely responses to questions generated by the Army Staff on training site issues. Supplementing the primary methodology is an assortment of geographically based analysis tools used to determine the availability of training resources to units of the Reserve Component. This analysis was sponsored by the Assistant Deputy Chief of Staff for Operations and Plans.

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Validation of Subject-Matter Expert (SME) Estimates of Task Performance Decrements When Wearing the MOPP 4 Chemical Protective Ensemble
Abstract not available.

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Toward the Deterrence of Aggression: Modeling, Strategies, and Froce Characteristics

The concepts underpinning the deterrence of aggression have changed considerably since the dissolution of the Soviet Union. Supporting the Strategic Deterrence Joint Mission Area Assessment chaired by the Chief of Naval Operations Strategic Submarine Branch (N871), The John Hopkins University/Applied Physics Laboratory performed basic theoretical

development and analytical work expanding the framework of deterrence from "nuclear only" to a broader context. In two Warfare Analysis Laboratory Seminar Exercises (WALEX) the ideas were further explored and refined by representatives from a wide range of organizations, including members of the Chief of Naval Operations staff, the intelligence community, Navy and Marine Corps operational staffs and Joint staffs, and academic and analytical groups. From this work emerged a significantly different perspective on the use of conventional forces to deter a wide spectrum of aggression, from terrorist acts through major regional conflicts. This article presents some of the results of this work, including:

* A new analytical model of an aggressor's decision process;
* A revised definition of deterrence;
* Four strategies for pursuing deterrence objectives;
* A suggested process for selecting the appropriate deterrence strategy;
* Implications of deterrence "failures"; and
* Some commentary on the deterrence utility of forward deployed forces.

WG 25 -- Social Science Methods
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Modeling and Simulation inSupport of Theater Missile Defense Attack Operations
Abstract not available.

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Development of a Time Methodology for Micro Saint Modeling of Visual Displays and Control Consoles
Abstract not available.

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Minuteman III Mate/Demate Operations: A Human Reliability Analysis
Abstract not available.

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Mission Essential Task List (METL) Assessment Using a Linguistic Application of Fuzzy Set Theory

The US Army uses "trained", "requires practice" and "untrained" to rate the extent to which a unit is proficient in combat tasks. The rating of untrained is rarely used because it connotes failure. Hence, proficiency is normally evaluated using the two remaining rating terms. Since quantitatively assessing training is methodologically difficult and would probably produce measures of questionable validity and precision, a qualitative approach is preferred by the user community. Their current approach is inadequate because it neither offers flexibility nor precision. This paper proposes a new rating method based on a linguistic application of fuzzy set theory. A new rating language on which to evaluate the specific doctrinal compor of mission readiness was produced. A computer program which demonstrated that the doctrinal components could be systematically integrated to produce a quantitatively determined, yet linguistically expressed, overall rating was written and tested. Recommendations for further research are made.

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A Cognitive Engineering Methodology for Interface Design
Abstract not available.

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A Methodology for COEA Analysis: MOE Data Reduction and Interpretation
Abstract not available.

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Judging Statistical Significance Graphical Methods vs Traditional Parametric Methods

An article published by Dunlap and May in the *Bulletin of the Psychonomic Society* suggested that one use standard error bars based on three times the standard error to graphically infer significance as long as the sample size per mean is nine or more. Differences in population means are inferred when standard error bars do not touch or overlap. When sample variances are unequal, the article also suggested using the largest standard error as the conservative unit of measurement. This effort investigates the validity of these recommendations for various sample sizes, variances, and population mean differences. The results are based on 250 simulations that were used to compare traditional parametric methods (t and F tests) and the graphical method. The findings reflect that fir various cases the graphical method is extremely conservative. The probability of a researcher not being able to detect true treatment differences is much greater for the graphical method.

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A Comparative Analysis of Eye Fixations During Day and Night Low-Level Flight With US Army Aviators
Abstract not available.

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Nearshore Oceanographic Forecasting During Logistics Over the Shore Operations

Amphibious landings and Logistics Over the Shore (LOTS) operations require accurate wave information. Selection of a LOTS site requires that historical wave data, usually available only by hindcast, be used to chose the most favorable time and location. During the LOTS operation, the Commander In Chief (CINC) requires accurate forecasts of waves, water levels and currents in order to optimize the selection of lighterage vessels and to maximize the throughput of supplies within the environmental constraints. Engineers at the US Army Engineer Waterways Experiment Station (WES), Coastal Engineering Research Center (CERC) have developed a real-time system that may be used by the CINC to forecast the above environmental factors using a small computer in the field. The present system, demonstrated on a work station, but targeted for a high end personal computer, accesses weather forecasts from the Fleet Numerical Oceanographic Center (FNOC) and calculates waves at the site of interest using a second generation spectral wave model. Waves are propagated to the site using an appropriate refraction/diffraction model over the nearshore bathymetry. Water levels and currents are calculated using a finite element ADvanced CIRCulation model (ADCIRC). The calculations are updated every 12 hours to provide a continuous 72 hour forecast of local ocean conditions. Graphical User Interfaces (GUIs) have been designed to ease the application of the technology for the field personnel.

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Tactical Wheeled Vehicles of the 24th ID Used in Operation Desert Storm

A basic problem for logisticians and Army planners is to determine what and how much equipment is needed to do a wartime mission. Prior to Operation Desert Storm (ODS), wartime equipment requirements were based on field exercises and National Training Center experience. Actual usage in ODS was significanylt different than predicted usage. The best way to collect this type of information is to send data collectors out with the unit-which was not done during ODS. We did the next best thing-collect information from units once they returned to the US.

We established several projects to collect mileage, deployment times, maintenance and logistics data. The project we wish to discuss is our effort to "reconstitute" the maintenance and readiness history of a division based on actual records. This division was the only one to bring back sufficient records and is the actual wartime collection of data on wheeled vehicles.

We will also discuss preliminary findings from other similar efforts (such as the special data collection on vehicles sent to ODS, Kuwait, and Somalia).

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Finding an Optimal Stationing Policy for the US Army in Europe After the Force Drawdown

With the continuing reduction of forces in Europe, it is apparent that the base support structure cannot be maintained at the current levels. The purpose of this effort is to develop a methodology to assign US Army units remaining in Europe to installations in an economical manner, and to make recommendations regarding which installations are candidates for deactivation and closure. A mixed integer programming model has been formulated which minimizes annual costs subject to constraints on required resources, one-time implementation costs, unit proximity, and support requirements. The model can be used to provide decision makers with insights regarding resource utilization and shortfalls and costs of implementing various stationing plan alternatives. Model development and data collection issues are discussed.

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RSD Banding for Effectiveness

Air Force Materiel Command's Vision IV Conference (Spring of 1993) voiced concerns about how to best allocate limited Air Force obligation authority for RSD (Repairable Spares) procurement. A priority system was established by HQ AFMC that created bands of priority for all Air Force Weapon Systems. The weapon systems were placed in bands based upon precedence ratings that addressed mission essentiality. The Air Force possesses a data base of repairable requirements and projected needs (D041). In order to calculate the "buy" (items that must be bought for future needs), an analysis tool was needed to spread the limited funding. That analysis tool became known as exponential banding.

The exponential banding approach spread limited funds so that weapon systems in the higher priority bands get closer to their target requirements than those in lower priority bands. The algorithm takes the sum of the requirements multiplied by the priority factor (the factor is percent raised to an exponent similar to a power series) and sets those values equal to the funding.

The next step that evolved was to further analyze the aircraft systems by using a current analysis tool that measured aircraft availability modified to incorporate the priority bands. Using this method, Aircraft effectiveness was optimized with limited funds.

The two methods establish a framework for future computations with limited funding authority. The basic philosophy is to establish a priority system and allocate funding which best optimizes effectiveness with respect to stated priorities. This paper describes some history, some mathematics, and a lot of work which has culminated in the US Air Force implementation of RSD Banding for Effectiveness.

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A Chance Contrained Multiperiod Model for Base Level Consumable Inventory Control

This paper discusses development of a chance constrained program for multi-item, multi-period inventory control for consumable items at each base-level supply store. The probability of filling customer requisitions is maximized while observing constraints on: 1) the dollars invested in the inventory, 2) minimum probability of filling requisitions for high-priority items, and 3) meeting previously unfilled demands on high priority items as quickly as possible.

The chance constrained program developed yields decision rules expressing the quantities of each item to order at each period. An equivalent deterministic convex program is developed and tested with real data.

Using simulations, the performance of this chance constrained model is compared to the current Air Force system (SBSS) and the iterative procedure proposed by E. Gardner in 1979.

This research has been partially funded by the Air Force Logistics Management Agency.

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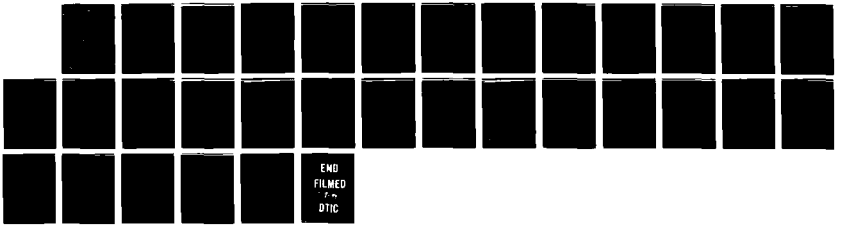

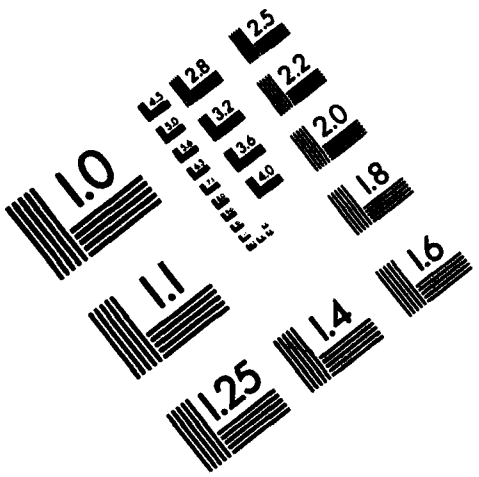

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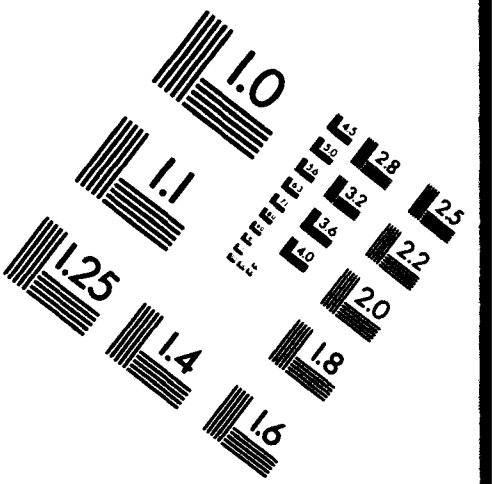

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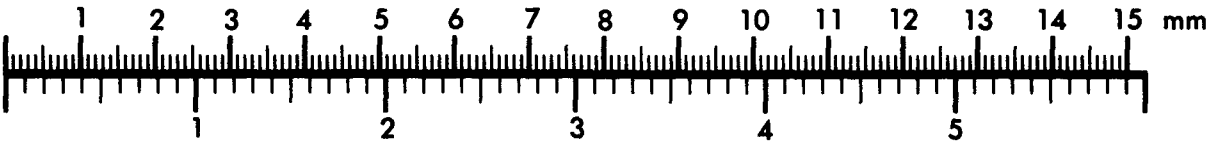

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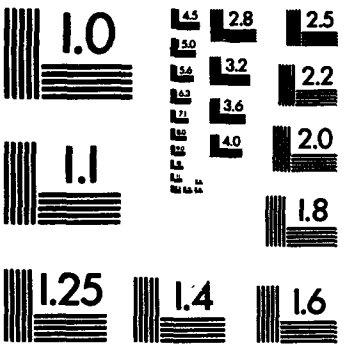

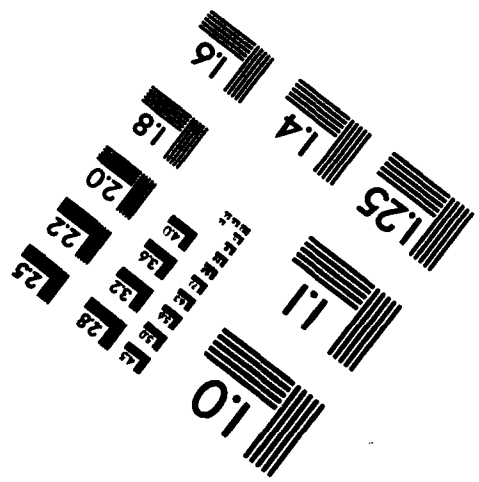

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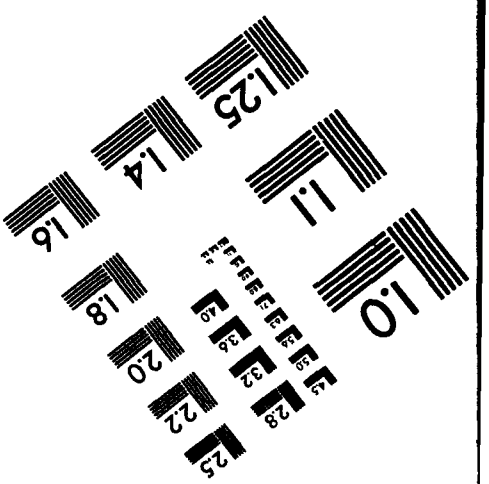

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Constrained Funding for Depot Level Reparables

The Air Force is currently developing aircraft availability based methods to allocate constrained funding for aircraft reparable components. The Aircraft Availability Model (AAM) produces curves of cost against availability that minimize cost for a given availability target or maximize availability for a given cost. The AAM uses a marginal analysis technique to buy items in sequence on the basis of greatest increase in availability per dollar. The Logistics Management Institute invented the Aircraft Availability Model, during the mid-70s, in part, to solve constrained funding problems. There are problems that arise in the implementation of this concept. These include: trading-off effectiveness versus cost among many weapon systems (the standard method only does trade-offs within a weapon system); treatment of non-demand based requirements that may be important, but provide minimal contribution to aircraft availability. The Air Force is addressing those problems by setting targets based on priority bands developed by operation planners and assessing the requirement giving priority to demand-based requirements.

We found that prioritizing weapon systems by groups has value. We also found that allocating funding based upon availability targets (as opposed to funding targets) improves effectiveness.

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Derivation and Validation of Class IV Supply Planning Factors

The Class IV supply category includes fortification materials, obstacle and barrier materials, and construction materials for base development and general engineering. It is a diverse category, ranging from sandbags and lumber for fighting positions to concrete, wire, gravel, steel, plywood, pipe, nails, and other materials used to build the infrastructure required to support military operations. Access to a quick, reliable estimate of the Class IV supply tonnage requirements for a given contingency is crucial to high-level military planning and analysis.

The current method for computing such an estimate requires a single planning factor, a consumption rate expressed in pounds per person per day. Deriving this type of planning factor is not straightforward. The supply requirement itself varies considerably from one contingency to another and depends on a great many factors. We present the results of our current TRADOC-sponsored effort to develop and validate a method for computing contingency-specific Class IV planning factors dependent on a given set of generally known conditions.

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Economic Retention/Returns in DLA and Impacts Acrorss DoD

DoDI 4100.37, Retention and Transfer of Materiel Assets, specifies policies for the retention and transfer of materiel assets. The economic retention limit specifies the amount of stock that should be retained to meet future peacetime demand for purely economic reasons.

This analysis uses a break-even equation to determine the maximum amount of stock that should be retained for economic reasons. The equation balances the two alternatives available: (1) to incur the cost to hold the stock until it is used or (2) to dispose of the stock and take the chance that it may need to be reprocured to meet future demand. The same analysis is performed for the returns limit, except that the expected cost to hold is increased by the cost to return the item to the wholesale depot. Adoption of the Economic Retention Limits (ERL) model developed under this project would effectively reduce the dollar value of on-hand inventory assets for hardware and medical items by approximately $1.9 billion. Further, this ERL model would reduce Agency operating cost by $86 million (FY 93 net present value over the 25 year planning horizon).

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Flexible Computer Integrated Manufacturing Decision Support Sytstem

The Flexible Computer Integrated Manufacturing (FCIM) Decision Support System (DSS) is an automated program which evaluates the cost of conventional resupply versus FCIM procurement. The model accepts quantity, price and leadtime breaks offered by one or more vendors and computes the Total Relevant

Cost (TRC) associated with each proposed procurement. Input consists of current inventory levels, item data, parameter data, and vendor data for each item. For each vendor supplied price and leadtime, inventory levels are calculated and an optimum quantity is selected based on minimum costs. Depending on input parameters and constraints, the model selects the computed quantity, the vendor quantity, or constrained quantity and calculates the TRC associated with the final selection. As an evaluation option, the model will recalculate levels but retain the user supplied quantity as the final order quantity. The model also has a sensitivity analysis option which provides trade off estimates between price and leadtime.

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The Palletized Load System (PLS): An Analysis of PLS Cost Effective Uses

The Palletized Load System consists of a truck, trailer, and series of specialized flat racks or "sideless containers" which significantly reduces the handling of supplies and equipment which are loaded and transported by the system. As a result of this more efficient handling, the number of trucks required to haul the same amount of supplies is also reduced. A single driver, using the hydraulic system and hook built into the truck, can lift a PLS flat rack onto the bed of the truck or trailer in a matter of minutes. Other forms of loading require the use of material handling equipment (MHE) and additional personnel to perform the same mission in a much greater length of time. In prior analyses, PLS was shown cost effective for the distribution of ammunition from the corps storage area forward and is currently being procured for that mission. The British version of the PLS was successfully used for the delivery of water and bulk petroleum in Saudi Arabia during the Gulf War. The primary purpose of this analysis was to determine if there are other applications for PLS, in addition to the distribution of ammunition, which are cost effective and should be considered for future United States Army use. Other applications of PLS which are effective include: Deployable medical systems (DEPMEDS) equipped hospitals; engineer bridge units; and aviation intermediate maintenance units (AVIMs). This paper provides some background information on the development of the study and the final approved results.

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Simulation of Inland Waterways Traffic Systems as a Line of Communication Component in OCONUS Sustainment Operations

Sophisticated logistics models have been developed to simulate and evaluate logistics and sustainment capabilities. One component has not been adequately included in the overall transportation system - use of the available inland waterways. In some geographic areas, especially underdeveloped or developing countries, a river system may provide the best possible transportation link for at least a portion of the supply link between the theater supply port and the forward troop location. As a part of the US transportation system, inland waterways have demonstrated their value to moving large volumes of material economically, safely, and reliably.

The Corps of Engineers has been using event simulation modeling of inland waterways systems for about twenty years in the planning, design, development and operation of the Western River waterway system. Using a model of the waterway and accounting for seasonal flows, channel restrictions, locks and dams, bridges, and expected travel times, the generated tow or ship movements are then simulated with an event simulation model to determine the ability of the transportation system to process the traffic.

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Supply Usage Requirements Estimator (SURE) Program

The SURE is a microcomputer planning tool developed for use by logistics planners at all levels. Constructed as a template on the popular LOTUS 1-2-3 commercial software, the SURE quickly determines operational ammunition, bulk petroleum, and population based supply requirements. The SURE is menu-driven and contains loading and usage instructions oriented toward the inexperienced computer user.

The SURE provides the user with the capability to develop task forces and save them for future use in the program. It also allows the user to make adjustments to unit equipment quantities to reflect actual MTOE quantities. The databases include nearly 1000 Standard Requirements Codes (SRC) taken from the 99 SAMAS file. The daily requirements for a single unit or a

multi-unit task force are calculated using consumption rates, combat postures/geographic usage profiles, and SRC equipment densities.

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Budget and Readiness (BAR) II Model

Budget and Readiness II (BAR II) is a personal computer program which models the Navy Supply System from the point of view of OPNAVINST 4441.12B. Bar II computes Average Customer Wait Time (ACWT) from values of fill rates and average response times at each of three echelons: Consumer, Intermediate, and Wholesale. System Material Availability (SMA) is calculated from fill rates at the Intermediate and Wholesale echelons. BAR II relates the spares budget at an echelon to the resulting fill rate here. The program models the effects of changing budgets on resulting fill rates, or of changing fill rates on resulting budgets. For example, BAR II tells us how much to increase the wholesale budget to maintain the present ACWT value when the intermediate level fill rate is reduced by a given amount. Moreover, the BAR II user can combine groups of saved screens such as the screens for subsystems of a weapon system, and arrive at weapon system values of ACWT, SMA, Fill Rates, and Budgets. Also, by providing values of system Mean Supply Response Time and of Mean Time to Repair to bAR II, the user can obtain system Operations Availability, Ao.

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Logistical Analysis of the Loss of the LST from the Amphibious Fleet

This analysis discusses the impact on the ship to shore logistics capabilities of an Amphibious Task Force (ATF) resulting from the retirement of the LST (Tank Landing Ship). Specifically, this study focuses on the loss of the capability to conduct bulk ship to shore transfer of fuel via the Amphibious Assault Bulk Fuel System (AABFS).

The main goal of this analysis is to determine if a gap exists in the ATF's ability to provide adequate refueling support to the Marine Expeditionary Brigade (MEB) forces operating ashore.

An analysis of the daily fuel requirements of a MEB sized ATF are discussed along with various alternative logistical methods for supporting these forces ashore over a 30 day period. Included in these methods are the use of assets currently on hand in the operating forces as well as proposed methods for adapting commercial equipment for military use. Hypothetical scenarios are used to illustrate the various bulk ship to shore fuel transfer alternatives.

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Intergrated Family of Test Equipment (IFTE) Electro-Optical (EO) Program Systems Analysis

The Army is relying increasingly on complex electronic and EO weapon systems. Maintenance of these complex systems is a key factor in their system availability. Although there appear to be a number of alternative approaches which would adequately maintain the EO sub-systems, the approaches vary in required resources. This analysis will determine whether the Army's preferred approach, using general purpose ATE for EO systems, is cost-justified compared to other alternatives.

Exploring New Manpower Sources: The Army's Challenge of the 90's

TRAC-LEE developed and executed a methodology to analyze civilian training options to Army training. The Light Wheeled Vehicle Mechanic is the subject Military Occupational Specialty (MOS) for the analysis. This paper presents the results of the 63B10 VOTEC Pilot Study. The study determined: (1) the Army's ability to gain civilian trained mechanics from Vocational/Technical (VOTEC) institutions, (2) the effectiveness of changes to current Army training programs and, (3) the VOTEC soldier's success at their unit.

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Assessing the Performance of Electronic Maintainers: The Critical Nee for Closed-Loop Maintenance Data Collection Systems

Failures in electronic components are frequently difficult to detect due to the often intermittent

nature of the failures. In fact, many electronic component failures are only revealed under the stresses and conditions of the operational environment. This paper specifically focuses on the problems of getting sound measurements of diagnostic accuracy for individual electronic maintainers but most of the data collection issues raised are basic logistics issues associated with component tracking through the logistics system.

This paper explores the requirements for upgraded (i.e. closed-loop) data collection systems, the capabilities and status of currently available data systems, and practical problems that may be encountered in attempting to integrate information from a personnel database with information from a logistics (maintenance) database.

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The Multiple Year Package Buy System: An Automated Acquisition System to Generate Solicitation Packages of Spare Parts Based on Expert Rules and the Top Down Packaging Methodology

The objective of the Multiple Year Package Buy (MYPB) System is to provide a tool to assist in the grouping of spare parts (National Stock Numbers - NSN's), into solicitation packages composed of items which all have similar manufacturing requirements. By packaging NSN's from the same manufacturing grouping into one solicitation package, a significant amount of Procurement Administrative Lead Time for solicitation package preparation is eliminated. This reduction in lead time decreases the amount of inventory which must be held to achieve readiness objectives and therefore reduces acquisition costs. On 14 Major Systems at CECOM (Communications and Electronics Command), a Major Subordinate Command of the U.S. Army, it was determined that $28 million could be saved on reduced safety level inventory if the approach recommended in this paper is implemented. While the methodology of this paper is presently applied within a Weapon System, there is no reason why the program cannot examine every part within every weapon system simultaneously and develop solicitation packages for multiple Weapon Systems. There is also the potential of cutting across service lines to develop DOD wide solicitation packages, as well. The potential savings increase with the elimination of each boundary.

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Power Projection Logistics Advanced Technology Demonstration

The Gulf War was an example of power projection. Logistics underwrote the evolving deployment, operational execution, sustainment of the force and re-deployment upon completion of the mission. Logistical simulation must help in planning and execution. Using a four screen/module approach commanders can "see" what is needed for deployment, sustainment and operational execution. By use of object oriented, distributed interactive data bases, materiel and units needed for force projection can be graphically portrayed so the operation and logistical commander can "see" the logistical needs of the force to be employed. Total visibility of materiel from "factory to foxhole" by use of "smart tags" will insure knowing what is where and when it is to arrive. Use of "smart" maps will show what is on the ground, air, or sea. Use of advanced distributed simulation technology will link data bases for collaborative joint planning and execution. In short, the vision of this simulation is to be the command and control system for logistical commanders at strategic, operational and tactical level.

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The Integrated Maintenance Information System (IMIS): Benefits and Costs of Incremental Capabilities

The Air Force's Armstrong Laboratory is developing IMIS technology as an Advanced Technology Transition Demonstration. IMIS could give flight line maintenance personnel several important new capabilities. They include inter- active electronic technical manuals, connectivity with maintenance data systems, dynamic diagnostic aiding, and remote parts ordering. Which of the feasible mixes of these capabilities would provide the largest net benefit? The paper addresses this issue for the Air Force's F-16's. It provides estimates of the incremental benefits and costs of each capability.

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A Fresh Look at Materiel Management Integration or How Wholesale and Retail Stockage Decisions Impact the DoD Mission

Support to the field at the retail level from DOD's extensive wholesale CONUS-based system has always had an impact on the mission. However, in recent years, as the DOD community continues to downsize (sometimes referred to as "rightsize"), decisions made at the wholesale level have taken on a greater significance. This is due to a number of factors related to consolidation.

This paper will look at a recently completed DLA project that has focused on the Navy-DLA interface to this problem. This effort represents the first time in the history of DLA that the retail and wholesale systems have been "wickered" together. Since findings related to this project are having a major impact on Agency decisions related to materiel positioning, the trend to combine retail and wholesale requirements in order to make "smart" operational decisions has taken on a major role. This has resulted in an Agency pushy to acquire Service historical data to facilitate materiel positioning decisions.

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The Effect of Administrative Logistic Downtime on the Operational Availability of Weapon Systems

The Reliability Working Group (RWG) of the Joint Munitions Effectiveness Manual/Surface to Surface (JMEM/SS) is charged with providing reliability (MTBF) and maintainability estimates to the Methodology Evaluation Working Group (MEWG). Operational Availability (Ao) is a top-level parameter that ties the above two parameters together along with estimates of the downtime which includes Mean Time to Repair (MTTR) and Administrative Logistics Down- time (ALDT). It has been shown that ALDT comprises 90 percent of the down- time and is thus a major contributor to total downtime. Ao is driven by down- time. Under some conditions, ALDT, a component of downtime, becomes a major driver of Ao. This paper hopes to stimulate interest in ALDT on the part of the Army and Navy, provide information to understand ALDT and, eventually, to result in the assignment of areas of responsibility to manage ALDT.

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Emerging Improvements to Logistics Representions Within Military Modeling and Simulation Through Use of Physics of Failure Concepts

The reliability aspects of logistics representations embedded within military Modeling and Simulation (M&S) are understandably constrained by the reliability technology used. Physics-of-failure methodology, an emerging reliability technology, is an approach to design, reliability assessment, testing, screening, and stress margins that utilizes knowledge of root-cause failure mechanisms to prevent product failures through robust design and manufacturing practices. This approach proactively incorporates reliability in the design process by establishing a scientific basis for evaluating new materials, structures, and electronic technologies. While the physics-of- failure approach is primarily focused on encouraging innovative, cost-effective design through the use of realistic reliability assessment, a variety of other applications which require reliability assessment information, including the logistics representations within military M&S, can also benefit. Since the physics-of-failure approach represents a leap forward in reliability technology for electronics, an associated improvement in military M&S will develop as the new reliability technology is utilized.

Application of physics-of-failure concepts to the reliability of Army electronics is currently underway within the Army's Electronic Equipment Physics-of-Failure (EEPOF) Project. Two EEPOF efforts being sponsored by the Defense Modeling and Simulation Office pertain to the military M&S. Presented in this paper, is an overview of the physics-of-failure approach to electronics reliability, a conceptual discussion of the potential impact on military M&S, and an overview of current EEPOF M&S efforts.

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Specialized Repair Authorization in the US Army

The U.S. Army allows units to request repair of depot-level reparables in the field. This paper discusses a methodology and procedures to determine when field repair should be allowed. The decision process includes both economic and non-economic criteria. The results of a pilot test based on the methodology are also presented.

WG 27 -- Manpower and Personnel

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Abstracts not available.

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Designing a New Distribution System for US Navy
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How Successful are Lateral Occupational Specialty Moves
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ONTRAC: Predicting Officer Endstrength
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Serving Her Country: An Analysis of Women's Enlistment
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Women in the Marine Officer Corps
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Resource Predictive Modelling

Military operations research has traditionally focused on predicting the implications of alternative decisions in terms of materiel and forces. Predicting materiel and force requirements is challenging, interesting work, and a significant step in the direction of having the right materiel and forces when you need them. Having the right materiel and forces when you need them requires the appropriation of dollars from Congress with adequate lead time to acquire the materiel and train the forces.

Operations research can make significant contributions to improving financial resource decisions and securing the necessary resources. Financial decisions involve the Programming and Budgeting for some two to seven years in the future, and Budget Execution over the next twelve months. The Programming and Budgeting decisions are made in the context of cyclical events, i.e., the submission of the services' POMs and Budgets.

The Programming and Budgeting processes involve the integration of everything that a service plans on doing, the summarization of plans, and the relating of everything planned into dollars. Since the dollars are never adequate to support everything, decisions need to be made about what gets funded, partially funded, temporarily unfunded or terminated. A decision in any area may well have implications on other areas and across years. The decision processes is iterative and the time between iterations decreases as one approaches the seminal event.

This is the problem space for financial resource predictive models -- an area ripe for information systems to improve the efficiency of data exchanges and analytic models to improve the effectiveness of decisions. This paper will focus on the characteristics of practical, resource-predictive, decision support tools and the role of the operations research analyst.

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Approximating the Effects of Changes in the Business Base

The effects of changes in the business base are often ignored in estimating the costs of large development and production programs. However, these effects may be significant, not just for the program being changed, but also for other programs produced by the same contractors. Indeed, these effects are increasingly important with the dramatic reductions occurring in the defense budget. Assessing the effects of changes in the scope of programs is substantially complicated by the pattern of inter-locking subcontracted arrangements, which cause the business base effects to ripple throughout the defense industrial base. This paper presents a coarse method for approximating the implications of program scale changes on both prime and major subcontractors that is relatively easy to apply. The method begins with budget profiles which form a *base case* for the programs of interest and for the other programs in the industrial sector. From the *base case*, the contractors' revenues, direct costs and fixed overhead are estimated. The costs of a proposed plan, which varies the scope of the programs, is estimated with the fixed costs from the *base case*. The programs' revised direct costs are determined, and the fixed overhead for each firm is reallocated among that firm's programs. Empirical data for the satellite industry is presented and used to estimate the model parameters.

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The Rayleigh Model Applied Research and Development (R&D) Cost

This presentation reviews several studies that indicate the appropriateness of the Rayleigh model for modeling weapon system Research and Development (R&D) expenditures. An application of the Rayleigh model for determining a budget profile for an Engineering, Development, and Manufacturing (EMD) from a point estimate of the total R&D costs is discussed. Finally, the usefulness of the Rayleigh model to track on-going R&D expenditures and to estimate the likely final R&D cost is presented.

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A New Multiplicative Error Regression Technique

A new Multiplicative Unbiased Regression Technique (MURT) has been developed to model multiplicative error in least squares regressions. Multiplicative error is an appropriate assumption when

modeling systems in which the dependent random variable ranges over more than order of magnitude and errors in the dependent variable are believed to be proportional to the level of the variable. Previous methods to model multiplicative error have usually depended on log-transforms, either log-linear regressions or non-linear regressions of the log transformed dependent variable. Unfortunately log-transforms involve transformation bias such that the unit space equation is not unbiased. MURT involves an iterative, weighted least squares regression that is shown to provide unbiased regression results while modeling a multiplicative error. This represents a significant addition to the regression tool box for cost and systems analysts.

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Object Oriented Analysis

In today's changing defense environment, it is imperative to husband the limited resources available to support mission needs. Although predictive models and decision support systems can accurately support fact based decisions, the underlying assumptions of these systems must be reviewed.

In order to prepare for a future that supports readiness while lowering costs, DoD must relook and restructure its current processes and business practices. A common sense, easily understood architecture must be created that supports the core capabilities of DoD and that ferrets out non-value added functions and outmoded regulations. Then the resource systems must be redesigned to provide cost effective, readiness sustaining support.

Object-oriented (0-0) analysis supports identification of mission, requirements, and cross functional processes. 0-0 provides a shared understanding of real-world objects/entities, their behaviors, and their interaction in support of meeting DoD objectives. Most important by using an object-oriented approach, all of the processes and activities can be integrated. The result is that the effects of change within one area upon other areas can be determined. Because of its reuse capability, 0-0 supports rapid modeling and reduces time spent "re-inventing" what already exists.

Object-oriented analysis of business practices will support the development of processes that support necessary requirements and streamline the requirements determination process while also supporting defendable costs. By using a front-end object-oriented analysis with periodic re-baselining, the predictive and decision support models needed to forecast and monitor the resources of the DoD will be more accurate and the information they produce more defendable.

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Findings an Optimal Stationing Policy for the U.S. Army In Europe After the Force Drawdown

With the continuing reduction of forces in Europe, it is apparent that the base support structure cannot be maintained at the current levels. The purpose of this effort was to develop a methodology to assign U.S. Army units remaining in Europe to installations in an economical manner, and to make recommendations regarding which installations are candidates for deactivation and closure. A mixed integer programming model has been formulated which minimizes annual costs subject to constraints on required resources, one-time implementation costs, and unit proximity. The model can be used to provide decision makers with insights regarding resources utilization and shortfalls and costs of implementing various stationing plan alternatives. Model development and data collections issues are discussed. Results will be given.

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Value Added Analysis for Army Equipment Modernization

This paper describes the Value Added Analysis methodology which was used as part of the US Army's Planning, Programming, Budgeting, and Execution System to assist the Army leadership in evaluating and prioritizing competing weapon system alternatives during the process of building the Army budget. The Value Added Analysis concept uses a family of models to measure an alternative system's contribution to the program using a hierarchial assessment framework. A mathematical optimization model is then used to simultaneously determine an alternative's cost-benefit and to identify an optimal mix of weapon systems for inclusion in the Army budget.

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Advanced Decision/Resource Modelling

As DoD funding becomes more and more finite, determination of requirements must be addressed in direct relation to available resources. The projection of requirements must be measurable, defendable, and traceable to a common methodology used by competing consumers such that priorities may be established. In addition, the development of these requirements must be rapid and accurate.

Through the use of the Object-oriented (00) system design methodology, the Army has built a family of resource predictive models for use at various organizational levels. These models address the need for requirements determination and manipulation in a common framework, regardless of the organizational level. Much of the models functionality is also shared across subject domains, such as Balance of Sustainment, Depot Maintenance, and Individual Training. The object-oriented design methodology, in contrast to top-down, procedural design methodologies, provides a means of defining desired system functionality in terms of real world entities or "objects" and combines information with the methods used to manipulate that information. This equips the functional experts and the systems analysts with a way of communicating in a common language to define the model.

Within a specific functional area, such as Depot Maintenance, the 00 based model provides a common methodology and framework at all organizational levels to determine requirements, perform "what-ifs" drills based on a changing operational environment, and project the dollar and manpower resources needed to support the requirements using a common baseline. "Adjusting requirements based on changes to the DoD environment can be addressed quickly and accurately and helps eliminate the "guessing game".

The 00 design methodology also lends itself to providing a standard framework for performing what-if drills, regardless of the functional area. For example, the Army has developed a family of predictive models which address several different subject domains such as Individual Training and Balance of Sustainment. Though these are very different subject areas, a group of common processes was developed and is shared across all the models for such things as establishing baseline requirements, creating alternative scenarios, and comparing projected alternative requirements to the original baseline requirements.

Establishing a common methodology to determine requirements and developing software which can be reused across functional areas will yield increasingly valid requirement projections and afford DoD a cost savings in Service wide system development.

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Analyses of the Relationship Between Development and Production Costs and Comparisons with Other Related Step-up/Step-down Studies

This paper examines the relationship between development and production hardware costs. This relationship, generally referred to as a step-up or step-down factor, is used as a technique for estimating either Engineering & Manufacturing Development (EMD) hardware costs or Production hardware costs. Some elements other than hardware such as design and support are also often dependent upon this relationship since they re generally estimated as a function of hardware. Also, in the Operating and Support Phase of the Life Cycle, maintenance effort is sometimes estimated as a function of the average unit hardware cost of production. Therefore, this research plays an extremely important role in trying to supply an estimating tool that will increase the reliability of Life Cycle Cost Estimates.

The rationale for this step-up/step-down factor and for this paper, as stated in [1], is that "an EMD (Engineering & Manufacturing Development) hardware prototype is a near production copy in design, physical and performance characteristics. However, the cost to manufacture such a prototype is usually accomplished on R&D (Research & Development) tooling, in an R&D environment and does not reflect the producibility engineering efforts and production line set-up as production model would. Therefore, the cost to manufacture an EMD prototype is more expensive than a production model." This subject has been addressed in [1], [2], [3], [4], and [5] for specific types of systems. However, as of yet, no comprehensive treatment of the issues has been examined. In this paper, we discuss previous step-up and/or step-down approaches, show our own analysis and studies in this area, and discuss how those studies relate to each other.

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Renewables and Energy Efficiency Planning Study (REEP)

The goal of the Renewables and Energy Efficiency Planning Study (REEP) was to develop and apply an analytical methodology for evaluating the economic potential of investment in energy efficiency and renewable energy at Army facilities. The developed methodology provides a logical framework for integrating and analyzing US energy and environmental policy, Army energy and environmental goals, Army programming and budgeting, and public and private sector funding. The core of the REEP methodology is a multiobjective mathematical programming model that quickly generates and analyzes optimal renewable energy and energy efficiency investment strategies for Army facilities on an annual basis through FY 2005. The model maximizes cost, energy, load, and pollutant savings for individual or combinations of renewable and conservation investments while explicitly considering budget constraints, energy and environmental goals and economies of scale. The REEP project was sponsored by the US Army Chief of Engineers.

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Reserve Component Training Installation Facility Yearly Requirements Study (RCTIFYRS)

The Reserve Component Training Installation Facility Yearly Requirements Study (RCTIFYRS) was charged with the tasks of developing and demonstrating a set of practical and comprehensible tools of sufficient fidelity to evaluate the economic implications of the expansion of currently or potentially available training facilities or the closure of facilities oriented toward support the Army National Guard and Army Reserve peacetime training missions. The heart of the methodology uses a multi-criteria bin packing heuristic to match unit training requirements with the resources available at potential training locations. The model's quick response time allows the generation of multiple cases, in order to test robustness, and provides for timely responses to questions generated by the Army Staff on training site issues. Supplementing the primary methodology is an assortment of geographically based analysis tools used to determine the availability of training resources to units of the Reserve Components. This analysis was sponsored by the Assistant Deputy Chief of Staff for Operations and Plans.

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Budget-Based Analysis, Europe

This paper describes a software design and development effort, based upon precepts from the field of economics, artificial intelligence and systems engineering, constructed to assist the leadership of the US Army, Europe (USAREUR) implement and monitor a specific Quality of Life program. The software system links together heterogeneous data concerning personnel, facilities, demographics, force structure and financial expenditures to form a holistic information source which permits significant "what-if" analysis according to the traditional decision support system paradigm. The system provides force structure descriptions, facilities capacities and requirements comparisons, Quality of Life compliance analysis, and detailed summaries of the financial resources required to support user-generated basing options. All system analyses and outputs are keyed to dynamic, time-phased facilities and force structure modification plans that the user is free to alter in every detail. Quality of Life program standards can also be modified. The system has been delivered to USAREUR and is in use at the headquarters as well as at each Area Support Group location.

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Mission Area Analysis (MAA), A Tool for Making DoD-Wide Tradeoff Decisions
Abstract not available.

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The Multiple Year Package Buy System: An Automated Acquisition System to Generate Solicitation Packages of Spare Parts Based on Expert Rules and the Top Down Packaging Methodology

The Army acquisition process for space parts is composed of a number of distinct sub-processes. The sub-processes include the operations of requirements determination thru technical data package development and solicitation to award. The most time intensive is the solicitation sub-process. The time that this sub-process consumes is a function of an fixed overhead portion and a variable portion. The overhead portion is the major factor; therefore, the time required to solicit for a number of different items on the same solicitation is not much greater than soliciting for one item. Therefore, it is appropriate to solicit for as many parts as possible within one solicitation. The constraint of this strategy is that a solicitation can only be composed of parts which can be produced by a single vendor. The grouping or packaging of NSNs into similar manufacturing processes, so that they can be included in one solicitation package, is presently attempted using a bottoms-up, engineering approach. This bottoms-up approach at packaging is a very tedious and time-consuming effort. After the packages are developed, the present process passes the potential packages sequentially thru a number of departments to make sure that the items conform to various requirements. At each stage it is possible that problems will be found and the package will be returned to the previous department for rework. Rather than passing the potential package thru this gauntlet, the MYPB Working Group got all participants together in the same room and incorporated each Directorate's concerns, thereby re-engineering the process into the MYPB System.

System Description

The objective of the Multiple Year Package Buy (MYPB) System is to provide a tool to assist in the grouping of spare parts (National Stock Numbers - NSNs) into solicitation packages composed of items which all have similar manufacturing requirements.

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Using Dynamic Programming to Support Ship Design Decisions
Abstract not available.

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WESVA: A Decision Aid for Comparing Warhead Advanced Surety Research and Development Options Warhead R&D

Incorporating advanced surety features in new warhead concepts can reduce the risks of accidental nuclear material dispersal, detonation, or unauthorized

use. However, successful concept development and implementation entail significant uncertainties, especially given tight constraints on research and development (R&D) budgets, time, and allowable nuclear tests. The simultaneous full pursuit of several concepts is also precluded. To help compare R&D options, we developed Weapon Safety Value Assessment (WESVA), a pragmatic decision aid based on multi-attribute utility theory. It was used by the LLNL Weapon Surety Program leader to: (1) methodically explore the sensitivity of option rankings to assumptions about key factors affecting concept desirability, (2) arrive at recommendations for concept selection, and (3) provide direction for further information collection. WESVA modeled key factors individually (e.g., estimated surety enhancements, probabilities of technical success, DOE/DOD acceptance given potential cost and military performance penalties, DOE producibility, etc.), then logically combined these models to compute an expected surety payoff for each alternative given decision-maker preferences. Benefits of a WESVA-like approach include documenting decision analysis inputs and assumptions explicitly, and providing detailed feedback to designers for adjusting or refining warhead concepts to improve the expected payoff of their designs.

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Weapon-Target Allocation for Force-Level Strike Planning

This paper describes the application of optimization technology to force-level strike warfare planning. The problem is to generate a strike concept that integrates tactical aircraft and cruise missile strikes from multiple bases, while simultaneously considering both attack of assigned targets and suppression of implied targets (threats). The use of optimization techniques enables the planning cycle time to be compressed as well as consideration of alternative plans under different planning assumptions. The problem is formulated and solved as a nonlinear, nonseparable integer programming problem. The paper describes the problem formulation and algorithm as implemented and demonstrated in an advanced technology prototype. Plan management issues and recent extensions of the approach to distributed planning environments are also discussed.

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The Use of Decision Analysis Tools in the Joint Services Lightweight Integrated Suit Technologies (JSLIST) Program for Acquisition of Next Generation Chemical Protective Ensembles

This paper reports the integration and use of decision analysis tools to support requirements definition, test planning, and acquisition decisions for a family of next generation chemical protective ensembles under the Joint Services Lightweight Integrated Suit Technologies (JSLIST) program.

The JSLIST program is a coordinated acquisition program by the U.S. Army, the U.S. Marine Corps, the U.S. Air Force, and the U.S. Navy to develop and field the next generation chemical protective ensembles that meet all services' requirements and mission needs using common test and analysis methods. The JSLIST acquisition strategy includes testing to screen many candidates, in order to identify the highest potential technologies for downselection and transition to full scope testing, evaluation, and possible fielding.

The JSLIST Project Managers sanctioned the development of a Downselection Process integrated into the joint acquisition strategy, the adaptation of commercial software to support interviews and analyses, and the maximization of user involvement throughout the process. The JSLIST Downselection Process was developed to analyze Service requirements, prioritize decision factors, plan testing and analysis, provide a means to conduct analyses, and produce a normalized ranking of candidates relative to standard items. The process incorporates principles of various decision support methods: AHP, the Delphi Method, social science survey techniques, and software applications (Expert Choice and Excel). The advantages of using the JSLIST Downselection Process as a decision support tool include validity achieved through employment of expert inputs and proven mathematical analysis tools, and simplicity in terms of the hierarchy structure itself, rating scales, software interaction, and real time analysis and feedback.

The foremost focus of the Downselection Process approach is to be easily understandable, user-friendly, and useful to decision makers, while providing a tool to structure and document decisions and maximize commonality among services. This paper describes the use of decision analysis tools in the JSLIST Downselection Process; how the process is structured and implemented to accomplish these goals (including hierarchy development, questionnaire development and use, interviews, scoring functions, and use of downselection models); and describes the preference results using figures and graphics.

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A Reconciliation of Multicriteria Decision Analysis Methodologies

There are actually only a half-dozen unique methodologies used for multicriteria decision making. The two most popular approaches are Multiattribute Utility Theory (MAU) and the Analytic Hierarchy Process (AHP). Proponents of these two approaches have failed to reach any substantial agreement on the relative usefulness of each approach, when one would be better used than the other, or how a weakness in one approach might be strengthened by use of the other approach. The debate has degenerated in recent journal articles, to the point where the arguments seem to shed more heat than light. We believe that much of the debate results from mutual misunderstanding of the proper application of the methods.

The purpose of this paper is to explain the differences between the two methodologies in simple, clear language for both the analyst and decision maker and to report on our attempt to reconcile them by drawing upon the strengths of both methods to improve the decision-making process. We begin this paper with a summary of the AGP and MAU methodologies and a description of the leading commercial software used to them. We then describe the results of two controlled decision conferences we conducted to help understand the strengths and weaknesses of both methods. Finally, we describe some concepts for blending the best features of both approaches into a single practical application, and report on the results of a third decision conference using an integrated approach.

There are three key features of interest in the MAU approach: interval scales, swing weights, and linear additive summation. In contrast, the AHP approach uses ratio scales, importance weights and Eigenvector matrix algebra for summation. We believe that the two methods offer strengths which, when combined, produce a more complete and useful analysis. For example, one approach is to use the robust and easy-to-elicit weighting technique of AHP but to score the alternatives using the interval scales used in MAU.

The task we selected for the decision conferences was to rank order seven US cities in terms of their overall livability. For background data, we used the 1993 Places Rated Almanac. The Almanac provides data on 343 metropolitan areas in North America and compares them on 10 criteria: living costs, job outlook, housing, transportation, education, health care, crime, the arts, recreation, and climate.

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Measures of Effectiveness: Quantitative Tool for Decision Making

Abstract not available.

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Abstract not available.

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Demonstration and Evaluation of the Munitions Effects Assessment Prototype

Abstract not available.

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Introduction to WG 30 -- Decision Analysis

Many of the techniques used in Decision Analyses appear to differ in mathematical approach. These differences contribute to enormous disagreement about the applicability of one technique over another. This Introduction outlines common elements that underlie several techniques and then discusses assumptions that lead to apparent departures in methodology.

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Bootstrap Approach to Portfolio Investment

When the amount of investment at any level is constrained, investment strategy need only be couched in terms of relative worth among investment options. We have used common hierarchical methods to obtain the relative contributions of Technology Areas to Operational Needs. These relative contributions lead to prioritization of the Technology Areas. We suggest how these relative

contributions can be used to form a strategy for changes from the current technology program.

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A Methodology to Assess the Contribution of the Global Positioning System to Air Combat Outcomes

The Air Force has a requirement to quantify the force enhancement effects of military space systems, but no methodology currently exists for the measurement of their contribution to air combat outcome. This research examines the Global Positioning System (GPS) and models its influence on air-to-ground combat. The decision analysis technique of influence diagrams is used to identify the effects of GPS launch decisions and constellation size on the navigation accuracy available to air combatants. The effect of accuracy variations on combat outcome is shown by using a value tree to identify the affected campaign Measures of Effectiveness. The study reveals that the use of GPS for navigation and weapons guidance results in a significant increase in sortie lethality that depends on the actual probabilities of survival, engagement, and kill for various weapon, platform, and target combinations. Also, the simultaneous loss of several GPS satellites is shown to have only a moderate time-averaged effect on navigation and combat outcome in the Northeast and Southwest Asia theaters. The methodology presented can be adapted to the study of other military space systems.

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Warfare Analysis: A Fusion of Expertise

Abstract not available.

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Selecting Defense Systems Using Decision Analysis

This paper presents the decision-making process in selecting Air Force defense systems. The inconsistencies of this process will be addressed from a decision analysis perspective. In addition, the application of multiobjective and single objective decision analysis to this decision-making process will be discussed.

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Use of Decision Support Tools for Migrating Department of Defense Automated Information Systems

Abstract not available.

WG 31 -- Computing Advances in Military Operations Research
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Rapidly Prototyping to Efficiently Use Distributed Interactive Simulations

The Combined Arms Tactical Trainer (CATT) is the future family of training simulators which will meet DIS standards and bring the Army into the 21st Century for training, combat developments and operational contingency preparation. To be ready for virtual battlefield training, warfighters must design and execute training plans that enhance unit training proficiency. The CATT Training Exercise Development System (CATT TREDS) rapidly prototypes state-of-the-art technologies to link applications together in an intelligent, object-oriented user-friendly system for unit commanders.

CATT TREDS will provide unit commanders an intelligent decision support tool that will save planning time and automatically apply after-action review feedback to the training exercise planning process. Currently, commanders spend hours referring to training and field manuals, training records, unit standard operating procedures and directives to develop how best to train

their unit most effectively under resource-declining conditions and limited training opportunities. Recognizing that future battlefield training and preparation will rely more and more on simulators and simulations, warfighters must develop training plans to enhance unit training proficiency, matching essential task lists against proper training resources. Also, the assessment of the training via after-action reviews must be fully integrated with the training event to ensure a unit learns and returns to train at a higher state of readiness. CATT TREDS applies state-of-the-art technologies to link applications together in an object-oriented user-friendly, user-accepted system designed especially for active Army and ARNG unit commanders as they prepare for training, and eventually, wartime tasks.

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Aggregate Level Simulation Protocol (ALSP) - Training for the Future

Training has always been extremely important to ensure the readiness of the United States military forces. In these times of smaller budgets and streamline fighting forces, training is the only way to insure our military is ready when they are called.

Models and Simulations are currently being employed to support training of personnel, including joint and unified command staffs. These Service developed computer simulations are expensive to develop and require support organizations to operate. The Aggregate Level Simulation Protocol (ALSP) is a research and development project responding to a desire to be able to re-use known reliable Service models to train in a Joint environment. ALSP allows disparate simulations to interact with each other through a common, message-based protocol interface. Therefore, aggregate level simulations representing distinct segments of a battlefield can be connected and provide a common environment to support major training exercises. An Army model, representing army ground operations, a Navy model, representing naval force operations and an Air Force model, representing air operations, can provide an integrated representation of war in a theater.

ALSP provides computerized support for Joint training exercises while allowing the use of familiar training simulations. The collective group of simulations is known as the ALSP Confederation. This paper addresses 1993 and 1994 ALSP Confederation development and the management processes that focused this joint development effort.

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A Measure of Reconnaissance

We suggest measures of the value of reconnaissance based on the concept of entropy used in communication theory. Bayes' formula is used to update the current state of knowledge about target location, as the reconnaissance battle proceeds. This generally causes the entropy to decrease; the amount of decrease is a measure of the information gained.

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Developing an Unmanned, Armed Surveillance System: A Real Example of the Systems Engineering Design Process

This paper discusses the needs and requirements of the future battlefield and evaluates whether an Unmanned, Armed Surveillance System can meet those needs through a top-down approach to system design. Cadets at the United States Military Academy have developed a concept for an Unmanned, Armed Surveillance System and have conducted operational testing and other analysis on their conceptual designs using Janus (Army) and ProModel. Their analysis involved trade-offs of system parameters and force integration issues involving tactical employment considerations. Our goal was practice Systems Engineering through the conceptualization and design of an Unmanned, Armed Surveillance System and evaluate its effectiveness on tomorrow's battlefield under several different scenarios and missions.

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The 21st Century Land Warrior in Janus (Army)

Cadets at the United States Military Academy have designed a concept for several variate roles of the 21st Century Land Warrior (dismounted). Cadets also conducted operational testing on their conceptual designs in Janus (Army). Trade-offs of system parameters defining sleep deprivation and heat exhaustion were performed as well. Our goal was to evaluate the 21st Century Land Warrior's effectiveness on tomorrow's battlefield under several different scenarios and missions.

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Measuring the Warfighting Value of Reconnaissance

This paper discusses the reconnaissance needs and requirements of the future battlefield and evaluates whether selected future systems will meet those needs. Cadets at the United States Military Academy have conducted unique testing of the RAH-66 and prototype UAVs in Janus (Army) in an attempt to measure their ability to gather timely and critical tactical information. Our goal was to evaluate methods of measuring the effectiveness of reconnaisance on tomorrow's battlefield under several different scenarios and missions.

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The Battle of Gettysburg in Janus (Army): The Second Day (Devil's Den)

We have designed several civil war era weapons and have recreated the historical terrain of Gettysburg in Janus (Army). Tactical trade-offs were performed and statistically analyzed for historical relevance. Our goal was to evaluate the significance of several critical tactical decisions as well as the timeliness of military actions. Included were several tactical variations of the battle near Devil's Den, the Wheatfield, and Little Roundtop.

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A Multi-User, Multi-Processor Configuration for Janus (Army) Using SUN-OS

At the US Military Academy we have designed a user environment utilizing SUN hosts and HP X-terminals for Janus (Army). Nine processors are available for use by over 30 user accounts which often include 6-8 scenarios running simultaneously. We have developed an integrated environment for cadets to use PCs (DOS and UNIX (LINUX and SCO)), Multi-processor SPARC-Servers (SUN), and X-Terminals (HP) to run Janus and JEDA (Janus Enhanced Data Analyzer) and many PC applications. We have also configured a 486 PC sporting X-emulation software to run Janus (Army).

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The WPC SAM Lethality Methodology

Abstract not available.

WG 32 -- Advanced Analysis, Technologies and Applications

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Aggregate Level Simulation Protocol (ALSP) -- Training for the Future

Training has always been extremely important to ensure the readiness of the United States military forces. In these times of smaller budgets and streamline

fighting forces, training is the only way to insure our military is ready when they are called.

Models and Simulations are currently being employed to support training of personnel, including joint and unified command staffs. These Service developed computer simulations are expensive to develop and require support organizations to operate. The Aggregate Level Simulation Protocol (ALSP) is a research and development project responding to a desire to be able to re-use known reliable Service models to train in a Joint environment. ALSP allows disparate simulations to interact with each other through a common, message-based protocol interface. Therefore, aggregate level simulations representing distinct segments of a battlefield can be connected and provide a common environment to support major training exercises. An Army model, representing army ground operations and a Air Force model, representing air operations, can provide an integrated representation of war in a theater.

ALSP provides computerized support for Joint training exercises while allowing the use of familiar training simulations. The collective group of simulations is known as ALSP Confederation. The 1993 ALSP Confederation was composed of three Service models: USA Corps Battle Simulation (CBS), USAF Air Warfare Simulation (AWSIM), and USN Research, Evaluation, and Systems Analysis (RESA) model. This ALSP Confederation provided an integrated simulation system to support Exercise Ulchi Focus Lens 93 (UFL93) for US Forces in Korea.

The paper will address ALSP Confederation development, and the management processes that focus this joint development effort. The 1993 ALSP Confederation development will be used as an illustration.

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Managing Uncertainty Explicitly in Simulation

Simulation of complex subjects such as military engagements is subject to a "chaotic" response, where a seemingly insignificant change in a parameter can produce dramatically different outcomes. This extreme sensitivity is due to the presence of nonlinear processes, especially decision making, and seems to be characteristic of the reality represented and not just an artifact of simulation. This problem makes the use of simulation in studies more difficult, because traditional sensitivity analyses may not be valid given a chaotic system response. This paper suggests that the management of this uncertainty be made part of the simulation system, and that accountability for why a simulation produces a variety of outcomes be explicitly tracked. Thus, the operation of the simulation system would produce not only a variety of results, but probabilities and confidences associated with those results. This is in contrast with the current approach of attempting to determine probabilities and confidences by statistical means that may not be valid in the face of chaos, or unaffordable. There are several technical challenges to doing so: A simulation system must be able to automatically create new replications at important decision points or other critical events that produce different simulation trajectories. The system must be able to distinguish which such critical events are capable of producing significantly different outcomes and which produce random effects whose combination tend toward a mean, otherwise such a system would be drowned in a combinational explosion of self created replications. It must be possible to recognize when there is no significant difference between replications. so that they can be combined to minimize the number of simulation replications. Finally, some of the procedures for performing these functions appear to lend themselves to parallel processing, special hardware, or both. This paper explores these issues, and suggests a plan of study to determine the practicality of the approach.

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Demonstration and Evaluation of the Munitions Effect Assessment Prototype

Abstract not available.

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An Expert Systems Approach to Automated Test Planning

Abstract not available.

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Blacksmith, the Army Flow Model

Abstract not available.

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Training and Leader Development Simulation Plan for Mounted Warfighting

Simulation - whether stand-alone, appended, computer-driven or embedded is the way the Total Force (Soldier through Corps and beyond) will rehearse for combat in the future. operation Just Cause, the fall of the Berlin Wall, operation Desert Shield/Storm, the dissolution of the Soviet Union dramatic events - however the world is still a dangerous place to live and America's response - contingency operations - is the order of the day.

Department of Defense (DoD) needs to train and synchronize the total force to maximize the synergism of the total force's capability. However, DoD will be unable to train in the future as it has in the past. Environmental concerns, reduced budgets, higher training costs, more complex weapons systems requiring increased land and range requirements for training, will force us to reconsider how we train the total force. Training at the joint level with the integration of coalition forces heretofore executable only on a limited scale may be unexecutable in the future except in simulation.

Given Contingency Missions, the CATS simulation plan focuses on the Maneuver Brigade Task Force. This requires the integration of CBT/CS/CSS, Heavy/Light/SoF, Air Force/Navy/USMC and Allies. The simulation plan allows leaders and staffs to identify Courses-of-Action in response to the contingency, develop the METL and train it in the time available, design the correct force structure, train the courses of action, and evaluate units prior to deployment. Therefore, simulation, in the future, not only trains in the traditional sense, it necessarily becomes a combat rehearsal system. WARSIM 2000 captures this vision.

In the future and even now, time and space are the critical limitations on training. In the fourth dimension time and space are overcome - simulation provides additional time to the unit by saving the time required to prepare and move to the field. Further, in simulation STXs can be rerun and modified until the unit attains proficiency. This saves the time required to move the unit back to the start point and the brass on the ground and the ground torn up by acceleration or neutral steer does not give away the point along the course where actions occur. The maturation and miniaturization of our simulation will allow the force to embed the current TADSS capability in the weapons system. This will allow units to train in peace time using the same training devices as they train in war. When reconstituting crews and units, the devices the NCOs and officers used to train their units in peace time will be with the unit in time of war available for training and rehearsals.

Additionally, to tailor, train and sustain the total force for contingency missions under different conditions and situations and to train tasks and events which are inherently too dangerous for our people and destructive to our equipment further exacerbates the current training challenge which future simulation overcomes.

Given the state of simulation described above, commanders may be able to visually synchronize the battlefield thereby bringing to bear all the complex and multi-faceted weapons systems at the right time and the right place to destroy the enemy quickly with minimum loss of or risk to American fighting forces. " *The leveraging of fully integrated and internetted state-of-the-art information and communications systems will enable commanders to control forces, synchronize effects, achieve near total situation awareness, rapidly pass information to the correct echelon and move about the battlefield -- and, most importantly, command*". The CATS briefing slide, full size and in color at TAB A (Slide 2) depicts graphically the complexity of synchronizing the battlefield.

This graphic visually shows the great number of variables and constraints which go into C3I when viewed across the operational continuum from the Corps level. The brigade and below battle is only a part of the Corps fight. Additionally, there are the operations being conducted beyond the FEBA, to include the vertical integration of airspace requirements and the video, digital and communications information from satellites. A lot of information to assimilate, hopefully, in near real time to make the best C3I decisions. Leaders and staffs must visualize the battlefield with varying degrees of fidelity depending upon their echelon - simulation currently can't provide this total picture. Leaders and staffs must understand the commander's intent, visualize how the battle plan will unfold, capitalize on the dynamics of synchronization, and gain the warfighting confidence to exploit opportunities on the battlefield. Simulation/simulators currently only provide the forward edge of the battlefield - battalion and below with brigade interaction. In the future, using simulation or virtual reality/altered presence technology the real time visualization of the battlefield in 3-D will be attainable. At that juncture, we may for the first time realize and fully appreciate the synergism of synchronized combat power.

The vision describe in this draft document has greater applicability than just to combat and peace keeping missions. Imagine if a simulation of this scale,

with its capability were available to the Federal Emergency Management Agency (FEMA). By example, this simulation may tell combat leaders the best course-of-action to resolve a contingency and the priority of combat capability from the first scout's point-of-entry to the Corps proper; then, couldn't the same simulation prioritize for disaster relief officials the first medics point-of-entry through the follow-on civil engineers and reconstruction specialists requirements for hurricane Hugo/Andrew or an earthquake in San Francisco? The key to the future as described in the paper is to leverage technology to determine the best and most appropriate response to any emergency situation, national defense or otherwise.

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Algorithms for Pattern Theory
Abstract not available.

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Explosive Ordnance Disposal Information Search, Retrieval, and Delivery System
Abstract not available.

WG 33 -- Modeling Simulation and Wargaming
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Simulations Quantitative Performance Bounds and Requirements Analysis for Hard-Real-Time Distributed Interactive Simulations

Networks of distributed interactive simulations that communicate with each other through standard protocols show considerable promise to improve the realism and cost effectiveness of military simulation. Projects have been initiated to use distributed interactive simulations to support military training, analysis, research, acquisition, and test and evaluation. Current investment and efforts to rush this new technology into operational use are understandable. However, it is important that the DOD community also understand the bounds on the operational performance of this technology. In particular, it is of interest to understand how delays of "latencies" between remote simultaneous events are determined. These are dictated by the level of the operformance of the hardware and software components of a simulation network. Quantitative analysis appl;ying queuing theory can estimate the aggregate performance of a networked distributed simulation--a "confederation" from the parameters that describe the performance of components. Such analysis also can be used to determine the requirements for the performance of therse components to achieve desired aggregate performance goals. This presentation will discuss and differentiate simulations--or "actors"--in the confederation. The presentation also discusses analysis to establish quantitative requirements on the confederation components to permit them to keep latencies below target thresholds. Qualitative conclusions about desirable characterisitics for distributed interactive simulation condederations are discussed based upon these analyses. The present analysis only considers hard real-time distributed interactive simulations, such as those described by the IEEE protocal 1278. Subsequent, separate analyses will consider time-managed distributed interactive simulations.

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Managing Uncertainty in Simulations

Simulations of comples subjects such as military engagements is subject to a chaotic response, where a seemingly insignificant change in a paramenter can produce dramaticlly different outcomes. this extreme sensitivity is due to the presence of non-linear processes, especially decision making, and seems to be characteristic of tjhe reality represented and not just an artifact of simulation. this problem makes the use of simulatin in studies more difficult, because traditional sensitivity analysis may not be valid given a chaotic system response. this paper suggestes htat management of this uncertainty be made part of the simulation system, and that accountability for why a simulation produces a variety of outcomes be explicitly tracked. Thus, the operation of the simulation system would produce not only a variety of results, but probabilities and confidencies associated with those results. This is in contract with the current approach of attempting to determine probabilities and confidencies by statistical means that may not be valid in the face of choas, or unaffordable. There are several technical challenges to doing so: A simulation system must be able to automatically create new replications at imoportant

decision points or other critical events that produce different simulation trajectories. the system must be able to distinguish which such critical events are capable of producing significantly different outcomes and which produce random effects whose combinations tend toward a mean, otherwise such a system would be drowned in a combinatorial explosion of self created replications. It must be possilbe to recognise when there is no significant difference between replications, so that they can be combined to minimize the number of simulation replications. Finally, some of the procedures for performing these functions appear to lend themselves to parallel processing, special hardware of both. this paoper explores these issues and suggests a plan of study to determine the particality of the approach.

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JADO/JEZ Simulatin of Air Defense Operations

Abstract not available.

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A Methodology to Assess the Effects of Chemical and Biological Weapons in the Battlefield

Dispite the dissolution of the USSR, the unprecedented victory of the Allied Forces during Desert Storm, and other continuing changes in the world, the proliferation of weapons of mass destruction (Chemical and Biological) is becoming one of the most serious security threats that the US will confront. the Third World nations without significant conventional military power are now able to develop chemical and biological warheads. As the possibility of US contingency forces becoming exposed to chemical and biological (CB) effects continues to grow, analytical tools are required to support the various elements of the DOD community as they address the issues of weapons of mass destruction (WMD). The JANUS interactive model is being developed into such a tool. JANUS is a two-sided model which is a high-resolution stochastic force-on-force simulation deopicting the various combat systems operating in specified scenarios. TRAC-WSMR is currently in the process of improving the CB simulation capabilities of JANUS. This paper focuses on the methodlology that is being used in this effort. the technical approach of this effort if to integrate existing methodologies for representing the effects of WMD and their unique effects on personnel performance and behaviour in a constructive combat simulation. The main task will be to incorporate the VLSTRACK chemical cloud trandport and diffusion model into JANUS. This effort will produce a version of JANUS capable of portraying agent clouds, cloud travel, cloud dissipation, contamination levels, casualty effects, point detector capability, and effects of CB protective equipment on personnel performance will be incorporated into JANUS.

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Quantifying The Value of Reconnaissance Using Lanchesterian Type Equations

This paper presents a mentod to quantify the value of reconnaissance for both direct and indirect fire weapons for the defense in sector battle scenario. The Lanchester area fires model and the Helmbold equations were modified to allow the lethatlity of the defending blue force to be increased as the gained more combat intelligence about the attacking red force, thus modeling intelligence as a true combat multiplier. By adjustments made to parameters in the model, the lethatlity of blues direct and indirect fire weapons could be adjusted based on the quantity and quality of their intelligence assets. With information from a computer database, and from the COMAN model, maximum likelihood attrition rate estimates were calculated for both red and blue forces for ten heavy defensive battles conducted at the Army's Ntional Training Center. In each battle the red force attrition rate was fit to a curve which represented a percentage of blue's full potential, represented here by the square law. Using this model of combat simulation, and with come preliminary work with comparable systems, one could implement a change in blue's intelligence assets and then pprovide a quantitative measure of the effect that this had on the outcome of the battle.

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Modeling and Simulation for Expeditionary Warfare

The Chief of Naval Operations has focused the "...From the Sea" strategy on four key operational capabilities:

A. Command, control, communications, computers, intelligence, and surveillance (C4I/Surveillance)
B. Battlespace dominance
C. Power projection of joint forces, and
D. Force sustainment

Within this strategy the Expeditionary Warfare Division (N85) must understand and analyze broad but related warfare areas: amphibious warfare, shallow wate anti-diesel submarine warfare, mine and anti-mine warfare (to include surf, land, deep and shallow water mines), navel special warfare, riverine warfare, and maritime prepositioning forces. Expeditionary warfare is complex but can be made more understandable usinmg computer models and simulations to document and analyze solutions to specific problems. Modeling and simulation provides a scientific approach with a documented, repeatable audit trail to:

establish requirements,
identify appropriate force mixes,
evaluate concepts and alternatives,
assess sustainability,
determine weapon system specifications,
provide training, and
provide decision aid support to the deployed commander.

This paper discusses requirements for modeling and simulation and how modeling and simulation can be applied to better understand thje problems and issues of expeditionary ewarfare. Attributes of models used to simulate specific warfare areas are discussed and why it is desired to have a federation of models that work synergistically. Paper emphasizes compliancy with the common operating environment and the Navy's modeling and simulation master plan.

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Chemical and Biological Weapons and DIS

Abstract not available.

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The Virtual Interactive Target (VIT): A Step Toward Realistic Phenomonology in DIS

Abstract not available.

An Independent Verification and Validation of the Future Theater Level Model Conceptual Model

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An Independent Verification and Validation of the Future Theater Level Model Conceptual Model

Matin Marietta Energy Systems, Inc. is the Management and Operating Contractor or the Department of energy's Oak Ridge National Laboratory and other Oak Ridge Federal Facilities. The Data Systems Research and Develo[ment (DSRD) Program is the unit of Energy Systems with principal responsibility for data systems work performed for other federal agencies, such as the Department of Defense. DSRD has considerable expertise in combat modeling, simulation and gaming and in performing independent verification and validation of combat models. Because of our expertise and our independence with regard to the Future Theater Level Model (FTLM), the Joint Staff/J-8 asked and received from the Department of Energy our aid in performing an independent verification and validation study of the FTLM.

We subjected the conceptual design of the FTLM to those tests that we thought appropriate to its design stage, to its purpose as an analytical combat model, and to its capabilities as specified in the Mission Needs Statement. The conceptual design passed those tests. We recommend that its development be continued.

Because this recommendation is positive, we recommend increased attention in the areas of design of model input and output support and decision logic creation. We also recoimmend the institution of informal configuration management control. These steps are appropriate as the model moves to a more complex and costly statge of development. We further recommend continuation of the planned integration of independent verification and validation into the FTLM design and construction process.

The presentation will briefly describe the FTLM (as it is conceived), the techniques used for Verification and Validation of a model concept, and the results of this process.

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Lanchester on Lanchester

It is true that over 75 years ago a British automaotive and aeronautical engineer was bold enough to publish the results of his investigation on the military applications of aviation (at a time when flying had only just been proven possilbe). And it is also true, that this individual's theories stand today as the cornerstones of "equations of combat", and are considered to be amongst the most valuable analytical contributions to the art of war. But to those who have been terrorized by the academic references or rely on his equations (the algorithms which drive the attrition process in our many-on-many combat simulation models) a description of Lanchesters actual thoughts have never really been presented. Despite the numerous references and devilish derivations based on his famous equations, we have perhaps lost out on the mindset and content of Lanchester's basic work. And so to remedy this shortfall in information, to answer the question, "What exactly did Lanchester say?", this paper examines in an interesting and enlightening tone the recorded thoughts of one of the most important contributors to the use of combat modeling and simulation in modern analysis. The paper discusses the then (1917) envisioned strategic and tactical uses of airpower, weapon effectiveness analysis, and issues in reconaissance and combined arms operations. It discusses Lanchester's concepts on aviation command, control, and logistics; the national and political implications associated with airpower developments; and one man's vision on the importance of battle space dominance.

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Statistical Considerations for Monte Carlo Simulations
Abstract not available.

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Impact of Computer Models in DoD Upper-Level Decision Making and Force Structure Analysis
Abstract not available.

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The Modeling of Signature Reduction, Active and Passive Countermearures in the CASTFOREM Simulation to Evaluate Armored Vehicle Survivability .
Abstract not available.

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Aggregate Level Simulation Protocol (ALSP) – Training for the Future

Training has always been extremely important to insure the readiness of the United States military forces. In these times of smaller budgets and streamlined fighting forces, training is the only way to insure our military is ready when they are called.

Models and Simulatins are currently being employed to support training of personnel, including joint and unified command staffs. These Service developed computer simulations are expensive to develop and require support organizations to operate. The Aggregate Zlevel Simulation Protocol (ALSP) is a research and development project respoonding to a desire to be able to re-use known reliable Service models to train in a Joint environment. ALSP allows disparate simulations to interact with each other through a common, message based protocolinteface. Therefore, aggregate level simulations representing distinct segments of a battlefield can be connected and provide a common environment to support major training exercises. An Army model, representing Army ground operations a Navy model, representing naval force operations and an Air Force model, representing air operations, can provide an integrated representation of war in a theater.

ALSP provides computerized support for joint training exercises while allowing the use of familiar training simulations. The collective group of simulations is known as the ALSP Confederation. the 1993 ALSP Confederation was composed of three Service models: USA Corps Battle Simulation (CBS), USAF Air Warfare Simulation (AWSIM), and USN Research, Evaluation and Systems Analysis (RESA) model. This ALSP Confederation provided and integrated simulation system to support Exercise Ulchi Focus Lens 93 (UFL93) for US forces in Korea.

The paper will address ALSP Confederation development and the management process that focus this

joint development effort. the 1993 ALSP Confederation development will be used as an illustration.

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Non-Monotonic Effectic in Models with Stochastic Thresholds

Dewar, Gillogly, and Juncosa demonstrated the presence of non-monotonic results in even simple combat models that include thresholds. We investigated whether or not non-monotonic behavior would remain when stochastic thresholds replaced deterministic thresholds. In this work, we demonstrate that stochastic thresholds do not eliminate non-monotonic effects, and can even make them worse when compared with deterministic model outcomes.

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Non-Monotonic Results in a Stochastic Simulation
Abstract not available.

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Naval Operational Modeling of Mine Countermeasures
Abstract not available.

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Analysis of Combat Troop Casualty Rates for Implementation in a Forcasting Simulation Model
Abstract not available.

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Battlefield Combat Identification system–Near Term (BCIS-NT) Cost and Operational Effectiveness Analysis (COEA)

The problem of friendly fire casualties has been documented throughout history. However, during Operation Desert Shield/Storm the number of friendly fire casualties (24 per cent) far exceeded the average amount in previous conflicts. As a result of lessons learned in Desert Storm (decreased visibility due to dust/smoke, misidentification of targets, etc.), the Army Chief of Staff directed that a task force be formed to investigate and improve combat identification. A major outcome of this task force was to pursue development of a combat identification device for ground to ground and air to ground (rotary wing only) platforms that could be fielded by 1995.

In support of this BCIS-NT program, a General Officer Steering Committee selected a millimeter wave question and answer technology to meet requirements for the combat identification device based on technology demonstration and analysis performed by the task force. Subsequently, HQDA, DAMO-FD (study sponsor) required a cost and operational effectiveness ana;ysis (COEA) be conducted to determine if a millimeter wave (MMW) BCIS could reduce fratricide without decreasing combat effectiveness. Five MMW systems were compared in the COEA; three had range resolution around the interrogated target while the remaining two relied solelyon interrogating the entire beam width. Both 45 mil and 22 mil beam widths were investigated.

The basic approach to this study was to conduct a technology review, followed by an effectiveness analysis, a cost analysis and a training impact analysis. The technology review compiled fratricide results from several sources, to include both historical acconts of battles and "simulated fratricide" occurring at the two Army training centers (Ft. Irwin, CA and Grafenwohr GE). Combat effectiveness was determined by using a noninteractive combat simulation (CASTFOREM) to study the effects of the five MMW BCIS on battle outcome. The cost analysis compared the cost of fielding different BCIS variants, and determined the variations in the costs of fielding one of them to one, two, or four divisions, with and without inclusion on rotary wing platforms. The training analysis consisted of a survey of the affected Army schools to determine BCIS impacts on the training subsystem.

The principal results of the study were as follows:

- Any BCIS-NT alternative reduces direct fire fratricide
- In a high fratricide situation, BCIS can improve Blue combat effectiveness
- non-ranging BCIS variants provide significant protection to the enemy by

misidentifying Red vehicles as Blue, and
- Impact on training is minimal.

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Theater Air Command and Control Simulatin Facility (ACCSF)

The TACCSF Facility is a national asset operated by the Air Force, with Army participation, and is a resource available for use by any US or Allied agency. Typical applications which the facility supports include, but are not limited to:

- Development and refinement of new system reuirements, concepts, tactics, plans and procedures,
- Systems integration/interoperability,
- Planning, scoping, and rehearsing live operatins,
- Extending the results of live operatins into larger scenarios

Air Combat Command (ACC) has designated the TACCSF as the primary operator-in-the-loop simulation facility for theater missile defense (TMD) studies. The Air Force conducted a TMD test at TACCSF in February 1993 to analyze timelines and accuracy of information flow and launch point determination for attack operations. More complex live-simulated mixed activities are scheduled for FY94. The TACCSF is currently linked to the National Test Facility (NTF) and the Advanced Research Projects Agency (ARPA) WARBREAKER Simulatin Facility. Distributed Interactive Simulation (DIS) protocols are used to exchange information between the simulations. The TACCSF will soon be linked to other joint simulations to create the neccessary architecture to conduct studies, rehearse live fire demonstratins and exercises, and train crews in this critical mission area.

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Simulation of Inland Waterways Traffic Systems as a Lines of Communications Component in OCONUS Sustainment Operations

Abstract not available.

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