

# MORS PHALANX

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## Assessments of Multi National Operations

A MORS Special Meeting  
5-8 November 2012  
Tampa, FL



See page 4 for a listing of 2012–13 Special Meetings | Mark your calendar for the 81st MORS Symposium, 17–20 June 2013, United States Military Academy, West Point, NY  
Inside this Issue: OR in the Five Eyes Countries, Minerva Research Initiative, Datacards

# Report Documentation Page

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# Operations Research in Defense of the Nation

Michael W. Garrambone, MORS President, Infoscitex Corporation, michael.garrambone.ctr@wpafb.af.mil

When asked about the MORS name, I frequently think back to the pre-WWII days when the British scientists were called upon to devise ways to defend their nation from the impending bomber threat. The slogan “the bomber always gets through” was sufficient cause for the government to ask the British scientific research and development centers to find some means to protect the homeland. Although there were no magic ray guns, there was a hope that perhaps radio waves could be employed to give early warning by determining range and direction of incoming aircraft. As the technical aspects of improving towers, antennas, and display devices materialized, A. P. Rowe, the Director of the Bawdsey Research Station, voiced his objections about the way the operations were proceeding with respect to the “plotting, filtering, and telling” of aerial information. He directed a section of his team to perform operations research (OR) to improve efficiency and effectiveness and from this directive came the “Operations Research” title. Seeing the merit of this system, Air Chief Marshall Dowding asked that a team be assigned to his headquarters designated as the Operation Research Section of Fighter Command.

As you can see, our roots are in the military services, but the applications of OR are everywhere—from business to medicine, from engineering to social sciences. The number of OR techniques continues to grow, and those employing them have various titles such as industrial systems engineer, operational analyst, systems analyst, quantitative analyst, ops researcher, intelligence, and cost analyst. OR continues to be a multifaceted discipline, and those who serve have a deep military heritage.

## A Past and New Beginning

It is along these lines that I take the helm of MORS with this sense of heritage and our diversity of disciplines, interests, and applications. Serving the Society in any capacity is an honor, and I am blessed to have this opportunity to serve all of you as Presi-

dent. It is also with a sense of history that I thank all of my predecessors, and especially our Immediate Past President, **Ms. Trena Covington Lilly** of Johns Hopkins University Applied Physics Lab, and her predecessor, **Mr. Terrance J. McKearney** of The Ranger Group. They have given me sage guidance over the years and I am thankful to have them now as wise council. Terry will become an Advisory Director this year, and Trena, in addition to becoming our Immediate Past President, has assumed the role of acting editor of *Phalanx* as we search for a new editor.

As you know, June is the time for electing new officers for the MORS Executive Council (EC). The Board of Directors (BoD) has elected **Dr. Stephen R. Riese** of Johns Hopkins University Applied Physics Lab as President Elect, **Mr. Robert R. Koury** of Price Systems as Vice President for Finance and Management, **Ms. Renee G. Carlucci** of Center for Army Analysis as Vice President of Meeting Operations, **COL Simon R. Goerger** of OSD (P&R)—Readiness Directorate as Vice President of Membership and Society Services, and **Mr. Rafael E. Matos** of WBB Consulting as Secretary of the Society. **Ms. Susan K. Reardon** continues to preside as MORS CEO. Departing the EC this year are Secretary of the Society **COL Clark H. Heidelberg** of the Army War College and Vice President for Meeting Operations **Dr. John R. Hummel** of Argonne National Laboratory. A special thanks to Clark and John for their outstanding service on the EC.

Membership on the MORS Board of Directors is also by election. Each year several BoD members conclude their four-year tenures and are either elected to the EC, retire from the board, or request a one-year status as a board-approved advisory director. Based on an extensive nomination process that looks at service to the Society and other professional criteria, individuals are nominated and presented for board vote. Historically all nominated individuals are noteworthy leaders and have a proven work ethic. This year, **Mr. Joseph F. Adams** of the Institute for Defense Analyses, **Ms. Sheila A. Simberg** of the Army Materiel

Systems Analysis Agency, and **CDR Harrison C. Schramm** of the Naval Postgraduate School were elected. Please welcome these new members, who will begin their introductory committee assignments.

Retiring from the BoD after four years of outstanding service is **Dr. Arch A. Turner** of the Department of Homeland Security. Dr. Turner has been an outstanding spokesperson for his department, has served on the EC as the Secretary of the Society, and has led the MORS Ethics and Professional Practices Committee during his tour of duty. In keeping with his wishes, he will continue serving MORS as an advisory director.

As mentioned earlier, after six highly successful years and 24 outstanding issues, **John Willis** of Augustine Consulting has stepped down as the MORS *Phalanx* editor. We extend our best wishes to John, who was consistently able to garner newsworthy and interesting stories about the people and events of both MORS and INFORMS MAS and to publish numerous and enlightening short articles of technical importance.

## The 80th MORS Symposium

The 80th MORS Symposium at the United States Air Force Academy at Colorado Springs was simply terrific. More than one thousand attendees were welcomed by our USAF Academy host, **Colonel Andrew A. Armacost**, and our Academy onsite coordinator, **Lieutenant Colonel Jeremy B. Noel**. We extend thanks to **General William L. Shelton**, our inspiring keynote speaker, who set the stage for the event. Hats off to Program Chair **Bruce D. Wyman** of Bruce D. Wyman Company, Deputy Chair **Thomas E. Denesia** of NORAD-USNORTHCOM, and WG/CG Coordinator **Rochelle A. Anderson** of the TRADOC Analysis Center for orchestrating this outstanding event. We saw five composite groups and 34 working groups provide more than 650 classified and unclassified technical presentations. Thanks to **Dr. Donna W. Blake** of Blue Storm Technology for organizing all of our special sessions and to **Ms. Lisa M. Kaiser** of the

See *MORS President* on page 4...



Greg H. Parlier, MAS President, [gparlier@knology.net](mailto:gparlier@knology.net)

In addition to sponsoring the Seth Bonder Military OR Scholarship, we also reinforce our MAS objective to “develop students and OR practitioners capable of addressing the complex challenges of the 21st century” by recognizing top undergraduate operations research students at our service academies during awards ceremonies just prior to their graduations each May.

Our congratulations and best wishes to this year’s impressive recipients from the Class of 2012: Coast Guard Academy—**Colin Schembri**; Naval Academy—**Nicolas Woods**; Air Force Academy—**Mark Williams**; and at West Point—**Zachary Price**. And thanks to all who presented on behalf of MAS at each academy: **Admiral Stosz** and **Captain Melinda McGurer**, **Commander Dave Ruth**, **Colonel John Andrew**, and **Dr. Tim Elkins**, respectively. See articles on page 16 for further details on each of these newly commissioned officers.

Note the earlier date this year for the 2012 INFORMS Annual Conference, October 14–17, Phoenix, Arizona (<http://meetings2.informs.org/phoenix2012>); early registration deadline is September 10. Within our MAS “cluster,” almost 150 papers are scheduled to be presented across 36 sessions, including nine joint sessions with CPMS, Data Mining, Decision Analysis, Emergency Management and Terrorism Security, Public Programs, Service, and Needs (PPSN), and Service Science, along with more than a dozen outstanding contributed papers, and two tutorial presentations.

Please plan to join us during the conference for our annual MAS business meeting, scheduled on Monday evening, October 15 at 6:15 in the Phoenix Convention Center.

Balloting is complete for our next MAS Vice President/President-Elect, who we’ll welcome and induct during this meeting. Regardless of the outcome, our gratitude to **George Mayernik**, **Chris Arney**, and **Joe Davis** for volunteering their leadership skills, considerable time, and effort for this long-term (six years) commitment to our professional society. We will also present several awards: the Seth Bonder OR Scholarship; the Bernard O. Koopman Prize for

the best publication on military OR; and the Steinhardt Prize for outstanding contributions and lifetime achievement.

We had a record number of submissions for the Bonder scholarship this year—18 candidates nominated from 15 different universities across the nation. Thanks to our prize committee members for their yeoman work, and past-president **Pat Driscoll** for chairing our various awards committees again this year. As is our tradition, the business meeting will be immediately followed by our reception at 7:15. Hats off again to **George Mayernik**, our industrious Industry LNO, for securing corporate sponsor donations, which continue to make these annual events, and our reception, highlights of the year.

Planning is now ongoing for our Spring 2013 annual MAS conference, the likely location will be the Hyatt Monterey near the Naval Postgraduate School replicating this year’s great venue. Please contact **Bill Fox** or **Walt DeGrange** if you wish to assist with program development, chair a session, etc. MAS is also co-sponsoring the upcoming MORS “Affordability Analysis” Workshop in early October in Crystal City.

Great news... two of our active-duty MAS council members were promoted and reassigned this summer: **Chad Long** to Commander and reassignment as Chief, Information Systems Division at the Coast Guard’s Aviation Logistics Center; and **Doug Matty** to Colonel and Chief, Joint Requirements Assessment Division in J-8 on the Joint Staff. Congratulations and best wishes to you both.

In May we formally adopted our Joint Student Membership Bundling program with MORS. All student members of both organizations will now enjoy the membership benefits from both organizations, including our newly launched bimonthly WebEx events. The initial WebEx was held on Friday, July 20, 2012 with an overview of future bimonthly events and an introduction to operations research professional organizations led by MAS council member **Jeff Eaton**. **Julie Seton** and **Walt DeGrange** then provided overviews of MORS and MAS. **Jim Morris** discussed operations

research in the Federal Government and Armed Forces, and **Dan Behringer** concluded with research opportunities. The webinar was recorded, and we now have a link on our INFORMS MAS webpage. WebExes will continue in September and will cover a range of subjects of interest to students conducting research and entering the exciting operations research workforce.

Over the summer, MAS council member **Doug Matty** coordinated an INFORMS MAS “community of practice” for US Army operations research professionals, with Army functional area 49 (ORSAs) proponent representative Colonel Simon Goerger. The work was completed as part of a comprehensive “functional area assessment.” This effort can reinforce and extend our value proposition as a society by offering professional development and outreach support. Topics span many areas, including emerging trends and issues, training and certification, publications, meetings and conferences, networking, communities and special interest groups, awards and recognition, resources, and outreach. The initiative, described in an informative white paper, may potentially serve as a model for our use with other services and agencies as well. Thanks to INFORMS Executive Director **Melissa Moore** for her encouragement, and especially to Director of Communications **Barry List** for his efforts in developing and refining this initiative.

On the international front, I look forward to representing MAS at the 29th ISMOR ([www.ismor.com](http://www.ismor.com)) near Hampshire, UK in late August. We plan to extend our international presence and contributions, continuing our Military, Defense, and Security Application stream at several upcoming international venues, including:

- Second International Conference on Operations Research and Enterprise Systems, Barcelona, Spain, February 16–18, 2013 ([www.icores.org](http://www.icores.org))
- The EURO-INFORMS Joint International Meeting, hosted by the Italian OR Society in Rome, Italy, July 1–4, 2013 (<http://euro2013.org>)

See *MAS President* on page 4...

Center for Army Analysis, who put on 24 tutorial classes in support of our MORS Education and Professional Development Program.

## Future Events

As you look to the future, you can see MORS continuing to be highly relevant to the needs of the National Security Analytical Community. Upcoming events include:

- *Affordability Analysis: How We Do It*, October 1–4, 2012, Lockheed Martin's Global Vision Center, Arlington, Virginia.
- *Assessments of Multi-National Operations*, November 5–9, 2012, MacDill Air Force Base, Florida.
- *MORS Industry Showcase and Professional Development Day*, December 6, 2012, Hilton Mark Center, Alexandria, Virginia.
- *MORS Quadrennial Defense Review (QDR) Workshop*, January 28–31, 2013, Washington, DC, area (tentative).

- *Design of Experiments* (proposed), TBD February 2013, Washington, DC, area.
- *Professional Wargaming*, March 25–28, 2013, Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland.
- *MORS Education and Professional Development Colloquium*, April 17–18, 2013, United States Naval Academy, Annapolis, Maryland.
- *81st MORS Symposium*, June 17–20, 2013, United States Military Academy, West Point, New York
- *MORS Lunch and Learn*, periodically throughout the year, at various locations including the MORS office building, Alexandria, Virginia.

## Programs and Priorities

It is important to note that all of the work in MORS is done by a small and dedicated professional staff and a large and devoted, passionate group of volunteers. The volun-

teers come from industry, academia, and government, and use their own uncompensated time to create programs and support special events through yearlong committee work, special projects, and outstanding and important meetings, symposia, workshops, and colloquia. We are guided in our efforts by the MORS Sponsors, who provide wisdom and relevance in our changing world, and are like-minded in the goals of the Society. It is our intent to maintain financial stability in austere times, continue to create new valuable products and professional services, and maintain and constantly improve our meetings, publications, and educational events. We are aware of our heritage and determined to take excellent care of our current and future MORS membership and to enhance and advance the profession of operations research. ■

- 20th IFORS 2014, Barcelona, Spain, July 13–18, 2014 ([www.ifors2014.org](http://www.ifors2014.org))

Other ongoing efforts include developing support arrangements and collaborative partnerships with other organizations and agencies for future MAS conferences, workshops, and events (e.g., Defense Strategies Institute; [www.dsigroup.org](http://www.dsigroup.org)), including other professional societies (e.g., MORS, SOLE) and institutes pursuing scientific research and applications (e.g., New England Complex Systems Institute, [www.necsi.edu](http://www.necsi.edu)). Please let us know your thoughts and ideas, and/or if you would like to contribute to these various initiatives.

I'll soon pass the MAS gavel along to Professor **Bill Fox** in Phoenix, so this is my final MAS President's column in *Phalanx*. I want

to publicly thank our Executive Council and all MAS council members—both elected and appointed—for your support and contributions, and especially to MAS past-presidents **Pat Driscoll**, **Ed Pohl**, **Dean Hartley**, **Keith Womer**, and **Bruce Fowler** for your sage advice and guidance. Working diligently behind the scenes is a superb and responsive INFORMS administrative staff. On behalf of MAS, thank you all for your indispensable support; and my personal thanks to **Melissa Forde**, **Mary Magrogan**, and **Ellen Tralongo** at INFORMS, **Janny Leung** at IFORS, and to *Phalanx* managing editor **Joan Taylor**, for your incredible service to MAS.

Most importantly, my sincere *thanks* to you all—our MAS membership, a remark-

able group of professionals supporting our Nation on this unique cusp of history—for this opportunity and privilege—truly an honor—to serve. I express my deep gratitude for your continued support and confidence throughout the journey... quite a ride! (and, as a former paratrooper, you know I am not easily impressed). See you in Phoenix.

**“Veni, Vidi, Duci”**







## Highlights of the 80th MORS Symposium

Bruce D. Wyman, [bdwyman@bdwyman.com](mailto:bdwyman@bdwyman.com)

**M**ore than 1,000 individuals, representing all of the Services and a broad selection of government, industry, and academic entities, participated in the 80th MORS Symposium held at the United States Air Force Academy (USAFA), Colorado Springs, Colorado, on June 11–14, 2012. Our return to USAFA was graced by great weather, excellent host site support, and a robust program.

On Monday we had a wide array of engaging tutorials (please see the separate article by Lisa Kaiser on page 6) and again offered a short course for continuing education unit (CEU) credit through George Mason University. Also on Monday afternoon, we conducted our judging of three teams' presentations competing for the David Rist Prize. We also held the well-attended "First Timer's Orientation," followed closely by the MORS Member Reception at the Colorado Springs Marriott—the MORS headquarters hotel.

Tuesday morning kicked off with a lively and engaging plenary session, which included a memorable and timely keynote address by **General William L. Shelton**, USAF, Commander, Air Force Space Command.

**Trena C. Lilly**, the MORS President, presented the following awards and prizes:

- *New MORS Fellows*: **Dr. Paul K. Davis** and **Mr. Ervin Kapos**
- *Vance R. Wanner Award*: **BG(Ret) Michael L. McGinnis, FS**
- *Clayton J. Thomas Award*: **Dr. William Forrest Crain**
- *John K. Walker, Jr. Award*: **COL Karl Gingrich, CDR Matthew Shane, and Maj. Matthew Durkin**
- *MOR Journal Award*: **Dr. Howard D. McInvale, Dr. Mark P. McDonald, and Dr. Sankaran Mahadevan**
- *Wayne P. Hughes Award*: **LTC Joseph M. Lindquist, PhD**
- *David Rist Prize*: **MAJ Matt Dabkowski and COL Bradley Pippin**, TRADOC Analysis Center at Fort Leavenworth, "Force Design/Force Mix: Building the Best Army Possible with Reduced End-Strength"; Runner

Up: **Dr. Gregg Burgess**, PhD, Director of National Intelligence, Systems and Resources Analysis, "Cross-Intelligence Cost-Benefit Assessment of National Intelligence Programs"

- *Richard H. Barchi Prize*: **Shatiel Edwards** and **Brett Haas**, Program Executive Office, Ground Combat Systems, "PEO Ground Combat Systems Capability Portfolio Analysis Tool (CPAT)"

At the conclusion of the plenary session, all the participants scurried outdoors to observe a spectacular aerial display by the USAFA's *Wings of Blue* parachute team.

Attendees participated in more than 600 presentations across the symposium's seven composite groups, 34 working groups, four distributed working groups, and one focus session, in addition to a palette of Sponsors and other special sessions (please see the separate article by Dr. Donna Blake on page 6). Thirty-one demonstrations were scheduled, and there were 18 poster sessions, which had exemplary visibility during the symposium in the central reception/break area. All presentations approved for public release are now available to registered attendees on the MORS website.

In addition to the professional presentations, attendees were able to participate in the 80th Welcome Mixer at the USAFA Stadium Press Box on Tuesday evening. The MORS social event was held on Wednesday evening at the US Olympic Training Center and participants were treated not only to tours of the training facilities, but also to a gymnastics demonstration, and a Wounded Warrior wheelchair basketball game. Some of the gymnasts competed on the US Olympic Team. Anyone expecting a nonaggressive basketball game was surely surprised by the game that was played. The Fourth Annual MORS 5K Run was held on Thursday morning with more than 70 participants.

### 80th MORSS Disciplines Survey

One of MORS' long-range goals is to increase the number of disciplines represented during MORS Symposia. In prepa-

See **Highlights** on page 6...



Photos, top to bottom: Keynote speaker General William L. Shelton, USAF, Commander, Air Force Space Command; and USAFA Cadet Sam Griner presenting the American flag to MORS Immediate Past President Trena Covington Lilly; and USAFA's *Wings of Blue* parachute team demonstration.





## 80th MORSS Special Sessions

Dr. Donna Blake, donna@bluestormtec.com

This year's annual symposium featured 16 Special Sessions, including the MORS Heritage Session, "Origins of Operations Research in the USAF," chaired by **Deborah Ray** (USA Manpower Analysis Agency); the Office of National Intelligence Session, "Operations Research in Support of the Intelligence Community," chaired by **Roy Pettis**; and the Homeland Security and Homeland Defense Analysis Special Session, presented by **Col David Denhard** (NORAD-USNORTHCOM), **Thomas Denesia** (NORAD-USNORTHCOM), and **Arch Turner** (DHS/S&T). The Prize Paper Session, coordinated by **COL Simon Goerger** (OSD (P&R), USA), included presentations by the Rist and Barchi prize winners.

As in previous symposia, the 80th MORSS included Special Sessions by each of the MORS Sponsors: Air Force, Army, Navy, and OSD/CAPE. Other Special Sessions at the 80th MORSS included:

- "Sponsor's Hot Topic: How Analysis Is Changing to Better Support DoD Decision Makers."
- "The Deployed Analyst," chaired by **Ms. Renee Carlucci**, featured presentations by **Capt Paul Nicholas** (USMC), **Capt Timothy Merkle** (USMC), and **LTC Joseph Lindquist** (USA), all recently returned from Iraq or Afghanistan
- "Strategist's Corner: Two Sets of Tools for Thinking about an Uncertain Future: National Security Challenges from Climate Change to China," by

...**Highlights** from page 5

ration for the 79th MORSS, the program staff developed and executed a disciplines survey in which responses were collected from the principal authors of accepted presentations across all the groups. The survey comprised a list of 78 "disciplines, sub-disciplines, and sub-subdisciplines" and that same listing was used for this year's survey of principal authors. The program staff asked respondents to self-identify "to what 'disciplines' does your presentation have relevance?" Responses were received on 135 separate presentations. During the

**Jacob Heim** (RAND Corporation)

- "80th MORSS Junior/Senior Analyst Session," jointly chaired by **Dennis Baer** and **Rafael Matos** (WBB Consulting, Inc.)

Military Wargaming, introduced in the 79th MORSS with "Drive-On Metz," returned as the "MORS Air Battle Wargame," directed by **Michael Garrambone** (ASC/XRA (InfoSciTex Corporation)). The Military & Analysis Special Session included two tutorials, two lunchtime game sessions, and the final outbrief Thursday afternoon. Other Special Sessions, generally offered at only one MORSS, included:

- "SAFEGARD—The Maritime Integrated Air and Missile Defense Multi-Mission Model," chaired by **Jerry Smith** (OPNAV)
- "Panel for Software OT," chaired by **Brian Thompson** (AFTEC)
- "Cyber Test and Evaluation," chaired by **Ken Pickett** (MITRE)

For most Special Sessions at the 80th MORSS, participation was enthusiastic with attendance close to or even exceeding room capacity.

Special Session topics, whether reoccurring or one-time offerings, should be relevant to the OR community and not be covered by any other type of session or group in the annual symposium. If you would like to suggest such a topic for the 81st MORSS at the US Military Academy at West Point, please contact the 81st MORSS Special Session Chair, **Cindy Grier** (TRAC-FLVN), at cindy.l.grier.civ@mail.mil. ■

79th MORSS survey, 75 of the 78 disciplines were represented. The three "nulls" were biochemistry, geology, and hydrology. During our 80th MORSS survey, 74 of the 78 disciplines were represented. The four "nulls" were different from those in the 79th MORS survey: meteorology, military law, literature, and anthropological linguistics. The responses provided a strong continuation from the initial survey and again underscored MORS' success in providing a robust symposium that represents a strong array of multidiscipline presentations. ■

## Tutorials

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Another great team effort went into this year's MORS Symposium tutorial sessions at Colorado Springs, Colorado. This year's team provided 21 tutorial presentations to more than 700 attendees. The longer presentations on Monday ran from one-hour overviews up to eight-hour in-depth classes. During the week, tutorials were one-hour sessions during the lunch break. This year, 40 classroom hours of instruction were delivered to symposium attendees of all ranks and educational levels by an array of outstanding educators, experienced practitioners, and renowned subject matter experts. A variety of tutorial topics were offered this year, providing new opportunities to satisfy the widely diverse MORS audience. Topics included:

- Problem definition
- Modeling and simulation
- Visual data analysis
- Sensitivity analysis
- Cost estimation
- Linear and nonlinear programming
- Scenario development
- Wargaming

The second annual wargaming tutorial also took place this year. The three-day tutorial kicked off on Monday with a presentation for novices interested in wargaming or players preparing to participate in games. The lunchtime tutorials on Tuesday and Wednesday gave attendees the opportunity to be active wargame participants.

If you have a tutorial you would like to present during the 81st MORSS at the United States Military Academy, West Point, New York, please contact **Mr. Joe Adams**, the 81st MORSS tutorial chair, at jadams@ida.org. ■



# MORS to Team up with CENTCOM and Others to Capture Latest Thinking in Assessments

COL Neil Fitzpatrick, United States Central Command

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## Overview

The US Central Command (USCENTCOM) will host the Military Operations Research Society (MORS) Workshop and a conference involving those engaged in Afghanistan assessments on November 6–9, 2012 at MacDill Air Force Base, Florida. The primary objective of the MORS workshop, entitled “Assessments of Multinational Operations—From Analysis to Doctrine and Policy,” is to develop information that can help inform doctrine, policy, and methods for organizations and countries performing assessments.

Any member of the North Atlantic Treaty Organization (NATO)/International Security Assistance Force (ISAF)/Partnership for Peace (PfP) community with a SECRET clearance can attend the MORS Workshop, with all briefs and discussions restricted to SECRET releasable to NATO/ISAF/PfP or below. All those performing, using, or conducting research on assessments are encouraged to attend the workshop. This includes practitioners that may not be associated with the operations research field, such as interagency specialists, intelligence experts, and planners. The Afghanistan Assessments Conference (AAC) is by invitation only.

The MORS special meeting will use the combination of subject matter experts in policy and doctrine fields with practitioners of quantitative and qualitative assessments (with emphasis on operations research areas) to (1) identify and capture the current status of assessment techniques and procedures, (2) extract the ones that provide useful insights and applications to the overall community, (3) incorporate these insights into an unclassified document for use by allied assessment communities, and (4) publish a general article in a non-OR publication describing the possible interactions between assessment and planning (to include general ideas, concepts, techniques, and processes). The workshop intends to provide unclassified products for use by the entire community.

One unique aspect of this meeting is the leveraging of expertise from ongoing operations in Afghanistan through a concurrent and interactive session with the Afghan Assessment Conference. The primary objective of the Afghanistan Assessments Conference (AAC) is to identify potential solutions to four key assessment questions facing the ISAF in Afghanistan. One potential question is how to continue to perform assessments with the reduced information flow due to the drawdown. Given the size and scope of assessments in Afghanistan, it makes sense to leverage the expertise in both organizations (MORS and the Afghan assessment community) in each other's event. The two efforts complement each other, as they share similar goals—that is, to improve current and future assessments in Afghanistan and, more broadly, to better inform key leader decisions in future operations around the globe. Current plans call for the MORS workshop to meet Monday to Thursday, with the AAC starting Wednesday afternoon and ending on Friday.

## Background

Over the last decade, many organizations across the globe have paid increasing attention to the operations assessment area. At its core, the political and military leaders involved in various operations want to be able to answer to nations, organizations, and the populations a deceptively simple question: “Are we succeeding in what we are trying to accomplish?” Answering such a question—and support the answers with relevant facts and figures—has proven elusive and difficult in most cases. Often, assessment processes and methods provide incomplete or inadequate answers, or fail to meet commander's needs. Even when an assessment meets the need, the dynamics of human interaction (especially in conflict) and the changing environment render the need to adapt and adjust processes to fit the new paradigm.

In particular, the assessment staffs in the current conflicts face a multitude of

challenges because commanders rotate in and out of theater, political information demands shift as fast as public opinion, and data sources vary in accuracy and consistency. Combining qualitative and quantitative information with context, into a cohesive picture of the status of an operation or campaign that supports decision making is the goal of any campaign-level analytical effort. Because the operational tempo in the region is high, there is rarely an opportunity to discuss and document the valuable insights and techniques and procedures developed to deal with a counter-insurgency (COIN) environment. This workshop will capture some of this important information before it is lost and provide it to participating nations and organizations for use in their policies, handbooks, and/or doctrine.

Several recent events and activities have worked on assessments, and the special meeting intends to include their information as baseline information. They include (but are not limited to) the following.

*Afghanistan Assessments Conference.* This periodic meeting centers on assessment information flow and related challenges. The 3+1 Afghanistan Assessments Community (3+1 AAC) conducts these classified sessions. (The term “3+1 AAC” refers to the three major multinational headquarters supporting Afghanistan [International Security Afghanistan Force (ISAF), Joint Forces Command—Brunssum (JFC-B), and the Supreme Headquarters, Allied Powers Europe (SHAPE)] plus USCENTCOM.) Most previous conferences were hosted by JFC-B. USCENTCOM will host this 3+1 AAC and it will have its own agenda. (If you plan to attend and are involved in the 3+1 AAC, please contact J-8, USCENTCOM point of contact for more details.) Having these two meetings executed concurrently in the same location provides a unique opportunity for both groups that cannot be duplicated. It is anticipated that many from the 3+1 AAC will attend

See *Assessment* on page 8...



the first two days of the MORS workshop. Furthermore, the results of the workshop will be summarized and briefed to the 3+1 AAC on Friday.

*MORS 2009 Irregular Warfare Workshop.* This workshop, held in Orlando, Florida, addressed assessment frameworks and cataloged some best practices coming out of Iraq and Afghanistan. Armed with a clearer understanding of an assessment framework and data requirements, the OR community worked with the operational community to improve the assessment and data management processes in both theaters. This forum, in conjunction with other efforts, led to the discussion and inclusion of some ideas and general insights on the use of assessments in various policy and doctrinal items. By 2011, the prevailing view was to assess a campaign through the plan's lines of effort or lines of operations (LOO) (i.e., security, governance, essential services, economic development, information operations, etc.). Associated with each LOO in the plan were corresponding measures translated into a quantitative item (number, "stop light chart," or similar information).

*NATO Operations Assessment: A Case Study Based on Planning for Transition in Afghanistan.* In June 2010, the NATO Research and Technology Organization (RTO) System Analysis and Studies (SAS) Panel established a specialist team to respond to a request from ISAF to improve data collection and sharing in Afghanistan. In July, the scope expanded to include developing metrics to support decisions for transitioning responsibilities from ISAF to the Afghanistan government. The resulting study was organized according to ISAF's four lines of operation (LOO) —security, governance, rule of law, and economic development—and included recommended metrics for each line of operation, a Best Practices Guide, and suggestion for improving data collection and sharing (including an enduring data cards project used to identify data sources).

*Recent Published Articles and Documents.* A series of articles from Dr. Jon Schroden, Dr. Stephen Downes-Martin, Ben Connable, and others have addressed major concerns about assessments—in particular, the need to develop relevant and usable assessment processes and products. One area of note from the perspective of the conference centers on operations that misemploy quantitative measures—in essence, the

overuse and misuse of numbers.<sup>a</sup>

*Evolving Assessment Paradigms.* In 2011, commands across the globe started to re-examine their assessment processes and started moving toward a different approach. Headquarters, International Security Assistance Force in Afghanistan brought in alternative perspectives (to include critics) and developed an alternative approach. Military elements in the Philippines, Horn of Africa, and other areas started putting forth various methodologies to address the commander's need for an assessment. This workshop will strive to include these assessment perspectives in its agenda.

*Other Activities.* Across the globe, countries and international organizations have developed information on assessments and translated it into various publications—usually as a section in their handbooks, policy documents, or doctrinal manuals. More direct examples include the NATO Assessment Handbook and the United States Department of Defense Joint Publications 3.0 and 5.0. Other publications address the need to assess operations and determine progress in a more indirect manner, such as various chapters in the United Nations Peacekeeping Operations: Principles and Guidelines. In addition to publications, meetings, and conferences to address assessments (directly or as a part of the overall operational process) occur regularly.

## Objectives

The primary objective of this MORS workshop is to develop a document that can help inform doctrine, policy, and methods for organizations and countries performing assessments. To achieve this objective, the workshop will use a combination of subject matter experts in policy and doctrine fields along with practitioners of quantitative and qualitative assessments (with significant emphasis on insights from members of the 3+1 assessments community and operations analysis areas) to (1) identify and capture the current status of assessment techniques and procedures, (2) extract the assessment techniques and procedures that provide useful insights and applications to the overall community, (3) incorporate these insights into an unclassified document for use by allied assessment communities, and (4) publish a general article in a non-OR publication describing the possible interactions between assessment and planning (to include general ideas, concepts, techniques and processes).

## Participants

The workshop is open to all citizens of NATO/ISAF/PfP countries with a SECRET clearance. The workshop organizers are especially interested in having individuals with backgrounds in assessments. Because the assessment process involves more than just numbers and statistics, practitioners of assessments from a qualitative perspective are encouraged to attend. Special invites will be made to members of the 3+1 Afghanistan Assessment Community as we seek to capture many valuable lessons learned over the past eight years of conflict.

## Approach

The workshop will begin with a short series of background presentations, a keynote, and expert panels. This will be followed by two and a half days of working group sessions and working group out-briefs on the last day. There will be limited background presentations as most participants are familiar with current assessment concepts as contained in international and national publications. In other words, the special meeting intends to move beyond a basic discussion on assessments and work on expanding upon areas that will help an individual or organization plan and execute an assessment. A read-ahead document will be provided in advance of the actual event so that the limited time is utilized effectively.

The underlying concept of the working groups centers on the idea of an assessment handbook with the following topic areas:<sup>b</sup>

- Principles of Assessment
- Assessment and the Environment
- Strategic Theater Assessments (Theater Campaign Assessments)
- Campaign Assessments
- Operational and Tactical Assessments
- Operations Analysis Tools for Assessments
- Data and Knowledge Management

Each topic area will stand alone so that organization using the results can easily focus on a particular area. In other words, the event organization is not prescriptive. Instead, the approach intends to provide a "menu" so that the entire community of participants can employ it to fit into their current way of executing assessments.

Each of the working groups above will develop a more detailed read-ahead package specific to the assigned topic, and will focus on developing or refining a doctrinal chapter or equivalent product



devoted to their functional area. The working group chairperson/co-chairperson will coordinate the read-ahead with the special meeting chairs prior to distribution; the chairs can assist in that distribution and in other matters as needed. The read-ahead should provide a framework based on available publications and other information. This read-ahead provides a road map for the working group. It highlights what information is requested from the working group. The product will include a completed topic paper derived from the provided framework.

The special meeting will also employ an eighth working group—the Synthesis Group. This group has several functions:

- Look across all the workshop activities and the deliberations of the individual working groups to make observations on common themes, problems, gaps, linkages, interdependencies, overarching concepts, and other issues
- Facilitate cross-feed of information between the working groups to help ensure a more integrated workshop outcome
- Assist the working group chairs and co-chairs in accomplishing their objectives
- Prepare a synthesis report summarizing the workshop activities and the Synthesis Group's observations, comments, and recommendations
- Provide an Executive Summary for the Handbook that is derived from the material developed in each of the working groups

The Synthesis Group will accomplish this by participating in all workshop activities, as well as by stationing members in each working group. Some of its members will roam between working groups, and others will concentrate on producing the group's products—out briefing, final report, and

Handbook Executive Summary. Synthesis Group membership is by invitation—agreed to by the MORS special meeting/Synthesis Group leadership.

## Administration

The interactions with another meeting and the needs of the sponsors dictate a more condensed agenda than usually seen in MORS special meetings. The opening session will take place Monday morning (November 5) with the welcome, plenary speaker, keynote speaker, and administrative instructions. Current plans call for an initial panel of experts with recent experiences or expertise in the assessment field. The special meeting will have only two other one-hour panel sessions involving intelligence and interagency. Most of the time available will be provided to the working groups. The organizers understand that these groups need the time for product development.

Working groups will present their products Thursday. This will include an out-briefing to all of the special meeting attendees. The special meeting chairperson will provide a comprehensive out-briefing to the AAC Friday.

A social event will be held during the week with a cash bar and complimentary hors d'oeuvres. A snack area will be made available during the meeting. Other administrative items are currently under development.

Attendees will be asked to provide an e-mail address to facilitate the distribution of read-aheads and administrative information.

## Call for Participants and Points of Contact

As noted previously, the workshop organizers are especially interested in having individuals with backgrounds in assessments.

However, those who wish to interact with the experts are encouraged to attend as long as they meet the criteria attendance. Due to the size of the facilities and the level of participation, attendance may be limited.

If you would like more information, please contact the special meeting points of contact: H. J. (Tougy) Orgeron at herman.j.orgeron.civ@mail.mil or 703.806.5464, Renee Carlucci at renee.g.carlucci.civ@mail.mil or 703.806.5617, or CDR Marcia Melvin at marcia.melvin@centcom.mil or 813.529.8118.

## Notes

<sup>a</sup>Recent examples of published work from the three individuals mentioned include the following: Ben Connable, *Embracing the Fog of War: Assessment and Metrics in Counterinsurgency* (Santa Monica: RAND Corporation, 2012); Stephens Downes-Martin. "Operations Assessment in Afghanistan is Broken: What is to be Done?" *Naval War College Review*, Vol. 64, No. 4 (2011), 103-125; Jonathan Schroden, "Why Operations Assessments Fail: It's Not Just the Metrics," *Naval War College Review*, Vol. 64, No. 4 (2011), 89-102. Headquarters, ISAF used their work and incorporated their insights into a presentation at HQ, ISAF, in 2011. It must be noted that other experts in the field not mentioned here have explored the assessment area and have published as well. Writers include (but are not limited to) Jason Campbell, Michael O'Hanlon, Jeremy Shapiro, Adriana Lins de Albuquerque, CDR Robert J. Michael II, William P. Upshur, Jonathan W. Roginski, and David J. Kilcullen.

<sup>b</sup>The actual organization of the working groups are current as of the time of this publication and can be changed before the actual event. ■





## MEETING ANNOUNCEMENT

# MORS QDR Workshop Scheduled for the DC Area in late January 2013

*Chairs: Mr. Mike Leonard and Dr. Jim Thomason, Institute for Defense Analyses*

**A**MORS workshop “to explore and discuss issues and gain insights for the 2014 Quadrennial Defense Review (QDR) in a challenging budget environment” is scheduled for January 28-31, 2013 at a location in the Washington, DC area. The workshop will begin on Monday afternoon with optional tutorials on topics such as the QDR legislation, an overview of the current defense strategy, and sum-

maries of ongoing analytical preparations. On Tuesday morning the workshop officially kicks off with presentations by senior officials from past and current administrations and reviews of lessons learned in prior QDRs. Working group sessions will begin on Tuesday afternoon and continue all day Wednesday and Thursday morning with outbriefs on Thursday afternoon.

The workshop will be held at the

SECRET rel Australia, Canada, Great Britain, United States (ACGU) level with allied participants expected from Australia, Canada, and the United Kingdom. Special emphasis will be placed on gaining interagency, White House, and Congressional participation. Mark your calendars now and follow the planning on the MORS website. ■



## MEETING REPORT

# Analytical Approaches to Airborne ISR Workshop

*John Orem, OSD/CAPE, john.orem@osd.mil; and Jim Bexfield, FS, and formerly OSD/CAPE, jim\_bexfield@comcast.net*

**K**nowing where the enemy is, how many there are, what they're doing, how they're supplied and what kind of support they have gives our forces a distinct edge. Airborne Intelligence, Surveillance, and Reconnaissance (AISR) is a key capability for providing near real-time threat identification, tracking, and targeting, as well as battlefield situational awareness. AISR missions, performed by manned and unmanned platforms and the sensors they employ, have expanded exponentially in the recent Iraq and Afghanistan conflicts as ISR sensors become smaller and more efficient and platforms become more reliable and able to provide persistent loiter time. Determining the proper portfolio of AISR assets and ensuring that we have the manpower and enablers necessary for future success requires challenging and innovative analyses.

To respond to this challenge, MORS held a workshop at National Defense University, Fort McNair, Washington, DC, on April 16–19, 2012. More than 120 people attended the workshop, which was open to all citizens of Australia, Canada, Great Britain, and the United States (ACGU) with a SECRET clearance. The workshop's goal was to improve one's understanding of the strengths and limitations of current AISR analytic techniques and generate ideas for

developing new and improved analytic methodologies.

This workshop used a different approach from the traditional MORS workshop approach to accomplish these goals. Most of the workshop was devoted to four 3-4 hour plenary sessions that addressed a major AISR issue. Each session focused on a specific topic and consisted of an introduction to the issue area; briefs on the analytic methodologies used in recent exemplar studies that influenced Department of Defense (DoD) decisions in the issue area; reviews by a discussant of the strengths and limitations of these analytical approaches for emerging issues in the area along with suggestions for improving the analytical approaches used in future studies; and a discussion by a panel of experts and the workshop participants that continued the emphasis on identifying ways to improve analytically.

There were three keynotes by senior DoD officials that set the stage for the discussions and four working groups that met for about five hours (compared to 16 hours in a typical MORS workshop) to address a specific AISR analytical question. The working groups provided a 15-minute overview of their findings, and a synthesis group captured the major takeaways in Thursday afternoon presentations.

## Keynote Speakers

The three keynote speakers were candid and often provocative in their remarks.

- The Honorable **Christine Fox**, Director, Cost Analysis and Program Evaluation (CAPE), OSD, discussed four major challenges facing the Department of Defense—ranging from A2AD and counter-WMD to decreasing resources—and charged the analytic community with developing new approaches to better deal with unstructured problems and issues of capacity in an uncertain future.
- The Honorable **Michael Vickers**, Undersecretary of Defense for Intelligence, OSD, provided insights and challenges regarding the “state of intelligence” from the AISR perspective.
- **LTG Michael Flynn**, Assistant Director of National Intelligence for Partner Engagement, ODNI (at the workshop we learned about LTG Flynn's new assignment as Director, Defense Intelligence Agency), drew from his OIF/OEF experiences to provide insights on issues such as “How much intelligence do we share with our allies?”

Table 1 presents additional observations from the keynote presentations.

**Table 1. Additional observations from the keynote presentations.**

Challenges	
<ul style="list-style-type: none"> <li>Major challenge is identifying better ideas on how to analyze unstructured problems</li> </ul>	<ul style="list-style-type: none"> <li>What ISR capabilities do we rationalize (sustain, archive, dispose) post-Afghanistan? Integration is the key leadership challenge over the next decade</li> </ul>
Use of scenarios	
<ul style="list-style-type: none"> <li>Need to get away from reliance on a few comprehensive scenarios as the primary basis for sizing</li> </ul>	<ul style="list-style-type: none"> <li>Good analysis over a wider range of scenarios is necessary to answer key question</li> </ul>
Analysis insights	
<ul style="list-style-type: none"> <li>Bimodal warfighting environment: (CT and A2AD) ISR missions are very different—little projected overlap in AISR solutions</li> </ul>	<ul style="list-style-type: none"> <li>Analysis should incorporate agility as a portfolio characteristic. How do we build capability quickly to adapt and expand (reconstitute) in the event we “get it wrong”?</li> </ul>

**Table 2. Plenary topics and presentations.**

Topic 1: Determining force mix	Topic 2: Improving our ability to find high-value targets (HVT)
<ul style="list-style-type: none"> <li><i>ISR Aircraft Force Mix Study</i> (Dr. Doug Shiels, IDA)</li> <li><i>Institutionalizing UAV Front End Assessment (FEA)</i> (Dr. Laura Williams, OSD/CAPE)</li> </ul>	<ul style="list-style-type: none"> <li><i>High Value Targets (HVT) Study</i> (Dr. Hugh Chen, Dept of Energy [formerly OSD/CAPE] &amp; Mr. Chris Whitlock, IBM)</li> </ul>
Topic 3: Determining capacity	Topic 4: What enablers do we need?
<ul style="list-style-type: none"> <li><i>Army BCT Integrated Sensor Coverage Area (ISCA) Study</i> (Mr. Terry Mitchell, HQ Army/G2 and Mr. James Hildebrand, IBM)</li> <li><i>USAF Support to BCT Study</i> (Dr. Glenn VanDerWoude, HQ Air Force/A9)</li> <li><i>Army AISR Portfolio Review</i> (Ms. Pamela Blechinger, Army/TRAC Ft. Leavenworth)</li> </ul>	<ul style="list-style-type: none"> <li><i>Processing, Exploitation and Dissemination (PED) Study</i> (Isaac Porche, RAND)</li> </ul>

All of the speakers acknowledged the complexity of dealing with an uncertain future. Because we must accept that invariably that “we will get the future wrong,” an analytic emphasis on robustness of conclusions under a range of possibilities, and the value of capabilities that can adapt, expand, and reconstitute under changing circumstances should be emphasized. The speakers suggested the community explore alternative methodologies that embrace risk and the unknown in more broadly scoped analyses. In addition, the idea that investment is needed in a primarily bimodal way to ensure capabilities in both the counterterrorism (CT) and area access/area denial (A2/AD) domains was generally accepted. Our analysis should align with this reality.

### Plenary Sessions

The bulk of the workshop consisted of plenary sessions that addressed four major AISR topics. Each session began with a review of the issues in the topic area by the workshop chair, followed by exemplar briefs on the methodologies used to support recent decisions in the area. Next, a discussant from the expert panel commented on the state of the methodology. This was followed by comments and suggestions for improvements from the other members of the panel and the audience. Table 2 lists the topics and briefs.

The workshop was fortunate to have three MORS sponsors as members of the expert panel. The members of the panel were:

- **Mr. Arthur Barber**—Deputy Director of the Assessment Division, Office of the CNO (N81) (discussant for topic 1 and Navy sponsor)
- **Dr. Jacqueline Henningsen**, FS—Director for Studies & Analyses, Assessments, and Lessons Learned, Headquarters US Air Force (AF sponsor)
- **Dr. Matthew Schaffer**—Deputy Director, Analysis and Integration, Office of the Secretary of Defense, Cost Assessment, and Program Evaluation (CAPE) (discussant for topic 3 and OSD sponsor)
- **Dr. Steve Warner**—Director, System Evaluation Division, Institute for Defense Analyses
- **Dr. Igor Mikolic-Torreira**—Special Assistant for Operations Analysis, Office of the Secretary of Defense, Cost Assessment, and Program Evaluation (CAPE) (discussant for topic 2)
- **Mr. Frank Strickland**—Senior Fellow, IBM Center for The Business of Government, Partner with IBM’s Global Business Services (discussant for topic 4)
- **Ms. Pamela Blechinger**—Director of Operations, US Army Training and Doctrine Command Analysis Center, Fort Leavenworth

Many of the key observations by the discussants and audience applied to multiple topics so we provide some general observations instead of summarizing results by topic.

- **Determining future ISR demand.** The idea that “there will never be enough AISR resources” was pervasive throughout the workshop. Therefore, the focus of many was on “how much is good enough” and how to allocate resources and manage demand.
- **Debate about analytic approach.** Our community has long argued about macro (campaign level) versus micro (mission level) approaches. We need to better understand the strengths and weaknesses of each approach.
- **Good analytic practices.** Considerable emphasis was placed on the urgent need to better incorporate risk and uncertainty into our analyses. For example, assessing what Special Operations Forces (SOF) needs to address High Value Targets (HVTs) can reduce risk.

See Meeting Report on the following page ...



**Table 3. Key working group observations.**

WG 1: Capacity	WG 2: Capability
<p>What analytical techniques can one use to tie AISR capacity to the required missions? (Chairs: Brian Hodges, TRAC Fort Leavenworth; Dr. Todd Calhoun, OSD CAPE)</p> <ul style="list-style-type: none"> <li>Capacity requirements, even based on prioritized operational ‘needs,’ will never be satisfied ... budget constraints will dominate</li> </ul>	<p>What are the analytic techniques required for CT and A2/AD AISR missions and how are they different? (Chairs: Dr. Jeff Grobman, OSD/CAPE; Mr. Mike Payne, AF/A9)</p> <ul style="list-style-type: none"> <li>Analytic attributes and the nature of the data are more important to assessing capability than the specific analytic tools used</li> </ul>
WG 3: Manned vs. Unmanned Mix Analysis	WG 4: Processing, Exploitation, and Dissemination (PED)
<p>How do manned systems and unmanned systems differ in the analytic techniques used to measure them? (Chairs: Dr. John Borsi, OSD CAPE; LtCol Mark Mocio, JS/J8)</p> <ul style="list-style-type: none"> <li>Analytic techniques do not need to be different to resolve manned vs. unmanned questions</li> </ul>	<p>What analytic techniques can help inform the relationship between AISR, PED force structure and mission effectiveness? (Chairs: Mr. Kevin Sherman, USDI; Dr. Gregg Burgess, ODNI)</p> <ul style="list-style-type: none"> <li>Will never satisfy demand; key questions are “how much is good enough” and “how do we manage demand”</li> <li>Primarily limited by manpower; not likely to change given current technological vectors</li> </ul>

- **Sharing of databases and studies.** Emphasis should be placed on better sharing of databases and improving knowledge of their existence. Analysts often don’t find out about something the study needs until late in the process. In addition, data is rarely “clean”—analysts need to improve our ability to use unstructured, heterogeneous data.

**Working Groups**

The third track consisted of four working groups, each addressing a specific question associated with AISR analysis. Each group leveraged insights gained from keynote and

plenary presentations during their limited time (5–6 hours) to deliberate on their assigned question. They also used short overview briefs from other completed studies that focused on the group’s question. Table 3 summarizes the major insights from each working group.

**Summary**

The Synthesis Group, led by **Mr. Ed Brady**, Strategic Perspectives, Inc., made three suggestions in their briefing:

- **We need to shift our analytic footing to deal with an unpredictable future.**

This includes using a wider range of scenarios and parameter spaces even if it results in less detailed analyses. In doing so, it is essential that we illuminate risk in our analytic assumptions and use methodologies that incorporate and communicate these risks.

- **We need to build and sustain a mechanism that captures existing data and facilitates analytic sharing.** Initiatives should be undertaken to gather and leverage empirical data as well as operator plans, priorities, and processes before they are lost. This requires some mechanism that facilitates sharing of study plans, analytic methodologies and techniques, assumptions, and results as well as raw data.
- **We need to include agility as a key performance factor.** Measuring agility and adaptability is a major challenge for the future. The use of drones in Operations Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) is an example of adapting an existing capability to a new future. Agility includes the ability to rapidly “reconstitute” in light of changing circumstances. This reconstitution might be after a force reduction, or after causalities—neither of which have been given much analytic thought in the past 10 years.

Finally, we thank all of the individuals mentioned here, the other attendees, the MORS staff, and the excellent support provided by National Defense University for making this workshop a success. For more information, please contact John Orem (john.orem@osd.mil or 703 614-1490). ■



## A Tribute to Lieutenant General Glenn A. Kent

Dr. Bob Sheldon, FS, [bs@group-w-inc.com](mailto:bs@group-w-inc.com)



**L**t Gen Glenn A. Kent, USAF (ret), a strategist, analyst, and teacher whose career spanned World War II, the Cold War, and the post-Cold War eras, and the 1980 MORS Wannier laureate, died April 25, 2012.

Gen Kent was cited for:

*"his outstanding contributions to the military operations research community in general and to the Military Operations Research Society in particular. Over the years, General Kent has enriched the content and strengthened the credibility of military operations research as a significant and influential discipline for defense decision making at the highest levels of the United States Government. He has been uncompromising in his insistence upon complete objectivity in analysis and his unswerving devotion to the principle that the purpose of operations research is to illuminate, rather than to advocate."*

Gen Kent served 33 years in the US Air Force, and his extraordinary career is summarized in his official Air Force biography, which can be found at <http://www.af.mil/information/bios/bio.asp?bioID=6042>.

Among his many literary accomplishments is Gen Kent's most widely circulated article "On Analysis," which was origi-

nally published in the May 1967 issue of *Air University Review*. In that article, Gen Kent says, "The purpose of an analysis is to provide illumination and visibility to expose some problem in terms that are as simple as possible." MORS republished that article in the March 2000 issue of *Phalanx* for the analytical community. It is available online at <http://www.airpower.au.af.mil/airchronicles/aureview/1967/may-jun/kent.html>.

Clayton Thomas, FS, former Chief Scientist, Air Force Studies and Analyses Agency, and former MORS Air Force Sponsors' Representative, once said of General Kent, "General Kent's career and exposition of good analysis constitute a gigantic case study that has educated students and executives for many years. His paper "On Analysis" is a true classic—a masterpiece dissertation of analytic principles. It is worth frequent re-reading."

Jim Bexfield, FS, gives his account of meeting Gen Kent:

*"In early 1971 I was assigned to AF Studies and Analyses (AFSA), which was then commanded by Maj Gen Glenn Kent. As a junior Captain I found myself supporting studies being led by more senior analysts. This changed one day when I was called into Gen Kent's office along with Rick Camp (a PL 313 [equivalent to an SES today] who, together with Clayton Thomas and several others, had recently joined AFSA after the Air Force's civilian OR organization was shut down). Kent had just returned from a trip during which someone had questioned the validity of the expected value model AFSA was using to assess bomber effectiveness. Rick and I were charged with assessing the validity of the current model and, if necessary, developing a better one. The result was a 6-month activity that included several incredibly informative sessions with Gen Kent and culminated in my first MORSS presentation in June 1972. I was a very fortunate junior analyst—indeed!"*

Paul Davis, FS, describes Gen Kent:

*"Although brilliant, irascible, and at times highly critical, Glenn Kent was at the same*

*time exceedingly generous in mentoring young analysts. He might rail about incompetence when he saw it in a meeting, but he was available for lengthy person-to-person in-depth discussions about matters both elementary and advanced. He thoroughly enjoyed the mentoring, the give-and-take with good young minds, their intellectual growth, and their later success."*

Roy Rice, FS, commented that,

*"You're nobody in the Air Force OR community unless you've been wired brushed by Gen Kent. The man was brilliant! We will miss him."*

Many of Gen Kent's publications completed during his 20 years at RAND are available online at [http://www.rand.org/pubs/authors/k/kent\\_glenn\\_a.html](http://www.rand.org/pubs/authors/k/kent_glenn_a.html). This list includes Gen Kent's memoir, *Thinking about America's Defense: An Analytical Memoir*, published in 2008 by RAND ([http://www.rand.org/pubs/occasional\\_papers/OP223.html](http://www.rand.org/pubs/occasional_papers/OP223.html)).

Gen Kent's MORS oral history appears in *Military Operations Research*, Volume 17, Number 2. We are deeply indebted to Gen Kent's wife, Mrs. Phyllis Kent. As Gen Kent's eyesight declined, it was Mrs. Kent who read the oral history transcript to Gen Kent so he could do justice to its review for generations of new analysts. ■





## An Appreciation of Alfred G. Brandstein (1938–2012)

Cortez D. (Steve) Stephens, Marine Corps Combat Development Command, [cortez.stephens@usmc.mil](mailto:cortez.stephens@usmc.mil)

Gene Visco, FS, [eugene.visco@lmco.com](mailto:eugene.visco@lmco.com)

The operations analysis world lost one of its prime contributors when Alfred G. Brandstein “AlGeBra” (a wonderful application of the initial letters of his name) passed away on June 13 of this year. Al, also known as Dr. B. to his many colleagues and leaders at the US Marine Corps Combat Development Command (MCCDC), Marine Corps Base Quantico, was the analysts’ analyst. We had the good fortune to have served with Al in different capacities. Steve worked with Al in what is now the Operations Analysis Division at the MCCDC. Al was essentially the founder of that division, later becoming the chief analyst of MCCDC. One of his most significant contributions to the field of military operations research is the creation of Project Albert, a comprehensive, international program of the application of agent-based models to critical operational problems. Al fostered the development and improvement of agent-based models, not only throughout the Marine Corps but throughout the military components of the Department of Defense and allied and friendly nations. Gene had the good fortune to serve on Al’s advisory group for Project Albert, and thus had his eyes opened to

the potentials of agent-based modeling approaches to understand complex military operational problems.

Prior to his service with the Marine Corps, Al worked for the Army at the Harry Diamond Laboratories in Virginia. In 1980, he joined the Analysis Support Branch at MCCDC. During Operations Desert Shield and Desert Storm, he directed the Marine Corps Operations Analysis and Assessment Group. Later, he ascended to the rarified civil service rank of the Senior Executive Service as chief analyst, where he directed Project Albert from its inception.

During his days at Quantico, Al became renowned for his concern for the growth of younger analysts, particularly active-duty officers. Through a variety of mechanisms, he served as a mentor to echelons of Marine Corps officers on the road to becoming significant contributors to the intellectual base of the Marine Corps; Quantico is now recognized as the center of the Corps’ forward thinking. Always, the most junior analysts in the Corps had the undivided attention of the most senior analyst when they needed to discuss a perplexing problem or just wanted to hear words of wisdom.

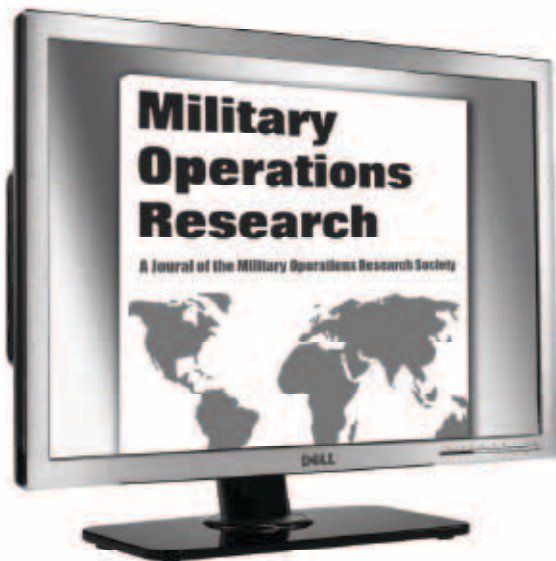
After leaving the Marine Corps, Al provided consulting services to Northrop Grumman and the MITRE Corporation,

where he conducted further research on border security using agent-based models.

Al Brandstein also had time and energy to spare to provide MORS with great support and contributions. He served on the Board of Directors as the Marine Corps Sponsor’s Representative, as a Board Director, and in 2000, received the Clayton Thomas Award. The community is fortunate that Al’s oral history, documented by Steve and John Bruggeman, has recently been published in *Military Operations Research*, Volume 17, Number 1 (2012), so his history lives on.

Dr. Brandstein’s family has extended an invitation to Dr. Brandstein’s friends and colleagues. “Dinner and a memorial service for Alfred G. Brandstein will be held on Sunday, October 7 at 5:00 p.m. at the Old Hickory Golf Club, 11921 Chancelford Drive, Woodbridge, VA 22192. All are welcome to join in the celebration of his life. No RSVP necessary.”

The obituary in *The Washington Post*, June 17, 2012, listed a large family of children, grandchildren (seven), siblings, nieces, nephews, and cousins. Al also leaves behind a large “family” of military operations analysts who will remember him as a friend, colleague, mentor, and, above all, an honest and trustworthy fellow analyst. ■



## The MOR Journal is Now Online

> [www.mors.org/journal-online](http://www.mors.org/journal-online)

The peer-reviewed journal, *Military Operations Research*, is now available online. Members can access the current year and past two years for free. Material from the full 16-volume, 62-issue, 240+ article archive can also be researched and purchased on a subscription or per-article basis. Visit [www.mors.org/journal-online](http://www.mors.org/journal-online) and help build your research on a solid foundation.







## MORS Stephen A. Tisdale Graduate Research Award



Major Michael Kevin Chankij (right), United States Marine Corps, recipient of the Military Operations Research Society Stephen A. Tisdale Graduate Research Award, June 2012.

**M**ajor Michael Kevin Chankij, United States Marine Corps, was selected as the June 2012 recipient of the Military Operations Research Society Stephen A. Tisdale Graduate Research Award. A committee of Operations Research Department faculty who carefully examined several nominated theses meeting the criteria provided by your society made the selection.

Major Chankij's thesis is entitled "Assessing Resiliency of the JP-8 Distribution System on Guam." Assistant David L. Alderson and Distinguished Professor Gerald G. Brown of the Operations Research Department faculty advised Major Chankij on his thesis.

### Assessing Resiliency of the JP-8 Distribution System on Guam

Major Michael K. Chankij, United States Marine Corps  
BE, Vanderbilt University, 2000  
MS in operations research, Naval Postgraduate School, June 2012  
Advisor: Gerald G. Brown, Department of Operations Research  
Co-Advisor: David L. Alderson, Department of Operations Research  
Second Reader: CDR Harrison C. Schramm, Department of Operations Research

The island of Guam is a strategically vital United States territory with military infrastructure. Guam needs to be defended against both a thinking adversary and natural disaster. The strategic functions of Guam include basing and servicing for ships, soldiers, and aircraft. Among these strategic functions, we focus on one: the capability to provide fuel for military aircraft. This thesis analyzes the attack resiliency of the JP-8 delivery system from ship and storage tanks to aircraft at Andersen Air Force Base. This research utilizes measurements of current capabilities and measurements of current demand and projected increased operational tempo demand to quantify the effects of a worst-case disruption of the system.

By using an attacker-defender (AD) model, we seek to quantify mitigated effects of a worst-case scenario attack or natural catastrophe to US operations in Guam. The end result provides PACAF with those systems' resources that are most vulnerable and should be given priority for hardening.

### Biography

Major Michael Kevin Chankij was born on March 30, 1978 in Chattanooga, Tennessee. He graduated from Vanderbilt University in 2000 with a bachelor's of engineering degree in computer engineering and was commissioned via the NROTC program as a 2nd Lieutenant in May 2000.

Upon completing The Basic School in December 2000, he proceeded to Fort Sill, Oklahoma, for the Field Artillery Officers Basic Course. After completing training for his 0802 (artillery) designation in May 2001, he was assigned to Battery T, 5th Battalion, 10th Marines, 2nd Marine Division, II MEF. During this time, his billets included forward observer, Headquarters platoon commander, battery fire direction officer, battalion fire direction officer, and assistant operations officer.

In 2004, Maj Chankij was transferred to Camp Fuji, Japan, as the range control officer and camp operations officer. In

2005, he was promoted to Captain as well as transferred to 5th Air Naval Gunfire Liaison Company (ANGLICO), III MEF in Okinawa, Japan. He completed his training as a joint terminal attack controller in 2005. As a Firepower Control Team (FCT) leader, he deployed to Operation Iraqi Freedom (OIF) as part of a detachment with 2d ANGLICO, February to September 2006. Upon return from deployment, the detachment rejoined 5th ANGLICO and Maj Chankij returned to OIF with 5th ANGLICO, again as a FCT Leader, and was there from March to October 2007.

In 2008, Maj Chankij transferred to Fort Sill, Oklahoma, to attend the Army's Field Artillery Captain's Career Course (FACCC). In June 2008, Major Chankij graduated from FACCC, completing his requirement for career-level professional military education (PME). He transferred back to 5th ANGLICO in Okinawa, Japan, where he deployed from September 2008 to January 2009 to OIF as the assistant operations officer.

In March 2009, Maj Chankij transferred to 3rd Battalion, 12th Marines, 3d Marine Division, III MEF as the operations officer. He also commanded Headquarters Battery, 3rd Battalion, 12th Marines.

In June 2010, Maj Chankij transferred to the Naval Postgraduate School and reported in as a student for the Operations Research Department, Program 360. He was promoted to Major in October 2010. After graduation, Major Chankij will be reporting to the Operations Analysis Division, Quantico, Virginia.

Personal decorations include the Navy and Marine Corps Commendation Medal with Gold Star in Lieu of 2nd Award, the Army Commendation Medal, the Navy and Marine Corps Achievement Medal, the Army Achievement Medal with Bronze Oak Leaf Cluster in Lieu of 2nd Award, and the Combat Action Ribbon.

Major Chankij is married to Saori Chankij and they have one daughter, Misato. ■



## Military Applications Society Award for Excellence in Operations Research

### Cadet Mark J. Williams, US Air Force Academy



Cadet Mark J. Williams, winner of the MAS Award at the US Air Force Academy, 2012.

Cadet Mark J. Williams, from Potsdam, New York, was the winner of the Military Applications Society Award as the top operations research major in the Class of 2012 at the United States Air Force Academy (USAFA). Four departments—computer science, economics and geosciences, management, and mathematical sciences—co-administer the OR major at USAFA. 2nd Lt Williams was also a distinguished graduate (top 10% of his graduating class), ranking 56th of 1,073 graduates, and a member of Omega Rho, the national OR honor society. He finished with a 3.81 GPA, and was on the Dean's List during his eight semesters, as well as the Commandant's List (military excellence) for seven semesters and the Athletic Director's List (athletic excellence) for three semesters.

After completing a master's degree in OR at the Massachusetts Institute of Technology, 2nd Lt Williams will start his career as an Air Force operations analyst, and he hopes to eventually return to USAFA as a faculty member.

The USAFA class of 2012 totaled 14 OR majors—five were distinguished graduates (DGs), and six were inducted into the Omega Rho Honor Society (top 25% of graduating class). The DGs and Omega Rho inductees are Jane Demkowicz (DG), Michael Estacion

(DG), Nicholas Jernigan (DG), Sean Knowles (DG), Andrew Street, and Mark Williams (DG). Three members of the Class of 2013 (Zebulon Hanley, Kevin Rossillon, and Daniel Schonfeld) were also inducted into Omega Rho and will serve as class officers for the upcoming academic year.

In addition to Lt Williams, Lts Jernigan, Knowles, and Raymond Gutierrez will immediately enter graduate school (MIT, Harvard, and the Air Force Institute of Technology, respectively).

The OR majors excelled in their diverse capstone experiences. For example, the Mitchell Hall (cadet dining facility) team sought to reduce waste as they optimized the food-ordering process. The security forces consulting team developed an automated system of generating security scenarios that randomly test antiterrorism measures. Their system ensures periodic evaluation of high-value assets and was successfully implemented by the 1st Special Operations Wing at Hurlburt Air Force Base, Florida. Cadets working with US Space Command developed and evaluated concepts of operations and subsequent costs of potential on-orbit refueling of satellites within the geostationary belt. Another team analyzed the medical requirements and processes of USAFA's 10th Medical Group in supporting basic cadet training with related improvements in medical services to the local Colorado Springs military community. One team worked directly with the Commandant of Cadet's staff in studying cadet summer training programs. Not only did they develop a more efficient set of training opportunities, they created a large-scale program that optimally schedules all cadets into their necessary programs. Once again, cadets supported the local community by developing a statistically valid crime-prediction model and improving the crime data collection process for the Colorado Springs Police Department. Finally, working with the Air Force Culture and Language Center, cadets identified characteristics of Air Force personnel best suited for successful completion of the Language Enabled Airmen Program.

Six teams traveled to the US Military Academy to compete in the Donald R.

Keith Cadet Capstone Conference against students from USMA, George Mason University, University of Arkansas, and Stevens Institute of Technology. Against very high caliber research efforts, they won two of the four tracks and took second place in another track. The winning teams were Concepts for On-Orbit Satellite Refueling and Assigning Random Anti-Terrorism Measures.

### Midshipman Nicolas M. Woods, US Naval Academy



Midshipman Nicolas M. Woods, winner of the MAS Award at the US Naval Academy, 2012.

Midshipman Nicolas M. Woods, from McLean, Virginia, was the winner of the Military Applications Society Award for superior performance in operations research in the Class of 2012 at the United States Naval Academy (USNA). In May 2012, Nicolas was awarded a bachelor of science degree in quantitative economics and was commissioned an Ensign in the United States Navy. He completed his senior project, "Evaluating Conditional Cash Transfer Programs in Latin America," under the advisement of Associate Professor Ryan Brady.

ENS Woods has been designated to serve as a Navy submarine warfare officer and is currently in nuclear power training in Charleston, South Carolina.

## Cadet Colin P. Schembri, US Coast Guard Academy



Cadet Colin P. Schembri (center), winner of the MAS Award at the US Coast Guard Academy, 2012.

Rear Admiral S. Stosz and Captain M. McGurer presented 1st Class Cadet Colin P. Schembri the 2012 Military Applications Society Award for excellence in operations research at the US Coast Guard Academy in New London, Connecticut. In May, Colin earned a bachelor of science degree in operations research and computer analysis, graduating with high honors. Colin, a native of Dublin, Ohio, was also actively

involved in the CGA varsity crew team. His capstone project, "Satterlee Hall Room Scheduling and Analysis," was an innovative blend of integer programming and decision analysis that streamlined the Mathematics Departments academic scheduling process. ENS Schembri is scheduled to begin flight school in Pensacola, Florida, and hopes to return to the Academy as a mathematics instructor.

## Cadet Captain Zachery M. Price, US Military Academy at West Point

During the May 25th awards convocation at the United States Military Academy at West Point, New York, Department of Systems Engineering Professor Tim Elkins presented Cadet Captain Zachery Price the 2012 MAS Award for excellence in operations research. Price, who graduated from J.M. Tate High School in Cantonment, Florida, was commissioned into the military intelligence branch with field artillery as his initial detail. He was also a finalist for

the Lowe's Senior Class Award and member of the Fellowship of Christian Athletes. In addition to graduating with honors in operations research, Cadet Captain Price was captain of the baseball team and competed in the NCAA Regional Finals this past June. He will serve his initial assignment as an athletic intern at West Point with the Directorate of Intercollegiate Athletics.



Cadet Captain Zachery M. Price (right), winner of the MAS Award at the US Military Academy at West Point, 2012. ■

## MORS Dr. James T. Moore Graduate Research Prize

The AFIT's Department of Operational Sciences June awards process is over and this year's June graduating class was exceptional. The awards committee reviewed the best projects of the graduating class and through a blind vote selected the MORS award winner for the June 2012 graduation.

The winner, **Major Brady J. Vaira**, conducted research on aircraft collisions with avian species. The abstract appears below. Mr. Frank Campanile presented Major Vaira with this award at 3:00 p.m. on Thursday, June 14, at the combined award and graduation ceremony.

### Estimating Bird/Aircraft Collision Probabilities and Risk Utilizing Spatial Poisson Processes

Major Brady J. Vaira

Dr. Jeffery K. Cochran, Advisor

Sponsor: AMC SE/SEF, Flight Safety, USAF

Aircraft collisions with avian species are a serious safety problem as well as a serious economic issue. Aircraft / bird strikes have resulted in 33 fatalities, the loss of 39 aircraft, and damages to aircraft in excess of \$820M for the United States Air Force. The objective of this paper is to create a closed form mathematical model that estimates the

probability of a bird / aircraft collision and provides a risk score that can be utilized to underpin decisions made by planners and pilots. The major components of the model are the spatial Poisson process, the extended spatial Poisson process, a gamma distribution of bird altitudes, a relative risk score, a standardized risk score scale, and a risk filtering and ranking method. The spatial Poisson process allows for an independent distribution of birds within a bounded area. The extended spatial Poisson process accounts for the removal of birds from calculations within the bounded area after they have been encountered. The gamma distribution models the distribution of specific bird altitude bands within a bounded area. The relative risk score is a weighted risk score for 19 different species of birds that an aircraft might encounter. The standardized scale aggregates all risk scores over all the bird species and then calculates the value in a 0 to 10 scale. The risk filtering and ranking model combines the effects of a hit with the likelihood of a hit and displays the result in a graphic. The overall model that combines these components and calculates the output is an original contribution to the field of aircraft / avian collision models. Exercising the model reveals significant factors that influence the risk score as-



sociated with flying in a particular area. They are the total number of birds in the bounded region, the mix of species within the bounded region, the size of the aircraft, and the gamma height distribution of the birds within the bounded region. Knowing the gamma height distribution for the specific birds in an operations area (AO) can provide more fidelity to the planner. In fact, in several scenarios where the same number and species of birds for an AO was used, the difference in the overall aggregated risk score was twice as high as the score that was calculated when the gamma height distribution was not known. Additionally, when there were densely populated altitude bands of birds in the operations area, avoiding these bands cut the overall risk score by up to 50%. This is very useful information for decision makers to have when they are planning the specifics of their operations. ■



# MORS HERITAGE

## 1974–1977

As we continue the countdown to the 50th Anniversary of MORS, we would like to revisit our proud history and highlight the past leaders of the Society and key accomplishments over those years. Each edition of *Phalanx* will provide insight into several years of history. Enjoy reading about these individuals and what they have accomplished. More information on the Past Presidents can be found on the MORS website, including their Oral Histories.

### Significant Events

- 34th MORS Symposium, US Army Transportation Center, Ft. Eustis, Virginia, December 1–3, 1974. “Contributions of Operations Research to the Defense Decision Process”
- 35th MORS Symposium, US Naval Academy, Annapolis, Maryland, July 1–3, 1975. “A Case Study Approach for Military Operations Research”
- 36th MORS Symposium, FBI Academy, Quantico, Virginia, December 16–18, 1975. “Human Factors in Operations Research”
- 37th MORS Symposium, US Army Defense Center, Ft. Bliss, Texas, June 20–24, 1976. “A Current Assessment of Quantitative Techniques”
- 38th MORS Symposium, US Army Transportation Center, Ft. Eustis, Virginia, December 1–3, 1976. “Constraints on Military Force Readiness”
- 39th MORS Symposium, US Naval Academy, Annapolis, Maryland, June 28–30, 1977. “Applications of Military Operations Research for C3”
- 1974: The MORS BOD voted to share publishing cost of *Phalanx* with ORSA/MAS for the four issues in 1974–1975.
- 1974: Charles Tirplitz was designated as the MORS associate editor of *Phalanx*.
- 1974: A MORS minisymposium was held in the Washington, DC, area on April 16–17 on *Life Cycle Costing and Modeling Methodology*.
- 1975: Clayton Thomas succeeded Dr. Carroll Zimmerman as Air Force sponsor representative. He would serve MORS for 23 years in this capacity.
- 1975: Separate MORS and MAS editions of the *Phalanx* were published in the December issue.
- 1976: Two sessions at the 38th MORSS commemorated the 30th anniversary of the Office of Naval Research.
- 1976: MORS and MAS formed a joint committee to consider publishing a Military OR journal, to jointly publish monographs and to consider joint international collaboration.
- 1976: The Board of Directors increased the monetary reward for the Rist Prize from \$300 to \$500.
- 1977: Vance R. Wanner died of a heart attack on May 12, 1977 while serving in the capacity of MORS executive secretary.

### MORS Directors

consolidated list 1974–1977

<b>Marilyn Andrusis</b>	<b>Helene Little</b>
<b>John Bode</b>	<b>Maj James F. Lloyd</b>
<b>John Brinkerhoff</b>	<b>CDR James Martin</b>
<b>John R. Cameron</b>	<b>Fred K. McCoy</b>
<b>Bernard Clark</b>	<b>Col Gerald Medsger</b>
<b>Gordon Clark</b>	<b>Bernard Morgan</b>
<b>Roderick Clarke</b>	<b>Stephen A. Murtaugh, Jr.</b>
<b>Monti Callero</b>	<b>Col Charles F. Pilley, Jr.</b>
<b>Col George H. Dimon, Jr.</b>	<b>LTC Herbert Puscheck</b>
<b>Neil B. Downey</b>	<b>Richard Rose</b>
<b>John Durrenberger</b>	<b>Bernard Roseman</b>
<b>George Ellis</b>	<b>George Schecter</b>
<b>John A. Englund</b>	<b>Prof David A. Schrady</b>
<b>CAPT William Gost</b>	<b>Prof Michael Sovereign</b>
<b>William Grodowitz</b>	<b>David E. Spencer</b>
<b>CAPT Wayne Hughes</b>	<b>Robert Squire</b>
<b>Elwood Hurford</b>	<b>Charles Woods</b>
<b>Joseph H. Lane</b>	
<b>Chantee Lewis</b>	

### MORS Staff

**CDR Vance R. Wanner**, Executive secretary (passed away May 12, 1977)  
**Rita M. Garrett**, Secretarial assistant  
**JoAnn Ponce**, Secretarial assistant  
**Charles Tirplitz**, *Phalanx* associate editor (MORS)

### MORS Sponsors

**Dr. Wilbur B. Payne** and **David C. Hardison**  
Deputy Under Secretary of the Army (Operations Research)  
Sponsor's Rep: **F. Paul Dunn** and **Hunter M. Woodall, Jr.**

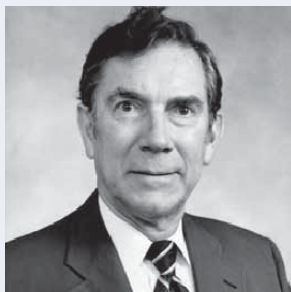
**Allan E. White**  
Office Chief of Naval Research  
Sponsor's Rep: **Robert J. Miller**

**MGen Jasper A. Welch, Jr.**  
Assistant Chief of Staff, Studies and Analyses  
United States Air Force  
Sponsor's Rep: **Dr. Carroll R. Zimmerman** and **Clayton J. Thomas**



## MORS Presidents

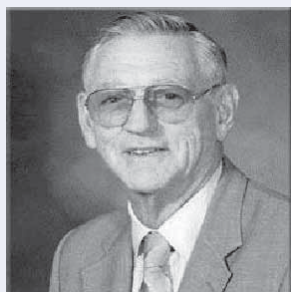
### Tenth MORS President: John K. Walker Jr.



John K. Walker Jr. served as First Vice President in 1973–1974 before being elected as the tenth President of MORS. Mr. Walker received his degree from Virginia Polytechnic Institute in 1941. He was a retired Army Colonel, WWII veteran, and one for the Army's first OR analysts. He was employed at the Rand Corporation in Washington, DC, for most of his professional career. Mr. Walker served as *Phalanx* editor for 12 years and *Phalanx* editor emeritus for seven years. He was elected as a Fellow of the Society in 1989 in the first class of Fellows.

1974–1975

### Eleventh MORS President: Marion Bryson



Dr. Marion Bryson served as First Vice President in 1972–1973, Second Vice President in 1974–1975, and MORS President in 1975–1976.

He graduated from the University of Missouri in 1949 with an undergraduate degree in math education and a master's degree in math in 1950. He received his PhD in statistics in 1958 from Iowa State University.

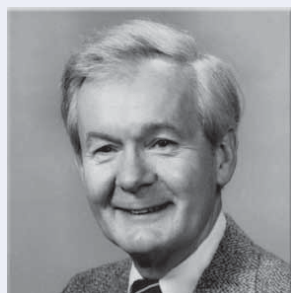
When the Combat Development Experimentation Command (CDEC) was reorganized and re-designated as a center in 1983, Dr. Bryson was appointed as the first civilian director, a position he held for nine years. The civilian equivalent of a Brigadier General, Dr. Bryson led the only test organization of its kind that included an armor-mechanized infantry task force dedicated to the test and experimentation mission. In August of 1991, Dr. Bryson relinquished his command of CDEC and became the Technical Director, Headquarters, Test and Experimentation Command, Fort Hood, Texas, 1991–1994.

Dr. Bryson received the Vance R. Wanner Memorial Award in 1985 and was inducted as a MORS Fellow in 1990. Dr. Bryson was inducted into the US Army Operational Testers' Hall of Fame in 1998 and the Army Operations Research Symposium (AORS) Operations Research/Systems Analysis (ORSA) Hall of Fame in 2005.

The impact that Dr. Bryson has made on operational testing yesterday, today, and tomorrow is unparalleled.

1975–1976

### Twelfth MORS President: Stephen A Murtaugh, Jr.



Stephen Murtaugh served as Second Vice President from 1975–1976 and MORS President from 1976–1977. He was the longest-serving elected, voting MORS director. Mr. Murtaugh was an OR analyst at the CALSPAN Corporation. He was the force behind the MORS workshop series, Human Behavior and Performance as Essential Ingredients in Realistic Modeling of Combat (MORIMOC I, II, and III).

1976–1977



# Organization of Operations Research in the Five Eyes Countries

Jim Bexfield, FS, [jim\\_bexfield@comcast.net](mailto:jim_bexfield@comcast.net)

Ben Taylor, Canadian Department of National Defence

## Background

This article is based on activities sponsored by the Joint and Combined Analysis (JCA) Panel of the Joint Systems and Analysis Group in The Technical Cooperation Program (TTCP). TTCP promotes defense scientific and technical information exchange and shared research activities among the five member nations: Australia, Canada, New Zealand, the United Kingdom, and the United States. The US lead to TTCP is Mr. Al Shaffer, the Principal Deputy for Research and Engineering in the Office of the Secretary of Defense. JCA is one of the more than 50 panels that meet at least once a year to accomplish this Science & Technology (S&T) collaboration. The panel fosters a mutual understanding of practices and perspectives in the defense operations research (OR) communities with a focus on strategic planning, model and data exchanges, and support to analysts deployed on current operations. This article explores the organizational structures, funding sources, workforce, research programs, interaction with other government organizations, and quality control/review processes used in the five countries.

## Location of Primary Analysis Organizations

The relationship between an analysis shop and the supported decision makers is a complex and critical one that depends on many factors.

On one hand, if the analysts are physically co-located with, and in the same chain of command as, the decision makers, they are more likely to be responsive to the needs of the decision maker. In such an environment, analysts will often be pulled into urgent activities that require significant background, creativity, and innovation to resolve. Such organizations place a premium on experienced analysts, as they place less emphasis on research activities to develop methods, tools, and staff.

On the other hand, analysts could be physically and organizationally separated from decision makers. In this kind of environment analysts can have the ability to focus on their craft without the distractions of the headquarters. Being members of a specialist scientific organization, rather than an analytical cell within a military or civilian bureaucracy, is conducive to in-depth research and longer-term professional development opportunities. The risk of physical separation is that analysis products may be overlooked, and thus urgent, important work may be done by nonspecialist staffs, or decisions will be made that are not informed by analysis.

There is no one-size-fits-all solution as the right degrees of separation and independence depend upon the type of work being undertaken, the access required to decision makers, and the degree of responsiveness and agility expected. Longer-term or repetitive analyses can be effectively handled in remote offices where the cost of living is lower than in a less high-tempo work environment. Conversely, agile and responsive analyses delivered directly to senior leadership probably need to be carried out by teams working very close to, and having frequent access to, the decision makers.

Four of the TTCP member countries have their primary analysis groups outside of the headquarters staff, within integrated defense science organizations, often with smaller embedded analytical teams providing guidance to the main analysis organization and promoting its products to the leadership. They are:

- Australia: Defence Science and Technology Organization (DSTO)
- Canada: Defence Research and Development Canada (DRDC)
- New Zealand: Defence Technology Agency (DTA)
- United Kingdom: Defence Science and Technology Laboratory (DSTL)

As their titles suggest, these organizations conduct a wide range of defense research work of which only a small part is OR. The United States is the exception to this model. The four services, the Joint Staff, and the Office of the Secretary of Defense all have significant analysis organizations either in or near the Pentagon that directly support senior decision makers. In addition, the US Army, Air Force, and Navy have significant analysis organizations outside the Washington, DC, area that perform analysis to support their acquisition, training, personnel, and testing activities. Of the five countries, only the United States has a significant OR capability in the services. The other four countries concentrate their OR talent in integrated research organizations, although those organizations maintain teams aligned to their services and major military commands.

## Funding

“He who pays the bills is in charge” is an axiom of life. When analysis organizations have their own budgets they can potentially set their own priorities and schedules after negotiation with clients. OR organizations that depend upon funds from client organizations sometimes have less flexibility in developing their work programs. These organizations typically use some form of contract or task order that specifies deliverables and time schedules. This model requires a mechanism that enables the development of new OR methods and the growth of analysis capacity and capability.

The five member countries vary significantly in how they fund OR activities. The UK changed from an internally funded model, where budgets were assigned centrally to research organizations, to an externally funded model in the 1990s, where research clients had research budgets and tasked research organizations for services, resulting in marked changes in culture and practices. The potential downside of becoming too fixated on near-term client needs was mitigated by having clients willing and able to invest in development of the OR discipline and its tools independent of the business pressures to deliver specific products. The pendulum is now swinging back to more of an internally funded model. In Canada the OR organization is largely funded from a departmental science and technology budget, but accepts “top-up” payments to increase capacity where partners request it and also chooses to have many teams embedded with clients. Australia and New Zealand follow



mostly an internally funded model similar to Canada whereas the United States is a hybrid. Most of the major US analysis organizations have a strong cadre of professionals that develop analysis products and they also have a budget line they can use to task studies and model development. These studies may be performed by federally funded research and development firms such as RAND and the Institute for Defense Analyses or by private corporations such as SAIC and Boeing under the close direction and guidance of government analysts.

## Analysis Workforce

All five countries have a significant, for their size, highly qualified civilian OR workforce with a fairly large number of PhDs. However, only the United States, believing that an officer who combines professional military experience and OR skills is uniquely qualified to bring operational realism, and the resulting credibility, to the analysis, also has a significant number of military officers with advanced degrees and significant OR experience. In the other four countries, military staff are embedded within OR organizations. Their primary purpose is to provide subject matter expertise to guide analyses and to provide a gateway to the wider military community. They may well pick up some analytical skills in the process but they are not generally expected to be expert practitioners of OR. New Zealand has had military officers with an OR specialty but none have been trained recently. Furthermore, almost all of the analysts from Canada and the UK that deploy to support operations in Afghanistan are civilians. Australia deploys analysts paired with military officers while the United States sends a significant number of military officers trained as analysts. The US Army and Air Force have OR career fields for their military officers that enable those trained in operations research to have multiple assignments in analysis organizations. The US Navy and Marine Corps will send officers for advanced degrees in OR but will usually limit their follow-on assignments to one tour in an analysis organization (the recently retired Chairman of the Joint Chiefs of Staff, ADM Mullen, has a master's degree in OR). Finally, all five countries use some of their funds to purchase embedded contractor support for their OR organization, with the UK having the highest percentage of contractors.

## OR Research Program

This is another area where an organization may take a spectrum of potential stances. At one end are academic research centers seeking to advance the science of OR and the supporting tools. For them, pushing the boundaries of the discipline is their *raison d'être* although they may provide some client services to help pay the bills. At the other end of the spectrum are analysis shops that are 100% dedicated to producing outputs for customers using either existing tools or simple tools they develop as part of the analysis. Such organizations may rely on client-directed activity with other organizations to bring in major new tools. Most OR organizations fall between these two extremes, with the United States being more client-oriented, with some professional development and tool enhancement, whereas the other four countries lean in the other direction, with each having independently funded OR research and tool development programs. In research organizations, analysts are encouraged, or even required, to be active in professional circles and to publish in the peer-reviewed literature. In more client-focused organizations, such engagements may be less frequent and

not as valued. Although the more academic-oriented analysis organizations will likely have a greater exposure to the full breadth of OR techniques, they may create conflict between the needs of analysts to advance their academic or professional credentials and wider organizational priorities. The converse is that OR groups without the academic perspective may have limited knowledge of the most advanced ideas (think of the eastern European automotive industry during the Cold War).

## Defense OR Support to Whole of Government Analyses

The defense OR organizations in four of the five countries provide a considerable amount of support to other government organizations in areas such as homeland security, and wider security, strategy, and intelligence analysis. DRDC, DSTL, DTA, and DSTO all work with clients outside of the Defense Department. The limiting factors are likely to be the organizational mandate to support it, a willingness of nondefense clients to have an organization with its roots in defense to work in their lanes and cross-governmental coordination to allow it to happen. This practice seems to be much more limited in the United States although there is a growing relationship between the analytical organizations in the Department of Homeland Security and the Office of the Secretary of Defense.

## Quality Control/Review Processes

All of the countries have peer and senior-level review processes. In the United States, an analysis must go through one or more senior-level reviews before reaching the senior decision maker. In addition, peer review often occurs at professional meetings such as those held by the Military Operations Research Society (MORS). There are annual defense-related OR conferences in Australia, Canada, and the United Kingdom, which serve a similar peer-review function to MORS within those nations. Analysts frequently attend conferences outside their own nations and meetings held by multinational organizations such as TTCP and NATO. Such meetings provide an additional informal peer-review mechanism, although it is limited to the methodological level when the work is of a nationally sensitive nature.

All countries apply model verification and validation (V&V) practices before using new tools. The UK, however, is the only country with a scrutiny organization. The British OR scrutiny teams (there are also non-OR technical scrutiny teams) provide an independent perspective on the OR conducted to support major defense program decisions. Staff in these roles are all experienced OR practitioners but are independent of the OR organization(s) conducting the analysis. Their role is to advise senior decision makers as to the technical merits of the analyses presented to them. In practice, this means the development and promulgation of guidance and best practices and the provision of advice to both analysis and the clients of analysis. They can advise clients as to the kinds of analysis they should be seeking and the fitness for purpose of the approaches taken by the analysts. They can also intervene to "protect" analysts who feel they are being pressured by clients to take shortcuts or to introduce biases into their work. Although scrutineers can "red flag" any analyses going forward to senior leaders that they do not see as fit for purpose, they strive to resolve all issues before a submission takes place.

*See Operations Research on following page ...*

## Conclusion

This article compared and contrasted the OR approaches taken by the five TTCP nations so the leadership in each nation can better understand its options for potentially improving its OR practices. There is no one right way to organize defense OR resources to support decision makers; rather, there is a range of options that may have consequences for issues such as the nature of the advice generated, the formulation of the analysis program, the culture within the analysis organizations, and the career opportunities for the analysts working within them. It is not surprising that the 20,000-person New Zealand Defence Force organizes and uses OR in a much different way than does the much larger US structure. Each country must consider its own unique issues and culture.

## Acknowledgements and Disclaimer

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basis of the material presented in this article. The article reflects the views of the authors and not necessarily those of the analysis organizations in any of the five nations.

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## FEATURE

# Assessing Counter-Piracy Tactics: Is It Better to Fight or Flee?

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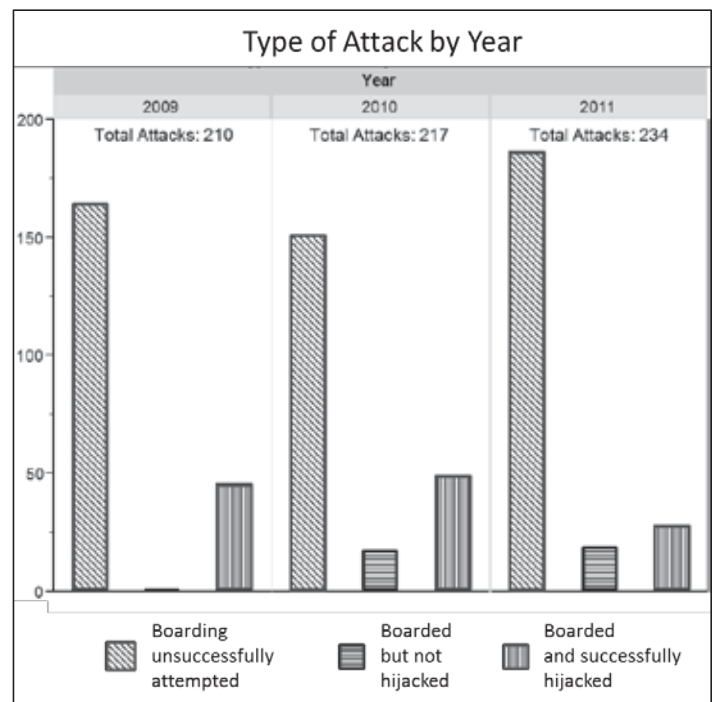
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Recent estimates set the worldwide cost of piracy as high as \$12 billion per year and the cost of military operations in the Horn of Africa (HOA) as high as \$1.27 billion in 2011 alone (Bowden and Basnet 2012). At the end of 2011, 159 people were being held for ransom by pirates. From 2010 to 2011, total ransoms paid to Somali pirates increased from an estimated \$111 million to \$160 million, with an average payment per ransom of just under \$5 million (Bowden and Basnet 2012).

More than half of worldwide piracy occurs in the Red Sea, Gulf of Aden, and Somali Coast and more than 40% of the world's seaborne oil passes through the same (Lorenz et al. 2012). The high cost of piracy off the HOA has resulted in many insurance firms designating the area as a "war-risk" zone and raising rates accordingly. There is a growing multinational naval effort to patrol the high-risk area and combat the pirate action groups (PAGs), which now consist of multiple skiffs supplied and deployed by larger mother ships. The use of privately contracted armed security personnel (PCASPs) is also on the rise (Lorenz et al. 2012).

Although the last six years of reporting has been incomplete due to a prevailing belief among shippers that increased reporting leads to higher insurance premiums, the International Maritime Bureau (IMB) has tracked yearly increases in HOA piracy events. This increase in reporting has been attributed to the increased military focus in the region, which has brought with it greater awareness and a greater willingness of ships' crews and owners to report incidents. Figure 1 shows the types of attacks by year from 2009–2011. The year 2011, however, brought about a new trend in the form of a notable decrease in successful attacks by Somali pirates. That is, although reported attacks *increased* by 8% (from 217 to 234),



**Figure 1.** In 2009, if a ship was successfully boarded, it was almost certainly hijacked (46 of 47 boardings resulted in a successful hijacking). In 2010, boardings increased but hijacking success dropped, keeping the total number fairly constant (49 of 65 boardings resulted in a successful hijacking). In 2011, combined boardings and hijackings dropped from 65 to 47, and the proportion of hijackings to boardings dropped from 75% to 55%.

attacks resulting in boardings *decreased* by 27% (from 65 to 47), and attacks resulting in successful hijackings *decreased* by 43% (from 49 to 28) (ICC-IMB 2012).

The IMB attributes the decrease in boardings and hijackings in 2011 to the military focus in the region, the effective employment of IMB-recommended best management practices (BMPs), and the deterrent effect of PCASPs (ICC-IMB 2012). However, our analysis of the data they have collected suggests these factors are listed in reverse order of effectiveness.

In particular, we conclude that, despite the obvious public relations value, the high cost of the naval effort may not offer the best return on investment in terms of piracy deterrence. Although the preemptive naval interdiction of 20 PAGs in 2011 certainly mitigated some of the piracy threat to area shipping, other trends suggest that awareness of the threat and the progressively stiffer antipiracy measures taken by owners and crews are a far more dominant factor.

## Analyzing the Data

The IMB posts limited piracy reporting data on their website at [www.icc-ccs.org](http://www.icc-ccs.org), where full quarterly and yearly reports can also be requested. Their full annual reports include narratives for each reported event as well as considerable analysis of relevant trends (ICC-IMB 2012). For the analysis in this article, comprehensive spreadsheet data of all reports submitted from 2009 to 2011 were obtained from the IMB. These spreadsheets consist of numbered event reports, narratives, and columns of data derived either from the reporting forms submitted to the IMB by ship owners and masters or from a report called in to the IMB Piracy Reporting Centre in Kuala Lumpur, Malaysia.

For the purpose of our analysis, the IMB's piracy reporting data includes useful fields such as attack type (attempted, fired upon, boarded, hijacked) as well as environmental factors and target attributes. Although these are important details in determining pirate activity patterns and target preference, they do not describe the level of difficulty the pirates encountered in attempting to board and hijack the ship. To categorize events based on this information, we culled through narratives that describe the details of piracy events, including the actions taken by crews, if any and if known. Then, using words and phrases such as "security team," "warning shots," and "evasive maneuvering," we categorized crew response. Table 1 provides the criteria we used for categorizing crew response

according to the level and type of crew resistance, as well as whether naval forces were involved in the response.

## Results

From 2009 to 2011, naval forces were mentioned in 196 of 661 piracy reports (30%). After filtering out reports with incomplete information, naval influence was instrumental in 145 of 592 reported events (24%). As Table 2 shows, with or without naval assistance, crews repelled 85% of attempted boardings; crews who had no naval assistance were only 3% more likely to be hijacked once boarded than crews who did have naval assistance. Statistically speaking, there is no difference between the two distributions in Table 2 ( $\chi^2 = 2.17, p = 0.34$ ), suggesting that naval assistance has little to no effect on the outcome of an attack. Clearly, the time-late nature of naval assistance results in its value being greater after being boarded than before, but for all the resources devoted (\$1.27 billion in 2011), one would hope for a greater impact of naval force presence.

Although naval assistance seems to be essentially unrelated to whether an attacked vessel is successfully hijacked, the effect of crew resistance on thwarting hijacking is substantial. Specifically, as Table 3 shows, boarding rates drop from 36% with evasion alone to 2–4% with TDF and NLF tactics, respectively. In contrast, evasion tactics alone are easily overcome by pirates, who are progressively adapting to ship-hardening measures as well. What does remain true is that when faced with stiff resistance, PAGs have been content to divert their efforts to less-defended targets.

Now, when assessing these results, some consideration must be given to the fact that, in addition to incomplete narrative data collected on many successful hijackings, unreported, unsuccessful events undoubtedly exist. Kaivn H. Chinoy, a Mercantile Marine Officer and Senior Marine Surveyor at CSL Global (Canada) Ltd. wrote in his report on Somali piracy (Chinoy 2011):

*The ship owners have been known to discourage Masters from reporting an unsuccessful attack as they don't want bad publicity, increased premiums or ship to be delayed while a formal investigation takes place.*

Although the number of these unreported unsuccessful events is unknown, there would have to be more than 1,800 unreported unsuccessful attempted boardings with crews only

**Table 1. Crew response resistance category and associated criteria.**

Category	Criteria
No resistance	Targets that were either boarded without their knowledge or had no means of self-defense. This category consists largely of small sailing and fishing vessels. Events where no mention of resistance was made due to lack of detailed knowledge were excluded from the dataset.
Evasion	Includes evasive maneuvers, including attempts to swamp pirate skiffs with the ship's wake. Passive ship-hardening measures such as barbed wire along the ship's outer hull are also included in this category. Also included in this category are crews who, once boarded, attempted to isolate themselves from the attackers in a "citadel" until assistance arrived.
Nonlethal force (FLF)	Other kinetic force short of deadly force as well as ship hardening measures (usually referred to as antipiracy measures). Event descriptions such as the use of rocket flares, long-range acoustic devices (LRAD), pressurized water hoses, and propeller-fouling implements are included in this category.
Threat of deadly force (TDF)	Deadly force or the threat of deadly force. Event descriptions such as security team or crew members exchanging fire with pirates, firing warning shots, or presenting on deck with automatic weapons are included in this category.
Naval involvement	When naval forces respond in a meaningful way, they are counted in this category. This can include a range of responses from deploying a boarding team to helicopter fly-bys and warships arriving on station during the attack.

*See Counter-Piracy on following page ...*



**Table 2. The time-late nature of naval involvement translates to a boarding rate that is statistically no different than the total population. Unless the crew can remain protected in a citadel, naval assistance is usually too late to prevent a boarding from progressing to a hijacking.**

Attack type*	Without naval assistance	With naval assistance
Attempted	379 (84.8%)	123 (84.8%)
Boarded	25 (5.6%)	12 (8.3%)
Boarded and hijacked	43 (9.6%)	10 (6.9%)

\*Classification of attack type is in accordance with the IMB data classification with the exception that our "attempted" category is the sum of attacks classified as "attempted" and "fired upon" by IMB.

**Table 3. Immediate, aggressive resistance improves a crew's chances of repelling boardings. The decrease in the number of boardings when NLF or TDF is statistically significant compared to evasion only ( $\chi^2 = 107.7$ ,  $p < 0.001$ ).**

Attack Type	Crew Resistance Category		
	Evasion only	Nonlethal tactics	Threat of deadly force
Attempted	135 (64.0%)	238 (95.6%)	129 (97.7%)
Boarded	24 (11.4%)	10 (4.0%)	3 (2.3%)
Boarded and hijacked	52 (24.6%)	1 (0.4%)	0 (0.0%)

using evasion tactics before the percentage of unsuccessful boardings would approach what was observed with the use of TDF and NLF tactics. We consider such a large number of unreported events to be very unlikely.

## Conclusions and Recommendations

Published research on the subject of piracy has raised a chorus in favor of better application of operational art, and the recommendations encourage a more terrestrial focus. Dr. Milan Vego of the Naval War College asserted only last February that the US military's neglect of operational art is a contributing factor to the lack of antipiracy success (Vego 2012). Virginia Lunsford identified key centers of gravity in her explanation of pirate dependency on "recruits, a base of operations, sophisticated organization, some degree of outside support, and cultural bonds that engender vibrant group solidarity" (Lunsford 2008). Naval forces have great reach and influence, but in this arena they are far too blunt a tool restricted by policy to operating in an adjacent battle space.

Until the policy gap is closed, however, naval forces can continue to have an effect. Part of the support network does extend seaward, and the mothership operations and associated communication and coordination required to convert an attempt into a paid ransom are indeed vulnerable to naval tactics. However, as Larry Cosgriff and Edward Feege pointed out in 2010, if a ship cannot successfully survive the critical 15-minute window from the time pirates are detected to the time they typically board when successful, few options remain for warships and their crews by the time they arrive to assist (Cosgriff and Feege 2010). This is why PCASPs are so valuable.

Somali pirates clearly prefer easy targets and once they have control of the vessel and crew they gain a distinct advantage over responding forces. Because crew-served tactics are more respon-

sive, they deter attacks more effectively than dispersed naval forces. Although the use of armed resistance has been highly successful in delaying and deterring pirate attacks, even trained, conscientious PCASP teams introduce risk of unnecessary escalation of force and improper use of force. As such, future antipiracy initiatives should:

- Increase focus on awareness efforts and urge crews to adopt aggressive antipiracy measures in high-threat areas. Along with the IMB's BMPs, the use of trained personnel capable of employing deadly force should be included.
- Encourage increased legitimacy of PCASPs through international organizations such as the IMB, utilizing standards such as the International Code of Conduct (ICoC) and their guidance on the Rules for Use of Force (RUF) (Lorenz et al. 2012). Encourage the insurance industry to cooperate in the licensing of PCASPs so they can mitigate their risks and effectively incentivize rather than penalize their use.
- Continue multinational naval operations in the region, but with increased focus on disrupting pirate camps and collecting evidence from captured pirates that can aid in disrupting the complex networks required for the piracy operations to remain economically attractive.

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# Philosophical Foundations of Analytic Modeling

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Conceptualizing and building analytic models is both an intellectual and a creative endeavor. The goal in each case is to create a representation of a portion of reality with fidelity sufficient to reveal its structure, essential characteristics, and perhaps beauty, in order to convey something to or evoke a response from the viewer. For example, an impressionistic painter creates an image with seemingly random splashes of color; a Haiku poet forms a word picture in a few carefully crafted lines; and an analytic modeler develops a mathematical or graphical description of an operations, strategy, or policy problem. A wide palette of technical approaches is available in each case, but they have limitations. The creative task is to choose, from among the available words, colors, media, methods, or components that are suitable for creating the desired effect. For an analytic model, the choice of components is driven by the modeler's worldview—his or her assumptions about the portion of reality being modeled.

Our motivation for exploring the philosophical foundations of analytic models is a lack of transparency in some analyst or action officer presentations and reports as to the nature of a model's underlying assumptions. This opaqueness may hide a dangerous truth—that the chosen model is inappropriate for the particular application. The result can be models that don't make sense and, worse, decisions that are flawed. Figure 1 illustrates the disconnect that can occur between a modeler's intent and the use of the model.

To avoid the consequences of poor model choice, analysts and model users must recognize that each analytic model comes with a set of assumptions, that these need to correspond sufficiently well to external realities, and that the only way to verify this is to make the assumptions explicit. This realization leaves one better suited to critique and validate one's own use of models, and to observe and evaluate how team members and others use them. To do this, i.e., to understand the nature of a model's assumptions, one must be familiar with the philosophical concepts—the philosophy—that underpins them.

The word “philosophy” comes from the Greek word for “love of wisdom,” *φιλοσοφία* (philosophia). It commonly refers to one's search for an intellectual understanding of reality and values, or to one's system of beliefs, concepts, and attitudes. Formally, philosophy is an intellectual discipline composed of the study of ethics, aesthetics, logic, metaphysics and epistemology. Of these, epistemology holds the most interest to modelers. It deals with the nature of knowledge and justified belief. It addresses questions such as “What does it mean to know something?” “What are the sources of knowledge?” and “How can we verify what we think we know?”

Epistemological notions are fundamental to the nature of analytic models, because analytic modeling efforts have as their foundation sets of assumptions about the nature of knowledge that directly address epistemological issues. For instance, what does it mean that a model is a reasonable representation of reality? Does

reasonable mean that the model *captures* reality correctly, or does it mean that it comprises an interpretation that is sufficiently *useful* in dealing with reality? In either case, how do we justify that knowledge? What are its sources? How can we verify what we think we know about the model, and about what it represents about reality? These kinds of questions indicate that constructing, validating, verifying and applying analytic models involve epistemological issues and, indeed, that analytic modeling is an epistemological endeavor.

## Epistemology

Epistemology is a well-developed field of philosophy, with roots that go back at least to the Greeks of the fourth and fifth centuries B.C. Alfred North Whitehead, the influential mathematician and philosopher of science of the early 20th century, wrote that “the safest general characterization of the European philosophical tradition is that it consists of a series of footnotes to Plato” (Whitehead 1979). The various branches of epistemology are distinguished by their viewpoints concerning the nature of knowledge and justified belief. These core presuppositions are axiomatic: one cannot prove them using logic. Instead, they form the foundation from which one builds an understanding of reality, the framework from which one generates, sustains, and applies knowledge. They may be cognitive (“The world is flat”), affective (“Life is good!”), or evaluative (“A bird in the hand is worth two in the bush”). Just as one's conscious and unconscious personal worldview shapes one's attitude and therefore colors every personal interaction and experience, one's epistemology is the lens through which one sees the usefulness and applicability of modeling and analysis, and therefore it influences the conceptualization and structuring of every analytic model. Understanding the epistemological underpinning of ana-

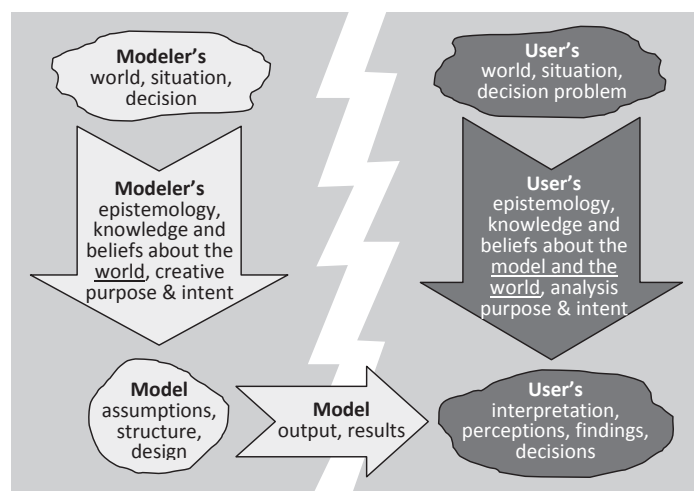


Figure 1. Disconnect between modeler's intent and user's perspective.

See *Philosophical Foundations* on following page ...

lytic modeling enables us to avoid misusing models and, moreover, to make the best use of what they have to offer. As analysts, we owe this to each other and to those for whom we do our work.

Although distinct and relatively well defined, the principal branches of epistemology are neither mutually exclusive nor necessarily contradictory. We briefly summarize them here. For more detailed descriptions, a good resource is the Epistemology section of *The Stanford Encyclopedia of Philosophy* (Steup 2010).

### Rationalism

Rationalism holds that there are significant ways in which we gain concepts and knowledge other than through sense experience. For instance, it can involve an intellectual, deductive, or intuitive process. Examples include Archimedes’ “Eureka” moment (intuition) and Einstein’s derivation of the Theory of Special Relativity (deduction). Some rationalist standpoints hold that reason is the only path to knowledge. Less extreme viewpoints hold that reason is merely superior to other means of acquiring knowledge.

### Empiricism

Empiricism holds that the ultimate source of concepts and knowledge is sense experience, including the external senses (touch, taste, smell, hearing, sight), the inner sensations (pain, pleasure, cold, hunger, thirst, etc.), and the emotions (joy, serenity, fear, anger, contentment, grief, etc.). Extreme empiricist views hold that such experience is the only source of knowledge. An example is a die-hard experimentalist who completely eschews theory.

Empiricism and rationalism form two poles of a continuum of philosophies that combine elements of both. For example, logical positivism (a.k.a. logical empiricism, scientific philosophy, and neo-positivism) combines the empiricist idea that observation is indispensable for knowledge with rationalistic ideas that incorporate mathematical, logical, and linguistic constructs. Naturalism holds that nothing affects the structure and behavior of the natural universe except its own laws, so that the only function of science is to discover those laws.

### Foundationalism

Foundationalism holds that knowledge and justified belief are based on a foundation of noninferential knowledge and justified

belief. Several foundationalist schools exist. Privilege foundationalism holds that only knowledge of one’s own internal (mental) states can be noninferential. Experiential foundationalism holds that beliefs about external objects can be noninferential. Experiences justify basic beliefs in both cases, but the range of allowed experiences differs between them. An example of foundationalism is the second sentence of the Declaration of Independence: “We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness.”

### Pragmatism

Pragmatism holds that what matters is what we do with our knowledge, not how we know it. This philosophical tradition centers on the idea that theory results from and informs practice. In this view, no distinction exists between theory and practice, but intelligent practice is distinct from uninformed practice. The “engineers’ mindset” is a well-known example of pragmatism.

Pragmatism includes philosophies such as instrumentalism, verificationism, and fallibilism. Instrumentalism holds that concepts and theories are useful for explaining and predicting phenomena, but have no inherent value otherwise—they say nothing about what is real or not real. Verificationism is the view that knowledge is legitimate only if it can be verified. It is closely associated with logical positivism, particularly with the empiricist view that observation is the only way to acquire knowledge. Fallibilism underlies the natural sciences. It holds that because knowledge (concepts and theories) are empirically based, they are subject to change with new evidence. Thus, one must remain open to changes in knowledge. This perspective is antithetical to foundationalism.

### Relativism

Relativism holds that some aspects of experience, thought, evaluation, and reality exist only in relation to other aspects. For example, moral relativism holds that morality, rather than being absolute and unchanging, depends upon the situation and the people involved.

### Coherentism

Coherentism holds that the strength of knowledge and justified belief depends only on the strength of related areas of knowledge

**Table 1. Tenets of epistemological schools of thought.**

Epistemological Schools of Thought		
Epistemology: the study of the nature, scope and limitations of knowledge and justified belief		
Philosophy	Key tenets	Examples
Rationalism	We can gain concepts and knowledge in ways other than through sense experience	<ul style="list-style-type: none"> <li>Reasoning, intuition</li> <li>Archimedes’ “Eureka”</li> </ul>
Empiricism	Sense experience is the ultimate, indispensable and only source of concepts and knowledge	<ul style="list-style-type: none"> <li>“If I see it, I’ll believe it”</li> <li>Experimentation</li> </ul>
Foundationalism	Knowledge and justified belief rest on a foundation of non-inferential knowledge and justified belief	<ul style="list-style-type: none"> <li>“We hold these truths to be self evident...”</li> </ul>
Pragmatism	What matters is not how we know something, but what we do with our knowledge	<ul style="list-style-type: none"> <li>Engineers’ mindset</li> </ul>
Relativism	Some aspects of experience, thought, evaluation or reality are relative to other aspects.	<ul style="list-style-type: none"> <li>Moral relativism</li> </ul>
Coherentism	Knowledge and justified belief depend on coherence with related areas of knowledge and justified belief	<ul style="list-style-type: none"> <li>Virtual reality</li> </ul>
Conventionalism	Some aspects of reality derive solely from convention: If we agree, then it’s true	<ul style="list-style-type: none"> <li>Grammar</li> <li>Value of money</li> </ul>



and justified belief. The extreme case holds that there is no non-inferential knowledge and justified belief. This directly opposes foundationalism. Moderate coherentism permits some (but not all) knowledge and justified belief to rest on a foundation of non-inferential knowledge or justified belief. An example of coherentism is virtual reality—one might conclude that it is real because it all fits together just like reality.

### Conventionalism

Conventionalism holds that some aspects of reality derive solely from conscious or unconscious mutual agreement or convention, rather than from external reality. Examples include grammar, language, legal systems, monetary value, mathematical systems (e.g., Euclidean geometry, Group theory), logic, drill and ceremonies, the Geneva Convention, courtesies and customs, and accounting rules.

Table 1 summarizes the key tenets of the principal epistemological schools of thought.

An analyst may at times find himself or herself operating from the standpoint of one or more of these epistemologies, depending on the task at hand. For instance, for a verification, validation, and accreditation (VV&A) activity, it is appropriate to adopt an empiricist viewpoint. For development of novel science or mathematics to address emerging design or policy problems, a rationalist perspective is required. For modeling many aspects of military operations, one must use a conventionalist approach based on military doctrine. For performing the coding tasks needed to turn software use cases into source code, a pragmatist perspective is appropriate. Because one's epistemological viewpoint is intricately intertwined with the thought needed to create and use analytic models, it is worthwhile taking a close look at the elements that characterize and distinguish these models.

### Analytical Modeling

The conceptual foundation of analytic modeling derives from two aspects of the modeler's worldview. The first relates to epistemological assumptions about the system under study: its rationality; the nature of data, variables and their interrelationships; and mathematical axioms such as transitivity of addition and multiplication. The second aspect comprises assumptions about the structure of the problem space: its linearity or nonlinearity; continuity of time, space and functions; stochasticity of events and observations; existence and properties of optimal solutions; etc. Given this conceptual foundation, a modeler uses reasoning, intuition and experience—a Rationalist perspective—to choose a model's components and overall design. These two aspects collectively comprise the analytic model's structure. This encompasses notions such as the existence, characteristics, and identifiability of *best* solutions; characteristics of the value space including the ability to identify tradeoffs and sensitivities; the nature of intervariable relationships such as stochasticity, dynamism, and feedback; and properties of the feasible space such as linearity, convexity, continuity, boundedness, and mathematical problem structure.

Model structure relates indirectly to epistemology. For instance, a rationalist or foundationalist might believe that  $X$  would yield  $Y$  in the real world, and so believe that the problem has structure. But an empiricist doesn't have this kind of theory belief. Nor does a pragmatist, who nonetheless might take on a theory temporarily—reasoning, for instance, that it could be useful to suppose and then to see what happens. However, whereas individuals—e.g., model-

ers and model users—have epistemologies and assumptions about the world, models don't. Models have structure.

A worldview leads a modeler to build or use a model with a certain structure in order to gather information about a particular problem or situation. If the belief structure is valid or otherwise matches reality, then the resulting model is "good" and the results are valid. However, if the belief is not valid, then the model is incompatible with reality, and so performs poorly. A pragmatist modeler, for instance, might believe that analyzing a discrete, constrained, quadratic optimization problem would yield useful insight into a decision problem, despite strong indications that it might actually be a rather crude description of reality. This assumption would lead to an analytical model with a particular structure: a feasible space composed of a set of discrete points and bounded by a set of constraints, and an objective function that is a quadratic function of the decision variables. A modeler with an entirely different worldview might create a model with the same problem structure; for instance, a rationalist who believes that the feasible space actually is discrete and bounded, and that the true value function actually is quadratic. Differing worldviews can lead to identical problem structures. However, the meaning and implications of the structure differ in each case.

A key decision in analytic modeling is defining the type of data to embed in the model. For example, the set {71, 92, 65} could represent any of the four commonly accepted data types, depending on what the numbers mean. They could be labels randomly assigned to football players' uniforms (nominal data), their IQ scores (ordinal data), game-day temperature readings (interval data), or midterm exam scores (ratio data).

Use of any kind of data requires an epistemological assumption that the world is measurable, i.e., that the concept of measurement makes sense. This implies that measures are repeatable over time and space, so that, for instance, a yardstick will be the same length tomorrow as it is today, irrespective of location. It turns out that experiments verify this in our local environment. However, it is not true everywhere. Einstein's theory of general relativity indicates that time and distance are not absolute measures, and that it is not possible to extend measurements of length and duration to all time and all space. Instead, these measures depend on the relative speed of the observed object and the observer, the accelerations they are experiencing, and the strength of gravitational fields that affect them. The point is that we make assumptions—explicitly or implicitly—about the data we gather, based on our own epistemological outlook. Here a pragmatist perspective is useful. If these assumptions reasonably match our observations of reality within the range of interest (i.e., if they describe enough of reality to be useful), then the data measurements that we take are valid as input to an analytic model. If not, then the GIGO (garbage-in-garbage-out) principle holds.

### Philosophical Considerations

Although the variety of analytic models is quite large, they share a common set of assumptions about the nature of reality. For instance, they are all based on the idea that the concepts of mathematical analysis (algebra, geometry, and calculus) and logic are valid constructs, and that they are useful ways to describe or understand reality. Moreover, these models are data based: they rest on the viewpoint that measurements makes sense.

*See Philosophical Foundations on following page ...*

In addition to their common assumptions, analytic models have individual unshared elements. Modelers often formulate these with statements such as “Suppose **A**. Then **B**,” that may relate to the model’s structure. For example, a model’s description might state “We assume that attrition is a linear function of **A**. Then **B**.” This implies that the statement “**B**” follows logically from the “If” statement. For instance, **B** could be a formulation of part of a mathematical optimization problem, or a derivation of a closed form solution to the set of equations that forms the model. The statement “**A**” forms part of the model’s set of assumptions: it is a statement about the model’s structure, but not about the world. Contrarily, when the term “assumption” is applied to a person (e.g., a creator or user), it means something quite different. A modeler’s assumptions concern his or her worldview, which encompasses epistemological considerations as well as specific beliefs and knowledge about the world—but not about the model!

Not only do a model’s structural elements distinguish it from other models, but they also reveal its underlying assumptions. For instance, linear regression assumes the existence of underlying, unobservable stochastic processes that generate observable data points. Other methods within the same analytic domain (exploratory data analysis), such as visual data analysis and descriptive statistics, do not share these assumptions. Furthermore, analytic models outside of this domain do not even share the stochastic data assumption. Hypothesis tests, for example, make no such assumptions. Rather, they test the statistical validity of making such assumptions. Each model’s structure reveals the root assumptions that determine the meaning of its output and its applicability to a given real-world problem. If a model’s assumptions reasonably match or correlate well with reality, then it is a good predictor. If its assumptions do not match or correlate with reality, then it is inappropriate. This underscores the purpose of analytic models: to allow a decision maker to move away from unaided intuition by providing insight and/or solutions into the problem at hand. From this (pragmatist) perspective, a model doesn’t have to be perfect. It only needs to be good enough.

It is important to realize that there is no one-to-one correspondence between a modeler’s worldview and a model’s assumptions: you can’t pigeonhole models by epistemology. Saying that a model is empirical (based on data) is quite different from saying it is ratio-

nal (based on ideas and concepts), but in both cases the assumptions refer to the structure and data types contained in the model. Neither case specifies the orientation of the modeler.

Epistemological concepts help one appreciate and understand the meaning, proper use, and limitations of models and their output. This includes recognizing that different types of thinking and epistemologies are required for different modeling activities. VV&A perspectives are quite different from the types of thinking needed to conceptualize and frame analytic models, turn concepts into computer code, or apply a model’s results to a given decision problem circumstance. Analytical model building activities rest on a foundation of logical positivism, which combines elements of rationalism and empiricism. Engineered aspects of a model rely on pragmatism. Verification activities have empiricism at their root, leading to conflicts with rationalist system designers. There is no dogma here. However, differences in mindsets can cause serious communication, coordination, and value conflicts if a model’s stakeholders are unaware of each others’ philosophical perspectives.

On the other hand, if an analytic model’s stakeholders understand how philosophical outlooks affect one’s perception of the model, then they can coherently make value statements about its root assumptions; discuss them rationally; have a vocabulary available to motivate, understand and explain the model’s limits; and make defensible decisions based on its output.

Although the questions of epistemology form the foundation for building analytic models, it is useful to maintain a balanced philosophical perspective when evaluating a given model. For example, consider the questions a senior executive or flag officer might ask: “What did you base THIS on?” and “Where did you get THESE numbers?” At times a conventionalist perspective is useful: “Well, ma’am, it was the opinion of the team of subject matter experts that this is the correct approach,” or perhaps “We’re just following doctrine, sir.” At other times, a pragmatist approach may be required: “I don’t know how the model works either, sir, but its predictions are spot-on, every time.” On occasion, an empiricist approach may be appropriate: “These are the numbers that came out of the model, ma’am.” Or, perhaps, a rationalist approach is necessary: “Sir, these are the results of a Monte Carlo analysis based on the modified Lanchester resource attrition model.” Rarely will a foundationalist viewpoint be useful: “Well, isn’t it obvious?” All of these perspectives are defensible. Their variety indicates that, although an epistemology is capable of providing guidance, it is best to carefully consider its implications before adopting it for a given situation.

The key message is that if you don’t know the assumptions of a model, then it’s probably the wrong model to use. There is no judgment here. Explicit assumptions lead to better results. If assumptions and root philosophy are not clear, then misunderstanding follows from using, interpreting, and communicating the output of a model. The assumptions that modelers make about the world find expression in the structure of the models they build. A hidden yet avoidable danger in the use of analytic models lies in their indiscriminate application, where unstated assumptions can lead to misused models, mistaken analyses, and misguided decisions.

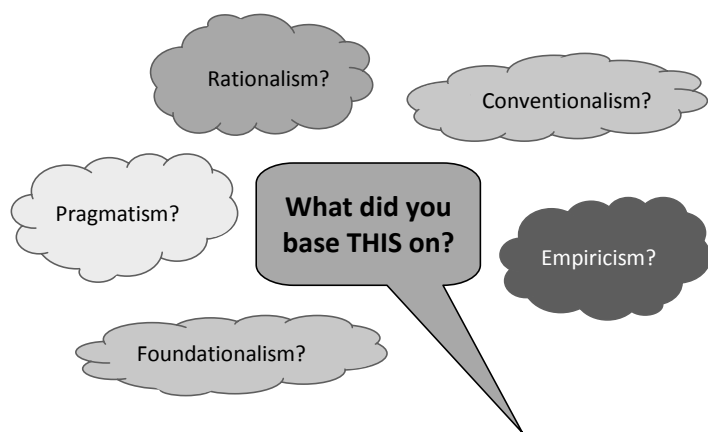


Figure 2. Communicating assumptions.

## Author Statement

The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Office of the Secretary of Defense, the Department of Defense, or the US Government.

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# USMA's Minerva Research Initiative: Why Is Understanding Culture Important for the Military?

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**I**t is no coincidence that in Roman mythology the goddess of wisdom and war were one in the same—Minerva. In many ways, today's military operations seem to continually push the limits that define complex issues in need of more and more of Minerva's wisdom. Because true system complexity can never be completely controlled or understood, it is only through Minerva-like wisdom that such extreme levels of operational complexity can be harnessed to produce a more informed and capable military. Napoleon understood the concept when he stated: "There are but two powers in the world, the sword and the mind. In the long run the sword is always beaten by the mind." This realization of the need for such wisdom in military operations is what motivated former Defense Secretary Robert Gates in 2008 to initiate Project Minerva to support and foster social science research and better understand the roles that culture and humanity play in military operations.

Today's military, much like governments and businesses in modern society, is based on the operations research (OR) premise that astute information processing can produce the knowledge to inform multiple-criteria, multidimensional decision making to yield sufficient wisdom to ensure operational success (Jensen and Bard 2003). No longer are military operations won by the most powerful physical force, but rather victory often goes to the smarter, information-dominant, culturally aware, net-centric force. Therefore, the US military needs to understand the cultural, social, behavioral, and political dynamics that shape the regions of the world that hold strategic importance to the United States. Through such wisdom, military leaders can better recognize the political trajectories of governments of countries where US military forces are deployed and meet the challenges of operating in complex socio-cultural environments. These operational issues spawn what is known as "wicked" problems,<sup>a</sup> which often need multi- and in-

terdisciplinary approaches that require information science, operations research analysis, complex modeling, and social and behavioral science perspectives (Ritchey 2011).

## Historical Background

The quantitative, information-based methodology of social and cultural reasoning began in the early 19th century, when Adolphe Quetelet and Auguste Comte incorporated statistical methods into the social sciences, thereby establishing the disciplines of demography and sociology and the beginnings of information science. By incorporating probability and statistics methods into social science, then called "social physics," they produced a quantitative basis for solving societal problems. Later, psychologist Jacob Moreno formalized the mapping of social relationships through what he called the sociogram to graphically represent individuals as points/nodes and the relationships between them as lines/arcs. For this work, he is credited with founding the basic principles of social network analysis<sup>b</sup> (SNA). These pioneers may not have been fully aware of the complexity of these phenomena and the massive amounts of associated societal data, but they were the first to use quantitative and qualitative reasoning to analyze these important issues. Quetelet's naïve view of data centrality that uses a concept called "the average man" extracted the mean and standard deviation from data sets to define and predict social phenomena. Although these metrics were sometimes misleading, the scientific method found its niche, as sociology became a science and society became a scientific data source. Quetelet's and Comte's colleague, Charles Babbage, applied these new methodologies and philosophies to develop quantitative-qualitative techniques to improve Great Britain's mail and railroad service. Geographer Carl Ritter took a similar track to develop the principles of human geography.

*See Minerva Research on following page ...*



Nearly a century later, Quetelet's primitive tools and concepts were vastly improved upon by economist Vilfredo Pareto. His study of income distribution and human decision making hypothesized that incomes and other social phenomena follow power law probability distributions; thereby developing more insight into the underlying structural complexity of society. In his book, *Trattato Di Sociologia Generale (The Mind and Society)*, Pareto put forward the first social cycle theory to continue the development of the modeling framework for social science. Throughout the 20th century, as the social sciences become as mathematically based as the physical sciences, through the development of viable models and metrics of human behavior, the art and science of problem solving merged with public policy and OR. This forged a problem-solving methodology for the information and human issues in government, business, and industry. The Minerva Research Initiative continues this research thread by developing social science models for military issues and bridging the intellectual energies of military and academic institutions.

In the military realm, the multiperspective and quantitative-qualitative work of Omar Bradley and Dwight Eisenhower, along with the insights of British mathematicians to develop social science models during World War II, led to the emergence of OR as a formal discipline. People such as George Dantzig made great contributions to develop problem-solving methods and structures that provided effective decision making in areas such as economics, logistics, and communication. After World War II, OR, much like sociology and human geography<sup>c</sup> (HG), was applied to many social problems in government, industry, and society as it matured in its development to become the "science of the better."

The socio-models and quantitative-qualitative theories of today are even more empowering and insightful. In these models, social and environmental factors are considered in their influence on how individuals form into communities, and how these networks make decisions as groups. Some of the most comprehensive of these develop theoretical or computational models that combine sociology, psychology, cognitive and neuroscience, operations research, mathematics, and computer science. These models have been called social-cultural perspectives and are rooted in various subdisciplines, including social anthropology (Johnson 1996), behavioral ecology (Dunbar 1998), neuroscience (LeDoux 1996), social psychology (Bandura 1989), cognitive psychology (DiMaggio 1997), and computational science (Epstein and Axtell 1996; Carley 1991). Socio-cultural perspectives have become increasingly relevant for military operations to mirror the complexity of globalization, particularly as it relates to the speed at which ideological shifts and social mobilization can occur.

## **Military's Interest in the Social Sciences**

A recent Department of Defense (DoD) study on models and metrics for social issues identified challenges and pitfalls and recommended a research plan that includes using network science (NS) in individual, organizational, and societal modeling for military issues (National Research Council 2005). This work spawned several DoD efforts that are specifically focusing on socio-cultural factors. This DoD R&D effort may transform the understanding and conduct of human affairs, which in turn may present challenges to the legitimacy of long-established, cumbersome institutions. For example, from a policy and organizational perspective, the United States may find it necessary to modernize and trans-

form its information and intelligence stovepipes to become more dynamic and adaptive collaborative networks. Such a development could provide leaders with information they can use to make decisions to attempt to manage the complexities of world politics. To get there, reliable data on human beings, as they function as interconnected consumers, warfighters, enemies, refugees, diplomats, criminals, and citizens of their respective nations, will need to be collected and assessed. NS, SNA, and HG can offer new approaches and solutions to minimize violence and ethnic conflict; prevent or manage warfare, pandemics, and poverty; protect the global commons; reduce income disparity; and negotiate the allocation of finite resources and space among nations and/or groups.<sup>b</sup> These new tools will help society manage its ever-growing complexity.

One of Minerva's goals is to improve basic understanding of the social, cultural, behavioral, and political forces that shape regions of the world of strategic importance to the United States. Its stated issue of concern is that:

*"Twenty-first Century national security challenges reflect the complexity of globalization, including rapidly shifting geopolitical dynamics, increased pace of communication, and unprecedented social change. From climate change to failed and failing states and the rise of violent extremism, from the rise of new powers to ethnic strife, disease, and poverty, the United States will be forced to grapple with a range of new and daunting challenges."* (<http://minerva.dtic.mil>)

Minerva research topics focus on:

- Strategic impact of religious and cultural changes
- Terrorism and terrorist ideologies
- Science, technology, and military transformations in China and developing states
- National security implications of energy and environmental stress
- New theories of cross-domain deterrence
- Regime and social dynamics in failed, failing, and fragile authoritarian states
- New approaches to understanding dimensions of national security, conflict, and cooperation

## **Minerva Efforts at USMA**

In addition to its supported research projects, the Office of the Secretary of Defense (OSD) placed Minerva Fellows at the Joint Professional Military Education schools and Service Academies to combine its research efforts with the education of the military force. OSD awarded the United States Military Academy (USMA) two fellows to investigate "Social, Spatial, and Cultural Topologies of African Villages" in the Department of Geography and Environmental Engineering, and "Understanding the Differences in the Islamic Ideology and in Asian Cultures" in the Department of Behavioral Sciences and Leadership. These projects will function independently, but both will attempt to formalize models of societies to account for the connectivity of people, information, and resources through social, cultural, and spatial systems. These initiatives will lay the foundation for understanding how cultural norms and extreme ideologies are born and maintained, and further how failed communities can be stabilized and prosper (<http://www.usma.edu/minerva/SitePages/Home.aspx>).

The West Point Network Science Center (NSC), using the modeling and metrics of NS to complement and cooperate with the social science and HG methodologies, is supporting both projects. In addition to the nascent Academy research team, social

and behavioral scientists in the Army at the Army Research Office (ARO) and Army Research Institute (ARI) are connected to the USMA Minerva Initiative through support of their own research programs. The focus of much of ARI's research efforts is on developing cross-cultural competency training tools. They support various projects including computer-based and immersion-based trainings that enhance culturally appropriate negotiations skills, navigating social network structures, and reading nonverbal cues. In related research, USMA researchers, through support from ARI, examine network typology of leadership to better understand the social structural dynamics that are important in communication and cooperation.

The Minerva Research Initiative efforts are just being launched at the USMA. Collecting and using data on the connectivity of people, information, and resources to produce network models for the foundation of community stability and prosperity, the researchers on the project "Social, Spatial, and Cultural Topologies of African Villages" are seeking to understand how socio-cultural challenges develop and spread in the context of understanding conflict and cooperation in Africa. The research will examine the evolution of community governments, as well as the interactions between local networks, such as clans and tribes. This research will provide insight into how stable and productive structures and organizations develop and sustain themselves. SNA research pays particular attention to the synergistic and emergent roles within communities that are overlooked in strictly reductionist and hierarchical frameworks. For example, relationships among women within a community may play significant roles in coordinating the flow of resources throughout the community and thus contribute to the long-term quality and stability of education, healthcare, and technology. Furthermore, social scientist and HG researchers are investigating how leaders emerge from communities. By including the spatial component, SNA tools are showing how ideas, people, and resources diffuse—or spread—across territorial space. As the project matures, the USMA's Minerva work hopes to enhance cross-cultural competence among military personnel for activities in Africa such as security force assistance, stability operations, civil affairs, development initiatives, and theater security cooperation.

The project, "Understanding the Differences in the Islamic Ideology and in Asian Cultures," will focus on evolution of social network structures within the Muslim world to provide insight into how cultural norms and extreme ideologies are born and maintained. The approach for the study includes qualitative and quantitative data collection and analyses. Because Muslims across the world range widely in how they internalize and interpret their relationship to Muslim ideologies, a better understanding of the differences in cultural meanings around Islamic ideology can improve the US military's ability to relate with culturally diverse populations and conduct counterinsurgency operations more efficiently. Social and contextual factors play a role in driving some groups to embrace violent tactics to achieve political objectives. Social influences from both local networks (a person's direct family and friendship ties) and broader social networks (communities and large organizations) strongly influence an individual's attitudes. From sociological and geographical perspectives, individuals, groups, and entire communities can develop a set of shared values around their perceptions of US forces.

Many of the most pressing national security challenges demand an understanding of social science methodology, literature, and theory to produce effective support to decision makers. The NSC

embraces these multidimensional approaches by using NS and SNA modeling and OR and HG tools to investigate complex social issues through support for projects involving interdisciplinary social science research for defense and national security applications. Therefore, the NSC, with its broad interdisciplinary team, is an ideal partner for the social science departments to conduct Minerva research. SNA has great potential in evaluating complex interactions of organizations and systems, by encompassing multiple perspectives to analyze and improve social, spatial, and cultural systems. The analytic focus of SNA is on relationships between individuals, unlike traditional analyses that center on the attributes of individuals. SNA helps to map the adoption and spread of specific attitudes and activities and pinpoints ideological tipping points within groups. Similarly, using geographic information systems (GIS) and HG perspectives, Minerva researchers seek to understand socio-cultural, economic, and political activities within the context of the geographic and political environment.<sup>c</sup>

The USMA's Minerva Initiative hopes to incorporate and integrate concepts from social science, human geography, OR, and SNA to evaluate complex interactions within an increasingly connected world and contribute to the DoD's goal of enhancing military strategies in vital regions of our world. As stated in the President's recently released *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense* document, "The United States and its coalition allies and partners have learned hard lessons and applied new operational approaches in the counter terrorism, counterinsurgency, and security force assistance arenas..." Lessons learned from the past decade of counterinsurgency and stability operations have proven that while we might acknowledge there was a need to culturally understand the environment in which US military forces were operating, we now can apply tools, such as NS, HG, GIS, OR, and SNA, to provide insight into future operations of all types and levels. Self-knowledge from within military operations and examining the cultural make-up of countries that are of national security interest may contribute by bridging academic insights to operational context. This will strengthen and ground the future of US military operations with the Minerva wisdom to encompass more precise planning and execution in the future.

## Notes

<sup>a</sup> Wicked problems are those that cannot be solved by applying known methods; they demand inventive models that are often elaborate, adaptive, and innovative. Often the models for wicked problems involve elements of systems or complexity theory.

<sup>b</sup> Network Science (NS) and Social Network Analysis (SNA) are emerging modeling methodologies that use dynamic web structures that include entities (nodes) and their relationships (links) in addition to system processes and entity attributes.

<sup>c</sup> Human geography studies the world through models of people, communities, and cultures in a spatial context that is other provided from data provided by geographic information system (GIS) tools.

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## Happy Birthday Gene Visco!

This year, Gene celebrated a milestone birthday. Now that he's 85 years young, the entire MORS community celebrates his contributions to military operations research, his leadership in MORS, and his friendship.







# Using DataCards for Socio-Cultural Data Discovery and Sharing

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## Introduction

DataCards ([www.datacards.org](http://www.datacards.org)) is a structured wiki that indexes data sources that can be used for analysis of all aspects of irregular warfare (IW) and socio-cultural modeling. As much as Wikipedia is a virtual, collaborative “encyclopedia” that provides detailed information on virtually any topic of interest, DataCards is a virtual, collaborative “card catalog” that indexes and describes a growing number of data sources around the world. Data cards (akin to baseball cards) have been, and are being, developed for every data source that can be identified to provide summary descriptions of the content, quality, intended purpose, and potentially appropriate uses.

DataCards was created in support of a North Atlantic Treaty Organization (NATO) System Analysis and Studies (SAS) Specialist Team on “Allied Information Sharing,” but has since been maintained to focus on data sources around the world by a partnership between the National Defense University (NDU) and Joint Data Support (JDS) in the Office of Cost Assessment and Program Evaluation (CAPE) in the Office of the Secretary of Defense (OSD); with funding support from US Africa Command (AFRICOM); the Office of the Undersecretary of Defense, Intelligence (OUSDI); and the TRADOC Analysis Center (TRAC).

The objectives of DataCards include:

- Making sources of data discoverable
- Reducing the search costs for data
- Providing a conduit for non-DOD and nongovernment data to the operator

Because one of the great difficulties regarding socio-cultural data relates to end user evaluation of data sources, DataCards also has developed a rating system (much like Amazon or other online retailers provide a star rating and commentary section for products listed for sale on their sites). In this case, the star rating of a source is derived from the source’s rating on nine criteria that were refined over a series of conferences by a diverse set of experts from across government, industry, academia, and the nonprofit/development community.

## The Data Problem

There is no central repository, authority, or even reason for collecting data that can be used to evaluate and analyze socio-cultural issues, which confounds the ability of DOD to conduct studies, modeling, or analyses; as well as address metrics for assessment of any sort. In the best of circumstances, the type of data sources that could be used to support such work are stove-piped among a number of different organizations within the military channels of the United States, not to mention the interagency entities in theater, other troop-contributing nations, nongovernmental organizations (NGOs) and other private organizations, and even the host nation itself if focused on a foreign country, as in Afghanistan or Iraq. Because the area of socio-cultural data and information is not well established or well understood, each of these organizations tends

to collect different data, for their own purposes, in their own way, and store it (if they even save it) without publicizing its existence. Furthermore, what is collected, how it is defined, where it is stored, and how its existence is communicated highly depends on the personality of leadership and staffs, which change over time given rotations in and out of theater, as well as across the country in different offices or sites.

There is no question that enormous volumes of relevant data have been and are being gathered and collected in theater that could support assessment; however, discovering the location, or even the existence, of such data is usually a laborious and difficult process. This is true anywhere for these types of data, given the lack of central authority and clarity regarding the need for such data, but it is even more true in a theater at war. Generally, the most effective approach to finding data in Afghanistan has been to use the “buddy network.” That is, an informal social network of colleagues and friends that can be accessed through a series of phone calls, emails, and conversations to understand what data are available and where they may be located. If the data acquirer is lucky, a trusted agent might even be able to provide an assessment of how “good” the data are once located, though this is a haphazard process as well. The DataCards tool was created with this problem in mind, so that anyone concerned with data could rapidly sort through the possible existence of specific sources socio-cultural data that might be relevant to their work, and to obtain an initial assessment as to the data’s suitability for their purposes.

## A Modest Start with DataCards

The objective in the creation of DataCards was to develop a capability that could become self-sustaining. To succeed, a community of interested parties, data owners, analysts concerned with data, and anyone with knowledge of data sources would have to share their information broadly to help overcome the identified problem. Technically, the best Web-enabled capability applied against such a problem is a wiki. A wiki provides a platform in which any user can contribute, edit, observe, or share their knowledge in a truly collaborative way. Because we are interested in the characteristics of data, and desire to standardize the search for and discovery of data sources, we added structure to the typical wiki environment in the form of defined fields and drop-down menus. The result was a structured wiki that indexes data sources that can be used for transition metrics or socio-cultural modeling.

The organizing principle for the project was to create a card for each source of data that quickly summarizes the content, quality, intended purpose, and potentially appropriate uses. The inspiration for this “card” concept was from the American game of baseball. For years, baseball cards have been developed, sold, and traded for each player in the game in a given year. The cards provide statistics that describe the player’s performance, position, history, and other characteristics of note so that fans can be informed about the attributes of any particular player. The simplicity of the concept,

*See DataCards on following page ...*

adapted to a Web 2.0 forum, seemed to be an easy way to capture the key metadata that users need to quickly triage potential sources of data for their needs.

## Key Findings from Data Summits in Support of DataCards

In support of the DataCards effort, NDU has hosted two “data summits” that brought together a diverse group of data experts from across the US government, academia, industry, national labs, and the nonprofit/development community. The first summit, held in January 2012, quickly broke into working groups after a keynote address by General (ret) James Cartwright. The working groups focused on refining and developing criteria for evaluating various types of qualitative and quantitative data sources. The second summit, held in June 2012, was also mostly composed of working group time after a keynote address by Frank Larkin, Vice Director of the Joint IED Defeat Organization (JIEDDO). The four working groups focused on Big Data, Qualitative Data, Geospatial Data, and Finding Data Sources. The second Summit’s working group findings included the following, as well as several other discussions.

“Data” is a user-defined term; it is not specific to one particular type of data. DataCards is a platform with a wide user base with varied data needs. DataCards should seek to assist with the discovery and evaluation of data sources.

Big data is a growing field of interest within analytical and knowledge communities. Big data, which was defined by the complexity, structure, and size of data, is not just social media but is generally transactional in nature, including financial transactions, short message service (SMS), and search engine results. These data exceed standard data processing tools and analysis as such data requires a different approach. Additionally, big data presents new challenges for users, who will require access to new technologies and changing existing policies and procedures that set the boundaries.

Many data sources are qualitative in nature and cannot be analyzed and machine processed the way quantitative or geospatial data are processed and analyzed. The working group devoted to qualitative data approached the topic by generating an extensive list of qualitative data types, associated limitations, and applications for most data types. A challenge identified during discussions was the lack of common definitions or taxonomy of qualitative data types.

The working group devoted to geospatial data found that the most important considerations for users interested in these types of data are robust search capabilities, a minimal path to finding data, and complete data. There are advantages to using DataCards to store geospatial data such as making the data more accessible to the user and enabling some visualization, but site maintenance and licensing issues can present challenges for storing data.

There is no one way for individuals to find data. Discovery is often project-specific and individuals tend to establish and follow predictable patterns of behavior when finding data because certain sources tend to be proven relevant and trustworthy. These behaviors are often a result of or are reinforced by constraints such as time, resources, classifications and permissions, and stove-piping. The Finding Data working group also identified various methods for data validation and verification—corroboration with other sources or experts, historical uses of the source, pedigree of the data, peer reviews—as well as associated risks to these methods, such as violations of pedigree or awareness of shelf life.

## Conclusions

Any interested party is invited to join DataCards at [www.datacards.org](http://www.datacards.org), and can obtain a username and password by emailing [help@datacards.org](mailto:help@datacards.org). As of this article’s writing, approximately 1,700 data sources have been identified, and DataCards will index well over 5,000 data sources in the coming months. In addition to a focused effort on data sources related to Africa by the Library of Congress, machine learning crawlers have been developed to suggest potential data sources across the Internet to the DataCards team. The Third Data Summit is expected to be held at the National Defense University at the end of November 2012. If readers are interested in attending, or in receiving notes and outbriefs from the Summit, please contact me or email [help@datacards.org](mailto:help@datacards.org) to be added to an email distribution list.

## About the Author

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# Solving a Problem with Either-Or Constraints and a Nonlinear Objective Function as a Mixed Integer Linear Program in order to Reconfigure the Force with a Minimum of Disruption

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In this article we use a military example to illustrate how a problem that, in its most natural formulation, appears complicated and difficult to solve, can be simplified and transformed until it is solvable with relatively inexpensive, general-purpose mixed integer linear programming software. The problem to be discussed is complicated by the presence of either-or constraints with additional difficulty contributed by a nonlinear objective function. We simplify the problem by producing a mathematical proof that solving the problem without the either-or constraints produces a solution that is optimal for the problem with the either-or constraints. This means we can drop the either-or constraints from the formulation and not worry that we are solving a different problem. We then exchange the nonlinear objective function for a linear objective function at the cost of introducing a set of 0–1 variables, which admittedly represent new either-or constraints but are simpler than the ones we started with. Our discussion here will be less rigorous development and more an attempt to illustrate the simplification and reformulation of the problem. In the final section, however, where we present an example, we lay out the problem formally to identify the elements of its software representation. For those comfortable with mathematical programming, a rigorous mathematical development is available in a companion paper from the authors.

Our illustrative example is drawn from an Air Force study of its future force, one that focuses on the allocation of its planned assets to its components. Its planned assets are two: aircraft and personnel, and its components are three: the regular forces or Active Component (AC), the Air National Guard (ANG), and the Air Force Reserve (AFR). The study, known as the Total Force Enterprise (TFE) project, is led by the Air Force planning and programming agency (AF/A8) with analytical support provided by the Air Force analysis agency (AF/A9). The force being planned is that of 2016, and planning objectives include minimizing risk, minimizing cost, minimizing stress on the force, and minimizing disruptions to Air Force operations in the course of the transition to the future force. To spawn and test hypotheses, AF/A9 has created a decision support tool which models the problem as a pre-emptive goal program with these various objectives as goals. Our focus here is on the modeling of the goal of minimizing disruptions by minimizing shifts of units from one component to another. Such shifts are expected to be disruptive in their impact, for example, on force readiness. We begin with brief introductions to goal programming and the TFE goal program.

## Pre-emptive Goal Programming

A pre-emptive goal program is an algorithm for multiobjective optimization. It solves a sequence of linear programs, each with a different objective formulated as its objective function. When a linear program in the sequence is solved, its objective function value becomes a goal which is just the right hand side of a constraint requiring subsequent linear programs in the sequence to achieve a value for this objective close to the goal. For example, were we to solve a linear program to minimize cost with objective function  $ax$  and obtain an optimal objective function value  $ax^*$ , then to any subsequent linear program, e.g., one minimizing disruptions, we would add a constraint of the form  $ax \leq (1 + pct)ax^*$ . The variable  $pct$  is typically a small percentage and would serve to keep the cost returned by subsequent linear programs in our sequence within  $pct$  of  $ax^*$ . In general, the solution obtained at the end of the sequence will vary with the order in which the objectives take their turn.

## The TFE Goal Program

Our TFE goal program seeks to satisfy multiple objectives subject to satisfying demand for personnel and aircraft while respecting resource limitations. Currently we include demand for 31 Mission Design Series (MDS) such as the B-1, the E-3 and the F-22. We also include demand for 291 Air Force Specialties (AFS), aggregates of which, such as those involving civil engineers, are our personnel categories. As an example of resource limitations, we enforce constraints on total endstrength, e.g., a limit on the total number of airmen the Air Force can employ.

The variables of the programs are the numbers of units planned for each of 612 unit types. Unit types are defined by a command, a kind, and a weapon system group. For example, the unit type  $AMC, ALF, C5\_C17$  designates airlift units (kind = airlift ( $ALF$ )) under the command of the Air Force Mobility Command ( $AMC$ ), which include C5 and C17 squadrons. The command of a unit type effectively assigns it to a single one of the three components.  $AMC, ALF, C5\_C17$  units are AC units.

Currently we have three general objectives, minimize risk, cost, and disruption to the force, which we seek to realize by means of a goal program consisting of a sequence of six linear programs. The minimization of risk is accomplished by three linear programs, one whose objective function is to minimize unmet demand for MDS, another whose objective function is to minimize unmet demand

*See Mixed Integer Linear Program on following page ...*



for AFS, and a third that minimizes the sum over all AFS of the ratios of unmet demand for an AFS to demand for the AFS. Similarly, disruption to the force is modeled both by changes in the numbers of units for each component and by shifts of units from one component to another. It was the latter metric that we found challenging to model and that gave rise to the disjunctive programs we discuss here.

### Minimizing Disruption

In the TFE goal program we distinguish simple increases and decreases in numbers of units of a unit type from the shift of units from one component to another. In the case of the former, we minimize a sum of the form

$$\sum_{\text{unit type}} | \text{units}_{\text{unit type}}^{\text{planned}} - \text{units}_{\text{unit type}}^{\text{current}} |$$

In our model all units of a given unit type belong to one component. We do not have units of the same unit type in different components. The calculation of the number of shifts involves comparing numbers of units for unit types of the same kind in different components as we now elaborate.

### The Calculation of the Number of Transitions

A *transition* is our term for the shift of a unit from one component to another, and our objective function is one which minimizes the number of transitions. We identify units by unit type and unit types by kind. Table 1 lists the unit types for units of aircraft mechanics along with the unit type, component, and notional data for the current number of units and the planned number of units returned by the TFE Goal Program. There are no systems associated with these unit types. A transition is the shift of a unit from one unit type to another of the same kind but different component.

Table 1. A listing of unit types of kind AMX

Kind	Command	System group	Component	Current	Planned
AMX	ACC		AC	22	15
AMX	AETC		AC	3	10
AMX	AFGSC		AC	2	5
AMX	AFMC		AC	13	35
AMX	AMC		AC	12	33
AMX	PACAF		AC	29	24
AMX	USAFE		AC	8	7
AMX	NGB		ANG	98	83
	AFRC		AFR	85	74

Table 2. Number of transmissions for the example in Table 1.

Component	Current c	Planned p	Increases s <sup>+</sup>	Decreases s <sup>-</sup>
AC	89	129	40	
ANG	98	83		15
AFR	85	74		11
		Total	40	26
Transitions = Min(40,26) = 26				

For a given kind, the number of transitions is calculated from the data for current and planned numbers of units by identifying winners and losers. For the given kind, winners are those components which enjoy a net increase from their current number to their planned number of units. Losers are those components which suffer a net decrease in units. The number of transitions is the minimum of the sum of the net increases for the winners and the sum of the net decreases for the losers. Table 2 shows the calculation of the number of transitions for the example in Table 1.

### Formulating the Problem of Minimizing Transitions

For each kind we must do what we have done for Table 2, namely, sum the increases, e.g., 40 = 40 + 0 + 0, and sum the decreases, e.g., 26 = 0 + 15 + 11, across the components and take the minimum of the two sums, e.g., 26 = min(40,26). Then we sum the minima for all the kinds, and this is our objective function. In formal terms we would write it as *minimize*  $\sum_{kd} \min(S_{kd}^+, S_{kd}^-)$  where

$S_{kd}^+$  = the sum for kind kd of increases over all components

$S_{kd}^-$  = the sum for kind kd of decreases over all components

The terms  $\min(S_{kd}^+, S_{kd}^-)$  are nonlinear.

Note in Table 2 that for each component we have either increases or decreases but not both because we are tracking the net change from the number of current units in the component to the planned number. Because we cannot know beforehand for any kind and component whether the component's number of units will increase or decrease, it is necessary to maintain two variables, one for increases, denote it  $(s^+)_{kd}^{cmp}$ , the other for decreases  $(s^-)_{kd}^{cmp}$ . In formal terms we represent the fact that at least one of the variables must be zero by the either-or constraints:

$$\left( (s^+)_{kd}^{cmp} = 0 \right) \vee \left( (s^-)_{kd}^{cmp} = 0 \right), \quad \forall cmp, \forall kd$$

### The Either-Or Constraints Can Be Dropped from the Formulation

It turns out, however, that the either-or constraints of the previous section can be dropped. That is, an optimal solution to the problem without the either-or constraints, which we shall denote  $(NLP)$ , is an optimal solution to the problem with them, which we shall denote  $(NLP_{eo})$ . Because  $(NLP)$  is obtained by dropping constraints of  $(NLP_{eo})$ , the feasible set of solutions to  $(NLP)$  contains the set of feasible solutions for  $(NLP_{eo})$ , and an optimal solution for  $(NLP)$  which is feasible for  $(NLP_{eo})$  must be optimal for  $(NLP_{eo})$ . Accordingly, to prove the either-or constraints can be dropped it is enough to prove the following proposition.

**Proposition:** An optimal solution for  $(NLP)$  is feasible for  $(NLP_{eo})$ .

**Outline of Proof:** We proceed by showing that, for any feasible solution to  $(NLP)$  which is not feasible for  $(NLP_{eo})$ , there is a solution which is feasible for both problems and has an improved, i.e., smaller, objective function value. This will imply that the optimal solutions, which are solutions that cannot be improved upon, must be feasible for  $(NLP_{eo})$ .

To this end we consider a feasible solution for  $(NLP)$  which, for some kind KD and some component CMP, has both positive increases and positive decreases. It is safe to assume that  $(KD, CMP)$

is the only such  $(kind, component)$  pair. If there are others, we could repeat our argument for each in turn. The objective function term for KD is  $\min(S_{KD}^+, S_{KD}^-)$  where, as we indicated earlier,  $S_{KD}^+$  is a sum which includes the positive increases for CMP and  $S_{KD}^-$  is a sum which includes the positive decreases for CMP. If we reduced both the increases and the decreases for CMP by the smaller of the two, we would obtain a solution for CMP in which either the number of increases or decreases is 0—that is, a solution which satisfies the either-or constraints. Furthermore,  $S_{KD}^+$  and  $S_{KD}^-$  would both be reduced by the same amount as would the overall objective function value which must include one or the other. In this way we have produced a feasible solution for  $(NLP_{ec})$  with improved objective function value, and the proposition is established. ■

## (NLP) Can Be Replaced by a Mixed Integer Program

$(NLP)$  is simpler than  $(NLP_{ec})$ , but it still has the nonlinear objective function  $\text{minimize } \sum_{kd} \min(S_{kd}^+, S_{kd}^-)$ . This objective function can be replaced by a linear function at the cost of introducing two new variables for each kind, one of which is a continuous variable while the other is a 0-1 variable. The continuous variable is  $L_{kd}$  which will be a tight lower bound on the pair  $(S_{kd}^+, S_{kd}^-)$ , i.e.,  $L_{kd} = \min\{(S_{kd}^+, S_{kd}^-)\}$ . With it we can formulate the objective function with a linear function as  $\text{minimize } \sum_{kd} L_{kd}$ .

To make  $L_{kd}$  a lower bound we require it to be no greater than  $S_{kd}^+$  and no greater than  $S_{kd}^-$ . We make it a tight lower bound by introducing the 0-1 variable  $x_{kd}$ . First, we can force the value of  $x_{kd}$  to be 1 by requiring it to be no less than the difference  $S_{kd}^- - S_{kd}^+$  divided by a positive number large enough that, when the difference is positive, the quotient is between 0 and 1, i.e.,  $x_{kd} - \frac{S_{kd}^- - S_{kd}^+}{M} \geq 0$ . When the difference is negative, we require  $1 - x_{kd}$  to be no less than the quotient of the difference  $S_{kd}^+ - S_{kd}^-$  divided by a positive number large enough that this second quotient is between 0 and 1. This forces  $x_{kd}$  to be 0.

Now that we have a way to control the value of  $x_{kd}$  which is related to the relative sizes of  $S_{kd}^+$  and  $S_{kd}^-$ , we use it to set the value of  $L_{kd}$  equal to the smaller of the two. We require  $S_{kd}^+ - L_{kd}$  to be less than a multiple of  $1 - x_{kd}$ , i.e.,  $M(1 - x_{kd}) - (S_{kd}^+ - L_{kd}) \leq 0$ . When  $S_{kd}^+ < S_{kd}^-$ ,  $x_{kd}$  must be 1 and, therefore,  $1 - x_{kd}$  must be 0. So the new constraint will force  $L_{kd} = S_{kd}^+ = \min\{(S_{kd}^+, S_{kd}^-)\}$ . Symmetrically, we require the difference  $S_{kd}^- - L_{kd}$  to be less than a multiple of  $x_{kd}$  which will force the difference to be 0 when  $S_{kd}^- < S_{kd}^+$ .

## An Example

In Table 3 below we provide an abridged screen shot of an example of our mixed binary linear program  $(MBLP)$  as formulated for a problem with one kind and just two components in What's Best!, a version of LINDO adapted as an add-in to MS Excel. The two components are the active component AC and the combination of the Guard and Reserve components ARC. First, we lay out the formulation so that we can relate the items in the table to it.

## Formal Statement of the Problem of Minimizing Transitions

We employ the following notation.

$C_{kd}^{cmp}$  = the current number of units for unit types of kind  $kd$  and component  $cmp$

$p_{kd}^{cmp}$  = the planned number of units for unit types of kind  $kd$  and component  $cmp$

$$(s^+)_{kd}^{cmp}, (s^-)_{kd}^{cmp} = \text{nonnegative variables such that } p_{kd}^{cmp} = \begin{cases} c_{kd}^{cmp} + (s^+)_{kd}^{cmp}, & \text{if } p_{kd}^{cmp} \geq c_{kd}^{cmp} \\ c_{kd}^{cmp} - (s^-)_{kd}^{cmp}, & \text{if } p_{kd}^{cmp} < c_{kd}^{cmp} \end{cases}$$

Our problem, formally stated, is

$$(MBLP) \quad \text{minimize } \sum_{kd} L_{kd} \quad (1)$$

s.t.

$$S_{kd}^+ = \sum_{cmp} (s^+)_{kd}^{cmp}, \forall kd \quad (2)$$

$$S_{kd}^- = \sum_{cmp} (s^-)_{kd}^{cmp}, \forall kd \quad (3)$$

$$p_{kd}^{cmp} - (s^+)_{kd}^{cmp} + (s^-)_{kd}^{cmp} = C_{kd}^{cmp}, \forall cmp, \forall kd \quad (4)$$

$$C_{kd}^{cmp} - (s^-)_{kd}^{cmp} \geq 0, \forall cmp, \forall kd \quad (5)$$

$$\dots \quad (6)$$

$$S_{kd}^+ - L_{kd} \geq 0, \forall kd \quad (7)$$

$$S_{kd}^- - L_{kd} \geq 0, \forall kd \quad (8)$$

$$x_{kd} - T(S_{kd}^- - S_{kd}^+) \geq 0, \forall cmp, \forall kd \quad (9)$$

$$M(1 - x_{kd}) - (S_{kd}^+ - L_{kd}) \geq 0, \forall cmp, \forall kd \quad (10)$$

$$(1 - x_{kd}) - T(S_{kd}^+ - S_{kd}^-) \geq 0, \forall cmp, \forall kd \quad (11)$$

$$Mx_{kd} - (S_{kd}^- - L_{kd}) \geq 0, \forall cmp, \forall kd \quad (12)$$

$$x_{kd} = 0 \vee x_{kd} = 1, \forall kd \quad (13)$$

$$p_{kd}^{cmp}, (s^+)_{kd}^{cmp}, (s^-)_{kd}^{cmp}, \dots \geq 0, \forall cmp, \forall kd \quad (14)$$

There are many constraints of the goal program which are unrelated to our formulation of transitions and need not be enumerated here. They include, for example, rotational and foundational demand constraints both for AFS and MDS, endstrength constraints, constraints on the ratio of officers to enlisted personnel, as well as any goal constraints generated by higher priority objectives. In acknowledgement of the existence of these unenumerated constraints, we include a numbered ellipsis (6) in the formulation above. Similarly, there are nonnegativity constraints (14) for the variables which appear here and an ellipsis to indicate that there are other variables which do not appear.

## Explanation of Table 3

Table 3 shows the final tableau. In general, the columns correspond to variables and the rows to constraints. The optimal objective function value is the value of  $L$  and appears in the cell just

See Mixed Integer Linear Program on following page ...

**Table 3. Abridged tableau of an example with two components and one kind.**

M = 1,000		Current Number of Units		Planned Number of Units	$(s^-)^{AC}$	$(s^-)^{ARC}$	$(s^+)^{AC}$	$(s^+)^{ARC}$	LHS	RHS	Dif	.GE. 0
$\epsilon = 1/M = 0.001$		$C^{AC}$	$C^{ARC}$									
Constraint Number	L	x	$p^{AC}$	$p^{ARC}$								
	21.711	1.000	51.711	2.632	0.000	27.368	21.711	0.000				
6	...		...		...		...		...			
4			1		1		-1		30	30	0	=>=
4			-1		-1		1		-30	-30	0	=>=
4				1		1		-1	30	30	0	=>=
4				-1			1		-30	-30	0	=>=
5					-1				0	-30	30	>=
5						-1			-27.37	-30	2.63	>=
6	...		...		...		...		...			
7	-1						1	1	0.00	0	0.00	=>=
8	-1				1	1			6	0	6	>=
9		1			-0.001	-0.001	0.001	0.001	0.99	0	0.99	>=
10	1	-1000					-1	-1	-1,000	-1,000	0	=>=
11		-1			0.001	0.001	-0.001	-0.001	-0.99	-1	0.01	>=
12	1	1000			-1	-1			994.34	0	994.34	>=

beneath it. The values of the other variables are in the cells to the right of that for  $L$ . In the leftmost column beneath the cell with the column header “Constraint Number” appear the numbers of the constraints according to the numbering of (MBLP) as laid out in the previous section.

The cells that pertain to the unexpressed constraints (6) contain no detail and are displayed in grey whereas the ones of interest to us are filled in and uncolored. At the very top of the table, we provide the value of the constants  $M$  and  $\epsilon = \frac{1}{M}$  as well as those representing the current numbers of units, viz., 30, for each of the two components. All the constraints as formulated in the tableau are in  $ax \geq b$  form so that the equation (4) is represented by a pair of inequalities. The equations (2) and (3) do not appear because we use their right hand sides instead of the left hand side variable, e.g.,  $(s^+)^{AC} + (s^+)^{ARC}$  instead of  $S^+$ .

The current number of units for both AC and ARC is 30, and the optimal solution puts the planned values for them to 51.71 and 2.63 respectively. Because we have a net reduction of forces from the current number 60 to the planned number 54.34 with  $S^+ = (s^+)^{AC} + (s^+)^{ARC} = 21.71$  and  $S^- = (s^-)^{AC} + (s^-)^{ARC} = 27.37$ , the 0-1 variable  $x$  is set to 1 in the solution and the number of transitions is  $L = \min\{21.71, 27.37\} = 21.71$ . Finally, it can be seen that the original either-or constraints  $(s^+)^{AC} = 0 \vee (s^-)^{AC} = 0$  and  $(s^+)^{ARC} = 0 \vee (s^-)^{ARC} = 0$  are satisfied.

### About the Authors

*Dr. Joseph M. Tama* has a doctorate in operations research from Carnegie Mellon University and has worked as a modeler and tool developer in USAF/A9 and its predecessor AFSAA since 2002. The most notable projects on which he has worked have been the 2004 Capabilities Review and Risk Assessment (CRRA), the 2005 BRAC, and in 2010 the Total Force Enterprise Project.

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Black & White, or Two-Color—Interior Pages Only				
Full-page	\$750	\$700	\$650	Trim: 8.5"x11", Live Area: 7" x 10" Full bleed: 8.75"x11.25" No bleed: 7.5" x 10"
Half-page	\$525	\$500	\$475	7.5" x 5" (bleeds not accepted)
Quarter-page	\$375	\$350	\$325	3.5" x 5" (bleeds not accepted)
Two-color (PMS 287 Blue & Black) ads are offered on interior pages only for an additional fee of \$250.				

**Issue Date**

PHALANX is published the first month of each quarter.

**Closing Dates**

- Space reservations are due the 1st of the month prior to publication.
- Advertising materials are due the 15th of the month prior to publication.

**Send Files To**

Military Operations Research Society  
1703 N. Beauregard Street, Suite 450  
Alexandria, VA 22311-1745, 703-933-9074

**File Requirements**

- 4-color ads are to be submitted in high resolution, press-ready PDF (300dpi) format in CMYK color mode. Be sure to include bleeds if needed.
- Black and white ads are to be submitted in high resolution, press-ready PDF (300 DPI) format in GRAYSCALE color mode.
- 2-color ads are to be submitted in high resolution, press-ready PDF (300 DPI) format in SPOT (PMS 287 & Black) color mode. Please do not include crop or printer's marks.
- Native files are not acceptable.



Trena Covington Lilly, Johns Hopkins University Applied Physics Lab and MORS Immediate Past President, Guest Editor

It is another period of transition as we welcome our new President Michael Garrambone, and welcome the newly elected Executive Council and Board of Directors. We also bid farewell to our *Phalanx* editor for the past six years, John Willis. I want to thank John for the exceptional job he has done in the past few years through the many transitions in leadership and look forward to his future involvement in MORS in a different capacity.

As we search for the new editor of *Phalanx*, I encourage you to become involved, share your ideas and suggestions on the qualities we should be looking for in an editor, and feel free to become a part of the MORS family by taking on this responsibility.

In this issue of *Phalanx*, we feature:

- Highlights of the exceptional 80th MORS Symposium held at the US Air Force Academy in Colorado Springs in June
- Thought-provoking feature articles
- Our President's report, which includes new initiatives to keep our Society thriving
- Special Meeting reports and announcements

We encourage you to submit your articles, announcements, and letters to the editor for publication in *Phalanx*. As we continue to serve you, thank you for your support for our Society and I invite you to grow with us as we move forward on the "winds of change."



## Phalanx Editor Search

The *Phalanx* is a quarterly bulletin published by the Military Operations Research Society in cooperation with the Military Applications

Society of INFORMS, and mailed to MORS and MAS members. An online version is posted on the MORS website. The *Phalanx* differs from the *MOR* journal as its focus is on providing Society-related information and perspectives on analysis and trends. The articles are not considered as refereed journal papers. The *Phalanx* editor works with the MORS office to generate *Phalanx*. Additionally, there are associate editors who may be called upon as support.

*Phalanx* is published in March, June, September, and December. There are standard articles in each issue dealing with special meetings, the MORS Symposium, prize announcements and winners, perspectives from the editor, and so on. In addition to the standard template per issue, the editor is responsible for finding topics and contributors for four to five additional articles.

Like most MORS leadership positions, the *Phalanx* editor position is an unpaid, volunteer position. Time commitment will vary, ranging from a few hours a week to recruit authors and articles, to 10 hours a week near publication time to edit articles, review the issue, and write "The Last Word." There is currently no official length of term for the *Phalanx* editor, but at least two years of service is desired.

Characteristics desired in a *Phalanx* editor include:

- Scientific breadth in operations research and related field
- High standards in research and publications
- Good organizational, writing and editorial skills

- Knowledge of the MORS/MAS communities, their missions, and importance
- Prior participation in MORS/MAS
- Editorial or other relevant experience demonstrating the ability to conduct:
  - Editorial review of submitted materials
  - Effective communication with the MORS/MAS leadership, *Phalanx* staff, and prospective authors
  - Effective management of co-editors, authors, and support personnel to produce a publication efficiently and on time
- Ability to identify and solicit thought-provoking and pertinent papers
- Ability to work with community to solicit relevant and quality advertising

Interested candidates are invited to submit the following information in support of their applications by January 5, 2013:

- A cover letter that addresses candidate's goals for *Phalanx* and why the candidate has the skills to accomplish these goals
- A curriculum vita that includes:
  - relevant experience including titles/roles and associated dates
  - education
  - contact information
  - references
- Samples of the candidate's writing
- Letters of recommendation are encouraged

Please send application packages either by mail to: Susan Reardon (MORS CEO), 1703 N. Beauregard Street, #450, Alexandria, VA 22311-1745, or by email to Susan@mors.org. For further information, please contact the MORS office at mors@mors.org.

# MORS' YOUNG ANALYSTS THE NEXT GENERATION OF LEADERS

The future of operations research and the national security community depends on new analysts taking the helm. MORS' Young Analyst Initiative facilitates this process by providing paths for emerging analysts to engage with MORS through publishing, meeting participation, volunteering, mentorship and recognition.

To highlight the achievements, interests and aspirations of young analysts, we turn the spotlight on one deserving individual in every issue of *Phalanx*.

To learn more about the Young Analyst Initiative, connect with other young analysts, see past featured analysts and learn how you can nominate a deserving analyst, please visit

[WWW.MORS.ORG/YA](http://WWW.MORS.ORG/YA)

## HUNTER MARKS OPERATIONS RESEARCH ANALYST HQ U.S. AIR FORCES IN EUROPE



- MORS member since 2008.
- My childhood ambition was to become an astronaut, but after a medical disqualification from my commissioning program, I found the path to OR.
- I became an operations research analyst to serve my country to the best of my ability. I was told that Operations

Research enables you to use mathematics to make decisions, which was something I desired growing up. The career field matched my gifts, abilities, and interest. So, I pursued a path to apply OR to national security problems.

- In five years I hope to continue my growth as an analyst and as a professional, making a difference both within National Security as an Air Force Civilian and within MORS as a Director.
- MORS is a family. Your peers and the analysts who came before you want to see you grow and develop as an analyst. They will be honest in their feedback and hold you true in your analysis. It is your responsibility to do the same for your peers and those who will come after you.







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## MARK YOUR CALENDARS!

### Upcoming 2012–2013 MORS Events

October 1–4, 2012  
 Affordability Analysis:  
 How Do We Do It?  
 Lockheed Martin Global  
 Vision Center,  
 Arlington, VA

November 5–8, 2012  
 Assessments of Multi  
 National Operations  
 MacDill AFB.  
 Tampa, FL

December 6, 2012  
 First Ever  
 Industry Showcase  
 Hilton Mark Center,  
 Alexandria, VA

January 28–31, 2013  
 (tentative)  
 Analytical Preparations  
 for the Next QDR  
 National Defense  
 University,  
 Washington, DC

March 25–28, 2013  
 Professional Gaming  
 Johns Hopkins University  
 Applied Physics  
 Laboratory,  
 Laurel, MD

April 17–18, 2013  
 Education & Professional  
 Development Colloquium  
 United States Naval  
 Academy,  
 Annapolis, MD

June 17–20, 2013  
 81st MORS Symposium  
 United States Military  
 Academy,  
 West Point, NY

Stay tuned for more details in the coming months! Check our website at [www.mors.org](http://www.mors.org) for the latest updates...  
 the Terms of Reference (TOR), meeting agendas, hotel information and rates, as well as other valuable meeting and logistics information.