

PHALANX

The Magazine of National Security Analysis | December 2016

METSM

EMERGING TECHNIQUES SPECIAL MEETING

Hilton Mark Center • December 6 – 7, 2016



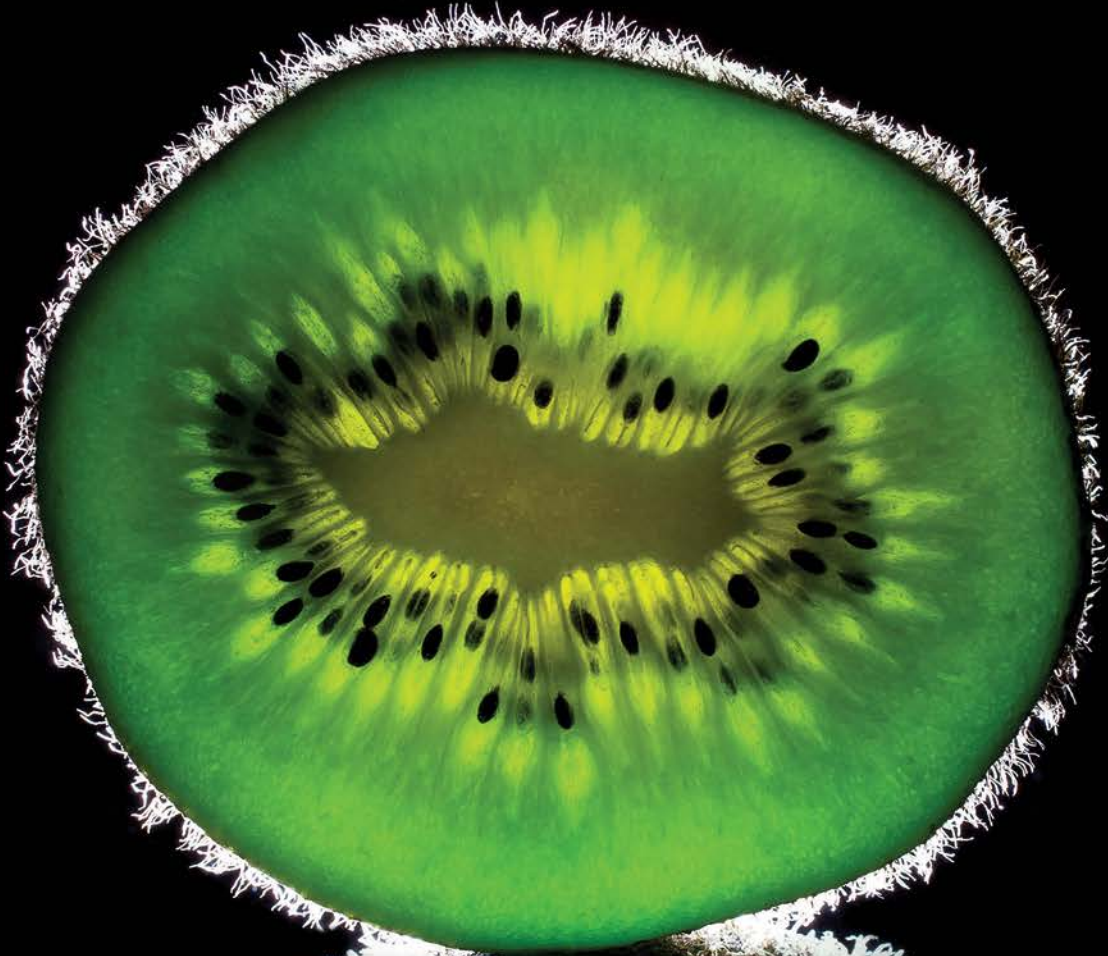
Volume 49, Number 4

In This Issue:

- IIPs at METSM
- Learning from Wargames
- New MORS Sponsor

Analytics see what you can't. So you can see opportunities within.

© 2016 Accenture. All rights reserved.



How do you go beneath the surface of your data to reveal the hidden possibilities? Analytics. We help our clients use analytics to turn data into insight, insight into action and action into tangible results. It's just one of our Digital capabilities, along with Interactive, Mobility, Cloud and Security — everything you need to compete to win. That's high performance, delivered.

High performance. Delivered.

Accenture **Analytics**

Part of Accenture Digital

Strategy | Consulting | **Digital** | Technology | Operations

IN THIS ISSUE

MORS/MAS

- 2 MORS President
4 MAS President
8 MORS Emerging Techniques Special Meeting
12 85th MORS Symposium
14 MORS Wargaming Workshop
20 Enhancing and Developing a Red Teaming Community in MORS
22 MORS Continuing Education Goes on the Road
26 Affordability Analysis: Organizing and Refining for Implementation
29 MORS Oral Histories

PROFESSIONAL FEATURES

- 30 Connecting the Dots: Learning from Multiple Wargames
38 Cost Drivers in Vehicle Maintenance

IN TOUCH

- 42 Young Analyst: Sarah Harrop
43 ISMOR is Back!
45 The PuzzLOR & Thinking Analytically: Spaceship
46 In Memoriam: Stephen Murtaugh, Jack Borsting
49 Milestones
50 Sponsor's Corner

PHALANX STAFF

Editor: Terry McKearney, The Ranger Group,
terry.mckearney@therangergroup.com
Production Editor: Joan Taylor, MORS,
joan@mors.org
Graphic Design/Layout: Spot Creations

Department Editors

Naval Analysis, Brian G. McCue, CNA,
brianmccue@alum.mit.edu
Letters to the Editor, MORS Office,
morsoffice@mors.org
Modeling and Simulation, James N. Bexfield, FS,
jim_bexfield@comcast.net
MOR Heritage, Eugene P. Visco, FS,
genevisco@embarqmail.com

Numbers from Operations, George W.S. Kuhn, LMI,
gkuhn@lmi.org
The Pseudo-Analytical Agenda,
Wright Handisides

PHALANX Editorial Board

Chair: Greg H. Parlier, IDA

MORS Publications Committee

Chair: CDR Harrison C. Schramm, OPNAV N81
Deputy Chair - Mr. Walter DeGrange,
CANA Advisors
Dr. Roger Chapman Burk, U.S. Military Academy
Dr. Richard F. Deckro, FS, Air Force Institute
of Technology

Mr. Michael W. Garrambone, InfoSciTex
Corporation: A DCS Company
Ms. Trena Covington Lilly, The Johns Hopkins
University Applied Physics Laboratory
Dr. Andrew G. Loerch, FS, George
Mason University
Mr. Hunter Adam Marks, MORS
Board of Directors
Mr. Terry McKearney, FS, The Ranger Group
Mr. James Muccio, The Perduco Group
Dr. Jerry R. Smith, OPNAV N81
Dr. Ben W. Taylor, DRDC CORA

Military Operations Research Society
2111 Wilson Blvd.
Suite 700
Arlington, VA 22201
703 933.9070; FAX 703 933.9066
e-mail: morsoffice@mors.org
www.mors.org

MORS OFFICERS

PRESIDENT

Mr. Norm Reitter
CANA Advisors
President@mors.org

PRESIDENT ELECT

Mr. Joseph F. Adams
Institute for Defense Analyses
Presidentelect@mors.org

VICE PRESIDENT (FINANCE AND MANAGEMENT)

Ms. Ronda J. Syring
VPFM@mors.org

VICE PRESIDENT (MEETING OPERATIONS)

Ms. Sheilah Simberg
VPMO@mors.org

VICE PRESIDENT (PROFESSIONAL DEVELOPMENT)

Dr. Simon R. Goerger
U.S. Army Corps of Engineers
VPPD@mors.org

SECRETARY OF THE SOCIETY

Dr. Darryl K. Ahner
Air Force Institute of Technology
SecretaryOfSociety@mors.org

IMMEDIATE PAST PRESIDENT

Mr. Thomas E. Denesia (Tom)
NORAD-USNORTHCOM/J84
PastPresident@mors.org

CHIEF EXECUTIVE OFFICER

Susan K. Reardon
Military Operations Research Society
susan.reardon@mors.org

The Phalanx (ISSN 0195-1920) is published quarterly, \$40.00 for one year or \$70.00 for two years (US Rates) by the Military Operations Research Society in cooperation with the Military Applications Society (MAS) of the Institute for Operations Research and Management Science (INFORMS). Principal office: 2111 Wilson Blvd, Suite 700, Arlington, Virginia 22201. Periodicals postage paid at Arlington, and at additional mailing offices. POSTMASTER: Send address changes to *Phalanx*, 2111 Wilson Blvd, Suite 700, Arlington, Virginia 22201. Please allow 4-6 weeks for address change activation.

INFORMS

5521 Research Park Drive, Suite 200,
Catonsville, MD 21228
800-4INFORMS FAX 443.757.3515
e-mail: informs@informs.org

MAS COUNCIL EXECUTIVE COMMITTEE

CHRIS ARNEY
President
WILLIAM P. FOX
Past President
ANDY HALL
Vice President
DOUG MATTY
Secretary/Treasurer

COUNCIL MEMBERS

MAHYAR AMOUZEGAR
AARON BURCIAGA
WALTER DEGRANGE
JEFF EATON
AMNON GONEN
CHAD LONG
GEORGE MAYERNIK
CHASE MURRAY
JESSE PIETZ
NATALIE SCALA

Subscriptions to *Phalanx* are included in the annual dues of both INFORMS/MAS and MORS members.



Printed
On Recycled
Paper

DISCLAIMER: MORS and MAS are professional societies for people, not organizations. As such, the articles published in *Phalanx* represent the professional views and judgments of individuals independent of the organization that may employ them or contract for their services. Except where specifically identified, statements and opinions do not necessarily reflect policies or positions of the Department of Defense or any other agency of the US Government.

© 2016, Military Operations Research Society and Military Application Society.

Giving Back to the Profession

This quarter, I'd like for all of us to take a moment and reflect on what it means to be a professional. There are several definitions to choose from; I somewhat arbitrarily choose that of the Professional Standards Council (AU), as given in the box below.

- We provide the voice of experience in this field through our Fellows, our collective membership, and through our Code of Ethics (www.mors.org/Home/About-MORS/Code-of-Ethics).

MORS provides numerous volunteer opportunities to choose from



Another key element to a healthy profession is a strong education program. Over the last years, MORS has created professional education opportunities through the Education and Professional Development (EPD) Colloquium (www.mors.org/Education/Education-Colloquium) and our recently established continuing education (CE) course program. In fact, we just provided our first professionally led CE courses for the MORS Wargaming Certificate during the Fall 2016 Wargaming Workshop. In addition to our first-class student offerings, highlighted by the annual Richard Rosenthal Competition at this year's EPD Colloquium, we will hold a seminar for senior leaders who are not directly in the OR profession, but who would benefit (or their subordinates and peers know they would benefit!) from learning more about OR and our profession. This provides you the opportunity to help others—those you know and/or work with—learn more about your profession.

A profession is a disciplined group of individuals who adhere to ethical standards, possessing special knowledge and skills in a widely recognized body of learning derived from research, education and training, and is recognized by the public as such.

Applied to the national security operation analysis community, we are accountable to those whom we serve. Service and “giving back” are two important principals. In this, the Military Operations Research Society (MORS) provides two useful keys:

- We provide numerous opportunities to connect with like-minded professionals, and opportunities to “give back,” by contributing to the professional dialogue via *Phalanx* and *Military Operations Research*, and participation in our Communities of Practice (COPs), symposia, and special meetings.

depending on where you are in your career, how much time you would like to commit, and the competing demands of your job and the rest of your life. Common ways to volunteer include being part of a symposium or special meeting leadership team, helping out with a meeting or symposium, volunteering to be a non-board member on a board committee, or pursuing election to the Board of Directors. (Connect with MORS volunteer opportunities at www.mors.org/Membership/Volunteer-with-MORS.)

However you do it, your “give back” is critical to our society's and, in many ways, our profession's success.

Norm Reitter

President, Military Operations Research Society

President@mors.org

MORS PRESIDENT

Since we're talking about the Wargaming Workshop, I was struck by how many dedicated volunteers it takes to have a successful MORS event. By all accounts, this Wargaming Workshop was a resounding success, with more than 260 participants, the largest MORS special meeting attendance in recent memory; provocative working groups; three simultaneously run games (learning by playing); a series of panel discussions that went broad and deep in many different organizational perspectives; and two incredible keynote addresses, one by Mr. Andy Marshall, and, a highlight of the workshop, a rousing talk by Deputy Secretary of Defense Robert Work.

This event would not have been nearly as successful without the leadership, persistence, and effort displayed by the workshop chair, CDR Phil Pournelle, USN (OSD ONA), his deputy, Ms. Yuna Wong (RAND), and the MORS Wargaming Community of Practice Lead, Mike Ottenburg (OSD CAPE). This also begs a special "call out" to the rest of the substantial workshop leadership team who also spent many hours giving back, preparing and facilitating the workshop activities. This team truly gave back to the MORS community, the wargaming community, and to their profession. This makes them all true professionals.

We expect December's MORS Emerging Techniques Special

Upcoming MORS Volunteer Opportunities

- MORS Emerging Techniques Special Meeting
December 6–7, 2016, Alexandria, VA
- EPD Colloquium
March 21–22, 2017, US Naval Academy, Annapolis, MD
- BOD nominations due, April 2017
- 85th MORSS, June 19–22, 2017, West Point, NY
- MORS BOD committees

Email: Volunteer@mors.org



Meeting (METSM), focusing on advances in visualization, modeling, simulation, and more, to be every bit as successful. I hope to see you there.

To close this article, I want to thank you, the many MORS volunteers, true professionals who continually give back to our society. We believe

in you and know that you believe in your profession. Please reach out to me, any MORS board member, or MORS staff member to discover ways that you can continue or start giving back to your society and your profession. I look forward to seeing you at our many MORS events! 

MAS PRESIDENT

Chris Arney
President, Military Applications Society
david.arney@usma.edu

Foundational Elements of OR in the Military and Security Arenas

This is my final column as president of the Military Applications Society (MAS) of INFORMS. During my two-year tenure, we have experienced exciting times with the emergence of analytics into all elements of society and the use of big data and data science to improve the validity of analytics and build its capacity as a viable decision-making tool. The significant changes in the security environment of the world have influenced MAS to consider expanding its area of interest to include security issues and applications. At the MAS annual meeting in Nashville, considered formal changes to the by-laws to formalize this expansion of interest of the Society.

In this last column, I would like to discuss a topic that has been my interest for decades, the basic or foundational research elements of operations research (OR) and how they affect the military and security users of this science. As analytics becomes the persuasive way in which we understand the world, we need to address the fundamental challenges of data and informational elements of OR science. The ultimate goals are to provide descriptive, prescriptive, and

predictive capabilities and powerful tools for analysts to perform these tasks. The availability of data often allows for both simulation and modeling to attack problems and helps analysts to build productive and secure decision making systems. Foundational work is still needed in areas such as algorithm scaling, clustering, appropriate measuring of dynamic elements such as diffusion and spreading, and understanding contagion, influence, and communication through networked flows. The mathematical theories of complexity, dynamics, emergence, and control are still developing to enhance those foundational theories of OR.

Another element of an interdisciplinary, applied science like OR/analytics is the need to be cognizant of potential applications and possible utilization of the results of research and tool making. For me, it has been exciting to see both network science and cyber science contribute to OR development and vice versa. At West Point, I have seen the OR students, faculty, and researchers in our Operations Research Center (ORCEN), Network Science Center, and the Army Cyber Institute (ACI) collaborate to perform research, solve problems, and make



tools. That collaboration has helped the development of theories and tools in cyber science, complexity science, and fractional mathematics that enhance the understanding and security of large networked systems. Of course, the use of social media analysis is another area where OR, cyber, and networks help with the understanding of this new element of modern society.

One of the places to look at the interface of OR with military missions is within the major missions of services, military units, and security forces and organizations. Listed here are some missions from the *Strategic Landpower: Winning the Clash of Wills* document that seem to have many needs for OR and analytics:

Chris Arney

President, Military Applications Society

david.arney@usma.edu

MAS
PRESIDENT

- Counterterrorism and irregular warfare
- Deter and defeat aggression
- Project power despite anti-access area denial challenges
- Counter weapons of mass destruction
- Operate effectively in cyberspace and space
- Maintain a safe, secure, and effective nuclear deterrent
- Defend the homeland and provide support to civil authorities
- Provide a stabilizing presence
- Conduct stability and counterinsurgency operations
- Conduct humanitarian, disaster relief, and other operations
- Lead through mission command
- Sociotechnical and sociopolitical infrastructure
- Logistical systems operation
- Trade and commerce
- Human resource management
- Coordination and movement of people, information, and resources
- Group decision making and discovery
- Data and visual analytics
- Organization design
- System test and evaluation
- What research initiatives require growth and innovation to bring OR to a more mature state to better support military and security needs?
- What is the trajectory for military and security-related OR over the next 10–20 years?
- How do we educate our new analysts now so they are ready for the future OR environment?

I do not have the answers, but I am confident as a professional community we will forge a productive future in OR.

I sincerely believe that through our collective efforts military OR will continue to grow and flourish as an interdiscipline and a tool for problem solving and understanding. I thank the MAS Council members and officers for their service. And, finally, I give my best to all military and security analysts, members of MAS (INFORMS), and to the new officers and council members.

Of course, we can add to this list many elements from other military services missions and needs and others that are outside of specific military and security missions, but related to all society, including the military. Some of these applications where OR is used include:

- Population health, epidemiology, and ecology

An objective is to synthesize the relevant domain areas with the fundamental technical areas in order to make critical advancements in the science of OR. It is essential that fundamental questions be generated from multiple disciplinary perspectives in order to investigate both the domain-specific needs and the underlying technical challenges. The goal of OR science is to understand the meaningful and appropriate bridges between theory and application. We can consider the following questions as we look to OR and its roles in the future of military and security operations and systems:

Statement of Ownership, Management, and Circulation (required by 39 U.S.C. 3685)

1) Publication Title: Phalanx 2) Publication No. 01951920 3) Filing Date: September 22, 2016 4) Issue Frequency: Quarterly 5) Number of Issues Published Annually: 4 6) Annual Subscription Price: \$70.00(US); \$200(non-US) 7) Complete Mailing Address of Known Office of Publication: Military Operations Research Society, 2111 Wilson Blvd., Suite 700, Arlington, VA 22201-3052 8) Complete Mailing Address of Headquarters of General Business Officer of Publisher: Military Operations Research Society, 2111 Wilson Blvd., Suite 700, Arlington, VA 22201-3052 9) Full Name and Complete Mailing Address of Publisher, Editor, and Managing Editor: Publisher: Military Operations Research Society, 2111 Wilson Boulevard, Suite 700, Arlington, VA 22201-3052; Editor: Terrance McKearney, Military Operations Research Society, 2111 Wilson Boulevard, Suite 700, Arlington, VA 22201-3052; Managing Editor: Joan Taylor, Military Operations Research Society, 2111 Wilson Boulevard, Suite 700, Arlington, VA 22201-3052 10) Owner: Military Operations Research Society, 2111 Wilson Boulevard, Suite 700, Arlington, VA 22201-3052 11) Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages, or Other Securities: None 12) For Completion by Nonprofit Organizations Authorized to Mail at Special Rates: The Purpose, Function, and Nonprofit Status of this Organization and the Exempt Status for Federal Income Tax Purposes: (1) Has not changed during preceding 12 months 13) Publication Title: Phalanx 14) Issue Date for Circulation Data Below: September 2016 15) Extent and Nature of Circulation: Average Number of Copies of Each Issue During Preceding 12 months: A. Total Number of Copies: 1111. Paid Circulation (By Mail and Outside the Mail): (1) Mailed Outside-County Paid Subscriptions: 965 (2) Mailed In-County Paid Subscriptions: 46; (3) Paid Distribution Outside the Mail Including Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Paid Distribution Outside USPS: 0; (4) Paid Distribution by Other Classes of Mail Through the USPS (e.g., First-Class Mail): 0 C. Total Paid Distribution: 1011 D. Free or Nominal Rate Distribution by Mail: 0 E. Total Free or Nominal Rate Distribution: 0 F. Total Distribution: 1011 G. Copies Not Distributed: 100 H. Total Sum: 1111 I. Percent Paid: 100% Number of Copies of Single Issue Published Nearest to Filing Date: A. Total Number of Copies: 1130 B. Paid Circulation (By Mail and Outside the Mail): (1) Mailed Outside-County Paid Subscriptions: 976; Mailed In-County Paid Subscriptions: 54; Paid Distribution Outside the Mail Including Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Paid Distribution Outside USPS: 0; Paid Distribution by Other Classes of Mail Through the USPS (e.g., First-Class Mail): 0 C. Total Paid Distribution: 1030 D. Free or Nominal Rate Distribution by Mail: 0 E. Total Free or Nominal Rate Distribution: 0 F. Total Distribution: 1030 G. Copies Not Distributed: 100 H. Total Sum: 1030 I. Percent Paid: 100. I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties).

(signed) Susan Reardon, Chief Executive Officer, MORS



You are cordially invited to attend the inaugural **Military Operations Research Society (MORS) Emerging Techniques Special Meeting (METSM)** being held December, 6-7 2016 at the Hilton Mark Center in Alexandria, VA. METSM will feature high-quality technical presentations from leading experts from both inside and outside the MORS family and provide an opportunity for consumers of analysis and nontraditional providers of analysis to meet and share their needs and capabilities. METSM will provide a forum for presentations, demonstrations, and discussions on developing and employing emerging analytic techniques with an eye toward the problems of the national security community.

Emerging techniques are defined as considered in the bounds of good practice by other practitioners but not fully embraced by the national security analytic community. METSM will focus on bringing techniques from other fields and societies to the broader operations research and national security analysis community. The METSM working groups or focus areas will include:

Advanced Statistical Techniques – This includes both theoretical and applied work, to include computationally intensive methods, big data, and machine learning.

Frontiers of Networks – The use of mathematical networks has exploded in recent years. This track will feature cutting-edge work in several applications.

Simulation Models – Simulation models are a staple in the national defense community. This track will feature speakers who are developing new and more efficient methods of simulation.

Visualization – Cuts across all of these areas; clean, efficient simulation turns “results” into “actionable insights”.

MORS is proud to announce that Les Servi, Group Leader of Operations Research, The MITRE Corporation, will be the keynote speaker.

To register, please visit the METSM website at

<http://mors.org/Events/Special-Meetings/Emerging-Techniques>

Keynote at METSM



Dr. Les Servi is a Group Leader at The MITRE Corporation and a member of the Defense Science Board. His diverse interests include the analysis of social media, cyber security, portfolio analysis for government procurements, designing of software test plans, and evaluating human social cultural behavior (HSCB) government-sponsored projects. He is an INFORMS Fellow and a former member of the Board of Directors of INFORMS.

MORS is honored to have the following distinguished guest speakers:



Susan M. Sanchez is a professor in the Operations Research Department at the Naval Postgraduate School. Her research interests include the design and analysis of large-scale simulation experiments.

She established and serves as co-director of NPS's Simulation Experiments & Efficient Designs (SEED) Center for Data Farming. Dr. Sanchez has long been active in the simulation community, and will be recognized as a **Titan of Simulation at the 2016 Winter Simulation Conference**.



Dr. Karla Hoffman is a professor in the Systems Engineering and Operations Research Department at George Mason University (GMU). Dr. Hoffman's primary research areas are

optimization and auction theory. Her research focuses on the development of new algorithms for solving large complex problems arising in industry and government. She has more than 100 published papers in these areas and has served on the editorial boards of numerous journals. She is a Fellow and Past President of INFORMS.



Dr. Janwai Han, is a leader in data science and data warehousing. He is a Fellow of ACM and Fellow of IEEE, and received the 2004 ACM SIGKDD Innovations Award, 2005 IEEE Computer Society Technical Achievement Award and the 2009 McDowell Award, the highest technical award of the IEEE. His co-authored book *Data Mining: Concepts and Techniques* has been adopted as a textbook worldwide.

Exhibiting at METSM

METSM will also feature exhibits by MORS Industry and Institutional Partners. To reserve a space, simply contact Eric Kokuma (eric.kokuma@mors.org). Please note that there is no additional cost to exhibit as a MORS Industry Partner.

MORS Emerging Techniques Special Meeting Highlights the Latest in Analysis

The goal of the Military Operations Research Society Emerging Techniques Special Meeting (METSM), December 6–7 at the Hilton Mark Center in Alexandria, VA, is to bring the national security community to the forefront in analytic techniques. Recognizing the need to

constantly improve our skills to keep current and relevant, METSM will bring together the MORS community, including industry, academia, and government to give producers and consumers of analysis a better feel for innovative techniques being developed in our field. It will also give technology developers,

innovators, and practitioners a better understanding of what is useful to the national security community. METSM takes the conversation about national security analysis beyond what's happening now and looks toward where technical analysis will be in five to 10 years and beyond.

METSM SCHEDULE

December 6			
Start	End	Subject	Speaker
0700	0830	Registration	
0730	0830	VIP Breakfast - by invitation	
0830	0900	Welcome	Norm Reiter, MORS President, Harrison Schramm, METSM Chair
0900	1000	Keynote	Dr. Les Servi
1000	1200	TECHNICAL SESSION 1	See Technical Sessions
1200	1300	Networking Lunch / Industry Panel	See Technical Sessions
1300	1400	PLENARY 2	Dr. Jangwai Han
1400	1530	TECHNICAL SESSION 2	See Technical Sessions
1530	1600	Cookie Break	
1600	1700	PLENARY 3	Dr. Karla Hoffman
1700	1830	Break	
1830	2000	Networking Panel	
December 7			
0700	0830	Industry and Institutional Partners VIP Breakfast	
0830	0930	PLENARY 3	Dr. Susan Sanchez
0930	1030	TECHNICAL SESSION 3	See Technical Sessions
1030	1200	TECHNICAL SESSION 4	See Technical Sessions
1200	1300	Lunch	
1300	1400	PLENARY 4	Dr. David Alderson
1400	1530	TECHNICAL SESSION 5	See Technical Sessions
1530	1600	Closing Remarks	Norm Reiter, MORS President, Harrison Schramm, METSM Chair

This two-day event will provide a forum for presentations, demonstrations, and discussions on developing and employing emerging analytic techniques with an eye toward the problems of the national security community. METSM will present the experiences of industry experts who are already succeeding in both the national security community and other analytic disciplines. Individuals keen to enhance their skills won't just learn "what" but "how" to succeed.

METSM will focus on:

- *Advanced Statistical Techniques.* These techniques include both theoretical and applied work, such as computational intensive methods, big data, and machine learning.
- *Frontiers of Networks.* The field of networks and the use of these mathematical constructs has exploded in recent years. This track will feature cutting-edge work in several applications.
- *Simulation Models.* Simulation models are a staple in national defense. This track will feature speakers who are introducing new methods and efficiencies.
- *Visualization.* This area cuts across all the previous three; clean, efficient simulation turns "results" into "actionable insights."

METSM features a full schedule of top-quality technical talks in addition to featured keynote and

TECHNICAL SESSIONS

Tech Session 1

Times	TRACK 1	Presenter	TRACK 2	Presenter
1000-1030	Text Analytics For Defense Applications	Tom Donnelly	Artificial Intelligence for Simulating Decision Making	Casey Bennett
1030-1100	The Peace Game	Matt Powers	Linear Decision-making models	Marc Canellas
1100-1130			Pilot situational with MIDAS	Becky Hooley
1130-1200	Dynamic Analysis Using Morphological Analysis	Simon Purton, NATO ACT	Analyzing the Mission Impacts of Cyber	Jackson Ludwig

Tech Session 2

Times	TRACK 1	Presenter	TRACK 2	Presenter
1400-1430	Emerging Techniques in Operational Assessment	Jason Skoch	The Reasonable Effectiveness of Roles in Complex Networks	Tina Eliassi-Rad
1430-1500	Low-Cost Automated Visualization IR	Carol DeZwarte	Community Detection and Classification in Hierarchical Stochastic Blockmodels	Minh Tang
1500-1530			A Kalman Filter for Networks	Jim Ferry

Tech Session 3

Times	TRACK 1	Presenter	TRACK 2	Presenter
930-1000	Adapting Combat Modeling and Analysis to National Security	Irme Balogh	Detecting anomalies in network streams	Anil Vullikanti
1000-1030	Automated Analysis and Visualization	Tom Tanner	Detection Theory on Random Graphs	Tom Mifflin

Tech Session 4

Times	TRACK 1	Presenter	TRACK 2	Presenter
1030-1100	RIP-TIDE research Plan	Mark Coy	Multiscale methods for modeling and optimization on networks	Ilya Safran
1100-1130	Experiential Memory Unit for Real Time Analysis	James Boyer	Modular Simulations Built around Core Engine	Krzysztof Rutkowski
1130-1200	Weaponizing Data	Aaron Burciaga	Knowledge Based Decision Making for Simulating Cyber Attack	Stephen Moskal

Tech Session 5

Times	TRACK 1	Presenter	TRACK 2	Presenter
1400-1430	Building Better Models using Robust Data Mining	Jim Wisnowski	Rapid Synthesis of high-level architecture	Himanshu Neema
1430-1500	Semantic Explorer and Semantic Vector	Jenna Page	Advanced Architecture for Modeling and Simulation	Janet Wedgwood
1500-1530	Advances in Systems and technologies	J. Jark Pullen		

plenary speakers. Opportunities for networking, mentorship, and technical discussions are baked into the METSM schedule and make this special meeting a must-attend

for managers, practitioners, and consumers of analysis. METSM will feature a military operations research-focused career transition panel and mixer the evening of December 6.

This mixer event will be free for MORS members in good standing, regardless of their attendance at the METSM. ↑

National Security Operations Research Industry and Institutions Featured at METSM

The MORS Emerging Techniques Special Meeting (METSM) will recognize the partnership of industry and special institutions (FFRDCs, UARCS) in the development of new approaches to national security analysis and the partnership between government agencies and industry/institutions in operations analysis. Several specific activities will highlight this partnership.

Exhibiting at METSM

METSM will feature exhibits and displays from industry and institutions. The two-day exhibiting opportunity will begin on Tuesday, December 6th, and will continue through the evening social. Exhibiting will resume Wednesday until the conclusion of the meeting. Please note that there is no additional cost to exhibit for MORS Industry and Institutional Partners (IIPs). Non-IIPs will be allowed to exhibit for a reasonable fee. Don't miss the opportunity to exhibit where consumers of analysis and nontraditional providers of analysis meet and share their needs and capabilities! To reserve a space, simply contact Eric Kokuma (eric.kokuma@mors.org).

IIP Breakfast

MORS IIP partners are invited to special breakfast on December 7 to meet Society leadership and exchange ideas as to how the Society's IIP program can be enhanced.

Networking and Career Panel

A special panel of industry and government leaders will discuss careers in the OR field for METSM attendees on December 6 in conjunction with the METSM's evening social. This will be an opportunity to meet fellow OR practitioners and share thoughts on the state of the profession.

Industry Panel During METSM

Phalanx editor and Past MORS President Terry McKearney will chair an industry and institution panel during lunch on December 6, entitled *Managing the Analytic Workforce: Industry's Approach to Recruiting, Assigning, and Nurturing Analysts for the National Security Domain*.

**WE ANALYZE INFORMATION
BEAUTIFULLY**

CANA

ADVISORS

CANA Advisors is a veteran-owned and woman-owned small business headquartered in Northern Virginia. We are a group of consummate professionals with extensive Federal government and commercial experience providing intimate logistics and analytics service offerings to our clients. We...



Improve organizational operations management, planning, and use of data to make decisions



Establish cost savings and significant investment returns with a focus on improving performance, readiness and capabilities



Craft analytics/OR-based decision support planning solutions in logistics, maintenance and supply chain operations



Apply statistical, simulation and optimization-based tools and analysis to support improvements to systems operations



Provide product placement solutions through strategic partnerships



Provide operations research and studies analysis for concept development and employment to support course of action analysis and decision making



Enhance organizational data quality, processes and planning through analytics assessments and action plan execution.

We develop highly skilled and expert talent - professionals with best in class knowledge, skills, abilities, and experience - who have domain and technical expertise to provide niche services that directly support government and commercial organizations' performance and efficiency goals.

HOW CAN WE HELP YOU SOLVE YOUR TOUGHEST PROBLEMS?

Follow Us On



To learn more about CANA Advisors and our professionals visit our website at
www.canaadvisors.com

7371 Atlas Walk Way | Gainesville, Virginia 20155 | Telephone (703) 317-7378 | Facsimile (571) 248-2563



Jim Treharne, Program Chair, MORS 85th Symposium

This is an exciting time for the military operations research community. Never have the analytical challenges been so complex, and never have the opportunities been so great. This is an extraordinary time in which our military operations research community continues to step up and offer senior leaders and decision makers relevant and credible analysis to enable them to make important national security decisions.

All of us should carefully read the 2015 National Military Strategy (Joint Chiefs of Staff, 2015). In this June 2015 document, the “Chairman’s Foreword” begins with:

The implications to those of us who provide the analysis to support our decision makers are many. Let me mention just a few. We must understand the complex and changing nature of the security environment that our military forces are operating in. We must provide analysis that carefully accounts for the great uncertainty that the future holds. Further, we must refine and develop our analytical capabilities to address the questions and issues that face the national security leadership with respect to strategy development, ongoing operations, acquisition, war planning, force and materiel development,

homeland security, and more.

Given the many complex adaptive systems that we face globally, our analysis must carefully address the key risks that we face and the mitigation strategies that will lead to successfully protecting our national interests.

The Military Operations Research Society Symposium provides the single best professional development opportunity each year for the greater community. This year’s symposium builds on the highly successful 84th MORS Symposium at the Marine Corps University, Marine Corps Base Quantico, VA, where we celebrated

MORS “50 Years of Securing the Nation.” This year, the United States Military Academy (USMA) is hosting our symposium from June 19–22, 2017 at historic West Point, NY. The theme is “Pivoting on a Strong Foundation to a Bright Future.” Since 1802, USMA has provided its Corps of Cadets the strong foundation necessary for their service to the nation. This symposium will reinforce the strong foundation necessary for

“Today’s global security environment is the most unpredictable I have seen in 40 years of service. Since the last National Military Strategy was published in 2011, global disorder has significantly increased while some of our comparative military advantage has begun to erode. We now face multiple, simultaneous security challenges from traditional state actors and transregional networks of sub-state groups – all taking advantage of rapid technological change. Future conflicts will come more rapidly, last longer, and take place on a much more technically challenging battlefield. They will have increasing implications to the U.S. homeland.”

our community to continue its unique and exceptional contribution to national security.

The planning team at West Point, led by the Systems Engineering Department, has been working for many months with the MORS staff and the symposium program staff to provide a highly professional, rewarding, and enjoyable conference for all attendees. The conference is sponsored by the Army, Navy, Air Force, Marine Corps, Office of the Secretary of Defense, and Department of Homeland Security. The symposium will have much to offer for the entire operations research community.

This year we moved up the announcement and call for presentations (ACP) to the beginning of November. This will give participants more time to develop their abstracts and to encourage their colleagues to do the same. If you have not done so already, carefully review the ACP and other important information regarding the symposium at <http://www.mors.org/Events/Symposium/85th-Symposium>. You will find 33 working groups, two distributed working groups, and one focused working group. We are confident that there is at least one working group for every interested national security analyst. We also have many volunteer opportunities. Volunteers are the backbone of our

Society's success. In addition to these groups, we are planning an exciting plenary session, tutorials, prize competitions and awards, special sessions, and much more. This will be your premier professional development opportunity in 2017. Join the many hundreds of analysts who will be congregating at the historic United States Military Academy next June.

Reference

Joint Chiefs of Staff. 2015. *The National Military Strategy of the United States of America*. 2015. www.jcs.mil/Portals/36/Documents/Publications/2015_National_Military_Strategy.pdf.

MORS Certificate in Wargaming

MORS is pleased to announce the remaining dates for the Certificate in Wargaming courses at the Hilton Arlington:

- Wargaming 101 - 18 January 2017
- Wargaming 201 - 19 January 2017
- Tools in Wargaming - 14 February 2017
- Facilitation - 15 February 2017
- Practicum - 8 March 2017

MORS Member per course is \$450 • Non-Member per course is \$500
Hilton Arlington, 950 N Stafford St, Arlington, VA 22203

Register Today!

For more information go to www.mors.org/certificate



MORS Wargaming Workshop

CDR Phillip Pournelle, Office of the Secretary of Defense

The MORS Wargaming Workshop, sponsored by the Defense Wargaming Alignment Group (DWAG), was a great success, with more than 260 attendees from six countries and keynote addresses by Deputy Secretary of Defense Bob Work and former Director of Net Assessment Mr. Andy Marshall. The workshop was conducted October 18–20 in Alexandria, VA, on the Mark Center Campus. Initial feedback indicated the workshop's working groups and panels advanced understanding about how wargaming should be integrated into the department's

analytic processes, introduced the fundamentals of the art of wargaming to a large number of novices, and improved the understanding of the practice of wargaming for many attendees.

The workshop was based on the Deputy Secretary's memo on the use of wargaming to support the Defense Innovation Initiative and an assessment by the Office of the Secretary of Defense (OSD) at a practitioner's summit in March 2016. The purpose of the workshop was twofold: identify best practices for use of wargaming to support the larger analytic process, and help generate

wargaming capacity and quality. The theme was to learn by doing.

The workshop officially began with the keynote address to the plenary group by Mr. Andrew Marshall, who founded the Office of Net Assessment in 1973 and served as its director until 2015. His remarks focused on how wargaming was employed in the past to support OSD in the development of net assessments. He stated that wargaming was particularly important in the assessment of nonquantitative factors such as competency, training, organizational psychology, and planning, which drove the choices available to our competitors. These crucial factors



could not be fully addressed with standard quantitative methods alone and wargaming was an important tool to gain an accurate assessment.

Following his remarks, a series of panels were held in the plenary session. The OSD DWAG quad chairs, OSD Policy, CAPE, ONA, and Joint Staff J-8 SAGD, discussed the need for wargaming to address qualitative factors to drive innovation and increase the decision space for senior leaders. They also discussed the need for quantitative tools to support quality and accurate games. The DWAG is working to support the sharing of insights, lessons learned, best practices, and tools using the OSD Wargaming Repository. The DWAG is also exploring ways to increase the use of the repository by making appropriate elements more conveniently and widely available.

The Services and Sponsors Panel included staff members from the headquarters of the Army, Navy, Air Force, and Marine Corps as well as a

representative from the Department of Homeland Security. Each described how they were developing their own “cycle of research,” aligning existing organizations, and developing their wargaming communities. Navy displayed a graph illustrating what appears to be the most developed service plan to move forward in the new year’s planning and budget process.

Nine regional and functional combatant commands were represented on the panel. Most combatant commanders are (re) building their wargaming capacity “out of hide,” leveraging the incentive funds overseen by the DWAG. In many cases, they are currently reliant on contractors to provide expertise. Fully employing wargaming will require greater emphasis on wargaming in joint professional military education (JPME), but such training is based on doctrinal definitions, which are based on the joint operational planning process. Wargaming, particularly when intended to meet the Defense Innovation Initiative, cannot be limited

to current doctrine, which focuses primarily to course-of-action planning. Professional doctrine needs to be revised to be more broadly inclusive of wargaming’s many applications.

The allies’ panel included representatives from Canada, the United Kingdom, and the Kingdoms of the Netherlands and Sweden. Each expressed how the end of the Cold War and efforts in Afghanistan and Iraq diverted resources away from wargaming, but recent events in Europe have highlighted the need to rebuild their wargaming capabilities and capacity. Interestingly, the senior leadership of these countries appears to be more inclined to embrace wargaming than here in the United States. They are keen to share insights and lessons learned with us but classification issues are stymieing these efforts. OSD will consider expanding access to the repository, starting with the Five Eye partners.

The Command Red Team featured Steven Rotkoff, director of the



University of Foreign Military and Cultural Studies (UFMCS) and Joe Cyrulik, an instructor from the Kent School. The purpose of the panel was to briefly introduce the Red Teaming methods taught by UFMCS, the structured analytic techniques (SATs) taught by the Kent School, how both came about in their respective communities, and to discuss connections with wargaming. Mr. Rotkoff traced the origins of Red Teaming in the Army to attempts to improve military planning in the aftermath of the US invasion of Iraq. Mr. Cyrulik identified the intelligence failures of 9/11 and weapons of mass destruction in Iraq as events that propelled the greater use of SATs within the intelligence community. One topic of discussion contrasted how DoD defines “red cell” as enemy emulation in a game and “red team” as an approach to help one’s own organization make better decisions, while the definitions are reversed within the intelligence community.

Following the panels, the workshop dispersed into three working groups, three classes, and three sample wargames. The working groups tackled specific questions; the classes introduced participants to new approaches; and the wargames provided experiential learning opportunities.

The highlight of the closing plenary was the keynote address by Deputy Secretary of Defense Bob Work. He outlined the challenges to the department characterized by the proliferation of precision strike weapons across the planet and their use and development by our competitors. He is concerned that our advantages over our competitors are eroding. He discussed how in the past the US jumped ahead using technology to offset numbers. In World War II, the Army assessed a need to raise 213 divisions to fight the Axis, but we counted on superiority in air and sea power offset these requirements and so chose to raise only 90. After World

War II, the United States first offset Soviet superiority in numbers with the deployment of a large number of nuclear weapons. After the Soviets gained nuclear parity, the second offset employed what the Russians called a Reconnaissance Strike Complex, combining near-zero-miss weapons, sensors, and a command structure to hit all echelons of a Soviet Army Group simultaneously. Mr. Work described how wargaming was crucial to the assessment process in each of these instances and he is convinced of the necessity to use wargaming to identify the next, or third offset. His vision for the third offset is largely dependent on how to best team humans and machines together, integrating the best of both into a capability greater than their sum. Normal quantitative methods alone are not able to capture many of the qualitative issues surrounding the challenges and opportunities we face. Therefore, there is a need for cycles of research integrating wargaming within the larger process in the Department of Defense.



The Deputy Secretary made clear that the wargaming initiative will go forward in the future. Financing for the DWAG incentive fund is in the Future Years Defense Program (FYDP) and would require positive action by future administrations to remove it. The key to long-term success will be for MORS and the wargaming community to capitalize on the opportunity and demonstrate value in the process for the department and the nation.

The closing plenary also heard summaries from the working groups, courses, and games.

Working Group One was tasked with exploring the best ways wargaming might be integrated into the department's analytic and acquisition process. Working Group Chair Paul Davis, FS, assessed the current difficulties as stemming from a schism in the view of wargaming by elements within MORS and the defense analytical community in general. The first group (systems centered) view human gaming as a

subset of modeling, while the second group (human centered) view human gaming and modeling as distinct and complementary disciplines. These two perspectives affect how organizations view analysis and its effectiveness, as well as how they establish standards, expectations, and practices.

The chair assessed that the deputy's memo indicated dissatisfaction with past practices, which have been dominated by the first group's viewpoint and a style of model-based work that has been short on creativity, innovation, adaptation, dealing with "soft factors," and dealing with uncertainty. Thus, the deputy was calling on those of the second viewpoint (human centered) to fill a void. That shift of emphasis to human-centered gaming is quite welcome, even though intellectually, there is a merit to the first view. The wargaming community must act to meet the demand for improvements and innovation in the wargaming process. But the "how" of wargaming, its integration with other analytic

activities and analytical methods, depends on the overall objectives. The design and utility of a wargame depends on what issues and functions it is intended to address; for example:

- Creating ideas, options, concepts of operations, and strategies
- Testing and tightening tentative plans, whether operations plans or program plans—seeking to make them more robust
- Sensitizing policymakers to known serious problems that, because of their abstraction, have not proved gripping enough to cause action
- Creating shared understanding of issues, the general terrain akin to a chessboard, and the general nature of options and adversaries through communication and professional socialization, as when the joint and the interagency communities learn together about a problem area

Depending on which of these is the intent, gaming may be designed



to support the needs of analysis and modeling or—precisely the contrary—gaming may be used to break out from the normal assumptions embedded in usual analysis and modeling.

Working Group Two's results were described by Ed McGrady. The group was tasked with identifying best practices within wargames for communicating with people in and around games, and implementing innovative methods within games. They worked to identify specific technologies that could help us with game design, such as commercial products for game control, methods to record and analyze player interaction, instrumentation of players, and information visualization capabilities, such as capacitive displays, IR tracking, augmented/virtual reality, and alternative reality. They identified different game requirements and technology solutions. They worked to build games that explored game design across the spectrum of technologies. Bottom line: there are a wide range of technologies that can be very useful in games; nevertheless, technologies cannot replace the players, player interaction, or game control but rather can better enable visualization, communication, and data extraction from the game.

Working Group Three results were described by Stephen Downes-Martin. The group was tasked with addressing adjudication, which is crucial to enabling rigorous wargaming. The adjudication working group comprised highly experienced wargame adjudicators from across the discipline. They identified and addressed the barriers to effective adjudication, using a language processing approach to structure their discussion with maximum rigor. A detailed assessment of

DoD's wargaming process was conducted to identify where the barriers to the use of proper adjudication occur in that process, so preventing the proper level of rigor in departmental wargames. Working in two teams, the group generated a conceptual framework of the challenges facing good game adjudication, and developed several potential mitigating approaches. Recommendations growing out of this effort will be further refined after the conference and distributed to the broader community.

The workshop was book-ended by a pair of introductory classes on wargaming conducted by Drs. Peter Perla, Ed McGrady, and Jon Compton, held October 17 and 21. More than 30 people attended, with all seats taken and many others waiting for an opening on the standby list. MORS intends to offer these classes again this winter and spring. These were two of the seven classes needed to gain a certificate from MORS in wargaming and are intended to bring participants to an apprentice level of knowledge in wargame design. Additionally, on October 17 MORS offered a four-hour tutorial led by Mr. Mike Garrambone, FS, to introduce novices to basic wargaming concepts.

Steven Rotkoff taught the second course on Red Teaming methods. Participants used Red Teaming methods to explore ways to improve DoD gaming and planning. They generated fifty four ideas, and their top ideas were:

- Include more cultural factors in wargames; increase "peace gaming" and not just force-on-force and kinetic wargaming
- Identify more qualitative metrics
- Increase diversity within the

wargaming community

- Reduce general officer participation in wargaming design to the one general sponsoring the event to reduce dilution of effort

Participants in this second course expressed the view that Red Teaming advanced analytical skills and techniques should be applied to the wargames themselves (e.g., examining independent alternatives to the starting assumptions in a game).

Joe Cyrulik taught the third course on SATs, where participants learned about and applied SATs such as analysis of competing hypotheses and alternative futures analysis. Participants also discussed wargaming within the intelligence community, which views wargaming as a SAT.

The meeting's sample wargames were designed to improve understanding of the practice of wargaming by enabling participation in the design and/or execution of a wargame, providing practical experience of the techniques employed.

The first wargame employed SATs to develop a terms of reference. SATs were used to identify uncertainties, issues and themes, actors and actions, and other factors necessary to design a wargame. These were then employed in a matrix-style game. The participants designed and participated in a cyber-themed game with domestic and global social consequences.

The second wargame was a computer augmented political-military ("Pol-Mil") game set in Europe in the near future. It focused on phase zero operations during which competitors employed DIMEFIL-PMESII-based actions in their struggles with each

other. Players saw the advantages and disadvantages to the wargaming approach and enjoyed the opportunity to conduct “what if” experiments, as well as to experience the challenges of building a whole-of-government plan for a campaign across a theater.

The third wargame was a series of four matrix wargames led by Major Tom Mouat of the Defense Academy of the United Kingdom. The first three games introduced the concept of matrix style games to the participants. In the fourth game, the participants created and played their own matrix-style game addressing the current situation in the Baltics.

The workshop closed with a report from the synthesis group that identified what the wargaming community must do to make the most of the opportunities the department has opened:

- Get past “business as usual” and ensure that the design of wargames is based on best practices for the purpose of the game, not just what was used in the past;
- Better educate and assist decision makers to understand when and how to use wargames;
- Overcome myopia on adjudication goals and methods, which leads to intramural miscommunication

and disputes; and

- Better integrate digital and physical approaches. Too often instrumentality is chosen on basis of point of view not on fitness for purpose.

As the services and other organizations develop their cycles of research they need to ensure the senior decision makers are the focal point of the cycle

A central theme of balance and integration emerged from the conference. Just as the quest for a third offset strives to identify the best balance between humans and machines, so must the analysis community strive to find the best balance between quantitative and qualitative analysis surrounding the decisions humans will have to make in the uncertainty of a competition or a conflict. Both quantitative and qualitative techniques must be equally rigorous, but the definition and nature of rigor is different in the two fields. There is a need for a balance among various types of quantitative and qualitative work, including human wargaming and man-in-loop simulation. Further, there is a need for MORS to reach out to other fields to improve the analysis conducted for the national security community.

More work remains to be done.

The chairs from the workshop will complete a report on the insights gained from the workshop. MORS will continue its partnership with DoD and DHS sponsors and continue its new alliance with the international wargaming community. OSD intends to conduct another practitioner’s summit to assess those insights, identify future challenges and questions, and plot a course to move forward. OSD is considering another workshop next fall with an agenda based on that assessment. In the meantime, MORS and the larger wargaming community need to take advantage of the introductory courses offered by MORS, the Naval Postgraduate School, and the Air Force Material Command. MORS offers additional education through the Wargaming Community of Practice’s monthly brown bag sessions. These and other efforts give the community the opportunity to improve its capability to execute quality wargaming in a sustained manner. As the number of analysts who understand wargaming grows, the government’s ability to be an effective customer will grow. As the number of master wargame designers in the government grows, its ability to utilize quality gaming will improve. ↑



Enhancing and Developing a Red Teaming Community

Monique Kardos, Patricia Dexter, and Fred DJ Bowden, Joint and Operations Analysis
Division Defence Science and Technology Group, Australia

in MORS

On June 21, 2016, at the MORS Symposium, staff from the Australian Defence Science and Technology Group (DST Group) conducted a workshop on Red Teaming. Our intent was to expose our approaches to a broader community, with the possibility of developing a community of practice supporting all analysts in the Red Teaming space.

DST Group is part of the Australian Department of Defence. Its role is to provide scientific advice and

innovative solutions to defense and national security. In particular, it provides expert and impartial advice and support for the conduct of operations, for the current force, and for the acquisition of future defense capabilities.

The workshop allowed attendees to introduce themselves and their Red Teaming experiences. The organizations represented came from academia, industry, services, and defense civilians. The degree of experience with Red Teaming varied, from those with extensive knowledge to those interested in working in the field but with no Red Teaming experience.

The workshop explored three topics:

- Why Red Team?
- What is a good definition for Red Teaming?
 - Red Teaming approaches

- exposing assumptions and undocumented decisions,
- enumerating threats,
- challenging traditional or conventional thinking,
- testing and proactively challenging a system/process/decision/culture,
- thinking like the other side,
- challenging ignorance, and
- forming part of the role of an ORSA.

The aim of these actions is to ensure that decisions and arguments are as robust as they can be, with decision makers aware of the flaws in their systems. This then allows them to accept decisions or adapt to the highlighted risks.

This question also stimulated a discussion around whether Red Teaming is a noun or a verb. During the discussion on this point, it became clear that it has been used as both, and the consensus within the workshop was that it depended on the context.

What Is a Good Definition for Red Teaming?

The next area of discussion at the workshop focused on the varied definitions for Red Teaming. As shown in the literature (Zenko, 2015), there are many definitions of Red Teaming, again depending on the context in which it has been applied. It has in fact become an umbrella term for several variants of activity, and it is valuable to consider those variants.

To initiate discussion on what Red

Why Red Team?

The “Why Red team?” topic focused on understanding biases and dealing with poor decision making. Further thoughts included:

Teaming means, the following definition (adapted from Malec et al., 2012), was put forward at the workshop:

Any activity that analyses plans, processes, systems or equipment by using one or more alternate—typically adversarial—perspectives.

As expected, a final definition was not agreed to at the workshop. However, a constructive discussion was held, and based on this, a good starting point has been established.

The discussion initially focused on the word “alternative”, with the emphasis being how to ensure that “alternative perspectives” are in fact presented. Workshop attendees raised the concern that often participants of Red Teaming activities bring with them similar views on what is being considered. Suggestions for overcoming this included the use of nonstakeholders or outsider views. This aspect of the discussion did not dispute the definition presented,

rather confirmed one particular aspect: that is, the need to ensure alternative perspectives are part of Red Teaming.

At the workshop two main streams of Red Teaming were proposed: the first focuses on the adversaries and how they are likely to act, while the second focuses on the “objective critic” role. The initial stream was seen as the role of intelligence analysts rather than the focus of MORS; however, MORS may have a role in finding ways of measuring how well this type of Red Teaming has been done. Participants viewed the second stream as being a core business of an ORSA, and thus key to MORS. They felt it would be useful for MORS to develop some form of standard to determine how well such Red Teaming activities were conducted. For example, whether there was a way to determine the breadth of alternative perspectives and how influential they were in the final outcome.

A number of participants expressed concern regarding a strict definition of Red Teaming, since Red Teaming

activities are very context dependent. Additionally, they are often constrained in terms of time, relevant experts, resources, and application of outcome, which may heavily restrict what can be achieved. Thus there is a need to take into account the application of the outcomes, and potentially a need for a fit-for-purpose definition. Any measures also need to fit within this framework.

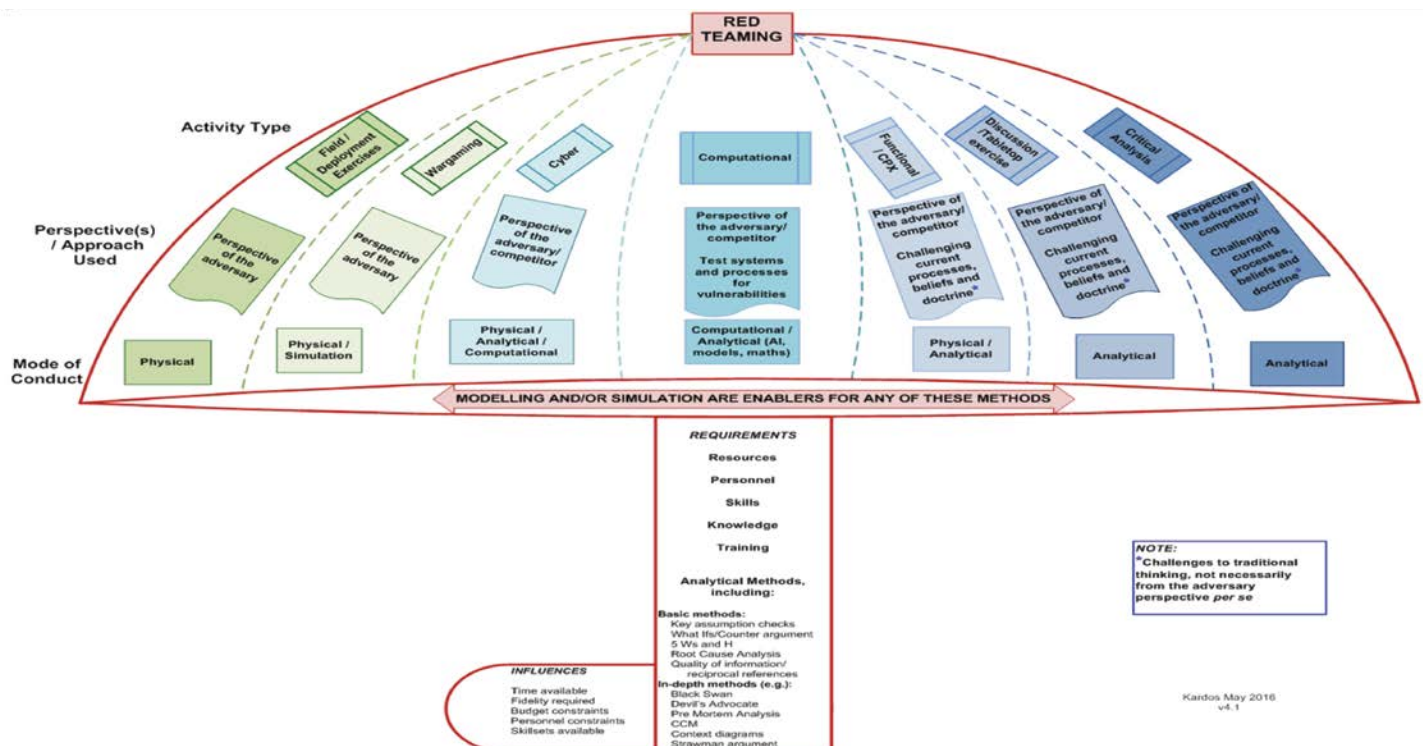
Red Teaming Approaches

At the end of the workshop, DST introduced an umbrella diagram of the breadth of types of Red Teaming, shown in Figure 1. Although there was insufficient time to discuss this topic in depth during the workshop, those in attendance largely agreed it covered the breadth of Red Teaming approaches that attendees had experience with. Further, this representation of Red Teaming approaches was distributed to participants post the workshop for comment.

Where to Next

Given the importance of Red Teaming as an ORSA tool, attendees generally

Figure 1. Breadth of Red Teaming approaches as developed by Kardos and Dexter



agreed that there would be significant value in a MORS Community of Practice in Red Teaming. With this in mind, work has begun on developing such a community and interested parties are encouraged to contact the authors at fred.bowden@dsto.defence.gov.au. The community will focus on sharing techniques and experiences in the application of Red Teaming in the military domain.

Key considerations going forward for the community include:

- Possible development of an agreed MORS definition for Red Teaming and practitioner handbook.
- Key seminars and written material on each style and type of Red Teaming and their application within the defence and homeland

security domains.

- Seminars on Red Teaming activity design, implementation, and analysis while taking into consideration constraints around freedom to explore all aspects of the problem, problem type, context of the Red Teaming, and challenges with sponsor biases and interactions.
- A community forum that will allow people to suggest ideas, approaches, experience, and lessons to the broader community.

We would like to hear from interested MORS members about how they would like to proceed in this space. Some ideas might be web-delivered presentations or seminars across the breadth of Red Teaming types to help familiarize others with the

various application spaces. Seminars on methods and pitfalls or the benefits of multimethod approaches may be another good source of benefit for members.

If there is interest, we will consider a second workshop at the next MORS Symposium and look at interim activities.

References

- Malec, C., Hanly, G., Grieger, D. and Kardos, M. (2012) Red Teaming in Support of National Security. DST Group -GD-0688. Classification: Restricted.
- Zenko, M. 2015. *Red Team: How to Succeed by Thinking Like the Enemy*. Basic Books.

MORS Continuing Education Goes on the Road

Walt DeGrange, Jennifer Ferat, Dr. Cy Staniec, FS, and Kirk Michealson, FS

Recently MORS was contacted with an opportunity to teach a course for the Naval Warfare Development Center (NWDC) onboard the Norfolk Naval Station with less than a 30-day turnaround. The topics requested were Effective Problem Definition/How to Define the Problem, Matching Problem Solving Techniques, Value-Focused Thinking, Visualization and Exploratory Data Analysis, and Presenting Analysis to Senior Leaders. MORS needed content and material to meet the request and reached out to the MORS Fellows for MORS courses and tutorials they were willing to be shared on these topics.

Continuing Education Background

This specific request fits in with the overall MORS continuing education (CE) efforts. From the continuing education survey MORS conducted in the June 2013–June 2014 MORS year, it was learned that MORSians and stakeholders alike preferred continuing education unit (CEU) and operations research (OR) practitioner courses. The MORS CE Committee's goal was to create courses that were not offered elsewhere. As a result, working with George Mason University and Old Dominion University, several CEU courses have been offered since the survey was completed and briefed to the MORS board of directors,

including Introduction to Analysis for Practitioners, Introduction to Analysis for Study Leaders, Multiple Objective Decision Analysis Goals and Objectives, Wargame and Technology, Risk Analysis, and An Affordability Analysis Approach to Maximize Value Across the Life Cycle.

In addition to the few CEU courses, the MORS Continuing Education Committee is expanding its OR practitioner courses with the recently announced MORS Certificate Program (MCP), which offers courses with certificates of attendance, although not formal certification. These courses have several subcourses and each of these subcourses are several

hours in length. The first MCP course is Wargaming to Support Military Analysis. The goal of this course is to ensure that students have the theoretical and practical understanding and means to create wargames, execute wargames, and evaluate the outputs of wargames and use the results to support analysis. The subcourses offered include Wargaming Theory, Wargaming Research Design, Wargaming 101, Wargaming 201, Wargaming Practicum, Wargaming Facilitation, and Tools in Wargames. Information on the MORS Certificate Program was presented in the September 2016 issue of *Phalanx*.

Future MCP courses planned include expanding the Risk Analysis and Affordability Analysis CEU Courses, as well as developing an OR practitioner course on the operations analysis (OA) process.

Course Development for the Navy

The request by NWDC was in line with the development of new MCP courses for the OR practitioner on the operations analysis process.

After the quick turnaround request was made by the NWDC, MORS Director of Education, Jennifer Ferat reached out to the MORS Fellows to determine if anything was “on the shelf” to cover the topics requested. Kirk Michealson, FS, responded that all but two of the requests were part of the MORS Continuing Education (CE) Committee tutorials for the 82nd MORS Symposium and they could be updated fairly easily for the Navy course. These tutorials were:

- Structured Analysis Using 8 Steps: An overview of the operations analysis process that was based on the scientific method, originally developed by Greg Keethler, FS, and Dr. Mark Waltensperger;
- Defining the Problem: More details into the first step of the operations analysis process, “critical thinking,” originally developed by Dr. Roy Rice, FS;
- Pairing Problem Solving Techniques with Classes of Problems: Developing the Modeling Approach: More details into the fourth step of the process, “establish the

methodology,” originally developed by Dr. Andy Loerch FS; and

- Presenting Results to Senior Leaders: More details to the last step of the operations analysis process, “reach conclusions and report,” originally developed by Jerry Scriven and recently updated by Dr. Greg Parnell, FS, Terry Bresnick, Trena Lilly, FS, and Kirk Michealson, FS.

The two additional topics requested were Value Focused Thinking/Multiple Objective Decision Analysis and Exploratory Data Analysis/Visualization. Relative to the first topic, Kirk teaches decision models for the University of Arkansas’ Masters of Science for Operations Management program and asked the program director, MORS Fellow and Decision Analysis subject matter expert Dr. Greg Parnell, FS for ideas. Dr. Parnell offered the transcript to Chapter 19, “Value Focused Thinking,” from the MORS Book *Methods for Conducting Military Operational Analysis: Best Practices* in the Department of Defense edited by Dr. Andy Loerch, FS, and Dr. Larry B. Rainey. The chapter provides



an introduction into value-focused thinking and multiple objective decision analysis with a recent military example.

For the second topic, Dr. Cy Staniec, FS, gathered information from the National Institute of Standards and Technology's *NIST/SEMATECH e-Handbook of Statistical Methods*, Chapter 1 on Exploratory Data Analysis or EDA, as well as information from the following references:

- *Exploratory Data Analysis* (Tukey, 1977)
- *Data Analysis and Regression* (Mosteller and Tukey, 1977)
- *Interactive Data Analysis* (Hoaglin, 1977)
- *The ABC's of EDA* (Velleman and Hoaglin, 1981)

EDA is an approach to data analysis and is a philosophy as to how to dissect a data set including what to look for, how to look, and how to interpret the data employing graphical techniques. This subject fits well into to the seventh step of the OA process, analyze the data.

The e-handbook is available online at no cost at www.itl.nist.gov/div898/handbook.

The overall operations analysis process course was rounded out with two sessions in Excel, presenting how to do the statistics, charts, optimization, and analysis techniques discussed in the other modules. These techniques included introductions in statistics (MAX, MIN, COUNT, mean, median, mode, variance, standard deviation, and conditional formatting), charts (creating charts, line, bar, column, histogram, scatterplot, regression, and combination charts), optimization (goal seek, solver, and linear programming with solver) and analysis (generating random numbers,

standard normal distribution, t-distributions, confidence intervals, hypothesis testing, F-test, and analysis of variance (ANOVA)).

These topics were integrated into a two-day course on the operations analysis process:

Operations Analysis Process: Day 1

- MORS Overview / Introduction
- Structured Analysis in Eight Steps (an overview of the OA Process)
- Define the Problem (step 1: Critical Thinking)
- Problem-Solving Techniques (step 4: Establish the Methodology)
- Introduction to Value-Focused Thinking/Multiple Objective Decision Analysis (introduced in the Problem-Solving Techniques Module)
- Excel Part I (statistics and charts)

Operations Analysis Process: Day 2

- Visualization and Exploratory Data Analysis (step 7: Analyze the Data)
- Presenting Results to Senior Leaders (step 8: Reach Conclusions and Report)
- Excel Part II (optimization and analysis)

Course Presentation for the Navy

The course was held on Wednesday–Thursday, September 28–29, at NWDC with Dr. Staniec and Kirk copresenting to more than 25 students. There were numerous discussions during the two-day course and many of these related the course content to their current missions, i.e., operations assessments for lessons learned and experimentation. Basically, the students work with thin data teasing insights out of anecdotal information and they wanted to learn about repeatable processes for their organization. Cy and Kirk offered

relevant ideas and examples for the students to consider.

Overall, the Navy customer was satisfied with the training. When the students were asked for their takeaways from the course, they mentioned many of the topics taught, such as seeing the overview of structured thinking, putting the story together with data visualization to present to senior leaders, defining the problem using critical thinking, being introduced to value-focused thinking, and understanding the tools available to do the work at their desktops. With these positive notes, there were some lessons learned for the next time the course will be offered. These include providing more examples and “sea stories,” especially as they relate to what the organization is doing, and demonstrating how to turn anecdotal information into insights.

Summary

For this first exportable training by MORS, the mission was accomplished well given the short timeframe for preparation. However, for future course preparations, MORS can benefit by conducting discussions with the key customers to identify their main issues before starting specific preparations. In any case, a strong foundation for an operations research practitioner course on the operation analysis process was developed by several MORSians, and the MORS Continuing Education Committee can use it to build the course into a full CEU and/or certificate courses.

For more information on the MORS Continuing Education Program, please contact the current MORS Continuing Education Committee Chair, Walt DeGrange, at walter.degrange@gmail.com or the MORS Director of Professional Development, Jennifer Ferat, at jennifer.ferat@mors.org. 

PHALANX

The Magazine of National Security Analysis

As the magazine for the Military Operations Research Society and the Military Applications Society, *Phalanx* reaches the leaders of the national security analytic community in government, industry, and academia and provides a unique forum for analysts to share and learn.

Why Advertising in Phalanx Makes Business Sense

- Every issue of *Phalanx* reaches over 10,000 analysts in the national security field
- *Phalanx* readers and contributors include the leaders in government industry, and academia
- *Phalanx* offers a flexible and economic advertising plan that will fit the budget of any sized organization

Phalanx Rates for Four-Color Advertisements

Rates per Issue

Location	1 Issue	2 Issues	4 Issues	Size (w" x h")
Inside front and back covers	\$2,000	\$1,920	\$1,840	Full-bleed: 8.75" x 11.25" Cover 3 (Inside back)
Cover 3 (Inside back)	\$1,850	\$1,775	\$1,700	Full-bleed: 8.75" x 11.25"
Interior full-page	\$1,750	\$1,680	\$1,610	Full bleed: 8.75"x11.25"
Interior half-page	\$1,050	\$1,050	\$950	7.5" x 5" (bleeds not accepted)

Phalanx is published quarterly in March, June, September, and December. Space reservations are due 45 days prior to publication and advertising materials are due 30 days prior to publication.

For more information contact phalanxadvertising@mors.org

Affordability Analysis

Organizing and Refining for Implementation

Bob Koury, Lisa Oakley-Bogdewic, and Greg Keethler, FS

At the 84th MORS Symposium in June 2016, the MORS Affordability Analysis Community of Practice (AA CoP) leadership presented the background and status of the AA CoP's efforts, the affordability analysis CEU course, and an overview of the affordability analysis measurement framework. During presentations and other discussions throughout the symposium, there were recommendations to better understand the difference between what the MORS AA CoP was describing as "Little a" and "Big a." Based on the feedback received at the symposium and in other CoP deliberations, it's clear that affordability analysts need to explore the determination of which decisions affordability analyses can support, how to support them, and how to inform leadership when establishing the new affordability goals and caps.

As a result of these discussions, the MORS AA CoP, with support from INCOSE, NDIA SED, ICEAA, and the PSM user's group, will be hosting a third Affordability Analysis Workshop, February 7–9, 2017, at the Lockheed Marion Global Vision Center in Arlington, VA, to review these recommendations.

Background

Given the current budget crisis and complex, uncertain security environment, the Department of Defense is very focused on "affordability." When Ashton Carter was the Under Secretary of Defense for Acquisition Technology & Logistics (USD/ATL), he defined affordability as "cost-effective capability."

Affordability has thus been defined, but discussions during the MORS 2011 special meeting on risk, trade space, and analytics in acquisition discovered that affordability analysis was ill defined and that there is not a consistent definition for affordability analysis across the Department of Defense. Participants in the meeting recommended developing and formalizing affordability analysis processes, including recognizing the difference between cost and affordability analyses, and that affordability analysis should include mission-based, portfolio-based, and capability-based analyses.

As a result of these recommendations, MORS led a workshop in October 2012 entitled, "Affordability Analysis: How Do We Do It?" The recommended next steps from this workshop were:

- Form a team to continue working
- Complete the research not conducted during the three-day workshop
- Develop an affordability analysis "How To" manual/guidebook/process
- Pilot the manual/guidebook/process on a couple of projects

In March 2014, MORS led a second workshop, "Affordability Analysis: Developing the Product." This was a combined MORS Special Meeting and Lean Six Sigma value stream mapping event to create a framework for a government and industry. There were four working groups that developed a value stream map for each of the four affordability analysis activities in the ARD's AA Framework. Each activity had an overview, inputs, subactivities and tasks, exit criteria, and outputs. Exit criteria were added for sufficiency and quality

In February 2016, the MORS AA CoP chair and co-chairs participated in the Practical Software & Systems Measurement (PSM) user's group, "Measurement: A Foundation for Affordable Solutions" conference. This participation resulted in a partnership with PSMUG to determine how analytical measurement of progress

and quality could be incorporated into affordability analysis.

“little a” vs. Big A”: The Affordability Analysis Conundrum

One of the major findings coming out of the work the AA CoP has completed over the last five years is highlighting of two types of affordability analysis, “little a” and “big A”:

- Affordability in the “small” means being frugal: being cost efficient in executing a program from beginning to end and not being extravagant in choosing capabilities and solutions to challenges; getting the most bang for the buck. This is “little a.”
- Affordability in the “large” asks the question, “Does this capability, for what it is going to cost (or is costing us), provide sufficient value in the context of all of the other things we need?” This is “Big A”.

Contractors, program managers, and others tend to operate in the “little a” realm, that is, “doing things right,” while DoD, Congress, and service leadership usually mean “Big A,” or, “doing the right things.” Overemphasis on “little a” can lead to being “penny-wise and pound foolish.” Affordability in the large is a judgment call. That judgment can change over the life of a program for many reasons, some of which may have absolutely nothing to do with the “little a” of a program. Analysis to support the “Big A’s” differs somewhat due to the nature of the associated questions.

Affordability is inseparable from prioritization. Because affordability is more of a concept of decision than it is a firm number, such as cost, “things” are only affordable if they are higher priority than things that are unaffordable. Affordability analysis illuminates what is achievable within a portfolio. The portfolio is relevant

and must be thoroughly examined to ensure that decisions are made with respect to the appropriate offsets. To accept something as affordable implies that something else might be unaffordable.

So the conundrum is who and how do you balance the two affordability types and who does this balancing? Are both types of analyses done by both government and industry? What are the interfaces between the two analyses types? What we have learned is:

- Affordability requires a holistic approach, spanning the executive and legislative branch to the program level. It may be characterized as participation at the enterprise, portfolio, and program levels.
- Affordability analyses at these various levels will not be the same, but the results from one level should relate to those of another.



- The scope or budget constraint varies depending on the level of analysis.
- We have good visibility at the program execution level but not at the portfolio capability and enterprise, or strategic level. This shouts out for high degrees of transparency needed for appropriate aggregate views.
- The maturity of affordability analysis varies across levels. For example, we know how to do an affordability analysis for, say, tanks, a program, but not for a direct fire capability, which requires prioritization or resourcing.

The AA CoP's work to date has answered some of these questions, but not all. We have proposed processes, methods, techniques, and potential data requirements. What we have not done is identified and explored completely the interactions of "Big A" and "little a" or the timing, use of processes, methods, techniques, and data.

The February 2017 AA CoP workshop is a two-and-a-half-day exploration of the following issues:

- Affordability input to allocate Pf TOA for long-term capability plans: methods to inform strategy and politics;

- "little a" decisions within "Big A" boundaries: governance, process, data, analytics;
- Optimizing with feedback: Measuring the process, operational outcomes, and fiscal gains to inform "Big A" and "little a" decisions.

These are important topics to explore and the MORS AA CoP encourages anyone who has an interest in affordability analysis to join us to participate or volunteer to lead a topic area at the February workshop. ↑



MORS Oral Histories

Now Available to a Wider Research Community

Captain Wayne Hughes, USN (retired), FS, Naval Postgraduate School, whughes@nps.edu

Dr. Bob Sheldon, FS, Group W, Inc., bs@group-w-inc.com

More than 50 MORS oral histories have been published in *Phalanx* and *Military Operations Research Journal* since the MORS Oral History Program was initiated by Gene Visco, FS, in 1998. Thanks to the support of the Naval Postgraduate School (NPS) Library, these oral histories are now readily available to a larger research community.

The NPS Dudley Knox Library director, Ms. Eleanor Uhlinger, was both receptive and enthusiastic when we proposed making the collection available through the NPS library. We also want to thank Mr. Jason Leyk, the library's electronic collections coordinator, who did the installation and will keep it up to date as future interviews are published.

Here is a sample of the MORS heroes interviewed in the collection. Many of them are MORS Fellows of the Society (FS), Past Presidents of MORS, and recipients of the MORS Wanner and Thomas Awards:

- Clayton Thomas, FS MORS Fellow #1 and the first MORS oral history we captured
- Lewis Leake, FS MORS President when MORS was incorporated 50 years ago
- E.B. Vandiver, FS Army MORS

Sponsor and long-time Director of the Center for Army Analysis (CAA)

- Lt Gen Glenn Kent, Air Force MORS Sponsor and founder of Air Force Studies and Analysis
- Gen Larry Welch, Chief of Staff of the Air Force and President of the Institute for Defense Analyses (IDA)
- Dr. Marion Williams, FS Chief Scientist and Technical Director, Air Force Operational Test and Evaluation Center (AFOTEC)
- Gene Visco, FS Army MORS Sponsor Representative

Some are past and current faculty at NPS, for example Jack Borsting, FS Dave Schradly, FS Al Washburn, Jerry Brown, and Wayne Hughes, FS.

As a bonus, many of the individuals interviewed graduated from NPS and have their theses posted in Calhoun too. For example:

- Andy Loerch, FS' oral history is posted at <https://calhoun.nps.edu/handle/10945/49249> and his NPS master's thesis is posted at <http://calhoun.nps.edu/handle/10945/19006>.
- Dr. Steve Balut's oral history is posted at <http://calhoun.nps.edu/handle/10945/49236> and PhD dissertation is posted



at <http://calhoun.nps.edu/handle/10945/16756>. Dr. Balut is the first OR PhD graduate from NPS.

- MORS Executive Vice President Brian Engler, FS' oral history is posted at <http://calhoun.nps.edu/handle/10945/49233> and his NPS thesis is at <http://calhoun.nps.edu/handle/10945/15188>.

MORS is continuing to collect oral histories. Among those to be published in the near future is Rear Admiral Sinclair Harris. His interview will be posted on Calhoun and his NPS thesis is posted at <http://calhoun.nps.edu/handle/10945/26932>.

Thanks to the NPS Dudley Knox Library for making our MORS oral histories available via Calhoun: The NPS Institutional Archive at <http://calhoun.nps.edu/handle/10945/49224>. These oral histories together tell an inspiring story of military operations research accomplishments and how our leaders operated as exemplars of best practice.

Connecting the Dots

Learning from Multiple Wargames

Robert C. (Barney) Rubel, Captain, USN (Ret), Professor Emeritus, US Naval War College

Intensifying chaos in the Middle East, the rise of revanchist peer competitors, and massive national debt all serve to increase pressure on the American armed forces.

Lacking the ability to address the pressure by increasing force size, the Department of Defense (DoD) seeks to increase the efficiency of the forces it does have through various means. One of those means is what the Deputy Secretary of Defense Bob Work and General Paul Selva call “revitalizing wargaming” (Work and Selva, 2015). Among the measures they call for to achieve revitalization is the establishment of a “wargaming repository” that contains reports of numerous wargames conducted by various elements of DoD. The implication is that those utilizing the repository could in some way use the results of multiple wargames—connect the dots, so to speak—to derive insights beyond those produced by any single game.

It is one thing to sift through such reports to glean hints on how to design and conduct wargames or to cue follow-on gaming or other research. This kind of data gathering is valid in and of itself. However, if the researcher seeks to employ the results from multiple games to generate deeper insights on warfare subjects, to synthesize game results,

the epistemic ground shifts. Such research is a potentially powerful tool, but care must be taken when comparing or aggregating the results of multiple games to avoid distorted or erroneous conclusions. Synthesizing qualitative research results, which are what wargames produce, is not a well-developed field, but there are a number of proposed methodologies emerging from the fields of medicine and social science research, such as meta-interpretation (Weed, 2005) and meta-ethnography (Britten et al., 2002) that could prove useful. This article will not delve into these techniques, but anyone undertaking to do multigame synthesis ought to review the literature.

The matter of linking wargames has a design and planning aspect also. It is not uncommon for a military service to run multiple, related games as part of a larger research or education project or “campaign.” For the games to relate effectively, designers must understand the logic of how multiple

events can be related and base their overall campaign and individual game designs on that understanding. This article will draw on the author’s more than three decades of professional wargaming experience to offer some insights and principles for leveraging multiple wargames.

We must start by reviewing the nature of the individual wargame. The best operative definition of a wargame comes from Dr. Peter Perla, whose book *The Art of Wargaming*



is a seminal work on the subject. He defines a wargame as, “a warfare model or simulation whose operation does not involve the activities of actual military forces and whose sequence of events affects and is, in turn, affected by the decisions made by players representing the opposing sides” (Perla, 1990, p. 276). The important part of the definition for our purposes is the part about the sequence of events being influenced by the decisions of players, the implication being human players. This means

characteristics of wargames, what is their utility as research tools as opposed to their educational value? Perhaps the deepest exploration of this question has been made by Dr. John Hanley in his doctoral dissertation entitled *On Wargaming* (Hanley, 1991), in which he answers the question by relating the nature and structure of wargaming to the amount of indeterminacy, the collection of unknown or unknowable elements, attending a problem. He establishes a spectrum of problems based on their intrinsic level of indeterminacy. They range from those that have no indeterminacy and so are amenable to engineering solutions, through those that can only be addressed by the use of statistics to those that have “strategic indeterminacy” in which the independent choices of two or more “players” govern the end state. At the far end of the spectrum lie those problems beset by “structural indeterminacy” in which even the structure and elements of the problem, such as its kinematics, variables and available response time,

are unknown (Hanley, 1991, p. 13).

Wargames thus produce qualitative information of various kinds, ranging from the nature of players’ decisions and why they made them, and under certain circumstances the consequences of those decisions, to the unveiling of otherwise hidden relationships among the constituent elements of the problem. Such output can be extremely useful in any number of ways for military decision makers. However, it is qualitative

information and does not prove anything. To be useful, decision makers must have confidence that a game’s results have some valid connection to the real world such that they are justified in taking risks based on it. This being so, the game that produced the information must have both internal and external validity, that is, the simulation accurately reflects some dynamics of the real world, and the game itself is conducted without internal errors, commonly known as game artifacts, that would obstruct or distort such reflection. It is beyond the scope of this article to engage in an in-depth discussion of game validity, but its importance in the matter of multigame comparison is critical. (For a more in-depth examination of game validity, see Rubel (2006).) A well designed and executed game will feature a report that forthrightly lays out any problems that were encountered in its execution that would affect what validly could be learned from it. If such information is not part of the game report, the researcher seeking to include that game’s results in a synthesis is working blind, either being forced to accept game results at face value, or discarding the results of the game.

Looking Back

The repository of game results that Deputy Secretary Work mentions necessarily consists of reports of games that had no defined relationship to each other for the most part, having different sponsors, different objectives, and different designs, not to mention a different set of umpires and players. This diversity of form and function makes comparability problematic. There may be many games that address similar scenarios using similar orders of battle, but again, differences in design and execution must be considered. Unless the games

that games have built into them a degree of indeterminacy that keeps them from being treated as scientific experiments. They are not replicable; each is unique, despite, perhaps, superficial similarities. Because of this, Dr. Perla goes on to say, “Wargames do not do very well at producing quantitative measures because they are often little more than a single realization of a complex stochastic process” (Perla, 1990, p. 276).

Given the indeterminate



incorporate the same computer simulation, used in the same way, for move adjudication, the outcomes of force-on-force engagements cannot be compared. Many manually assessed games, especially those that are constrained to a predefined number of moves or are otherwise time limited, tend to feature a form of logic that makes move outcomes relevant only to their particular game. In these games, umpire logic usually takes the following form, whether the umpires realize it or not, given the starting situation for the move and considering both the player moves and the conditions needed in the next move in order to move the game toward its objectives, what had to have happened, plausibly, to produce those conditions? Even when computer simulations have been used to assess player moves, game directors have frequently found it necessary to “adjust” the computer results to keep the game on track. This is a key reason it is generally not valid to compare move assessments from different games.

For similar reasons it is not valid to tally up who “won” across multiple games. In most military games, pushing the game to a decision is neither feasible nor desirable for any number of reasons. Only in rigidly assessed games, i.e., those in which players must follow a specific set of rules and move outcomes are the result of either deterministic or stochastic algorithms, does game outcome have any meaning at all. Even for these games, the fact of one side winning is less important than an analysis of the factors that contributed to the outcome. In manually assessed games, which are normally not pursued to a win/lose point in any case, no particular meaning can be attached to the relative situation of either side at the end of the game and

thus there is no basis for comparison of the end states among manually assessed games.^a

This is not to say that there is no basis at all for comparing diverse, manually assessed games. Perla advocates for an analysis of why players made their decisions, using a form of historical analysis (Perla, 1990, p. 276). On the other hand, Dr. Stephen Downes-Martin asserts that most game players are not actually qualified for their roles in a game, the normal case being that more junior personnel play more senior positions. Moreover, umpires are actually powerful players and their decisions are not valid grist for analysis. Instead he says that it is the communications between players and umpires and among players themselves that constitute the valid data a game has to offer (Downes-Martin, 2013). At this level of analysis, with due regard for the specific conditions of each game, multigame comparisons may be possible assuming such communications were accurately captured.

Player decisions and communications notwithstanding, games have the potential of producing another kind of information: hidden relationships among the elements of a military problem or situation. It is difficult if not impossible for most people to visualize the unfolding of a military operation of any size. This is why the Army does “rock drills,” walk-throughs of planned operations to uncover potential conflicts and problems that could not be detected just by reading the plan. Wargames are a powerful way of not only uncovering defects in plans; they can also reveal other subtle but important issues and relationships. Such information is inherently cumulative, adding detail to the understanding of a complex process. Thus this type of output can

be collected legitimately from multiple games. However, this is still qualitative, anecdotal information and care must be taken to avoid the temptation to subject it to statistical reduction.

There is also a temptation among many involved with gaming to overstate the scope and definitiveness of what particular games or games in general can produce. Games cannot predict and they cannot prove, or disprove, despite the potential appearance of such based on a comparison of game results with subsequent events in the real world. The world is not deterministic and things could have turned out differently in reality than they did in the game. Games can indicate possibilities that perhaps nobody had thought of, and if, subsequently, decision makers acted on those indications, the games actually influenced the future, a different thing than predicting the future. However, the process of going through old game reports can create the illusion they actually predicted subsequent events, creating or reinforcing a mistaken belief in their utility. Another issue is that of overstating game results by those involved with the game. The report may overstate what results came out of the game, especially if there are agendas involved in the results of the game. The researcher is aided by consulting the game’s analysis. If it forthrightly sets out game limitations and difficulties experienced in execution, it is more likely that the conclusions are accurately stated.

Looking Forward

It is one thing to dig through a set of reports from past games that were conducted for disparate purposes and had highly diverse designs and circumstances of execution. There are, as we have established,

significant logic constraints on how they can be validly compared. It would be different if there were some standardized procedure for move assessment as well as for scenario definition, orders of battle, and employment doctrine for Blue and Red. This has, in fact, been attempted at various times and in various ways, mostly without success. One reason is natural organizational stove-piping, but the deeper reason is that in order to be effective, games must be designed specifically for the need at hand. It is not that elements of previous games cannot be recycled opportunistically; it is that forcing a cookie-cutter approach too far distorts the gaming process, limiting its ability to produce valid and, in the best cases, unanticipated results.

Epistemic difficulties aside, if we want games to be relatable, especially within the context of a particular research or educational project or process, there are ways outside of draconian standardization to achieve it. To understand these ways, a bit of warfare theory is necessary. In any military campaign, individual events can be related in one of three ways. They can be related sequentially, in which Event A is prerequisite to Event B, and so on. The second type of relationship is cumulative; each event is related only insofar as it contributes to the total desired effect. Finally, there is the decisive event relationship. The goal is to precipitate an event that will decide the issue. Moves to precipitate such an event can be considered gambits; if one doesn't work then another one is tried. The sum total of such gambits, along with the decisive event, if it occurs, can be considered a campaign.

Series of games can be related in similar ways. A sequential series of games might proceed in a kind of

progressive manner in which the results of Game A are factored into the design of Game B. The games of the sequence could be related in any number of ways. One way is by time. Game A might examine Phase 0 and Phase I of a crisis scenario. Subsequent games would push deeper into the campaign⁹ with as much continuity in players and assessment methods as possible. A second method is through progressive refinement of issues. This was the basis on which the Navy's Global Wargame was conducted during its first five years: "Each game was a separate evolution rather than a continuation of the previous year. Although the scenarios did not tie directly to each other, as issues were identified, they were incorporated into each follow-on game, forming a series. The combined effect was to establish a longitudinal approach which examined problems over time and allowed intervening study to address specific issues" (Hay and Gile, 1993, p. 1). Assuming such games are separated by months, if not a year, care must be taken to ensure the results of Game A are accurately incorporated into Game B. Much can happen in the interval between games that could provide incentive to modify the scenario and order of battle for follow-on games, not to mention refining assessment techniques and bringing in different participants. Doing any of these things serves to weaken the relationship between the games and thus reduces the valid opportunities for cross-game analysis.

A second way of sequencing games is progressive iteration to achieve optimization. At the Naval War College, advanced student research groups conduct iterative games that explore high end naval combat. Generally the games involve delimited tactical or operational scenarios.

Players receive move assessments and then replay their moves based on what they learned from those assessments. Such replay continues until at least one side asserts that they cannot do any better. This progression toward move optimization provides additional insights beyond those available from a single run through and can be considered a sequential series of games.

There are other bases for sequencing games that are more tolerant of variations in design and execution of individual games. We will call them exploratory series. These can proceed either deductively or inductively. In a deductive series, Game A might broadly explore future warfare. Individual issues that arise out of it would be the subjects of follow-on games. The whole process would be one of progressively teasing out details and implications. An inductive series of games might consist of a series of preliminary games that explore and test tactical concepts, culminating in an operational game that examines how the various concepts fit or don't fit together. Finally, games could be linked in a functional series, for instance in conducting a crawl/walk/run educational process for a sponsoring organization or perhaps for the gaming staff itself.

The second kind of game relationship is cumulative. As components of an overall project to explore some large and complex issue, concept or phenomenon, individual games are related to the extent they incrementally add to the definition and understanding of the matter. Such games can also be used for education and training, with no game being prerequisite to any other. Iteration progressively enhances proficiency. The long series of

Using Player Communications to Analyze Wargames

I devised a theory of “the illusion of strength” based on the observation of player communications over the course of multiple wargames spanning more than a decade. The observation was that players in two-sided games tended to “game past each other,” that is, the militarily weaker side, usually Red, tended to focus on political, economic, and information stratagems in their moves while the militarily stronger side, Blue, focused on conventional military operations. Besides making life difficult for the umpires, this asymmetry led to Blue misreading signaling by Red, to the point where in some games Blue could not perceive how their apparently successful conventional military operations were actually painting the putative national command authority into a difficult political corner. The awful truth only became apparent in the hot wash when Red players explicitly laid out their strategy. Subsequently, a form of the same phenomenon popped up in a series of deterrence and escalation games. In these games, Blue and Red players

were mostly relatively senior policy and intelligence officials who knew each other from years of professional collaboration. Moreover, both Blue and Red players were familiar with Red doctrine and the Red players faithfully adhered to it during the games. Yet Red signaling was consistently ignored or misinterpreted by Blue players. Looking across all the games over the years, the common thread was Blue conventional military superiority. The author’s theory, right or wrong, was that having a strong suite imposed a kind of distorting lens on the way Blue players perceived the situation, preventing them from correctly interpreting Red signaling. Whether or not this theory holds any water, two points can be made. First, it didn’t matter that the games involved different scenarios, methods, or players. Player communications were the connecting link. Player communications can be considered a phenomenon that occurs outside of the game simulation itself and therefore can be a source of data whose validity can

maritime homeland security games conducted by the Naval War College after the 9/11 attacks were generally of this kind. Each had different objectives, a different design and sometimes different players, but the net cumulative effect was to improve the coordination among organizations concerned with maritime security.

There is another way that games can be related in a cumulative manner and that is as substrates for some form of social science experimentation, leveraging the idea that player interactions occur outside of the simulation itself. Especially if the games can be easily iterated, enough of them can be run to gather statistically significant amounts of data. An example, run by the Naval War College, was a simple computer-based, matrix game called Scud Hunt in which four players had to coordinate their particular set of reconnaissance and surveillance assets to locate hidden missile sites.

In the specific experiment, which examined command and control, the game was run 36 times with different C2 treatments to see which one was more effective. In this project, the games’ output—scores on how fast each team found the missile sites—was a surrogate measure of team efficiency. The experiment focused on the relative efficiency of various player organizational structures. This was valid because the players actually commanded and controlled each other—the basis for the investigation (Rubel, 2003). There are undoubtedly other opportunities for using games in this way.

The third kind of connecting link between games is the decisive event series. Normally, games that might be related in this way are what Professor Tom Culora, Dean of the Center for Naval Warfare Studies, refers to as “regency games” (Culora, 2016, p. 32), those whose objective is to educate and therefore influence senior

decision makers. Frequently a series of preliminary games or staff exercises are conducted in order to refine game inputs and hopefully enhance its impact. Regency games are generally “one-off,” so they must be treated as independent and unrelated. On the other hand, in the rare case in which Game A did not have the desired effect and Game B was conducted, there might exist some opportunity for intriguing synthesis. Some service Title X wargames had at least the embedded purpose of selling service concepts to a higher level audience. Another purpose of such games is to generate unity of purpose within or among organizations. Finally, in an exploratory mode such games are conducted to discover a key concept. In 2006, the Naval War College conducted such a game in support of the development of a new maritime strategy. The game did, in fact, reveal a key concept, defense of the global system, that was subsequently incorporated into

be judged independently of the simulation. Second, the observations and the author's preliminary theory could be considered "smelling smoke"; a hint that something is going on. This might indicate more gaming and possibly experimentation is needed to determine if the theory has any merit and whether it is of sufficient importance to warrant some action.

It should be also emphasized that the author's observations were directly of players making decisions in the context of the game. In some games (or more precisely, game campaigns in which a series of pregame staff exercises and postgame discussions by senior observers were all part of the process), the reports consisted of an analysis of the postgame discussions by "senior concept developers," whether they directly observed the game or just received the hot wash briefing. In the early 2000s the experimentation directorate (J-9) of Joint Forces Command took this approach. After each game a team of retired flag and general officers discussed game results and their comments were

recorded. Subsequently J-9 analysts did a statistical analysis based on how often certain issues were raised in those discussions, postulating that the frequency of occurrence corresponded to the importance of the issue. Among the problems with this approach was that the same senior officers were used in game after game. If one of them had a particular "hobby horse," he or she would bring it up every time and thus the analysis would raise its apparent importance. Additionally, the senior folks did not usually observe the game directly, much less participate, basing their discussion on the hot wash. Thus the record of their deliberations was two removes from game events, much less player communications. This is perhaps an egregious example, but the issue of interpreting what happened in a game based on a report requires some caution, as the researcher is one or perhaps two removes from the actual event or communication. If the objective is cueing rather than comparative analysis, the researcher is on firmer ground.

—R. C. Rubel

the 2007 national maritime strategy. Beyond the particular objectives of a game, the background reasons for such games, if they can be found, could be an interesting set of data points for analysis.

Conclusion

Wargame comparison, utilizing the results of multiple wargames, related or not, to derive insights beyond which a single game could provide, is an attractive concept that promises great utility. The fundamental problem is that of comparing apples and oranges. At first glance, a number of games may seem to be "apples," utilizing similar scenarios, adjudication methods, etc. But care must be taken to look beyond surface similarities so that unwarranted conclusions are not drawn from essentially incomparable information. The disciplined use of various emerging synthesis methods will help guard against this error. The other considerations raised in this article will permit researchers to

extract what legitimate meaning there is from the repositories of wargaming reports that are being established. From a gaming campaign design perspective, in which multiple games are intended from the outset to be related in some way, it is helpful to understand the ways in which campaign events can be related and using this understanding, avoid certain pitfalls like over or under standardization of game elements.

The formation of repositories of wargame reports has the potential not only to enhance the conduct of gaming, connected as will be the Navy's with the formation of a wargaming "virtual community of practice," but also to constitute a valuable source of research data that might uncover insights beyond that available from individual games, whether or not they were explicitly related in a gaming campaign. However, the process of synthesis must be approached in a careful,

disciplined manner in order to avoid insidiously erroneous results, or those more clearly unjustified and open to challenge, which might serve to damage the credibility of the process and of gaming in general. This article is meant to initiate a professional dialogue on the subject so that as this type of research gets underway, advances in methodology can be made.

Notes

^a A significant exception is the series of games conducted by the Halsey Groups at the Naval War College. These games feature manual assessment but are pursued iteratively, players learning from the results of each move, until at least one player says that they could do no better. This form of convergence on an optimum is in a sense, pursuing the game to conclusion.

^b The notional phases of a military campaign set forth in US Joint

Doctrine. See Joint Publication 5-0, Joint Operation Planning, August 11, 2011, p. III-39.

References

Britten, N., Campbell, R., Pope, C., Donovan, J., Morgan, M., and Pill, R. 2002. "Using Meta Ethnography to Synthesize Qualitative Research: A Worked Example", *Journal of Health Services Research & Policy*, Vol 7 No 4, 209–215; <http://betterevaluation.org/sites/default/files/Using-meta-ethnography-to-synthesise-qualitative-research.pdf>.

Culora, T. J. 2016. "A Wargaming Renaissance", *Proceedings Magazine*, Vol 142/5/1, 359; www.usni.org/magazines/proceedings/2016-05/wargaming-renaissance.

Downes-Martin, S. 2013. "The Diabolus in Machina of War Gaming", *Naval War College Review*, Summer, 67–80.

Hanley, J. T. 1991. "On Wargaming", *PhD dissertation*, University of Michigan, Ann Arbor.

Hay, B., and Gile, B. 1993. "Global Wargame, The First Five Years", *Newport Paper #4*. Naval War College Press.

Perla, P. 1990. *The Art of Wargaming*. US Naval Institute Press.

Rubel, R. C. 2003. *Using Wargames for Command and Control Experimentation*, a paper submitted to the 8th International Command and Control Research

and Technology Symposium; www.dtic.mil/dtic/tr/fulltext/u2/a466408.pdf.

Rubel, R. C. 2006. "The Epistemology of War Gaming", *Naval War College Review*, Spring, 108–128; www.usnwc.edu/getattachment/5f9410-594b-47bf-af57-4cf5e406e634/Epistemology-of-War-Gaming,-The---Rubel,-Robert-C-.

Weed, M. 2005. "'Meta Interpretation': A Method for the Interpretive Synthesis of Qualitative Research", *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, Vol 6, No 1, Article 37; <http://nbn-resolving.de/urn:nbn:de:0114-fqs0501375>.

Work, R., and Selva, P. 2015. *Revitalizing Wargaming is Necessary to be Prepared for Future Wars*, *War on the Rocks* (December 8); <http://warontherocks.com/2015/12/revitalizing-wargaming-is-necessary-to-be-prepared-for-future-wars>.

About the Author

Captain Rubel is retired and living in Monticello, Illinois. From May 2006 to August 2014 he was Dean of the Center for Naval Warfare Studies (CNWS) at the US Naval War College. Prior to assuming this position, he was Chair of the Wargaming Department. A 30-year Navy veteran, he was a light attack naval aviator, flying the A-7 Corsair II and later

the F/A-18 Hornet. He commanded Strike Fighter Squadron 131 and served as the Inspector General at US Southern Command.

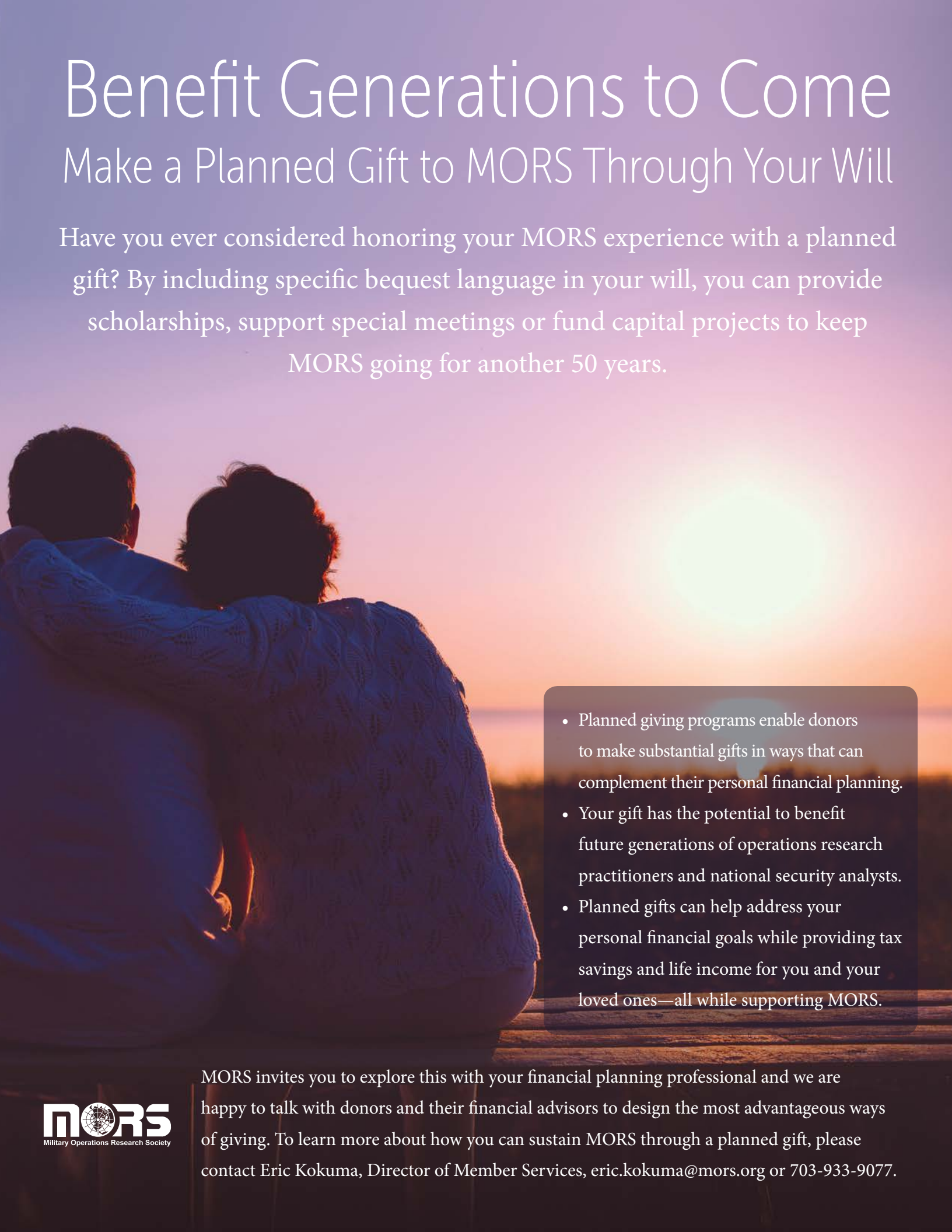
Captain Rubel's shore assignments were principally involved with professional military education. He is a graduate of the Spanish Naval War College in Madrid and the US Naval War College in Newport, RI. He completed three separate faculty tours at the US Naval War College as a joint military operations instructor and ultimately as the Deputy Dean of the Center for Naval Warfare Studies. During these tours he served as the William F. Halsey Chair of Air Strike Warfare and later the Colin Powell Chair of Joint Warfare.

As Dean of CNWS, Professor Rubel designed and directed an eight-month effort that provided the logic and concepts that underpinned the 2007 US national maritime strategy "A Cooperative Strategy for 21st Century Seapower." Professor Rubel increased student advanced research and developed new lines of inquiry including strategic cyberspace, unmanned systems, naval logistics, and command via challenged networks. He also redirected the vector of the International Law Department from teaching maritime law to research on cutting edge law of war issues. He has published over thirty articles and book chapters on a number of subjects related to naval operational warfighting and strategy.

Benefit Generations to Come

Make a Planned Gift to MORS Through Your Will

Have you ever considered honoring your MORS experience with a planned gift? By including specific bequest language in your will, you can provide scholarships, support special meetings or fund capital projects to keep MORS going for another 50 years.

- 
- Planned giving programs enable donors to make substantial gifts in ways that can complement their personal financial planning.
 - Your gift has the potential to benefit future generations of operations research practitioners and national security analysts.
 - Planned gifts can help address your personal financial goals while providing tax savings and life income for you and your loved ones—all while supporting MORS.

MORS invites you to explore this with your financial planning professional and we are happy to talk with donors and their financial advisors to design the most advantageous ways of giving. To learn more about how you can sustain MORS through a planned gift, please contact Eric Kokuma, Director of Member Services, eric.kokuma@mors.org or 703-933-9077.

Cost Drivers in Vehicle Maintenance

An Analytic Perspective

Maj Brian Bagley and Mr. Huntley Bodden, Marine Corps Logistics Command

Walter DeGrange, Carol DeZwarte, Norman Reitter, Harrison Schramm, and Bill Vinyard, CANA Advisors

We are all tempted to put off preventive maintenance, particularly if nothing seems wrong with the equipment in question: think of the times we have been tempted to delay regular automotive maintenance such as oil changes. How much does it cost “down the road” to wait another 100 miles for that oil change? We were asked a similar question by Headquarters, Marine Corps: Does deferring maintenance on amphibious assault vehicles (AAVs) lead to higher

field costs in future years, and if so, how much? For those inside the Pentagon “Budget Wars,” this is a common theme: “How much will it cost me in the future to perform a task that I cannot do today?” We took a data-intensive approach from several disparate sources to create an analytic answer.

Determining the cost drivers for various programs is a classic problem in both military and civilian operations research applications. In this case, we are reminded of the RAND Corporation’s study on the

cost of Navy ships (Arena, 2006). The problem is similar because we sought to identify a small number of cost drivers out of many candidates across a fleet. Our problem is compounded by considering costs of vehicles that are deployed, subject to a high number of influences, not all of which are provided in our data.

The AAV Fleet

We consider a fleet of 1,064 AAVs, including those assigned to the First, Second, and Third Expeditionary Forces (MEFs) and those attached to Maritime Prepositioning Forces. These vehicles are subject to both scheduled major overhauls (“depot maintenance”) and unscheduled maintenance away from depot (“field maintenance”).

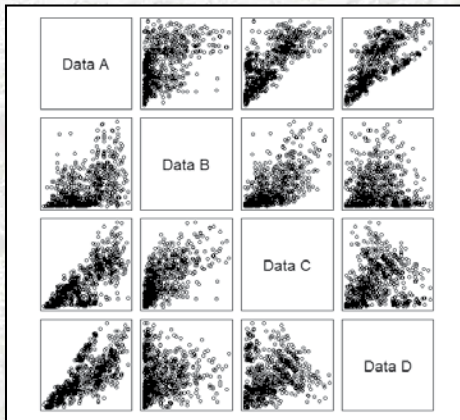
Data Sources

The chief difficulty was not so much obtaining the data as it was combining it from disparate sources into a single, coherent analytic dataset. The team sourced data from seven noncooperative data systems. Historic data stores had many useful data fields, but frequently lacked similar keys necessary to create a master table.

Figure 1. The AAV-7 amphibious assault vehicle in action. “Designed to assault any shoreline from the well decks of Navy assault ships, AAVs are highly mobile tracked and armored amphibious vehicles that transport Marines and cargo to and through hostile territory.” Photo at www.marines.com/operating-forces/equipment/vehicles/aav-7#features.



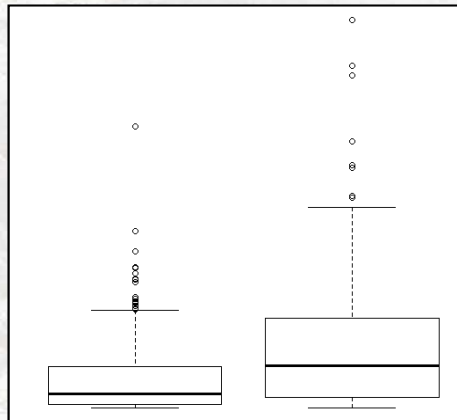
Figure 2. Plot of regressors against each other demonstrating multicollinearity. While it is preferable to have noncorrelated regressors, this was the structure of the data provided (data fields anonymized and axes suppressed).



Each source provided from several hundred to several hundred thousand records. We based our analysis on two extracted datasets. One was approximately 1,000 rows and 60 columns and organized by event. The other was approximately 11,000 rows and 15 columns and organized as time series. Pulling the data out of the underlying databases was a manpower-intensive project and required a lot of trial and error to create the right tools in Structured Query Language (SQL). Like many analysis projects, putting the data in a useful format required specially written functions and was the bulk of the analytic effort.

Our analysis team had two units: data extraction and statistical analysis. These two groups worked in tandem, developing the statistical analysis methodology in a spiral development before the data cleaning was complete. This practice added greatly to both the speed and quality of development because the statisticians working the data analysis piece were gaining familiarity with the data while it was still in beta and were also using the results to perform quality assurance on the data.

Figure 3. Boxplot of post-depot field costs by depot source. The difference in field costs was statistically significant ($p = 0$) between the two depots. We do not know if this is a feature of the depots themselves or the operating environment the vehicles were subjected to (axes intentionally suppressed).



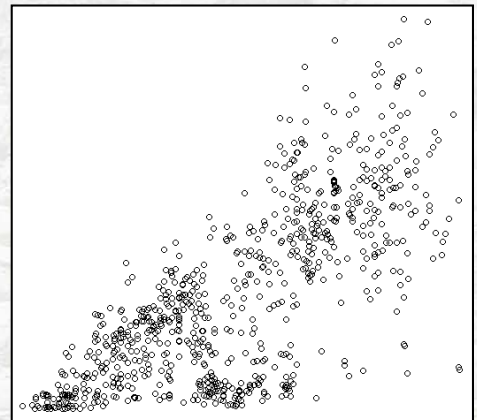
Data Analysis

We performed the data analysis in the statistical language R (www.R-project.org). Because R is a vectorized programming language, we were able to efficiently and quickly subset data, which was critical in this project because additional partitions needed to be added after the data was extracted. The advantage of R is that it is a lean implementation and functions for data can be quickly implemented. A disadvantage to R is that it does not have a true graphical user interface (GUI), although new users can get a GUI-like feel by using the package R Commander (Fox, 2005).

We employed a semi-automated model selection process. This was necessary because of the size of the dataset and high number of possible regression models. While there are several choices in semi-automated regression, we used a routine based on the Akaike Information Criterion (AIC) (Venables and Ripley, 2002) implemented in the MASS package (see, for example Akaike (1974)).

To explain the necessity of semi-automated selection, consider the following: the model had 60 possible regressors, yielding a total of $260 -$

Figure 4. Relationship between field down time and days to next depot repair. Unsurprisingly, vehicles that spend more time in the field between depot repairs spend more time “down” in the field.



$1 \approx 1.5 \cdot 10^{18}$ candidate models.^a

Using a computer that could build and evaluate linear models at the rate of one per microsecond, it would still take over 35,000 years to “brute force” all possible model combinations. The AIC algorithm balances model fit with complexity and is based on a likelihood-like scoring measure. A technical discussion of the merits of these two methods is beyond the scope of this article; the interested reader may see Raftery (1995).

Using AIC, we reduced the space of candidate regressors from 60 to seven in approximately 2 minutes. After the initial variable reduction, we consulted with the operators to see how the predictors the model chose compared with their field experience. It matched remarkably well. Subsequently, investigation into outliers and operator feedback led to the removal of two of those regressors to make the model more robust. Creating the final model was, in this case, and is generally, a balancing act between rigorous methodology, data available, and producing a model that gives useful insights to the customer.

There were two limitations to our statistical analysis, and we would be remiss if we did not mention them. First, the set of predictors chosen did exhibit multicollinearity, as is evidenced in the plot in Figure 2.

While we prefer data not to have this characteristic, it is not a fatal flaw. In our analysis, knowing our predictors were highly collinear made us vigilant against carelessly discarding predictors with low p-values whose effect may have been “masked” by collinear variables. The second potential statistical difficulty is heteroscedasticity, or nonuniform fit of the model across the response space. The remedies we attempted for this characteristic led to convoluted models that were not as useful as the one we produced, and we noted that the predictions for higher priced field costs were not as precise as those for lower field costs.

Results

We determined that the cost drivers for post-maintenance field costs are:

- Number of field repairs post depot
- Source of depot repair
- Field down time since depot
- Days to next depot repair
- Field up time since depot repair

Together, these five (5) variables explained 78 percent of the variability in field costs.

The statistical analysis revealed several characteristics of the relationship between depot activities and subsequent field maintenance

that were surprising, one significant regressor and several behaviors of cost over time. This is one of the advantages of statistical analysis: the data teaches us what it wishes regardless of entering hypotheses. Both the customer and the analyst team agree these characteristics need to be explored further to determine if a deeper dive into the data can explain these behaviors, or if interviews with maintainers or other explorations would be necessary. We look forward to applying this analysis to other systems of interest in the future.

What about the 22 percent of cost variability not explained by the model? This is most likely due to information not available for analysis and random chance. We must keep in mind that the vehicles are driven by Marines in the harshest of operating environments.

Summary

This is an example of a successful statistical analysis in practice. The techniques applied here are standard and can be found in most data analysis texts. The noteworthiness of this effort is in the merging and normalizing of a series of disparate data sources. Interestingly, the factors identified in this work by pure statistical means were agreed to by the experts. Mr. Ron Wilson, Deputy Director, Weapon Systems Management Center (WSMC) at Marine Corps Logistics Command backs the analysis stating: “This analysis provides WSMC with a cost model to help explain how deferring

maintenance compounds future costs.” We are looking forward to applying analysis similar to this to other vehicles subject to alternating field and repair cycles.

Disclaimer

The views presented are those of the authors and do not necessarily represent the views of the DoD or its components.

Note

^a Here we have used the very handy combinatorial identity $\sum_{0 \leq k \leq n} \binom{n}{k} = 2^n - 1$

References

- Akaike, H. 1974. *A New Look at the Statistical Model Identification*, *IEEE Transactions Automatic Control*, Vol 19, No 6, 716–723.
- Arena, M. V., Blickstein, I., Younossi, O., and Grammich, C. A. 2006. *Why Has the Cost of Navy Ships Risen? A Macroscopic Examination of the Trends in U.S. Naval Ship Costs over the Past Several Decades*. RAND Corp.; www.rand.org/content/dam/rand/pubs/monographs/2006/RAND_MG484.pdf.
- Fox, J. 2005. *The R Commander: A Basic Statistics Graphical User Interface to R*, *Journal of Statistical Software*, Vol 14, No 9, 1–42.
- Raftery, A. 1995. *Bayesian Model Selection in Social Research*, *Sociological Methodology*, Vol 25, 111–163.
- Venables, W. N., and Ripley, B. D. 2002. *Modern Applied Statistics with S*, 4th ed. Springer.

Improving Communication for Business Success



Communication is the oil that makes National Security conscious entities function; effective communication makes them function smoothly.

Whether you need an assessment of your business processes, a strategy for working with other organizations, an update to your emergency response plan, or training your analysts to be coherent to senior leadership,

WE CAN HELP YOU SUCCEED.

Indelible Enterprises LLC

Visit us at <http://indelibleenterprise.com>

Contact us at info@indentus.com

Indelible Enterprises



MORS' YOUNG ANALYSTS THE NEXT GENERATION OF LEADERS

SARAH E. HARROP



When did you join MORS?

2015.

What was your childhood ambition?

When I was a child I wanted to be an astronaut. I was intrigued by the mystery of space and all of the questions waiting to be answered.

Why did you become an operations analyst?

I have always been a very curious person, and my interest in problem solving was sparked at a young age. I completed my undergraduate degree in industrial and systems engineering at Virginia Tech and enjoyed most the classes and projects that involved statistics and operations research techniques. Becoming an operations research analyst allowed me to apply my education to conducting analysis in support of decision making, helping leaders solve problems.

Where do you see yourself in five years?

In five years, I see myself continuing to work within the Department of Defense and taking on more responsibility. I currently lead study teams but see myself furthering that by taking on a supervisory role, leading analysts and study teams. I also see myself being more involved in MORS, perhaps becoming a board member.

How has your MORS membership benefited you? What do you value most about your membership?

Becoming a member of MORS has benefitted me by expanding my network. I have worked with many people I may not have otherwise met. I value the collaborative environment that MORS fosters, the opportunity to discover new studies, learn new analysis techniques, and meet people in the industry who are future points of contact and sources of information. Since becoming a member of MORS I have had mentorship and opportunities that have led me to achieve greater success in my career.

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



ISMOR Is Back!

33rd ISMOR Is Another Success

Donnie Gilley, Chris Eastman, and Gene Visco, FS, Lockheed Martin

The 33rd International Symposium on Military Operations Research opened on Tuesday morning, July 26 at Royal Holloway, University of London, Egham, Surrey, with a keynote address by Jonathon Nancekivell-Smith, Director of Performance and Analysis, UK Ministry of Defence (MOD). The talk covered the defense

planning process in the Ministry. The three-and-one-half day program that followed provided 58 additional presentations, consisting of papers, workshops, posters, two post-dinner talks, and the Professor Ronnie Shephard Memorial Address at the banquet. The Shephard Address was presented by Dr. Tony Sinden, long-

time MOD official, serving multiple tours at the British Embassy in Washington, DC, and in recent years providing post-ISMOR comments and reviews.

The statistics: A total of 104 were registered, coming from 11 countries. The largest contingent was from the



United Kingdom (77); other countries were the United States (7), Israel (6), Australia (4), France, Netherlands and Norway (2 each), and Brazil, Canada, Germany, and Sweden (1 each).

The three authors provide a range of experience with the ISMOR series. One was attending his first ISMOR, designated a “junior” or “novice” on his arrival and graduated, along with other juniors, to the rank of “veteran” or “senior” at the banquet on Thursday evening. A second was attending his third ISMOR. The third was attending his 27th ISMOR.

Dr. Sindon’s Professor Ronnie Shephard Memorial Address introduced two questions, the second following the logic of the first. What makes analysis valuable? To respond to that question, one needs answer another: What makes a good analyst? He concluded there are four characteristics that are important in an analyst. Before he presented these characteristics, Tony provided an historical review of a number of analytical efforts he was involved in during his MOD years, including many amusing anecdotes. The four characteristics are:

- A focus on key issues—don’t lose sight of what is important amidst the confusion. Don’t set out with preconceived notions of the answer.
- Analysts need objectivity to ensure they provide an independent view. Analysis (and analysts) needs testing and challenging. Don’t be too proud.
- Ability to recognize that circumstances change, especially with

regard to technology and how it is used.

- Above all, analysts should have respect for the data—even if there is little of it. Analysts need to know both its value and its limitations.

Perhaps the most memorable, entertaining, and educational presentation, with a most interesting title was by Dr. Deborah Goodwin, Head of the Department of Communication and Applied Behavioural Science, Royal Military Academy Sandhurst. Her two-hour dynamic and dramatic talk was titled “What Was That You Said? Why Poor Listening Damages Us Professionally, and What Can We Do About It?” Dr. Goodwin not only presented cogent arguments for improving our listening, hearing, and understanding habits, but she added to her message by use of humorous vignettes. The drama of her presence was enhanced by her physical movement about the floor of the auditorium, almost to the extent of dancing! Some key “takeaways” from Dr. Goodwin’s session: active listening, emotion labelling (verbal statements of what you are hearing, for example, anger), paraphrasing (their meaning in your words), summary (clarification and moving on), mirroring/reflection (catching the Ferrari in the fast lane), minimal encouragers (to show—demonstrate—engagement), open-ended questions (to elicit responses), and silence (to encourage response). Her final points: De-escalate. It’s about them, not you! Listen! Don’t fall into telling: Enquire! Enquire! Enquire!

Startling news, presented at the closing ceremony of symposium, was the retirement of the Symposium Chair, Peter Starkey. As the chair for the last five years, Peter was the leader who returned ISMOR to its wonderful heritage days of the founder, Ronnie Shephard. By introducing a number of valuable and innovative changes to the design and funding of the symposium, Peter turned around the declining number of participants to the point that 33rd ISMOR reached enrollment equaling those of the Shephard days. Peter’s guiding leadership will be hard to replace. However, he will be succeeded by Judith Rawle, who has a distinguished career as a military operations analyst, Chief Analyst at CORDA, leader of the decision analysis panel of the Defence Scientific Advisory Council, and has had long involvement and commitment to ISMOR.

Dr. Sidon provided a solid summary of key lessons learned during the 33rd ISMOR:

- Analysis of “state on state” conflict is not uppermost this year. Is this just a US concern?
- Soft operations analysis can be used to support decision making across a range of issues.
- Analyses of data sets, both small and large, are welcome.
- Some indication that analysts are addressing some of the conflicts that are most pressing, e.g., Libya?
- But are analysts not tackling the challenges of “terrorism” (a generic term) or is it just too classified? ↑

PUZZLOR

& THINKING ANALYTICALLY

John Toczek

In the Market for a Spaceship?

A popular game in the Apple and Google app stores is a space adventure game where, among other things, you need to decide which spaceship to buy. There are dozens of different spaceships to choose from all with varying capabilities and costs.

Ten of these ships are shown in the accompanying table. Although there are additional ship capabilities in the game, only consider the ones shown in the table.

Ship Name	Cargo	Weapons	Equipment	Cost (\$)
Cicero	25	2	6	\$51,975
Cormorant	350	0	8	\$168,900
Dace	38	4	5	\$235,600
Hatsuyuki	28	2	8	\$171,900
H'Soc	45	2	7	\$150,000
N'Tirrk	80	2	8	\$250,000
Razor 6	60	4	6	\$294,900
Taipan	50	3	5	\$100,100
Teneta	65	2	7	\$125,400
Type 43	30	2	6	\$72,500



Question: Which is the most undervalued ship?

Send your answer to puzzlor@gmail.com by February 15, 2017. The winner, chosen randomly from correct answers, will receive a \$25 Amazon Gift Card. Past questions and answers can be found at puzzlor.com.

John Toczek earned his BSc in chemical engineering at Drexel University (1996) and his MSc in operations research from Virginia Commonwealth University (2005).

In Memoriam

Stephen A. Murtaugh, FS

Jim Bexfield, FS



I was very saddened to hear of the passing of Steve Murtaugh on November 2, 2016, at the age of 90. Steve was one of the five members of the first Fellows class who are sometimes referred to as the “true” Fellows. His contributions to MORS in the 1970s–1990s were immense. He is the only person that served three full terms on the MORS Board of Directors and was the 1976–1977 MORS President.

He won the Rist Prize at the 26th MORS Symposium (MORSS) and was a member of the committee that wrote the guidelines for establishing the Wanner Award. His early participation in MORS revolved around the papers he gave in several working groups (e.g., Cost/Effectiveness, Air Warfare, and Countermeasures) and support to the two-per-year symposia. It was during his chairmanship of the Contributed Paper Session for the 32nd MORSS that he asked me, a young Air Force captain, for help and later to chair that session at the 33rd MORSS. It was the start of my involvement in MORS, for which I am eternally grateful.

He chaired and participated in many committees during his fourteen years on the Board of Directors. One, the Ethics and Professional Standards Committee, he chaired several times. Steve felt strongly about the importance of ethics. The words in the current MORS ethics guidelines largely come from his pen. He was also passionate about including human factors in combat analysis. In this area Steve chaired the 2nd and 3rd MORIMOC minisymposia (More Operational Realism in Models of Combat) and formed and chaired the MORS working group on “Soft Factors in Military Modeling and Combat.”

In the 1990s Jack Walker, another of the famous members of the first Fellows class, wrote a series of “*PHALANX PHELLOWS*” columns where he introduced the early Fellows to the membership by describing their backgrounds and contributions to MORS. In his June 1993 Phalanx article, Jack refers to Steve as the “Mellow Fellow.” He describes Steve as someone who “is always there whenever skill or talent or application is needed in the furtherance of MORS programs.” In return, Steve wrote a two-page article introducing Jack Walker to the membership. It appears in the December 1995 issue of *Phalanx*.

Steve was born in Utica, NY. A quick learner, he finished high school in three years, graduating from New Hartford High School in 1944. After graduation, he enlisted in the US Air Force and began training to be a fighter pilot. After WWII, he earned a bachelor’s degree in engineering from Clarkson College of Technology, and in 1962 a master’s degree in engineering from the University of Buffalo. Steve married Elizabeth (Betty) M. Van Hatten in 1950. He was employed as an engineer with Boeing Airplane Company in Seattle, WA, from 1950–1952. In 1952, Stephen accepted a position as an engineer at Cornell Aeronautical Laboratory, Inc. (Calspan Corporation), in Buffalo, NY, where he was director of program development at the company’s Advanced Technology Center. He later led many of their proposal teams as his ability to organize and communicate technical information was superb. After retiring from Calspan, Steve wrote the code of ethics for the Town of Clarence, NY.

Steve Murtaugh was one of the kindest and most noble individuals I have ever known. Everyone who met him liked him immediately. He had a gentle way of encouraging MORSians to do more for MORS. We need more people like Steve in MORS today. He will be missed!

memoriam

Dr. Jack R. Borsting, FS

Dr. Bob Sheldon, FS



Dr. Jack R. Borsting, FS, Past President of MORS and the Operations Research Society of America (ORSA) passed away on August 16, 2016. A native of Portland, OR, Borsting attended Oregon State University, where he originally intended to study electrical engineering but was turned off by the tediousness of lab reports. Switching to mathematics, he received all three of his degrees in that

subject. Between his master's and doctorate, Borsting spent two years as an Air Force officer, working with the nuclear arms division of the Development Directorate at Kirtland Air Force Base. After receiving his PhD from the University of Oregon, he accepted an offer at the US Naval Postgraduate School (NPS), where he taught vector analysis and probability and statistics and worked on the Control Data 1604, the first-ever Control Data Corporation computer off the assembly line. In 1962, he joined the school's newly formed Operations Research Department, eventually serving as the head of the department. He was instrumental in recruiting first-generation operations research PhDs from Case Western University, the University of Michigan, and the Massachusetts Institute of Technology, building the school's OR department. He eventually served as the Provost and Dean at NPS.

Borsting was one of the founders of MORS and was a member of ORSA and the Institute of Management Sciences (TIMS) as well. His early enthusiasm for MORS culminated in his presidential election in 1970. He led

MORS during difficult times, working with the sponsors to secure the Society's long-term financial stability. For his work with MORS and ORSA, Borsting was awarded ORSA's George E. Kimball Medal, the Jacinto Steinhart Prize by ORSA's military operations research section, and the Vance Wanner Award by MORS.

In 1980, Borsting was nominated by President Jimmy Carter to serve as Assistant Secretary of Defense (Comptroller). Reappointed by President Ronald Reagan, he served in this role until 1983, preparing the management systems and budget for the entire Department of Defense (DoD). He was twice awarded the DoD's Medal for Distinguished Public Service. Borsting returned to academia as Dean of the University of Miami's School of Business Administration and as Dean of the University of Southern California's Marshall School of Business from 1988 to 1993.

In addition to his MORS honors, Borsting has been Honorary Treasurer of the International Federation of Operations Research Societies, a Fellow of the American Association for the Advancement of Science, and a Trustee of the Institute for Defense Analyses (IDA). Active in industry as well as government, he served on the corporate boards of Northrop Grumman Corporation, Security First Trust, PLATO Learning, Inc., Storer Communications, McDonnell Douglas Finance Corporation, Coast Savings Bank, Sun Bank of Miami, Ivax Diagnostics, and Whitman Education Group. He also served as Lead Governor of the American Stock Exchange and as a board member of Metropolitan Life Investors.



**FIND OUT
MORE ABOUT HOW
WE CAN HELP YOU
MEET YOUR GOALS
SYSTECON.US**

In Search of the Optimum

How do you right-size the spare parts inventory for an aircraft fleet? How many technicians and repair shops do you need to maintain readiness levels? What is the right time for system maintenance?

Systecon provides the analytics methods, and tools that give you the information you need to answer these questions and many more. Systecon brings more than 40 years of experience consulting on complex defense

projects and developing leading software applications.

Using our proprietary Opus Suite software, you quickly get an overview of what factors affect your availability and your costs to:

- Optimize organizations and systems from a lifecycle perspective
- Set the right procurement requirements and select the most cost-effective solutions

- Manage projects and develop program metrics related to system availability or maintenance capability
- Analyze and determine the optimum support requirements and the resources needed
- Monitor production and identify cost drivers and bottlenecks to continuously optimize the support solution

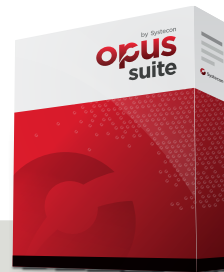
Unique expertise, & market-leading optimization software

Systecon assists hundreds of companies and agencies around the world. The proprietary Opus Suite software is used for some of the largest and most technically complex products and systems. All our clients have two things in common: the highest standards and a significant potential for optimizing capability and reducing cost.

SOME OF OUR CLIENTS

ALSTOM
AUSTRALIAN DEFENSE
AIRBUS
BAE SYSTEMS
BOEING
BRAZILIAN AIR FORCE
EADS
FINMECCANICA

LOCKHEED MARTIN
SAAB DEFENSE
SAMSUNG
SWEDISH DEFENSE
THALES
THYSSENKRUPP
UK MINISTRY OF DEFENSE
US DOD (ARMY, NAVY, AF)



Member Milestones

December 2016

MORS would like to congratulate **Mr. Joseph S. Drelling**, the winner of the 2016–2017 MORS Member Survey membership raffle. Joe and members like him provided MORS with valuable feedback through the member survey. As a result, he was selected at random to receive a complimentary one year MORS membership. Remember, next year this could be you so fill out the survey!

Aaron Burciaga (Maj, USMCR) was selected and elected to vice chair of the Analytics Certification Board (ACB). The ACB oversees the Certified Analytics Professional (CAP) program and is a standard setting and assessment body for professionals in the analytics field. It is comprised of highly regarded analytics and operations research professionals. Aaron was the first CAP in the USMC, and has provided service members with training at the Pentagon, Quantico, and Ft. Lee.

CDR Phil Pournelle, USN, currently serving at the OSD Office of Net Assessment, will be retiring from the Navy in December. He recently chaired the MORS special meeting on wargaming.

Coming Soon to *Military Operations Research Journal* ...

A Bayesian Approach to Evaluation of Operational Testing of Land Warfare Systems by **Lee Dewald, Sr., Robert Holcomb, Sam Parry, and Alyson Wilson**

Operational testing frequently involves force-on-force operations, which rarely meet the normal conditions required for traditional statistical methods, such as the assumption that experimental observations come from randomly selected samples of a known population or the ability to replicate the experiment an adequate number of times for confidence. This paper develops a new paradigm of using a Bayesian approach using prior observations drawn from modeling and simulation methods.

On a Quantitative Definition of Affordability by **Kent D. Wall and Charles J. LaCivita**

Affordability is a concept everyone seems to understand, but have trouble precisely defining and even more trouble quantifying. The authors show how a precise definition of affordability results by combining multiple objective decision theory and the microeconomic theory of the consumer, and how this definition leads to a quantitative definition of affordability risk. They illustrate both concepts using a straightforward application of standard simulation modeling and multiple objective decision making in a notional strategic defense planning and resource allocation problem.

Introducing Terrorist Archetypes: Using Terrorist Objectives and Behavior to Predict New, Complex, and Changing Threats by **John Coles and Jun Zhuang**

The so-called “Arab Spring” in 2011 has forced governments around the world to discuss and redefine the difference between terrorists, dissidents, and political activists. Understanding, and adapting to, an evolving threat space presents a significant challenge to intelligence and law enforcement communities around the world. This paper introduces an approach to developing dynamic profiles for terrorist organizations to give decision makers a tool to analyze the evolution of terrorist organizations, and estimate the likelihood of future attacks.

Strategic Targeting: A Social Network Approach across Phases of War by **Thomas Furman**

Social network analysis is a significant tool at the tactical level of military operations and aids in developing a targeting methodology; however, it has never been applied to strategic level, whole of government problems. This article uses political, military, economic, social, infrastructure, and information (PMESII) system attributes and network relational strengths as inputs. The output of this methodology produces a rank-ordered systems of interest list that satisfy the constraints and desired objectives within a particular Phase of War in a whole of government environment.



MORS' New Sponsor

Dr. Arch Turner, MORS US National Security Risk Analysis Community of Practice Chair and Operations and Requirements Division Sponsor Representative

SPONSOR'S CORNER

The Operations and Requirements Division (ORA) of the Department of Homeland Security's (DHS) Science and Technology (S&T)

Directorate recently became our Society's seventh government sponsor. As an element of a critical non-Department of Defense (DoD) national security organization, ORA sponsorship advances our Society's goal of "Leading the National Security Analysis Community."

ORA is one of four divisions of DHS S&T's Capability Development Support (CDS) Group. Other CDS divisions are Office of Systems Engineering (OSE), Standards (STD), and Operational Test and Evaluation (OTE). As CDS Group director, Dr. Steve Hutchison is one of four direct reports to the Under Secretary for Science and Technology, Dr. Reggie Brothers. Other S&T groups are the Research and Development Partnership Group (RDP), the

Homeland Security Advanced Research Project Agency (HSARPA), and the First Responders Group (FRG).

ORA is led by Dr. John Dargan and includes two branches: the Joint Requirements Council (JRC) Liaison Branch led by Ms. Lorraine Castillo, and the Operations Analysis Branch led by Dr. Arch Turner. ORA is comprised of ten highly qualified and experienced federal employee operations analysts and a superb team of support contractors and Intergovernmental Personnel Act (IPA) colleagues. Dr. Dargan is our new MORS Sponsor and Dr. Arch Turner, a past MORS Director and officer and present MORS US National Security Risk Analysis Community of Practice Chair, will serve as ORA's Sponsor Representative.

ORA provides a broad range of analytical support to DHS' major operating components as well as other department

offices and organizations. Recent analytical efforts undertaken on behalf of DHS major operating components include identifying process improvements in OCONUS biometrics and the handling of apprehended alien family units, an assessment of existing ISR architecture and processes, and personnel skills assessment methods.

Two additional key ORA customers are its parent organization, the S&T Directorate, and DHS's recently established Joint Requirements Council (JRC).

ORA operations analysts play an important role in helping the S&T Directorate's technical divisions to better understand operator needs and operating context. This helps them identify effective and affordable technology solutions to close or mitigate critical operational capability gaps. ORA also supports the S&T Directorate by leading the "Modeling and Simulation Engine" (M&S Engine), which

coordinates needed modeling and simulation support for HSARPA's "APEX Programs," focused efforts undertaken to help the Department achieve "visionary goals" that will contribute to "a more secure future for our nation." Recent important ORA M&S Engine efforts include providing M&S support to the Secret Service during Pope Benedict's visit to the DC area and ongoing efforts in support of the Secret Service's effort to provide National Special Security Event (NSSE) security for the Republican and Democratic National Conventions.

Providing analytical support to the DHS JRC is a particularly important and high-visibility ORA function. The DHS JRC was established in 2014 for the purpose of reviewing, approving, and validating operational requirements for the Department, a role analogous to that of DoD's Joint Requirements Oversight Council (JROC). DHS's JRC is led by a rotating operating component Senior Executive/

Flag Officer chair and is comprised of representatives of the Department's major operating components and selected other key offices and organizations. The JRC analyzes operational requirements and makes prioritized recommendations to the Department's Deputy Management Action Group (DMAG), which is chaired by Deputy Secretary Alejandro Mayorkis.

ORA provides the analytical support the JRC requires to inform its decision making. For example, in support of and at the direction of the JRC, ORA recently performed important force mix and laydown analyses of proposed aviation operations and acquisition initiatives involving substantial allocations of resources. ORA is also contributing to other important capability analysis reports (CAR), such as one examining the adequacy of port of entry non-intrusive inspection (NII) capabilities. These ORA analysis efforts are typically directed

by the JRC and performed in collaboration with cognizant operating components. They ultimately inform senior leader (e.g., DMAG) resource allocation decision making.

ORA also provides analytical support to the Department's three recently established joint task forces (JTFs),^b each of which are manned by a mix of US Coast Guard, Customs and Border Patrol (CBP), and Immigration and Customs Enforcement (ICE) personnel. The JTFs are critical elements exemplifying and supporting Secretary Jeh Johnson's DHS-wide unity of effort initiative. Examples of this type of analytical tasking include ORA leading/participating in recent capability and capability gap assessments undertaken to identify JTF Director common operating and intelligence picture requirements.

Over the past months, ORA has been working to establish an organic modeling and

SPONSOR'S CORNER

simulation capability to enhance its analytical “toolbox.” The Division is presently collaborating closely with CBP colleagues to develop the Department’s first organic system-of-systems analyses of border security and aviation domain awareness. These efforts will assess the contributions of the array of systems, platforms, and activities deployed and undertaken to secure our borders, to achieve desired levels of aviation domain awareness, and to help ensure that these resources are being utilized in the most effective and efficient way possible. DHS homeland security core missions^c are complex and rarely, if ever, performed by a standalone system or platform. ORA is collaborating with DHS operating components to establish the analytical capability needed to inform important system-of-systems resource allocation decisions.

ORA’s system-of-systems analysis, modeling, and simulation initiative is just one of the ways ORA is working to contribute to the advancement of Secretary Johnson’s resource allocation priority to “Strengthen Analytic and Requirement Capabilities to Inform Decision Making.” Others include its outreach across the Department to partner in the strengthening and

institutionalization of analytical capabilities and its decision to become more actively involved in MORS. In addition, ORA is presently in the early stages of defining a partnership with the DHS Office of Policy’s Strategy, Analysis, and Risk to join forces in the establishment of a DHS analytic agenda, a foundational component of the afore-mentioned FY18–FY22 resource allocation priority.

ORA is a small and relatively new organization committed to producing organizational performance improvement results for its customers. The Division was recently honored by its selection as the 2016 recipient of the Under Secretary’s Award, the top annual award, in recognition of its outstanding analytic and technical contributions to the Department and the security of our nation.

ORA chose to become a MORS Sponsor because it recognizes the valuable contributions of the Society to our nation and the benefits of a closer DoD–DHS analytical community partnership that sponsorship will engender. ORA believes the Departments share many similar challenges and can—and must—learn from and complement each other. ORA

is committed to working closely with, and being more involved in, MORS and to actively partnering in Society efforts to enhance and expand the capabilities and application of national security operations research. ORA sincerely appreciates MORS’ gracious welcome to sponsorship and will contribute however it can to Society efforts to promote the defense and security of our great nation.

Notes

^a Transportation Security Administration (TSA), US Coast Guard (USCG), Customs and Border Protection (CBP), Immigration/Customs Enforcement (ICE), US Secret Service (USCIS), US Citizenship and Immigration Services (USCIS), and Federal Emergency Management Agency (FEMA)—AKA, the “Gang of Seven.”

^b JTF East (Portsmouth, VA), JTF West (San Antonio, TX), and JTF Investigations (Washington, DC).

^c DHS’s five core missions are Enhance Security and Prevent Terrorism, Secure and Manage our Borders, Administer and Enforce Our Immigration Laws, Secure Cyberspace, and Enhance Community Resilience. ↑



SOMEDAY IS CLOSER THAN YOU THINK.

AT LOCKHEED MARTIN,
WE'RE ENGINEERING A BETTER TOMORROW.

We believe most of what's impossible today soon won't be. We take on missions of mind-boggling complexity where we don't just draw on the latest discoveries – we make them. We're changing the game in fields like nanotechnology, quantum computing, material science and autonomy. Together with our customers, we're creating a whole new world of possibilities.

Learn more at lockheedmartin.com





Military Operations Research Society
2111 Wilson Boulevard, Suite 700
Arlington, VA 22201
703-933-9070
Fax: 703-933-9066
www.mors.org

NON PROFIT ORG.
U.S. POSTAGE
PAID
PERMIT NO. 273
ANNAPOLIS, MD



Check our website at www.mors.org for the latest updates.