



**United States Military Academy
West Point, New York 10996**

ANNUAL REPORT
OF THE
DEPARTMENT OF SYSTEMS ENGINEERING
AND THE
OPERATIONS RESEARCH CENTER
FOR THE
ACADEMIC YEAR 2005

DTIC #: ADA438286

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SEPTEMBER 2005

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EXECUTIVE SUMMARY

The purpose of this document is to formally summarize and conclude the research program of the *U.S. Military Academy Department of Systems Engineering (DSE)* and the *Operations Research Center for Excellence (ORCEN)* for the Academic Year 04-05. The annual research report includes a statement of purpose for research which supports DSE and the ORCEN, a description of the two organizations, a list of the key personnel responsible for executing the plan, and an overview of the annual research cycle.

After this introduction, we present research summaries for applied research or problem-solving project. Each summary includes a problem statement and description, the methodology employed for project execution, a summary of results, a list of presentations and publications and a current status. Additional information is provided on the senior investigator, principal analyst the client organization, and points of contact.



PART I – THE DEPARTMENT OF SYSTEMS ENGINEERING RESEARCH PROGRAM

The purpose of the research program within the Department of Systems Engineering is to support cadet education and faculty development through the development, execution and presentation of relevant Army and Department of Defense research opportunities for significant clients.

The Department of Systems Engineering research projects provide the faculty and cadets with the opportunity to investigate a wide spectrum of interdisciplinary, systemic issues and to apply many of the systems engineering, engineering management, and operations research concepts studied in the classroom to real-world problems of interest to the Army and the Department of Defense (DoD). These projects demonstrate for both cadets and faculty the relevance and importance of systems engineering in today's high-technology military.

The research program in the Department of Systems Engineering (DSE) directly addresses four specific Academy needs:

1. Research enriches cadet education. Cadets learn best when they are challenged and when they are interested. The introduction of current issues facing the military into their curriculum achieves both. Early in their education, cadets are taught by their instructors the application of techniques to real issues and problems – issues and problems they will face upon graduation. Through this, they gain an appreciation of the robustness of the discipline and a greater understanding of their profession. As they progress in their education, they begin to apply these techniques to heretofore unsolved issues and problems. This codifies their education on the techniques and instills an adaptive, problem-solving mentality in the cadets.

2. Research enhances professional development opportunities for Army faculty. It is important to develop and grow as a professional officer in each assignment. On the DSE faculty, officers conduct research on relevant projects to remain current in their operational branch or in the Functional Areas 49, 51, 53 and 57. The research they conduct keeps them abreast of Army and DoD issues, at the forefront of their academic discipline and is returned to the classroom. They become better officers and leaders through the knowledge they gain and impart.

3. Research maintains strong ties between the Academy and Army/DoD agencies. The US Military Academy and DSE is a tremendous source of highly qualified analysts for the Army and DoD. Each faculty member holds an advanced degree in a technical discipline and has a deep understanding of the military and its issues. Research ensures that the Academy remains a significant part of the Army and DoD and not just another source of commissioning for junior officers.

4. Research provides for the integration of new technologies into the academic program. As the pace of technological advances increases, the

Academy's education program must not only keep pace but must lead to ensure our graduates and junior officers are prepared for their continued service to the Army. Research which applies the most advanced technology and techniques is critical to achieving this objective.

By being fully engaged in current Army and DoD issues, the Department of Systems Engineering and the Operations Research Center assures that systems engineering education at USMA and our faculty remain current and relevant. The military's return on its investment is meaningful career development experiences for officers, especially those in Functional Areas 49/51/53/57, an enhanced education program for the USMA cadets, and important investigation of vital Army and DoD problems at far less cost than would be required through civilian contracts.

The Department of Systems Engineering conducts research through its faculty and the Operations Research Center of Excellence (ORCEN). The ORCEN is the primary entry point for all research with the Department. The ORCEN Director is also the DSE Research Coordinator and oversees all aspects of the Department's research as well as personally directing research within the ORCEN.

PART II – THE OPERATIONS RESEARCH CENTER OF EXCELLENCE

The purpose of the Operations Research Center of Excellence (ORCEN) is to provide a small, full-time analytical capability to both the Academy and the United States Army and the Department of Defense. The ORCEN was established in 1990 through a Memorandum of Agreement between the Department of Systems Engineering, the Department of Mathematics (DMath) and the Office of the Assistant Secretary of the Army (Financial Management and Comptroller). Its establishment was born of the burgeoning need for developing research opportunities to enrich DSE and DMath education.

Personnel authorizations in the ORCEN are established by a Table of Distribution and Allowances (TDA). Funding support for the Operations Research Center is established by a Memorandum of Agreement with the Office of the Assistant Secretary of the Army (Financial Management). The Operations Research Center is organized under the Office of the Dean as an Academy Center of Excellence. A permanent military Academy Professor provides oversight and supervision to the Center. In addition, the TDA authorizes one O5 analyst, three O4 analysts, and a GS5 secretary. By agreement between DSE and DMath, DSE provides three analysts, an Academy Professor as the Director and one permanent staff member to serve as Executive Administrator and assistant to the Director and DMath provides one analyst.

The Operations Research Center was originally sponsored by the Assistant Secretary of the Army (Financial Management & Comptroller). Fully staffed since Academic Year 1990-1991, the Operations Research Center has made significant contributions to cadet education, faculty development, and the Army at large. The following is a

list of key personnel from the Operations Research Center for the Academic Year 2005.

Table 1: Key ORCEN Personnel

TITLE & ORGANIZATION	NAME	PHONE (DSN)	EMAIL
Professor and Head Department of Systems Engineering	COL Michael L. McGinnis, Ph.D.	688-2701	Mike.McGinnis@usma.edu
Professor and Head Department of Mathematical Sciences	COL Gary Krahn, Ph.D.	688-5285	Gary.Krahn@usma.edu
Director, ORCEN & Associate Professor	LTC Michael J. Kwinn, Jr., Ph.D.	688-5529	Michael.Kwinn@usma.edu
Executive Officer & Research Coordinator	Ms. Linda Ann J. Albronda	688-5897	Linda.Albronda@usma.edu
Deputy Director, ORCEN & Associate Professor	LTC Jeffrey B. Schamburg, Ph.D.	688-5539	Jeffrey.Schamburg@usma.edu
D/MS Analyst & Instructor	MAJ Wiley P. Rittenhouse, M.S.	688-5168	Wiley.Rittenhouse@usma.edu
D/SE Analyst & Instructor	MAJ Philip G. Martin, M.S.	688-5661	Philip.Martin@usma.edu
D/SE Analyst & Instructor	MAJ Steven Henderson, M.S.	688-3573	Steven.Henderson@usma.edu

PART III – FACULTY RESEARCH

The Department of Systems Engineering encourages its faculty to conduct research of value for the Army and the Department of Defense during their tenure at the United States Military Academy. This specifically includes the rotating junior faculty to support their professional development.

During Academic Year 05, the Department of Systems Engineering had 16 faculty members holding a Ph.D and 20 individuals on the faculty holding a Masters Degree. Each holds their advanced degrees in disciplines which support research in systems engineering, engineering management and/or operations research. This is a tremendous research potential for significant clients within the Army and DoD.

All research in the Department of Systems Engineering is overseen by a Senior Investigator (SI) to ensure quality and completeness for the client. These Senior Investigators all hold a Ph.D in a qualified discipline for the research project presented. Most research projects have an associated junior analyst assigned to them. This contributes to the development of the junior analyst as a researcher, the Senior Investigator as a research lead and provides the client with the best research available by the Department.

Table 2: DSE Senior Investigator

NAME	EDUCATION & DEGREE	PHONE (DSN)	EMAIL
COL Michael L. McGinnis	PhD – University of Arizona – 1995 MS – Rensselaer Polytechnic Institute – 1986 BS – USMA - 1977	688-2701	Mike.McGinnis@usma.edu
COL William K. Klimack	PhD – Air Force Institute of Technology – 2002 MS – Johns Hopkins University – 1999 MMAS – US Army CGSC – 1991 BS – Lehigh University - 1979	688-4625	William.Klimack@usma.edu
Dr Gregory Parnell	PhD – Stanford University – 1985 MS – University of Southern California – 1980 ME – University of Florida – 1974 BS – State University of NY (Buffalo) - 1970	688-4374	Gregory.Parnell@usma.edu
Dr. Patrick J. Driscoll	PhD – Virginia Tech – 1995 MS – Stanford University – 1989 BS – USMA – 1979	688-6587	Patrick.Driscoll@usma.edu
Dr. Bobbie Foote	PhD – University of Oklahoma – 1967 MS – University of Oklahoma – 1963 BS – University of Oklahoma - 1961	688-4893	Bobbie.Foote@usma.edu
LTC Timothy E. Trainor	PhD – North Carolina State University – 2001 MBA – Duke University – 1992 BS – USMA – 1983	688-4625	Timothy.Trainor@usma.edu
LTC Willie J. McFadden, III	PhD – Old Dominion University – 2000 MS – Naval Postgraduate School – 1993 BS – USMA – 1983	688-5941	Willie.McFadden@usma.edu
LTC Michael J. Kwinn, Jr.	PhD – University of Texas (Austin) – 2000 MS – University of Arizona – 1994 BS – USMA – 1984	688-5529	Michael.Kwinn@usma.edu
Dr Roger C. Burk	PhD – University of North Carolina – 1993 MS – Air Force Institute of Technology – 1985 BA – St. John’s College – 1974	688-4754	Roger.Burk@usma.edu
LTC Robert Powell	PhD – Stevens Institute of Technology – 2002 MMAS – US Army CGSC – 1999 MS – George Mason University – 1995 BS – Texas A&M University - 1984	688-4311	Robert.Powell@usma.edu
LTC William Bland	PhD – University of Virginia – 2003 MS – Florida Institute of Technology – 1995 BS – USMA – 1983	688-5181	William.Bland@usma.edu
LTC Jeffrey Schamburg	PhD – University of Virginia – 2004 MS – University of Virginia – 1995 BS – USMA – 1986	688-5539	Jeffrey.Schamburg@usma.edu
LTC Simon Goerger	PhD – Naval Postgraduate School – 2004 MS – Naval Postgraduate School – 1998 BS – USMA – 1988	688-5535	Simon.Goerger@usma.edu
Dr. Paul West	PhD – Stevens Institute of Technology – 2003 MTM – Stevens Institute of Technology – 2000 MBA – Long Island University – 1993 BS – State University of NY (Albany) – 1983	688-5871	Paul.West@usma.edu
Dr. Niki Goerger	PhD – Texas A&M University – 1992 MS – Mississippi State University – 1988 BS – Mississippi State University - 1986	688-3180	Niki.Goerger@usma.edu

Table 3: DSE Analysts

NAME	EDUCATION & DEGREE	PHONE (DSN)	EMAIL
LTC Pamela Hoyt	MS – George Mason University – 1996 MA – Naval War College – 1990 BA – University of Vermont (Burlington) – 1984	688-2788	Pamela.Hoyt@usma.edu
LTC Brigitte Kwinn	MS – University of Arizona – 1994 BS – USMA – 1984	688-6493	Brigitte.Kwinn@usma.edu
LTC Kent Miller	MS – Georgia Institute of Technology – 1994 BS – USMA – 1984	688-5578	Kent.Miller@usma.edu
LTC Veronica Zsido	MS – University of Louisville 1997 BS – USMA – 1987	688-5206	Veronica.Zsido@usma.edu
MAJ Gregory Boylan	MS – Georgia Institute of Technology – 2003 BS – USMA – 1994	688-4753	Gregory.Boylan@usma.edu
MAJ John Cushing	MS – University of Virginia – 2003 BS – USMA – 1993	688-4399	John.Cushing@usma.edu
MAJ Patrick Downes	MS – University of Virginia – 2002 BS – USMA – 1993	688-3114	Patrick.Downes@usma.edu
MAJ John Harris	MS – University of Virginia – 2002 BS – USMA – 1993	688-5536	John.Harris@usma.edu
MAJ Steven Henderson	MS – University of Arizona – 203 BS – USMA – 1994	688-3573	Steven.Henderson@usma.edu
MAJ Heidi Hoyle	MS – University of Virginia – 2004 BS – USMA – 1994	688-2788	Heidi.Hoyle@usma.edu
MAJ Robert Keeter	MS – University of Virginia – 2003 BS – USMA - 1993	688-4857	Robb.Keeter@usma.edu
MAJ Robert Lenz	MS – Ohio State University – 2003 BS – USMA – 1993	688-4756	Robert.Lenze@usma.edu
MAJ Grant Martin	MS – Georgia Institute of Technology – 2003 BS – USMA – 1994	688-5661	Grant.Martin@usma.edu
MAJ Thomas Rippert	MS – University of Texas (Austin) – 2003 BS – USMA – 1993	688-2510	Thomas.Rippert@usma.edu
MAJ Curtis Tait	MS – University of Virginia – 2004 BS – USMA – 1994	688-5537	Curtis.Tait@usma.edu
MAJ Travis Thompson	MS – Columbia University – 2004 BS – USMA – 1994	688-4792	Travis.Thompson@usma.edu
MAJ Eric Tollefson	MS – Georgia Institute of Technology – 2002 BS – USMA – 1994	688-5663	Eric.Tollefson@usma.edu
MAJ Jason Wolter	MEM – Northwestern University – 2004 BS – USMA – 1994	688-4888	Jason.Wolter@usma.edu
MAJ Ernest Wong	MS – Stanford University – 2004 BS – USMA – 1994	688-2668	Ernest.Wong@usma.edu
CPT TJ Lindberg	MS – University of Arizona – 2004 BS – USMA – 1995	688-4752	Travis.Lindgerb@usma.edu
Ms. Robin Burk	MBA – University of North Carolina – 1992 BA – St. John's College – 1973	688-2746	Robin.Burk@usma.edu

PART IV – THE DEPARTMENT RESEARCH CYCLE

Regardless of the research thrust, the research source or the client, each research proposal must be approved through the DSE Research Council and the Department Head. The ORCEN Director, in the role of the Department Research Coordinator, collects potential project proposals from Senior Investigators and brings the research opportunity to the Department Research Council which is headed by the DSE Department Head. This development of research opportunities is normally conducted in the summer, when the academic workload wanes for the Department’s senior investigators.

At the beginning of the academic year in August, the ORCEN the research council convenes to review each research proposal for support and for the identification of required resources. The ultimate authority for approving the allocation of resources (which includes funding, lab time and analyst time) is the Head, Department of Systems Engineering. Once approved, the researchers can execute the research plan.

The Research Cycle for an Academic Year for the Department of Systems Engineering is illustrated in Figure 1. This is a depiction of the objective annual research cycle, which involves several processes in executing the research plan. Among them is the development of research opportunities, the approval timelines and the completion times for each project. Research opportunities can be developed during the academic year, or off-cycle. These projects are tentatively approved through the Department Research Coordinator and the Department Head. They will ultimately be required to be approved by the Research Council in its January, mid-year meeting.

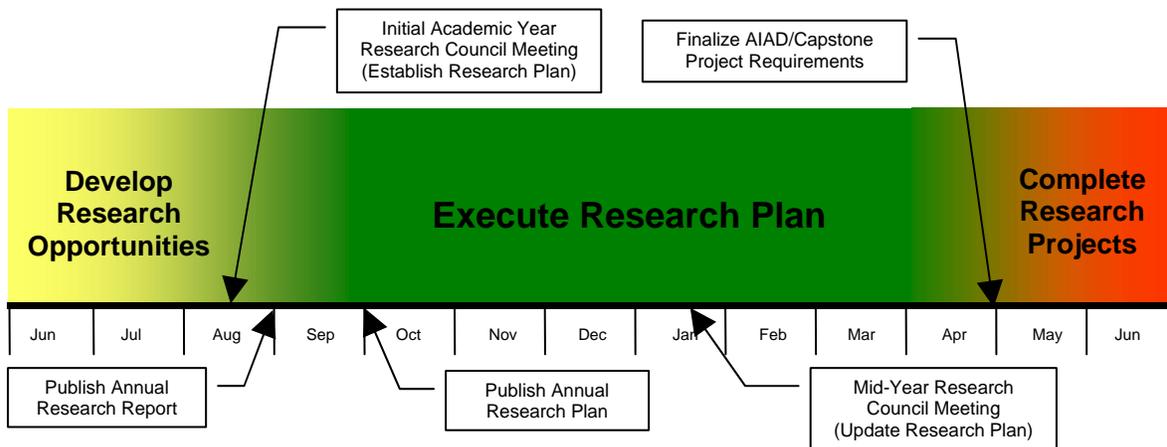


Figure 1: DSE/ORCEN Annual Research Cycle

As can be assumed based on the cycle above and the research approval process described above, the Department and the Operations Research Center does not solicit

nor conduct many “short turnaround” research projects though there are some that they conduct. The reason for this goes back to the initial objectives of the Department’s research program, which is to support the development of the junior analysts. In the ORCEN, the analysts rotate each year in the June timeframe. To ensure their time is used efficiently and they develop as a researcher, most projects are year-long works.

PART V – Principal Research Activities – AY05

Simulation Roadmap for Program Executive Office (PEO) Soldier Programs – Initial Steps in Implementation

DSE Project No: DSE-R-0501

Client Organization: PEO Soldier, Ft. Belvoir, VA

Principal Analyst: MAJ Grant Martin, M.S.
Senior Investigator: LTC Jeffrey Schamburg, Ph.D.

Point of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Mr. Charlie Tamez	PEO Soldier 5901 Putnam Road, Bldg 328 Fort Belvoir, VA 22060-5422	703-704-4073	Charlie.Tamez@us.army.mil

Problem Description:

Last year, analysts from the ORCEN worked on behalf of Program Executive Office (PEO) Soldier to address their need for improved combat modeling. That study recommended that PEO Soldier coordinate its requirements for very high fidelity combat modeling among three simulation programs. Those three programs are Objective OneSAF (OOS), Infantry Warrior Simulation (IWARS), and the Combined Arms Analysis Tool for the 21st Century (COMBATXXI or CXXI below). Each of these programs has its own initiatives and plans; this project has focused on defining the specific modeling requirements of PEO Soldier for those modelers for inclusion in their modeling plan.

PEO Soldier is the program manager for virtually every item of equipment carried or worn by soldiers around the world today. To aid them in acquisition decision-making, they need to be able to use combat simulation to modify the characteristics of any item of equipment and see the effect of the change. They also wanted to be able to model new, innovative, proposed products. They are responsible for the acquisition and fielding of over 450 products in the field today.

Proposed Work:

The first step of implementation is to get “buy-in” from senior leader stakeholders in the Army and Joint communities. Consensus across the military’s analysis, materiel development, and combat development communities will facilitate PEO Soldier’s

access to resources and their ability to influence the implementation. In addition to building consensus, briefings to the senior leadership give them an opportunity to provide feedback and recommendations.

The initial planning for implementation will occur in conjunction with the briefing process. This consists of establishing dialogue with the relevant simulation proponents, estimating costs, building a tentative timeline and set of objectives, refining the requirements, and solidifying the overall implementation plan.

Based on the results of that process, we will supervise the drafting and acceptance of Memoranda of Agreement (MoA) and/or Memoranda of Understanding (MoU) between PEO Soldier and the appropriate simulation proponents. Those documents enumerate explicit and detailed requirements that will be met by each party, to include tasks, costs, timelines, and reporting requirements. Once the MoA/MoUs are in effect, we must supervise execution of the plan by tracking reports, solving any issues that may arise and updating agreements as necessary. This will also include facilitating and possibly conducting an independent assessment of the simulation progress. The supervision of the execution of the plan is a continuous process that requires a systems engineering approach to ensure that the recommended system of systems achieves its potential.

Results Summary:

Given PEO Soldier's need, we used a product-based approach to define their modeling requirements, in contrast to a functional or abstract definition of a product's effects (i.e., situational awareness). Beginning with the 450 products, we selected the most critical 60 products or new technologies for definition. Our first step was to list the attributes and simple battlefield effects of the products. We then tied the effects of the products to the soldier functional hierarchy, developed in the prior year's research. Doing so has been significant for two reasons. First, by considering the functions of a soldier on the battlefield, we are forced to address secondary effects of a piece of equipment. Second, connecting the product to a soldier's function keeps the focus on the modeling of the individual soldier. Based on those functions, we could specify modeling inputs and outputs which would be required to model a particular item of equipment.

We distributed these requirements to the modeling agencies for their review. They provided a great deal of feedback and more importantly, were able to explain the current state of their modeling progress for PEO Soldier. Thus, PEO Soldier has a detailed understanding of their capabilities and can make informed decisions about how to invest its capital in simulation to support its decision-making.

Requirements and Milestones:

1. Gain Senior Joint and Army stakeholder "buy-in" via briefings – ***Completed as necessary by PEO Soldier.***
2. Coordinate, mediate, and draft Memoranda of Agreement (MoA) and/or Memoranda of Understanding (MoU) between PEO Soldier and simulation

- proponent agencies. – *PEO Soldier is reviewing the MoA, all other agencies have agreed to it.*
3. Refine simulation requirements, based on PEO Soldier products -- *Complete*
 4. Implementation – Coordinate for and execute the independent assessment of simulation development and capability – *To continue in AY06.*

Project Deliverables and Due Date:

- Presentations to senior leadership (October 2004) – *Complete*
- MoA signed by all agencies (October 2004) – *Being reviewed by client.*
- Independent assessment of capabilities (December 2004) – *Postponed by client until determination can be made fine tuning project direction.*
- Refined requirements to modelers (May 2005) – *Complete*
- Technical report (September 2005) -- *Complete*

Presentations and Publications:

- Tollefson, E. S., Boylan, G. L., Kwinn, M. J., Jr., Martin, P. G., Foote, B. L., and West, P. D., 2004, “United We Stand: Leveraging Concurrent Efforts to Support Infantry Soldier System Acquisition,” Presentation for the INFORMS Annual Meeting 2004, Denver, CO.
- Boylan, G. L., Tollefson, E. S., Kwinn, M. J., Jr., and Martin, P. G., 2004, “Determining Simulation Requirements and Identifying a Course of Action to More Effectively Support Acquisition Decision-Making for the Current and Future Force Infantry Warrior,” in the Proceedings of the 24th Army Science Conference, Orlando, FL, 2004.
- Tollefson, E. S., Boylan, G. L., Kwinn, M. J., Jr., Foote, B. L., and Martin, P. G., 2004, “Simulation Modeling Requirements for Determining Soldier Tactical Mission System Effectiveness,” published in the Proceedings of the 2004 Winter Simulation Conference, Washington, D.C.
- Martin, P. G., Schamburg, J. B., and Kwinn, M. J., Jr., 2005, "Implementation of a Federation of Simulations for High-Resolution Infantry Simulations," in the Proceedings of the Annual Conference of the Institute of Industrial Engineering, Atlanta, GA, 2005.
- Martin, P. G., Schamburg, J. B., and Kwinn, M. J., Jr., 2005, “Creating Requirements for High-Resolution Infantry Simulations,” Presentation at the 17th Triennial Conference of the International Federation of Operational Research Societies (IFORS), 2005, Honolulu, HI.
- Martin, Grant, Schamburg, Jeffrey B, Ph.D., Kwinn, Michael J. Jr., Ph.D., *PEO Soldier Simulation Roadmap: Initial Steps in Implementation*, Operations Research Center of Excellence, Technical Report DSE-TR-0501, DTIC # ADA435707, July 2005.

- Martin, P. G., Schamburg, J. B., and Kwinn, M. J., Jr., 2005, "Acquisition-Based Simulation," accepted for the Proceedings of the 2005 Winter Simulation Conference, Orlando, FL, 2005.

Personnel Briefed:

- LTC Jeffrey Schamburg, Ph.D. (DSE, USMA, Senior Investigator)
- LTC Michael J. Kwinn, Jr., Ph.D. (ORCEN Director)
- Representatives of IWARS, COMBATXXI, OOS Development Teams

Status: Complete

USAMMCE Organizational Analysis

DSE Project No: DSE-R-0503

Client Organization: United States Army Medical Materiel Center, Europe
(USAMMCE)

Principal Analyst: 2LT Heather I. Ritchey, B.S.

Senior Investigator: LTC Jeffrey B. Schamburg, Ph.D.

Points of Contact:

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MAJ Jeff Roberts	Support Operations U.S. Army Medical Materiel Center Pirmasens, GERMANY	DSN 314-495-7174	jeffrey.a.roberts@us.army.mil
LTC Chris Roan	Deputy Commander Operations U.S. Army Medical Materiel Center Pirmasens, Germany	DSN 314- 495-6189	Christopher.Roan@us.army.mil
COL Thomas Brown	Commander U.S. Army Medical Materiel Center Pirmasens, Germany	DSN 314- 495-7126	Thomas.Brown1@us.army.mil

Problem Description:

The Army relies on the United States Army Medical Materiel Center Europe (USAMMCE) to support units stationed and deployed overseas. To provide the best medical materiel support possible, USAMMCE must develop an organizational plan that considers current operations, potential future operations, and Army transformation. USAMMCE has decided to consider organizational changes that will improve its ability to support the Army's need for medical logistics in EUCOM and CENTCOM Areas of Responsibility (AORs).

USAMMCE potentially faces a critical manpower shortage given their current structure and reliance on borrowed military manpower following the realignment and relocation of troops in Germany following the end of the Cold War. This problem has surfaced as especially critical given the increase in operational requirements from the current action and deployments in the CENTCOM and EUCOM AORs.

USAMMCE is potentially seeking to reorganize their organization to better be able to effectively and efficiently respond to any additional future requirements without having to compromise on effectiveness or efficiency in meeting current requirements.

Proposed Work:

This study looked at the needs of the organization and its stakeholders, assessed the functions necessary for USAMMCE to fulfill its mission requirements, and developed an objective hierarchy to compare the alternatives. It included a review of the current staffing, organizational structure, and functions associated with the USAMMCE to provide alternative options based on operational requirements. This work integrated needs based off current/past workload and considered capabilities required in uncertain future. The purpose of this work was to provide USAMMCE decision-makers with an objective study on their current organization and provide a general recommendation for future improvement.

Results Summary:

The purpose of this analysis was to provide USAMMCE decision-makers with an objective study on their current organization and provide a general recommendation for future improvement. This study considered near term implementation and a five year time horizon. This study looked at the needs of the organization and its stakeholders, assessed the functions necessary for USAMMCE to fulfill its mission requirements, and developed an objective hierarchy to compare the alternatives. Three distinctively different alternatives for improvement of operations were developed. The recommended alternative looks to internally shift USAMMCE personnel resources and responsibilities. These shifts allow USAMMCE to leverage their capabilities more effectively. This is the best near term solution for USAMMCE because it allows maximum flexibility, and it can have a rapid impact in improving the performance of the organization. Furthermore, it provides flexibility for future changes as broader Army transformation decisions are made and as future operational requirements become clearer.

Some of the key contributions from this analysis include:

1. An unbiased systems analysis to help make decisions that will improve USAMMCE.
2. A critical look at core competencies, stakeholder needs, and key functional requirements. This analysis may be used as an internal leadership tool to help provide focus and direction for USAMMCE personnel. Furthermore, it provides an internal assessment and feedback for use by USAMMCE leadership. A similar approach can be conducted internally in the future and used for future assessment and feedback.
3. A developed objectives hierarchy for analysis. This objectives hierarchy can also be used as an internal leadership tool to help provide focus and direction for USAMMCE personnel. The objectives hierarchy may be adjusted and used for development and analysis of alternatives resulting from future studies similar to this one.
4. Three distinctly different alternatives for improvement and future direction of USAMMCE. These three alternatives provide a framework that can be used for implementation of organizational changes and future decision making. Furthermore, each alternative provides advantageous concepts that maybe

considered after assessment of the implemented alternative and after an analysis that looks at an even longer timeframe.

5. A recommended alternative with several choices for actionable concepts. The recommended alternative provides advantages in meeting the objectives: 1) improving preparedness for supporting the Army during transformation; 2) improving resource management; and 3) improving the quality of operations.

The recommended alternative looks to internally shift USAMMCE personnel resources and responsibilities. These shifts allow USAMMCE to leverage their capabilities more effectively. The alternative allows USAMMCE to capitalize on the new ERP system and further development of complementary communication, information, and automation systems. This is the best near term solution for USAMMCE because it allows maximum flexibility, and it can have a rapid impact in improving the performance of the organization. Furthermore, it provides flexibility for future changes as broader Army transformation decisions are made and as future operational requirements become clearer.

Concepts from the other potential alternatives may be appropriate further in the future after implementation of the recommended alternative and after additional analysis considering an even longer time horizon. At the same time, the future analysis will, in part, be based on an assessment of improved, streamlined operations based on the implemented alternative, the ERP system, and the most current operational requirements. Concepts from the Expanded Capabilities alternative may prove to be appropriate in order to meet continued increased operational requirements. The Expanded Capabilities alternative provides advantages in meeting the objectives: 1) improving the ability to meet customer demands; and 2) improving the quality of operations. On the other hand, concepts from the Advisory/Training Focus alternative may prove to be appropriate in order to meet long term Army transformation goals and to streamline medical material supply lines. The Advisory/Training Focus alternative may provide advantages in meeting the objectives: 1) improving resource management; and 2) improving quality of operations.

Requirements and Milestones:

- Conduct background research on USAMMCE organization – August 2004 - *Complete*
- Conduct interviews with USAMMCE personnel – August 2004 - *Complete*
- Present problem definition and initial findings at IPR - September 2004 - *Complete*
- Present final analysis and recommendations and write final report – September 2004 - *Complete*

Deliverables and Due Date:

- IPR – September 2004 - *Complete*
- Final briefing and final report - September 2004 - *Complete*

Presentations and Publications:

- Schamburg, Jeffrey B., Ph.D., Ritchey, Heather I., and Kwinn, Michael J., Jr., Ph.D., “United States Army Medical Material Center Europe Organizational Analysis,” Operations Research Center of Excellence Technical Report No.: DSE-TR-0503, DTIC #: ADA426780, September 2004.
- Schamburg, Jeffrey B., Ph.D., and Ritchey, Heather I., “IPR on the United States Army Medical Material Center Europe Organizational Analysis,” Pirmasens, Germany and Department of Systems Engineering, United States Military Academy, West Point, New York, September 2004.
- Schamburg, Jeffrey B., Ph.D., and Ritchey, Heather I., “Final Briefing on the United States Army Medical Material Center Europe Organizational Analysis,” Pirmasens, Germany and Department of Systems Engineering, United States Military Academy, West Point, New York, September 2004.

Personnel Briefed:

- MAJ David Gibson, Support Operations, U.S. Army Medical Materiel Center, Pirmasens, Germany
- LTC Chris Roan, Deputy Commander Operations, U.S. Army Medical Materiel Center, Pirmasens, Germany
- COL Thomas Brown Commander, U.S. Army Medical Materiel Center, Pirmasens, Germany

Status: Complete.

Army Modeling and Simulation Terrain Database Catalogue (Baseline) and Future Framework

DSE Project No: DSE-R-0504

Client Organization: Battle Command, Simulation and Experimentation Directorate

Principal Analyst: MAJ Grant Martin, M.S.
Senior Investigators: Dr. Niki Goerger, Ph.D.
LTC Jeffrey B. Schamburg, Ph.D.

Point of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Mr. Ed Curle	Battle Command, Simulation & Experimentation Office (DAMO-SB) Fort Belvoir, Virginia	703-601-0014	Edwin.Curle@hqda.army.mil

Problem Description:

The modeling and simulation (M&S) community relies on terrain databases to provide the underpinnings that drive analysis, acquisition, and training. Terrain database generation is cost and time prohibitive. Furthermore, reuse of terrain databases is hampered by the difficulty in identifying and accessing existing terrain databases with potential for reuse. There may be several different terrain databases for the same geographic location but not all may be useful for particular M&S or for specific studies and analysis. The Battle Command, Simulation and Experimentation (BCSE) Directorate (formerly AMSO) is developing the Army Digital Terrain Library (ADTL) to remedy this problem.

Proposed Work:

In this project, we will apply the Systems Engineering and Management Process (SEMP) to develop a metadata framework for organizing these terrain databases in the ADTL. Specifically, we will focus on choosing among potentially dozens of descriptive metadata fields, considering the need for easy search capability as well as initial data entry. The critical question to answer is: what does one need to know about a database before deciding to use it?

Results Summary:

We began by following the SEMP fairly closely, spending a great deal of time in the needs analysis phase. We conducted our needs analysis using a variety of tools – individual interviews with leaders in the field, background research, as well as

internet-based surveys. Our charge was to identify critical metadata fields for organizing terrain databases. The simplest parallel is to consider the “fields” found in a library card catalog. Therefore, when we began to model our potential solutions, we really were faced with trying to model individual candidate entries, not really entire alternative solutions. This departure from the SEMP proved challenging yet interesting and forced us to consider the real purposes behind the tools used in and outputs of the problem definition phase.

The result of the study was a concise set of metadata that is now being implemented by BCSE in the digital library. We were involved in collecting an initial set of databases from key agencies around the Army. That activity has given us a new perspective on our recommendation and highlighted some potential areas for modification.

Requirements and Milestones:

- Identify existing and developing terrain catalogs (September 2004) – *Complete*
- Conduct group sessions and stakeholder analysis (November 2004) – *Complete*
- Identify necessary metadata for organizing terrain databases (November 2004) -- *Complete*
- Develop several alternatives for data to include in a management and assessment framework (November 2004) -- *Complete*
- Develop prioritized list of essential metadata for this framework (December 2004) -- *Complete*
- Develop a recommendation for the framework for managing terrain databases (December 2004) -- *Complete*
- Conduct data call to populate this framework (December 2004) – *Complete*

Project Deliverables and Due Date:

- Metadata for organizing terrain databases (November 2004) – *Complete*
- Initial set of terrain databases using this metadata framework (December 2004) – Phase 1 - *Complete*
Phase 2 – *continuing into AY06*.
- Technical report (January 2005) -- *Complete*

Presentations and Publications:

- Martin, Grant, Goerger, Niki C., Ph.D., Schamburg, Jeffrey B, Ph.D., Kwinn, Michael J. Jr., Ph.D., *Modeling and Simulation Terrain Database Management*, Operations Research Center of Excellence, Technical Report DSE-TR-0504, DTIC # ADA435760, July 2005.

- Martin, P. G., Schamburg, J. B., Goerger, M. N., and Kwinn, M. J., Jr., 2005, "Finding the Right Terrain Database," in the *Proceedings of the 73rd Military Operations Research Society Symposium*, West Point, NY, 2005.

Personnel Briefed:

- COL George Stone, Ph.D., (Director, BCSE, Client)
- LTC Scott Schutzmeister, (BCSE)
- Niki Goerger, Ph.D., (DSE, USMA, Senior Investigator)
- LTC Jeffrey Schamburg, Ph.D. (DSE, USMA, Senior Investigator)
- LTC Michael J. Kwinn, Jr., Ph.D. (ORCEN Director)

Status: Complete

Shaping the ROTC Cohort

DSE Project No: DSE-R-0505

Client Organization: U.S. Army Accessions Command, Fort Knox, KY

Principal Analyst: MAJ Wiley Rittenhouse, M. S.
Senior Investigator: LTC Michael J. Kwinn, Jr., Ph. D.

Points of Contact:

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LTC Bill Warner	ATTN: ATTC-OP 55 Patch Road Fort Monroe, VA 23651	757-788-4606	William.Warner@usacc.army.mil
MAJ Vaughn Delong	ATTN: ATTC-OP 55 Patch Road Fort Monroe, VA 23651	757-788-3430	Vaughn.Delong@usacc.army.mil

Problem Description:

U.S. Army Cadet Command (USACC) has developed a new commissioning model – Shaping the Cohort (STC) - to meet the future needs of the Army for commissioned officers. It is designed to shape each cohort to meet the Army’s specific needs in terms of component, academic disciplines, race/ethnic makeup goals, gender, and targeted missions. STC does this by determining and examining the “prime market” at a university and basing the detachment’s mission on penetration of that market as opposed to one based on past performance. It is believed that the STC model improves the method of determining missions.

To determine market potential, USACC conducted two surveys that included 62 colleges and universities and over 7600 students. The goals of the survey were to determine knowledge and perception of Army ROTC among students, segmentation of local markets, how the school markets differed, and the characteristics that could lead to participation in Army ROTC. The data gathered is used to determine how many students at each school fit the criteria for the prime market.

Scope of Work & Methodology:

The Operations Research Center of Excellence (ORCEN) at West Point provided an independent assessment of the model's adequacy and determined if and how it could be improved. We began with a needs analysis to determine the real problem the model attempts to address. We then performed an analysis of the STC model and the process for determining missions. Finally, we identify recommendations to improve the model and concluded with suggested additional tools for use in conjunction with the STC model.

Results Summary:

The STC model uses an approach that makes sense with respect to USACC's current business practices. Its philosophy is consistent with the need to assign mission numbers to ROTC detachments in accordance with recruitable markets assessments. However, there is still enough variability in the recruitable market estimates to keep the model in its current role (a starting point that can be negotiated), as opposed to one with enough fidelity to eliminate the need for extensive mission adjustments. It is possible that, as the On-Campus Market Potential Study (OCMPS) proceeds (on which the STC model depends), this variability will be reduced or new and better indicators of recruitable market size may present themselves. Until that time, we geared our recommendations toward three short-term goals. First, simplify the implementation of the model to make it leaner and easier to work with. Second, utilize built-in Excel functions wherever possible to reduce or eliminate mathematical errors, incorrect value assignments, and data duplication. Finally, utilize historical production data to assign different minimum mission values, where appropriate, in order to assist in meeting the increased overall mission. Beyond the near term, we also recommended applying the DEA approach to available data in order to separate efficient and inefficient performers. This will provide additional data on which to base resource allocation decisions.

Presentations and Publications:

- Rittenhouse, Wiley, "Shaping the ROTC Cohort", invited presentation, Accessions Research Consortium, Louisville, KY, June 2005.
- Rittenhouse, Wiley and Kwinn, Michael, "Shaping the ROTC Cohort", Operations Research Center of Excellence Technical Report No.: DSE-TR-0505, DTIC No. ADA434913, April 2005.

Personnel Briefed:

- COL Rocky Gay, USAAC, June 2005
- LTC Steve McCarty, USAAC, June 2005
- LTC William Warner, USAAC, June 2005
- LTC Donna Korycinski, Center for Accessions Research, USAAC, May 2005

USMA Study of the Installation Management Agency CONUS Region Structure

DSE Project No: DSE-R-0506

Client Organization: Assistant Secretary of the Army, Installations and Environment, Mr. Geoff Prosch

Principal Analyst: LTC Tim Trainor, Ph.D
Senior Investigator: Prof. Greg Parnell, Ph.D

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Mr. Geoff Prosch Acting ASA(I&E)	Assistant Secretary of the Army for Installations and Environment (ASA(I&E)) 110 Army Pentagon, Room 3E464 Washington, DC 20310-0110	703-692-9800	geoffrey.prosch@us.army.mil
Mr. Scott Dias HQ Plans, IMA	Installation Management Agency ATTN PLANS (SFIM-PL-S) 2511 Jefferson Davis Hwy Arlington, VA 22202-3926	703 602-6854	Scott.Dias@hqda.army.mil

Problem Description:

In 2002, as part of the larger US Army transformation process, responsibility for installation management was reorganized under the Installation Management Agency (IMA). This radically altered the way the Army did business, and shifted control of billions of dollars for installations away from unit commanders and to the IMA. Since the IMA organization was developed and fielded quickly, many senior Army leaders questioned the value of IMA's use of four Regions in the continental United States (CONUS) to help manage installations. Due to this concern, the Vice-Chief of Staff of the Army (VCSA) ordered a study in the summer of 2004 to determine if these Regions should be reduced in number or eliminated to save manpower spaces.

At the end of May 2004, the Acting Assistant Secretary of the Army for Installations and Environment (ASA(I&E)), Mr. Geoff Prosch, asked the United States Military Academy (USMA) for support in analyzing the structure of the Installation Management Agency (IMA). Specifically, the ASA(I&E) wanted an analysis of IMA's use of four regions to manage CONUS installations. The purpose of the USMA study was to evaluate the effectiveness and efficiency of the current structure and provide recommendations for potential alternative structures.

During an interview of Mr. Prosch and MG Lust, the Assistant Chief of Staff for Installation Management (ACSIM), on 10 June 2004, Mr. Prosch stated that the motivation for this study was that budget 'woes' put pressure on justifying the manpower and cost of maintaining the IMA region structure. Also, the current region

organization was created by “happenstance and compromise”. Based on these factors, Mr. Prosch asked for an independent evaluation of IMA’s CONUS regions management organization that he could use in reporting to the Installation Management Board of Directors (IMBOD) at their next meeting in Oct 2004.

The scope of this study was limited to the organization and function of the four CONUS regions used by IMA and does not extend to the organization for installation management at the garrison level.

Proposed Work:

- Conduct extensive stakeholder analysis of HQDA, IMA and installation leaders to determine the needs and functions of the IMA CONUS regions.
- Develop alternative organizational designs for the number, functions and locations of the CONUS IMA regions.
- Develop a quantitative model to evaluate the potential value of these organizational designs.
- Provide conclusions and recommendations for the CONUS Region structure based on the analysis of alternative designs.

Results Summary:

Bottom Line

The bottom line study recommendations are:

- Retain the current IMA four-region structure in CONUS.
- To achieve any needed manpower savings, reduce the number of personnel working resource analysis functions on the Region staffs.
- Develop a transparent resource allocation process that will enable better communication between HQDA, HQ IMA, senior mission commanders and garrisons.

Impact on Army Decisions

This study provided the quantitative analysis to show that four regions was the right number for IMA to use for effective installation management. The analysis demonstrated that decreasing the number of regions would significantly reduce the value-added of IMA to installation management, while increasing the number of regions would provide little additional benefit. This study enabled the ASA(I&E) to articulate to the VCSA why the IMA should maintain four CONUS regions.

Overview of the Study Methodology

The study methodology used a decision analysis approach for organizational design and evaluation, an approach the authors have not found applied elsewhere for this type of problem. The study included conducting several stakeholder interviews, performing functional and comparative analyses, and developing a quantitative analysis model to evaluate the potential value added from various alternative

organizational designs. To gain insights the study evaluated eight different organizational design alternatives with the quantitative model.

Function of Regions

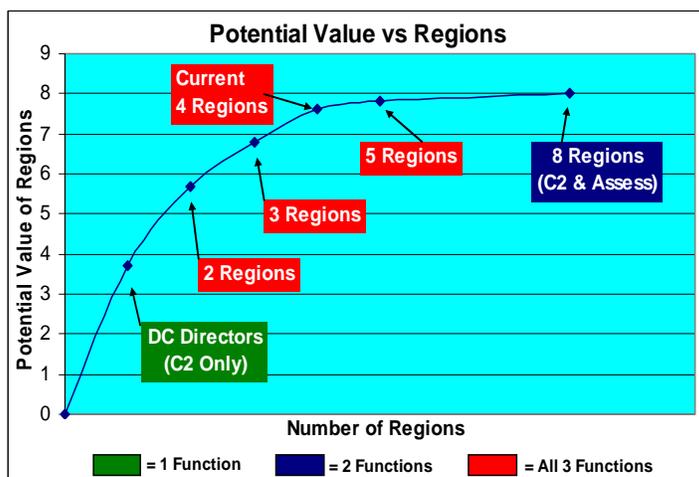
The stakeholder analysis, comparative analyses and other research allowed the study team to identify the core functions that regions perform in IMA. The three core functions listed in priority order are: conduct command and control of installation management, ensure the operational capability of installations, and analyze and prioritize resource needs for installations. Each core function is further defined by three-four key sub-functions. This functional analysis was validated through comparison with the IMA Region Mission Essential Task List and the proposed FY05 Region Manpower Allowance document. In addition, it was approved by the Director of IMA and the ASA(I&E).

Quantitative Model

To compare organizational design alternatives, the study team developed a decision analysis model using the functions of regions as the foundation for the evaluation. The goal of this quantitative model was to measure how well each organizational design alternative provided potential value added in meeting the core functions of regions. The team developed objectives that the organizational design should meet for each sub-function. To determine how well an alternative met an objective, the team created quantifiable evaluation measures. These evaluation measures were weighted to reflect their relative importance in meeting the overall objective. All fifteen measures of effectiveness are data-driven and not subjective in nature. The alternatives were then scored on each evaluation measure to determine the potential value-added (0-10 scale) from the region design alternative. We also evaluated the potential value-added versus cost in terms of personnel spaces for each alternative.

Results from Analysis of Organizational Design Alternatives

This graphic captures the essence of the conclusions from our analysis:



The current structure (4 regions) has *significantly* greater potential value than two or three region alternatives, and *slightly* less potential value than five or eight region alternatives. Additional regions add potential value, but at a diminishing rate. Our sensitivity analysis demonstrated that changes to the weighting and to the shapes of the value curves do not significantly affect our results.

Requirements and Milestones:

- Provide In-Progress Review to ASA(I&E) July 2004 *Complete*
- Provide Final Briefing with recommendations 13 Aug 2004 *Complete*
- Write technical report Fall 2004 *Complete*

Project Deliverables and Due Date:

- Final Briefing with conclusions and recommendations *Complete*
- Technical Report *Complete*

Presentations and Publications:

- Trainor, Timothy E., Gregory Parnell, Brigitte Kwinn, John Brence, Eric Tollefson, and Patrick Downes. "Decision Analysis Aids Regional Organizational Design," submitted to *Interfaces*, June 2005.
- Trainor, Timothy E., Gregory Parnell, et.al. *USMA Study of the Installation Management Agency CONUS Structure*. Operations Research Center of Excellence Technical Report DSE-TR-0506, DTIC No. ADA427027. West Point: USMA, November 2004.
- Trainor, Timothy E., and Gregory Parnell. "Organizational Design Using Multiple Objective Decision Analysis," INFORMS Conference on O.R. Practice, Applying Science to the Art of Business, The Institute for Operations Research and the Management Sciences (INFORMS), Palm Springs, California, April 19, 2005.
- Trainor, Timothy E., and Gregory Parnell. "USMA Study of the Installation Management Agency CONUS Region Structure," 73rd Military Operations Research Society (MORS) Symposium, West Point, New York, 22 June 2005.
- Trainor, Timothy E., and Gregory Parnell. "USMA Study of the Installation Management Agency CONUS Region Structure," Triennial Conference for the International Federation of Operational Research Societies (IFORS), Honolulu, Hawaii, July 2005.

Personnel Briefed:

- Mr. Geoff Prosch, Acting Assistant Secretary of the Army, Installations and Environment
- MG Larry Lust, Assistant Chief of Staff for Installation Management (ACSIM)
- MG Ron Johnson, Director, Installation Management Agency (IMA)
- Ms. Jan Menig, Deputy ACSIM
- Mr. Sakowitz, Deputy Director, IMA
- INFORMS, MORS and IFORS conferences

Status: Complete.

Hypersonic Projectile Mission Analysis

DSE Project No: DSE-R-0508

Client Organization: BAE Systems Analytical Solutions, 310 Voyager Way,
Huntsville, AL, & SAIC: 6725 Odyssey, Huntsville, Alabama,
35806.

Principal Analyst: LTC Willie McFadden, PhD
Senior Investigator: Dr. Bobbie L. Foote, PhD,
Other Researchers: Dr. Paul West, PhD, Dr. Roger Burk, PhD,
MAJ Greg Boylan, M.S., MAJ Mason Crow, M.S.

Points of Contact:

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Bob Walker	BAE Systems 310 Voyager Way Huntsville, AL.	256 864 2134	Bob.Walker4@Baesystems.com
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Problem Description:

A new capability has been developed partly by engineers at AMRDEC. This capability is a new engine with no moving parts that uses as fuel oxygen from the stratosphere and hydrogen carried by the engine. The engine has been tested at above mach 9 and a final system is expected to have speeds up to mach 12-14. The research team has been tasked to perform the following tasks:

1. Educate cadets about the legal obligations of the Army to perform cruise missile defense.
2. Create ways to evaluate systems as to their military value and train cadets in their use.
3. Develop methodologies for AMRDEC aided by BAE and SAIC to direct research approaches that will develop information to support funding for systems using this capability. These methodologies are to be designed to follow Army directives to transform the Army, create an objective force, increase the Armies ability to engage in joint missions, and follow the information requirements to facilitate Army acquisition policy.
4. Research and develop systems requirements for FCS using this technology and inform the clients of the details of these issues.

Results Summary:

Nine cadets have been trained in evaluating systems, designing analyses to support the acquisition cycle, and in evaluating the military effectiveness of systems and in evaluating the incremental military value of a new capability added to a current system.

The cadets created new software from COTS that shows that the Army now has the capability to evaluate standard scenarios as to the value of new system in terms of mission success, increased probability of success and to define parameters that should be determined by experiment.

A methodology for evaluating the risk to mission success of the network-centric joint systems was developed and a report made to the clients. This methodology is extensive and provides a roadmap for the SCRAMJET team to program future development work.

A new capability for ABM systems was proposed which involves the use of currently designed and tested aircraft and dirigibles to launch KE ABM from a loitering posture.

The value of such a capability was computed and shown to be a basis for mission success in certain scenarios.

A set of measures appropriate for evaluating new capabilities in CM and ABM defense was designed and tested.

A complete life cycle analysis for acquisition was designed and programmed in the software INTERCHANGESE.

A probability model that assesses the probability of defending against cruise missiles was updated from the literature and encoded and presented for AMRDEC use.

A new type of military unit was designed, an O & O developed for that unit and scenarios for their use and deployment were created and delivered.

Two major presentations to AMRDEC, BAE AND SAIC were given in Huntsville and our clients attended capstone day to here the cadet final reports. Over 23 attendees were there from BAE, SAIC, AMRDEC, and subcontractors for these organizations.

Personnel Briefed:

- COL George Prohoda, G-8
- Charles Tamez, PEO Soldier

Aviation Readiness (Army Lead-The-Fleet Revised LTF-R)

DSE Project No: DSE-R-0509

Client Organizations: PM LTF, Aviation and Missile Research, Development and Engineering Center (AMRDEC), U.S. Army Research, Development and Engineering Command (RDECOM), Redstone Arsenal, AL; APM LTF, U.S. Army Aviation Technical Test Center (ATTC), Developmental Test Command (DTC), Fort Rucker, AL; Army Aviation and Missile Command (AMCOM), Redstone Arsenal, Huntsville, AL.

Principal Analyst: MAJ Steven Henderson, M.S.
Senior Investigator: LTC Michael J. Kwinn, Jr., Ph.D.

Points of Contact:

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Mike McFalls PM LTF Army Test and Evaluation	AMRDEC, US Army RDECOM AMSAM-RD, Bldg 8716 Redstone Arsenal, AL 35898	DSN 746-3462 256-876-3462 Cell: 256-714-8362	Michael.McFalls@rdec.redstone.army.mil
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Mr. Robert Brown, AMCOM G-3, CBM	AMCOM G-3, Redstone Arsenal, Huntsville, AL 35898	256-842-8911	Robert.brown29@us.army.mil

Problem Description:

The purpose of the Lead the Fleet Revised (LTF-R) program is to gain better insight into the accumulated damage that each U.S. Army helicopter experiences during actual operational usage and to use that knowledge to evaluate overhaul and retirement times, increase safety and operational readiness, and reduce costs. The LTF approach is to examine aircraft usage data to identify linkages between certain flight conditions and component failure. These conditions included basic parameters such as gross weight, airspeed, altitude, roll angle, vertical acceleration, and ground-air-ground cycles.

Proposed Work:

The Operations Research Center of Excellence (ORCEN) will provide a full-time analyst and additional faculty members to provide data modeling and architecture design, and statistical and analytical research. Potentially, the ORCEN will also involve cadets in this year's research effort. Cadet involvement is beneficial in that it exposes cadets to real Army challenges and enables them to make an impact on the future of the Army which they will serve. As future leaders this experience also gives

them an insight into Army Aviation and enables them to see how Lead-the-Fleet will affect future aviation operations. Cadets will be offered Academic Individual Advanced Development (AIAD) opportunities to work as summer interns with LTF operations both in the field and with Westar headquarters. Analysts will conduct a thorough review of existing documentation and interviews of appropriate personnel to fully understand the current LTF mission, goals and measures of effectiveness. LTF will provide data collection, data dissemination, clarification and comments throughout the course of this effort.

Results Summary:

In addition to creating a baseline data warehouse architecture that permitted engineers and analysts to exploit existing aircraft performance data, we propose the following recommendations:

Army Aviation Maintenance Management System Overhaul. In our opinion, many of the complex data management tasks addressed in our design are the result of an outdated maintenance management system. The Total Army Maintenance Management System (TAMMS-A) specified in DA PAM 738-751 is a legacy system developed before the advent of modern information system technologies. This system, based on physical hard-copy records, does not address many of the complex data modeling issues required to achieve Condition Based Maintenance. As a result, any attempt to use information streaming from systems based on TAMMS-A will be clumsy, burdensome, and resource intensive. We recommend further research efforts focus on a redesign of TAMMS-A that fully supports the data requirements of CBM as well as satisfying other requirements of current TAMMS-A stakeholders.

Maintenance Data Entry Overhaul. This recommendation is closely related to the previous, and focuses on the procedures used to enter maintenance and failure data. Currently, the burden for entering low-level detailed information about maintenance actions and component failure information rests solely on operational units. These units are manned with hard working pilots, crew engineers, and technicians whose primary mission is keeping aircraft flying to support on-going operations in the field. These individuals are also responsible for a myriad of other important tasks not related to aviation maintenance. The extra time required to maintain the meticulous level of data integrity required by CBM is often legitimately sacrificed in the name of operational necessities. Future work must address this issue. Automated systems must be fielded that allow the end-users to quickly and effortlessly provide low-level details about maintenance actions and component failures without compromising their primary mission.

CBM Data Scoping. As previously mentioned, the amount of data required to field a CBM program is enormous. The problem is compounded by a natural paradox encountered in the fielding of large scale data warehouses [21]. This paradox pits the yet to be discovered benefits of having lots of data in a single location against the resources required to explore these benefits. The antidote for this paradox is to carefully and frequently review data requirements as new capabilities are realized. We recommend regularly examining the granularity requirements of CBM, as well as what specific data elements are actually being used. For example, do we still need to retain the co-pilot's radio select switch position in future MDR data loads?

Standard Cataloging of Abstract Maintenance Objects. Current maintenance information systems are very good at classifying and tracking physical objects and actions – e.g. specific components, maintenance tasks, and failures. However, the tracking and modeling of abstract maintenance concepts – such as what and where components might be installed on a helicopter or what standard maintenance actions might involve these components, is severely underdeveloped. Future research efforts involving aviation maintenance information systems must target this issue, and focus on producing Army-wide acceptable open source standards.

Open-Source Access to All Data. To reap the benefits proposed by the CBM concept (Figure 1), we recommend allowing full access to the widest population and lowest level of source data possible. We also recommend making this data set available to a broad audience of stakeholders. Maximizing the number of people that can access the data, and then engage in professional discourse will ensure we realize the full potential of CBM for the entire Army Aviation Community.

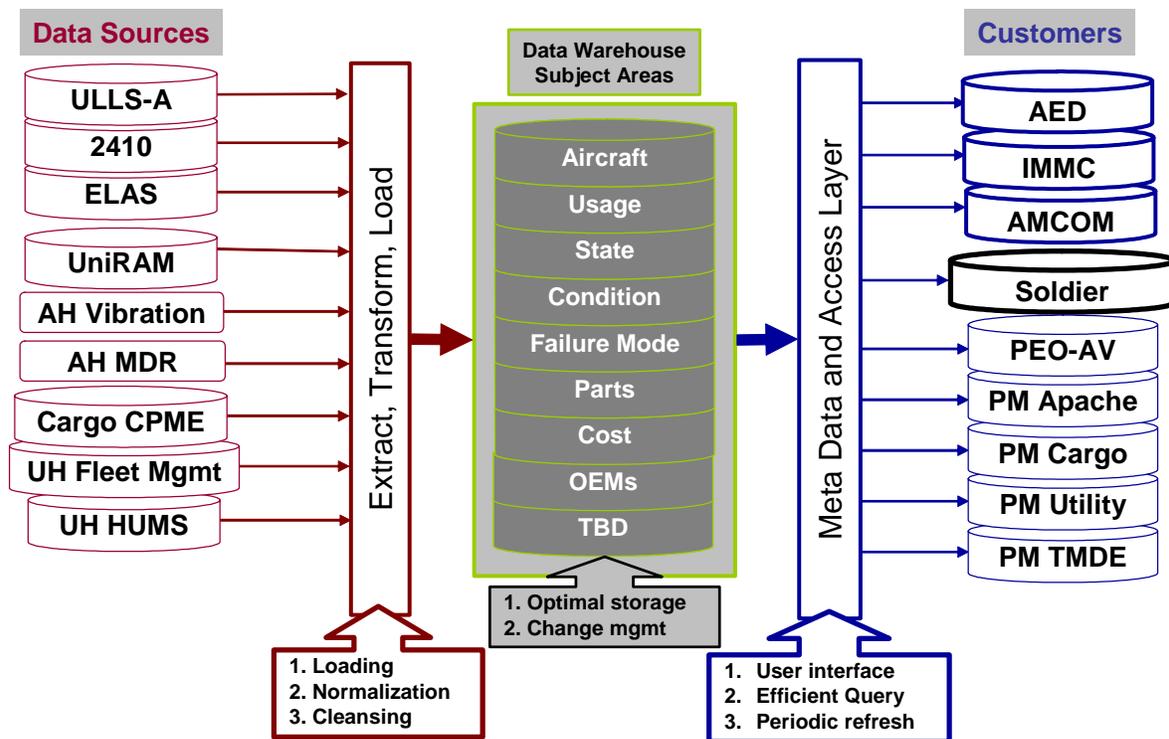


Figure 1 – Conditioned Based Maintenance Concept

Requirements and Milestones:

- Present Final Briefing with recommendations May 2005 *Complete*
- Write technical report May 2005 *Complete*

Project Deliverables and Due Date:

- Final Briefing with conclusions and recommendations *Complete*
- Technical Report *Complete*

Presentations and Publications:

- Henderson, Steven, and Michael Kwinn, Jr., A Data Warehouse to Support Condition Based Maintenance. Operations Research Center of Excellence Technical Report No.: DSE-TR-0509, DTIC No.: ADA434357, May 2005.
- Steve Henderson, (Presented by Simon R. Goerger). “Data Warehouse to Support Condition Based Maintenance,” Presentation, International Federation of Operational Research Societies, Honolulu, HI, 12 July 2005.

Personnel Briefed:

- Mr. Robert Brown, G-3, Condition-Based Maintenance, Aviation and Missile Command
- MG James Pillsbury, Commander, Aviation and Missile Command
- Mr. Randy Buckner, Aviation and Engineering Directorate

Status: Complete.

Support Leader's Digital Assistant (SLDA): A Tool for the Support Platoon Leader

DSE Project No: DSE-R-0510

Client Organization: Program Manager Logistics Information Systems (PM-LIS), Fort Lee, VA; PM-LIS Tactical Logistics Data Digitization (TLDD), Fort Monmouth, NJ

Principal Analyst: CPT Wiley Rittenhouse, M.S., MAJ Holly West, M.S.
Senior Investigator: LTC Michael J. Kwinn, Jr., Ph.D.

Points of Contact:

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Problem Description:

Currently, there are no tools designed to assist the maneuver battalions in daily logistics forecasting outside of the Class IX arena. Maneuver battalions forecast their logistical requirements (from support platoon leader through battalion S4) primarily by hand or with tools developed “in-house”. Maneuver unit personnel typically seek the assistance of FSB company commanders through informal channels to aid in accurate logistics forecasting. The goal is to achieve the most accurate supply forecast possible, but under the current system, over-forecasting or under-forecasting is common, which can result in unnecessary risk to the mission, maneuver units, or support unit personnel. Part of the problem is that maneuver unit personnel do not get the detailed logistics training needed to do accurate forecasting without outside assistance. Currently, the only automated tools available are designed for brigade

level and above. Often, the inefficiencies and forecasting errors that originate below brigade level will propagate through the supply system, further stressing it.

Scope of Work & Methodology:

The SLDA is a tool designed for the officers and non-commissioned officers in a maneuver battalion who are serving in logistics positions (support platoon leaders, battalion S4) to assist them in accurate logistical forecasting and rapid transfer of this information to higher echelons. Early versions of this tool were developed in Microsoft Excel and as a Palm application of limited scope. ORCEN work included the development of the requirements needed to further develop the SLDA as a PocketPC application. The goals of this system are ease of use, fast and accurate supply forecasts, and simplified data transfer.

Results Summary:

The software requirements specification (SRS) was developed and presented in the technical report. It includes a detailed description of the interface design and program flow, as well as a method for forecasting Class I from historical data.

Presentations and Publications:

- Rittenhouse, Wiley, “The Support Leader’s Digital Assistant: A Tool for the Support Leader”, presented at 73rd MORSS and included in conference proceedings, May 2005.
- Rittenhouse, W., West, H. and Kwinn, M., “The Support Leader’s Digital Assistant: A Tool for the Support Leader”, Operations Research Center of Excellence Technical Report No.: DSE-TR-0510, DTIC No.: ADA436574, June 2005.

Status: Complete

***Base Realignment and Closure (BRAC) 2005: Army Installation
Military Value Analysis and Implementation***

DSE Project No: DSE-R-0511

Client Organization: Deputy Assistant Secretary of the Army (Infrastructure Analysis)

Senior Investigator: Dr. Gregory S. Parnell, Ph.D.
Analysts: MAJ John Harris, M.S.

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Dr. Craig College, Deputy Assistant Secretary of the Army (Infrastructure Analysis)	Army TABS Office 1400 Key Blvd, Suite #2 Arlington, VA 22209-1518	(703) 697-3388	craig.college@us.army.mil
COL William Tarantino, Chief, Modeling Support Team	Army TABS Office 1400 Key Blvd, Suite #2 Arlington, VA 22209-1518	(703) 696-9529	william.tarantino@us.army.mil
COL Bob Derrick BRAC Division Chief, ACSIM	Headquarters, Department of the Army Asst Chief of Staff for Installation Mgt Base Realignment & Closure Division 600 Army Pentagon Washington, DC 20310-0600	(703) 601-1911	Robert.Derrick@hqda.army.mil

Problem Statement:

The purpose of this research project is to provide Base Realignment and Closure (BRAC) 2005 infrastructure analysis support to Dr. Craig College, Deputy Assistant Secretary of the Army (Infrastructure Analyses), the Total Army Basing Study (TABS) Group, and the Asst Chief of Staff for Installation Mgt Base Realignment & Closure Division. There have been four previous BRAC rounds in 1988, 1991, 1993 and 1995, during which defense officials picked 97 major domestic bases for closure, 55 major bases for realignment and 235 minor installations to be either closed or realigned. The BRAC 2005 round is part of the Defense transformation effort with strong involvement of the OSD and Joint Staff. The services developed their BRAC methodologies in 2003-2004. We developed and implemented a methodology to assess the military value of each Army installation and the total Army infrastructure. The installation data call was conducted in 2004. The Army analysis was conducted in Fall 2004. The BRAC Commission was formed in Spring 2005 to recommend realignments and closures to the SECDEF and President.

Scope of Work & Methodology:

The following were our major research objectives:

1. Identify key BRAC infrastructure and installation transformation issues and opportunities through research and interviews with Army senior leaders.
2. Develop an objective, credible, and auditable methodology for BRAC Army infrastructure transformation analysis and installation Military Value Analysis that will support senior Army decision makers.
3. Implement the Army Military Value Model using approved decision support software.
4. Write a technical paper that describes the methodology used to support BRAC decision making.
5. Conduct a cadet capstone research project to assess BRAC historical performance and develop a BRAC implementation complexity model.

Methodologies:

The methodologies we are using are stakeholder analysis, Multiple Objective Decision Analysis, and portfolio analysis using optimization.

Results Summary:

The following is our status for each objective:

1. (FY04) Identify key BRAC infrastructure and installation transformation issues and opportunities through research and interviews with Army senior leaders.
 - a. We interviewed over 30 Army senior leaders. We documented the findings in our methodology report.
2. (FY04) Develop an objective, credible, and auditable methodology for BRAC Army infrastructure transformation analysis and installation Military Value Analysis that will support senior Army decision makers.
 - a. The preliminary qualitative framework has been developed and approved by Dr. College.
 - b. We developed the quantitative evaluation measures and value functions for each installation Military Value criteria.
3. (FY05) Implement the Army Military Value Model using approved decision support software.
 - a. We helped develop the model using Logical Decisions. The model has been implemented by United States Army Concept Analysis Agency.
4. (FY05) Write a white paper that describes the recommended methodology to support BRAC decision making.
 - a. DoD announced their BRAC 2005 recommendations on May 13, 2005. First draft of paper describing the Army methodology is completed. We submitted the paper to Decision Analysis Journal..
5. (FY05) Conduct a cadet capstone research project to assess BRAC historical performance and develop a BRAC implementation complexity model

- a. The BRAC 2005 Implementation Cadet Project was started in started in August 2004 and completed in May 2005.
- b. CAA developed the following report for the Deputy Assistant Secretary of the Army (Infrastructure Analysis)using the model.

Presentations and Publications:

- Parnell, G., Harris, J., Hoops, B., Gardner, S., and Mounts, R., *BRAC 2005 Implementation Decision Support Tools*, Operations Research Center of Excellence Technical Report No.: DSE- TR-0409, DTIC No.: ADA426284, August 2004.
- Harris, J. and Parnell, G. S., “BRAC 2005 Implementation,” American Society for Engineering Management 25th National Conference, Alexandria, Virginia, October 20-23, 2004
- Parnell, G., Harris, J., Love, T., Johnson, R., McCorkle, T., Strozier, P., and Swaintek, S., *A Decision Tool to Address the Army’s BRAC 2005 Implementation Challenges*, Operations Research Center of Excellence Technical Report No.: DSE- TR-0511, May 2005.
- Ewing, P., Tarantino, W., and Parnell G., “Use of Decision Analysis in the Army Base Realignment and Closure (BRAC) 2005 Military Value Analysis,” Submitted to *Decision Analysis Journal*, June 2005
- Pedersen, Richard A. and Bassichis, Jeffrey, *Base Realignment and Closure (BRAC) 2005 Implementation Complexity Study (BICS)*, Center for Army Analysis, Report CAA-R-05-35, July 2005

Personnel Briefed:

- Dr. Craig College, Deputy Assistant Secretary of the Army (Infrastructure Analyses), August 2004.
- COL Tarantino and COL Derrick, several times.

Status:

1. Cadet report and BRAC 2005 Complexity Model were delivered to the client in June 2005.
2. COL Derrick has requested we consider a possible cadet capstone in FY 06.

High Energy Laser Weapons: Modeling and Simulations

DSE Project No: DSE-R-0514

Client Organization: High Energy Laser Joint Technology Office (HEL JTO);
AMRDEC

Principal Analyst: MAJ Eric S. Tollefson, M.S.
Senior Investigator: Dr. Roger C. Burk, Ph.D.

Points of Contact:

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Glen P. Perram Professor of Physics	Department of Engineering Physics Air Force Institute of Technology 2950 P Street Wright-Patterson AFB, OH 45433-7765	(937) 255-3636 ext 4504	glen.perram@afit.edu

Problem Description: *(Dissertation Research for PhD in Systems Engineering)*

The HEL JTO is coordinating the services' efforts to develop high-energy laser weapons. As part of this effort, the JTO recognized the need for end-to-end modeling of such weapons. Physics-based models exist for laser generation, beam formation and control, atmospheric propagation, and target interaction, but the JTO has no available model for a complete laser weapon shot ("photon birth to death"). Higher-level models of a military engagement, the execution of a military mission, or they carrying out of a campaign involving HEL weapons are also unavailable. It is clear that low-level, very detailed, physics-based models need to be linked in some way to higher-level engagement, mission, and campaign models, but it is unclear how this linkage should be worked.

To fill this gap, the HEL JTO asked the two service graduate schools of engineering (AFIT and NPS) and the three service academies (USMA, USNA, and USAFA) to form a consortium to research what modeling is required and to develop a model or family of models to meet the JTO's needs. AFIT agreed to lead this effort and the other institutions agreed to participate in ways appropriate to their capabilities and areas of responsibility.

The objectives of the effort are: (1) to develop a tri-service research team to integrate DoD fundamental research in end-to-end HEL modeling; and (2) to develop a government-owned, DoD-accepted global interface, which integrates existing and future HEL models. The initial focus must achieve a balance between (1) on-going, high-fidelity technical analyses, (2) engineering trade studies, which allow analyses

of a wide range of systems, not simply a deep analysis of any one selected system, and (3) analyses of HEL systems' military utility against a broad range of missions.

The lion's share of the effort will be with AFIT, as the institution with by far the greatest expertise and experience with high energy lasers. The participation of USMA is primarily in evaluating how HELs are or should be modeled in ground warfare and air and missile defense scenarios, and in helping develop linkages from physics-based models to higher-level engagement, mission, and campaign models.

Proposed Work:

This was the third year of a five-year, three-phase project. This year the Aviation and Missile Research Development and Engineering Center (AMRDEC) has joined the consortium to provide some Army expertise on high-energy laser systems. We planned to coordinate with them in developing some scenarios for HELCoMES, a laser engagement based on scaling laws being developed by the consortium: AMRDEC will provide the laser parameters, and USMA will provide engagement scenarios and analysis.

Results Summary:

We obtained a new simulator from AFIT called HELEEOS (High Energy Laser End to End Operational Simulation). This model is comparable to HELCoMES in level of modeling; both are supported by the HEL JTO. Since HELCoMES is a Government-developed product rather than contractor-developed, we decided it was more suitable for use at USMA. We installed it, verified operation, and studied the documentation. We are still in the process of evaluating its suitability for engagement scenarios of importance for the Army.

Status: Follow on as Capstone Research in AY06.

Selecting Portfolios of R&D Projects

DSE Project No: DSE-R-0519

Client Organization: Department of Systems Engineering, US Military Academy,
West Point, NY

Senior Investigator: Dr. Roger C. Burk, Ph.D.

Points of Contact:

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Problem Description:

It is a common problem for a research and development (R&D) manager to have to pick a subset of projects to pursue, i.e. a portfolio, from a larger set of possible R&D projects. This can be a difficult problem for many reasons, the most fundamental of which are the following three key characteristics: (1) Each project has a cost, and there is a total budget constraint, so not all desirable projects can be selected; (2) Different projects may be desirable for different reasons, forcing a tradeoff between competing objectives; and (3) The outcome of each project will generally be uncertain, because of the risky nature of R&D. This problem has been discussed in the technical literatures repeatedly since the 1960s. Members of the D/SE faculty (Parnell and Burk) have helped pioneer a new approach to the problem based on Value Modeling. This has resulted in several successful applications for clients such as the Air Force Research Laboratories and National Reconnaissance Office, which have been reported in scholarly publications. Now this approach needs to be put on a rigorous theoretical foundation and linked to the record of scholarly literature on the problem. This effort was to do that, culminating in a peer-reviewed scholarly paper.

Proposed Work:

- Review and analyze the scholarly literature on R&D portfolio selection
- Establish position of Value Modeling approach with respect to other approaches
- Write a paper that lays out the Value Modeling approach in a theoretically sound fashion and links it to the rest of the scholarly literature
- Present paper at an academic conference
- Publish in scholarly journal

Results Summary:

All relevant papers back to 1991 were read and carefully evaluated; earlier papers were evaluated via published surveys and individual reading of key works. We found that published research in this area has gone through several cycles of popularity since the early 1960s. Research appears in both management science journals and in engineering management journals; the two corpora are connected occasionally but not consistently. Optimization-based methods attracted much interest from academicians in the 1960s and 1970s, and are occasionally still published, but have proven useful in practice only in rare cases where the large number of resource or other constraints make it hard to develop good feasible solutions with simple heuristics. The major problem seems to be that optimization produces IP solutions that are both sensitive to small changes in the inputs and hard to justify to a non-technical audience. Published applications generally suggest that the major value to the client was from just structuring the model, especially the value function, rather than finding a theoretically optimal answer.

There is great variation in the aspects of the problem that are modeled, but little apparent awareness of a common problem structure. One consistent observation was that private-sector problem generally have ten or fewer criteria, while public-sector problems have dozens or more, reflecting a more numerous and diverse group of stakeholders. Another typical feature of successful applications is a simple additive value model. The inherent uncertainty of R&D is generally handled one of three ways, none which seem entirely satisfactory: including it as a criterion, evaluating its effect only post-optimality, or greatly complicating the problem with an explicit risk model.

This literature analysis bore out our initial judgments that this problem area needs an integrating treatment, and that our approach based on value modeling is an appropriate structure around which to base such a treatment.

Requirements and Milestones:

- Paper for conference presentation (*Complete*) and publication (*In preparation*).

Project Deliverables and Due Date:

- Presentation at INFORMS national meeting: 24-27 Oct 04. *Complete*
- Paper submitted for publication: June 2006. *In preparation*

Presentations:

- Burk, Roger C., *Selecting Portfolios of R&D Projects*, Institute for Operations Research and the Management Sciences (INFORMS) annual meeting, Denver, CO, 26 Oct 04.
- Burk, Roger C., *The Research and Development Portfolio Problem*, International Federation of Operational Research Societies (IFORS) conference, Honolulu, HI, 11 Jul 05.

Status: Final paper due June 2006.

Information Quality & Service Reliability

DSE Project No: DSE-R-0516

Client Organization: Office of Force Transformation, OSD

Senior Investigator: Patrick J. Driscoll, Ph. D.
Co-Investigators/Analyst(s): Michael Tortorella, Ph.D., Rutgers University
Edward Pohl, Ph.D., University of Arkansas

Points of Contact:

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Problem Description:

This study introduces a pragmatic methodology for examining the effectiveness of decision support information systems for Network Centric Operations based on the concept of *manufacturing information products*. Conceptualizing information flow in a decision support (intelligence-based) network as tiered manufacturing, we examine the usefulness of separating the construction, maintenance and delivery of these information products to an end user. Ultimately, we seek to refine the current understanding of quality and to introduce a framework suitable for uncovering a mathematical definition of *information reliability* that can be used to guide the construction of knowledge walls and other common operating picture environments whose singular purpose is to inform the user through inferential estimates based on observable evidence.

Scope of Work & Methodology:

- Properly develop a new generalized framework for measuring information quality based on concepts of reliability and network information services that can be applied to elements of the NCW/NCO framework in order to understand critical issues associated with network centric decision support information systems (DSIS) and their links to combat outcomes.
- Develop quantitative functional expressions that properly describe the sub-elements associated with the quality of organic information and the quality of individual information.
- Using both a service reliability and an information manufacturing system framework, identify and understand uncertainty associated with specific

information products in a DSIS network and its impact on critical dimensions of situational awareness and decision making.

Results Summary:

We first developed the definitions and framework for an information manufacturing environment, establishing a connection with previous research and extending it into a value-focused domain needed to understand the military use of information products. This resulted in two significant contributions: a refinement of information quality definitions and components, and an integrated, general purpose framework consisting of a product manufacturing area and an applications interface area (service). We then applied this framework to information networks extracted from two recent case studies involving US Special Operations Forces in Afghanistan within the tenets of Network Centric Warfare, illustrating its unique ability to identify systems level concerns that directly impact quality. These results completely recast the lessons being inferred through the application of the Network Centric Operations Conceptual Framework (NCOCF) previously introduced. We found that our interpretation produced insights that enabled actionable items from a systems sustaining point of view, whereas the previous lessons learned were decoupled from this notion. Lastly, we extended our concern to look at the reliability of information products, showing how this both complements a quality analysis and, taken together, prescribes a methodology for creating effective information-based decision support tools like a common operating pictures or knowledge walls.

Presentations and Publications:

- *Information Product Quality In Network Centric Operations.* With Mike Tortorella and Ed Pohl. Presented to Office of Force Transformation, Office of Secretary of Defense, Crystal City, Maryland, March 2005.
- *The Impact of Uncertainty in Reliability System Design.* With Ed Pohl. Presented at the INFORMS Annual Conference, Denver, Colorado, October, 2004.
- *Information Reliability & Uncertainty in NCO Systems.* With Ed Pohl, Michael Tortorella. Presented at the INFORMS Annual Conference, Denver, Colorado, October, 2004.
- *Reliability of Information-Fueled Services in Network Centric Operations.* With Mike Tortorella. 10th International Command and Control Research and Technology Symposium, Tysons Corners, Virginia, June, 2005.
- *Considerations of Quality and Reliability in Designing a Common Operating Picture.* With Ed Pohl, Mike Tortorella. To be presented to the International Federation of Operational Research Societies (IFORS) tri-annual conference, Honolulu, HI, July, 2005.
- Michael Tortorella, P.J. Driscoll. 2005. "Service reliability of NCO information product manufacturing systems," Research Report, Dept of Systems Engineering, Rutgers University, Piscataway, NJ.

- Michael Tortorella, P.J. Driscoll. 2005. “Reliability of Information-Fueled Services in Network Centric Operations,” *Proceedings* of the 10th International Command and Control Research and Technology Symposium.
- Patrick J. Driscoll, M. Tortorella, E. Pohl. 2005. “Information product quality in Network Centric Operations,” Research Report to Office of Force Transformation, OSD, Arlington, VA.
- Patrick J. Driscoll, M. Tortorella, E. Pohl, “Information Product Quality in Network Centric Operations”, Operations Research Center of Excellence, Technical Report No.: DSE-TR-0516, DTIC No.: ADA435046, May 2005.

Logical Ontology to Assess Information Advantage

DSE Project No: DSE-R-0517

Client Organization: Office of Force Transformation, OSD

Senior Investigator: Patrick J. Driscoll, Ph. D.

Co-Investigators/Analyst(s): MAJ Steven Henderson, M.S.,

Points of Contact:

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Problem Description:

This study focuses on developing a logic-based meta-model capable of making accurate estimates of a force's true operational state given only sensor generated battlefield evidence. Using three different network learning systems, Bayesian Belief Networks, Model Logic, and Fuzzy Logic, we use a force's operational state as a proxy for their operational intent which we argue is beyond our capacity to accurately assess. Ultimately, we demonstrate that it is possible to quantify and assess the degree of *information advantage* that one force has over another using this approach.

Scope of Work & Methodology:

- Define critical objects, rules and metrics required to establish an ontology capable of classifying NCW/NCO battlespace operations
- Develop a JAVA coded, computer-based application using an adaptive Bayesian Belief Networks to test the effectiveness of this ontology
- Develop an effective method for dynamically binning battlespace opportunistic information
- Develop an effective method for using both enumerative and eliminative logic for fusing this information
- Develop a method for representing the evolution of operational states and conditions leading to measures of information asymmetry

Results Summary:

We developed and tested a prototype framework called a meta-model intended to house several automated learning inference techniques. This framework is based on a finite set of operational states being decomposed into a finite set of key descriptors (not assumed to be mutually exclusive) that accumulate evidential support from sensor network flows. We also demonstrated the feasibility of reducing the information needed to identify and classify enemy operational states based on restricted sensor input.

In this vein, we applied three different network simulations: Bayesian Belief Networks, Modal Logic, and Fuzzy Set Membership, to demonstrate that a simplified information organization structure based on core information requirements is sufficient to accurately classify operational states. We established both end-state and time-evolving performance metrics for each system in order to compare the static and dynamic performance and are currently in the process of analyzing computational results based on these metrics.

Presentations and Publications:

- A Meta-model Architecture for Operational State Inference. With Steve Henderson. Invited presentations given to
 - Staff and faculty of the Defense Analysis Department, Naval Postgraduate School, Monterey, CA, January 2005;
 - NYC INFORMS Professional Chapter, New York, New York, February 2005; and,
 - Office of Force Transformation, Office of Secretary of Defense, Crystal City, Maryland, March 2005.
- “A Meta-Model Architecture for Fusing Battlefield Information,” with Steve Henderson. Accepted with revision for Military Operations Research Journal, June 2005. Technical Report delivered to OFT in March 2005.
- Steven J. Henderson, P.J. Driscoll, “A Meta-Model Architecture for Fusing Battlefield Information,” Operations Research Center of Excellence, Technical Report No.: DSE-TR-0517, DTIC No.: ADA434915, May 2005.

Using Agent Based Models (ABMs) to Determine Soldier Tactical Mission System (STMS) Effectiveness

DSE Project No: DSE-R-0519

Client Organization: PEO Soldier

Principal Analyst: MAJ Eric S. Tollefson, M.S.
Senior Investigator: Dr. Roger C. Burk, Ph.D.

Points of Contact:

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Problem Description:

Background: In order to remain the premier land fighting force in the world, the US Army soldier must be outfitted with the most technologically-advanced equipment possible. However, such equipment is expensive to design, test, evaluate, and implement. Therefore, proposals for such equipment should include a quantitative evaluation of the expected benefit to mission accomplishment that system or component provides the soldier and his unit.

Simulation models are a potential tool for such evaluations. However, the commonly-used simulation models for analytical studies, constructive simulation models, are currently not capable of modeling the advanced soldier interaction and situational awareness that the proposed soldier tactical mission systems (STMS) facilitate.

Problem: Program managers need a quantitative methodology to evaluate the benefit to mission effectiveness provided by the STMS as a whole, and by individual or groups of components.

Proposed Work:

Agent-based simulations provide the modeler a potential toolset capable of capturing the interaction between individuals on the battlefield. This project aims to build upon work done during the previous year by developing a methodology for using agent-based modeling to evaluate aspects of STMS effectiveness, to include development of scenarios and appropriate measure of effectiveness (MOEs), design of experiments, analysis of results, and recommendation for future research and software improvement.

Results Summary:

We were not able to make the planned progress this year. We evaluated the available ABM simulators and picked MANA (Map Aware Non-uniform Automata) because of its good user support system, its suitability for soldier-oriented problems, and Army experience with it. We obtained, loaded, and ran the simulator. We obtained a relevant scenario from TRAC Monterey that had been used in a study evaluating performance variations for Future Combat System equipment. We planned to begin gaining familiarity with MANA by changing the scenario from blue-attacking to blue-defending and seeing if we could confirm the study's conclusions. However, that scenario change turned out to be much more difficult than anticipated, because of the need to capture many new tactical behaviors in MANA parameters. This was a lesson in the difficulty of tailoring an ABM model to a specific scenario: you need a lot of data on agent behavior, and that data may be hard to come by. Because of this difficulty, and the press of higher-priority duties, we were not able to proceed further on this effort this year.

Status: Discontinued.

Applying Value-Focused Thinking to Effects Based Operations

DSE Project No: DSE-R-0520

Client Organization: Department of Systems Engineering, US Military Academy,
West Point, NY

Principal Analyst: MAJ Robert Keeter, M.S.
Senior Investigator: Dr. Gregory Parnell, Ph.D

Problem Description: (*Decision Analysis theoretical study for presentation at 73rd MORSS*)

Effects based operations (EBO) and value-focused thinking (VFT) overlap and support one another in several ways. This research/presentation was intended to bring to light these similarities in an operations research environment. Planners of EBO should use the tenets of VFT to improve their operations in terms of effectiveness and efficiency.

Proposed Work:

- Research the similarities between Effects Based Operations and Value-Focused Thinking

Results Summary:

The results of the research consisted of presentation to working group 28 (Decision Analysis) at the 73rd MORSS. The feedback from the members of the working group was generally very positive.

Requirements and Milestones:

- Brief at MORSS - *Complete*

Project Deliverables and Due Date:

- Brief at MORSS (June 05) - *Complete*

Presentations and Publications:

- 73rd Military Operations Research Society (MORS) Symposium, “Effects Based Operations” presented in Working Group 28 – Decision Analysis, June 23, 2005, United States Military Academy, West Point, NY.

Personnel Briefed:

- COL William Klimack (DSE, USMA, Associate Professor)
- WG28 (Decision Analysis Track), 73rd Military Operations Research Society (MORS) Symposium, United States Military Academy, West Point, New York, June 2005

Status: Complete

Capabilities Based Readiness Metric

DSE Project No: DSE-R-0522

Client Organization: USMA – Operations Research Center of Excellence (ORCEN),
West Point, NY

Principal Analyst: MAJ William Kaczynski, M.S.
Senior Investigator: Dr. Bobbie Leon Foote, PhD

Problem Description:

The army has struggled for a long time in devising a metric that represents an effective measure of a unit's ability to fight. A further problem has been incentives in the system that results in reports that are misleading. This is documented in the Navy and the Air Force also. Problems with the current metric have been enunciated by Deputy USD Paul Wolfowitz prior to the Afghanistan conflict. Further, the current metric does not offer a mathematical basis for procurement.

Results Summary:

A brief for the June 2004 MORS Symposium was prepared and delivered by MAJ Kaczynski which was chosen as the best of 16 briefs and automatically nominated for the Barchii Prize. A paper was prepared and given to the judges. The value of the paper was supported by Dr. Laura Junor, science advisor for the Defense Readiness System, and Paul Mayberry, USD for Readiness, who wrote a letter of support. The paper was not the winner, but copies of the paper were provided to COL George Prohoda of the Army G-8, who is now considering sponsorship of a capstone project for the fall semester of AY2006 and possible additional funding. MAJ Dave Sanders, also of the Army G-8 office was briefed as well and the paper provided to him. He has disseminated the paper to other members of G-8 for consideration. The paper was also sent out to members of Dr. Junors organization. We believe there is a strong possibility for funding.

Deliverables:

- Project Proposal to Army G-8 – June 2005 - ***Complete***

Presentations & Publications:

- William H. Kaczynski and Bobbie Leon Foote. "A Utility Based Optimal Metric for Coordinating Mission Capability, Supply Level, and Readiness

Reporting,” Presentation, 72nd Military Operation Research Society Symposium (MORSS), Monterey, CA, 22-24 June 2004.

Personnel Briefed:

- MAJ Dave Sanders
- COL George Prohoda
- US Army G-8
- USARDEC

Status: Complete

Computing Probabilities of Mission Planning and Execution Success

DSE Project No: DSE-R-0523

Client Organization: USMA – Operations Research Center of Excellence
(ORCEN), West Point, NY

Principal Analyst: Dr. Bobbie Leon Foote, Ph.D.
Senior Investigator: LTC Michael J. Kwinn, Jr., Ph.D.

Problem Description:

The prediction of effectiveness for individuals in a wide variety of military tasks has been widely addressed in a successful manner. These predictions are based on the results of training and experience and the time from the last training experience. But, the prediction of effectiveness for groups in a military task has had scant attention. This project is focused on developing and testing a mathematical model.

Results Summary:

A mathematical model of tank mission tasks has been developed in terms of a Pert/CPM representation. Data for testing this model is being gathered at Fort Know by LTC John Zsido.

Status: Complete

Discretization and Stochastic Search for Bayesian Network Learning with Application to Base Realignment and Closure (BRAC)

DSE Project No: DSE-R-0526

Client Organization: George Mason University, Virginia

Senior Investigator: LTC Pamela J. Hoyt, M.S.

Points of Contact:

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Problem Description:

This research focuses on developing a stochastic process for interleaving discretization and learning structure with missing data. We apply a new methodology to actual data from the U.S. Army's recent Base Realignment and Closure (BRAC) study, which consists primarily of both continuous and discrete variables complicated by missing data. Our goal is to improve performance by better discretizing continuous variables. Accuracy can be achieved by find a discretization policy avoids information loss due to discretization. We wish to minimize the loss of information. We can then measure the quality of discretization in terms of the Bayesian Dirichlet score achieved through discretization. Through inference we gain useful insights and understanding into the apparent dependencies existing between the BRAC domain variables. Currently, several variables are being used as prediction variables for determining timelines for base closing and disposition. The issue is whether our methodology improves the inference accuracy with respect to base closing and disposition times.

Scope of Work & Methodology:

- Interleave discretization with learning of structure to reduce the information loss due to discretization to improve classification performance.
- Develop a MATLAB coded, computer-based application using Bayesian Belief Networks to test the effectiveness of this process.
- Develop a Monte Carlo method for filling in the missing data with a stochastic search over discretization policies.

- Develop an empirical study to determine the relationship between performance and the amount of missing data.
- Evaluate Bayesian model averaging with multiple structures and discretization policies to determine if it results in more accurate inferences than using a single ‘best’ model.

Results Summary:

We developed a methodology for efficiently discretizing continuous variables within an iterative loop coupled with a Bayesian learning network targeting the identification of underlying relationships in the data. We integrated several software packages to allow us to conduct the experiments necessary to develop the interleaved learning process. Data was transformed into an appropriate format that was easily exportable to other packages. The primary and supporting software programs we used were Microsoft Excel for the database files, Netica ® and BNPC for constructing Bayesian Networks and Matlab ® for interleaving discretization and learning. All four software programs were incorporated into a single architecture to support this study. Our results demonstrated a significant improvement in performance using this new approach. Moreover, in an extension to existing methods, we evaluated our process using both test cases from the literature and applied our methodology to actual data from the Army’s 2000 Base Realignment and Closure (BRAC) study. This application identified previously unknown relationships among the decision variables believed by the Commission to be driving both the time and cost to close an installation.

From our work with sparse datasets the approach of arc counting of the learned relationships to develop a structure may provide a better structure as oppose to the structure with the highest BD score. This approach was successful with the BRAC but further experimentation will be required.

Presentations and Publications:

- Selected faculty of George Mason University, Fairfax, VA, October 2004
- Capstone briefing to BRAC Division, Teleconference, May, 2005

Acquisition Modeling and Simulation Working Group (AMSWG)

DSE Project No: DSE-R-0529

Client Organization: Office of the Under Secretary of Defense (Acquisition, Technology and Logistics)

Principal Analyst: Dr. Niki C. Goerger, Ph.D.
Senior Investigator: COL Michael L. McGinnis, Ph.D.

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Dr. Glenn F. Lamartin	Office of the Under Secretary of Defense (Acquisition, Technology and Logistics) (OUSD(ATL), Director, Defense Systems, SE FORUM		
Mr. Gordon Tillery	Systems Engineering Support Office Spt to OUSD(AT&L) DS/SE 1550 Crystal Drive (Crystal Square 2) Suite 1004 Arlington, VA 22202	(703) 412-3678	Tilleryg@syseng-so.com

Problem Description:

Advance the understanding and utility of modeling and simulation (M&S) across the acquisition process, with emphasis on meeting the challenges associated with Department of Defense (DoD) commitment to capability-based acquisition for systems, systems-of-systems (SOS), and families-of-systems (FoS).

Proposed Work:

- Interest and activity will include: Review and develop M&S policy, processes, investments, tools, infrastructure, technology, workforce education, and standards to facilitate systems, SoS, and FoS engineering, to include test and evaluation, across the acquisition life-cycle and integrated with other communities of interest (such as analysis, training, etc).
- Identify M&S capabilities that will enable it to serve as a core enable and integral element of SoS and FoS acquisition.
- Identify and overcome challenges in M&S to support SoS and FoS engineering processes, to include test and evaluation, and make recommendations for effective, focused solutions, including revising policy.
- Promote a culture for long-term M&S strategies in acquisition.

- Work with other activities (such as Defense Modeling and Simulation Office (DMSO)) to assure synchronization and coordination of functional domain M&S plans.

Results Summary:

- The AMSWG is/was chartered by and reports to the Office of the Secretary of Defense (Acquisition, Technology and Logistics) (OSD (AT&L)) senior level Systems Engineering (SE) Forum, established by Under Secretary of Defense (Acquisition, Technology and Logistics) memorandum dated February 20, 2004. The AMSWG conducted monthly meetings beginning in July 2004 to develop a charter, develop a plan, and deliverables to meet SE Forum objectives. The AMSWG Charter was approved by the SE Forum 4 February 2005 and included the following deliverables:
- Definition of M&S processes for better SE in support of systems, SoS, and FoS capability-based acquisition (D1)
- Identification of gaps in the enabling M&S processes for better SE in support of systems, SoS, and FoS capability based acquisition (D2)
- Recommended actions to address the gaps identified above to improve M&S technology use in acquisition, to include strategy, policy and guidance changes (D3)
- Draft an Acquisition M&S Master Plan, if required by the DoD M&S Master Plan and SE Forum (D4)
- Deliverables D1-D3 have been completed and will be presented to the SE Forum for approval in August.

Requirements and Milestones:

- Assessment of the current state of M&S in support of acquisition – ***Complete***
- An Acquisition M&S Master Plan as required by the DoD M&S Master Plan – ***Complete***
- Proposed policy and guidance changes – ***Complete***
- Long term strategy to make M&S an integral element of SoS and FoS acquisition - ***Complete***

Project Deliverables and Due Date: As determined by AMSWG

Presentations and Publications:

- Systems Engineering at the United States Military Academy (presentation to AMSWG)

Personnel Briefed (by USMA team):

- AMSWG members
- SE Forum members

Status: AY05 activities complete; however AMSWG is still meeting.

Validation Methodology for Human Behavior Representation Models

DSE Project No: DSE-R-0530

Client Organization: USMA - Department of Systems Engineering

Senior Investigator: LTC Simon R. Goerger, Ph.D.

Problem Description:

The Department of Defense (DoD) continually pursues new modeling and simulation capabilities to meet the training and analytical needs of the U.S.'s military establishment. Improvements to the fidelity of physics-based models have raised expectations for modeling human behaviors. However, the lack of verified data has made validating human behavior models difficult.

Although validation of physics-based models is well-defined using long-established standards, the practices are not well suited for validating behavioral models. This is due to several factors:

- The nonlinear nature of human cognitive processes (Department of Defense Directive, 2001)
- The large set of interdependent variables making it impossible to account for all possible interactions (Department of Defense Directive, 2001)
- Inadequate metrics for validating HBR models
- The lack of a robust set of environmental data to run behavioral models for model validation
- No uniform, standard method of validating cognitive models.¹

Proposed Work:

The objectives of my dissertation research were to (a) presents a methodology for validating HBR model implementations for use in Department of Defense training and research models and simulations and (b) mitigate issues regarding validation and use of HBR models implemented in legacy and emergent combat simulations. A vital component of the research included development of a research agenda for future research derived from questions and directions during the execution of the research. The objectives of the proposed work are to continue the analysis and presentation of research conducted for my dissertation in the area of assessment of subject matter experts in the validation of human behavior models and fuel the research agenda

¹ Cognitive models “describe the detection, storage, and use of information” (Solso, 2001). This refers to models that simulate the human thought process to select actions for execution during a simulation.

started in the dissertation. I propose to submit my work to three forums/conferences (2005 Conference on Behavior Representation in Modeling and Simulation (BRIMS), Interservice/Industry Training, Simulation and Education Conference (I/ITSEC), and European Simulation Interoperability Workshop (Euro-SIW)) and submit my research to at least one refereed journal. The benefits the Department of Defense by providing better human behavior representation models for use in training and the decision making process through more accurate and consistent assessment of model performance.

Results Summary:

The Department of Defense relies heavily on mathematical models and computer simulations to analyze and acquire new weapon systems. Models and simulations help decision-makers understand the differences between systems and provide insights into the implications of weapon system tradeoffs. Given this key role, the credibility of simulations is paramount. For combat models, this is gained through the verification, validation, and accreditation process required of DoD analytical models prior to their use in weapon system acquisition and other studies. The nature of nondeterministic human behavior makes validation of models of human behavior representation contingent on the judgments of subject matter experts that are routinely acquired using a face validation methodology. In an attempt to better understand the strengths and weaknesses of assessing human behavior representation using experts and the face validation methodology, the authors conducted experiments to identify issues critical to utilizing human experts for the purpose of ascertaining ways to enrich the validation process for models relying on human behavior representation. The research was limited to the behaviors of individuals engaged in close combat in an urban environment. This research presents the study methodology, data analysis, and recommendations for mitigating attendant problems with validation of human behavior representation models.

The intended outcome of *any* validation process applied to models of human behavior is to assure *simulated* human behavior is consistent with *actual* human behavior under the constraints and context of a specific domain. The overarching goal of this dissertation, therefore, is to develop a methodology for validating HBR model implementations for use in Department of Defense training and research models and simulations. In accomplishing this goal, we identify and mitigate issues regarding validation and use of HBR models implemented in legacy and emergent combat simulations.

The primary scientific advancement of the research addresses how consistently and accurately SMEs validate real or simulated human performance. The consistency and accuracy of SME assessments of HBR models directly impacts model consistency and accuracy and consequently, what we know about how it will perform in novel situations. The research demonstrates the effect of personality, bias, and assessment scale on the consistency and accuracy of SME responses during the validation process. It provides a means of identify SME bias which can then be mitigated through training or use of human performance evaluation techniques. The results make it possible to provide a more consistent and accurate assessment of the HBR model providing the M&S community with better models for training and analysis.

A second major contribution of the dissertation methodology is identifying the boundaries of the common area between the three communities that will be brought together for the validation of human based models. This work lays the foundation for the research agenda designed to improve the process of validating human behavior representation models.

Other notable contributions are as follows:

- Lessons learned from the use of human behavior evaluation techniques in the assessment of human behavior model;
- Identifies means to increase the consistency and accuracy of 'face validation' procedures for HBR models (M&S)
- Formulates new techniques for identifying and measuring the presence and impact of SME consistency and accuracy (M&S)
- Identifies quantitative patterns of bias based on SME responses to assessment questions (M&S & Psychology)
- Identifies methods for removal of SME bias to mitigate SME inconsistencies and inaccuracies (M&S & Psychology)
- Establishes a statistically significant relationship between bias and Neuroticism, Extraversion, and Openness Five-Factor Inventory personality styles (M&S & Psychology)
- Proposes a research agenda for the future enhancement of human behavior representation model validation procedures (DoD M&S Community)

Requirements and Milestones:

- Acceptance of Abstract and Paper for I/ITSEC (July 2004 - **Complete**)
- Identify appropriate refereed journal to submit paper to 01 October 2004: Submitted (04 March 2005) for refereed journal to be published in the *Journal of Defense Modeling and Simulation (JDMS) Special Issue*. - **Pending publication**.
- Abstract and Paper Requirements for BRIMS 2005 are not yet posted (Due Fall 2004): Replaced with session as an invited speaker at the *Joint NMSO/AMSO Verification, Validation & Accreditation, Technical Working Group 20, 16 February 2005*. - **Complete**
- Goerger, Simon R. Ph.D., *Assessing Human Behavior Representation Models*, Presentation at the International Federation of Operational Research Societies (IFORS), Honolulu, HI, 12 July 2005.

Deliverables and Due Date:

- Final Paper (I/ITSEC) - 24 September 2004. - **Complete**
- Final Presentation (I/ITSEC) - 01 October 2004. - **Complete**

- Presentation (I/ITSEC) - 06-09 December 2004. - *Complete*

Presentations and Publications:

- Goerger, Simon R., Ph.D., *Validation and Evaluation of Cognitive Models for Combat Simulations*, Dissertation Proposal and Presentation. 12 December 2002.
- Goerger, Simon R., Ph.D., *Validation of Cognitive Models for Combat Simulations: Attempting to Avoid the Black Hole*, Military Operations Research Society Symposium (MORSS), Quantico, VA, 11 June 2003.
- Goerger, Simon R., Ph.D., *Validating Human Behavioral Models for Combat Simulations Using Techniques for the Evaluation of Human Performance*. Paper presented at the 2003 Summer Computer Simulation Conference, Montreal, Quebec, Canada, 20 - 24 July 2003.
- Goerger, Simon R., Ph.D., *Using Human Performance Evaluation Techniques for Validation of Human Behavioral Models for Combat Simulations*, Presentation at the Navy Modeling and Simulation Management Office (NAVMSMO) Verification, Validation & Accreditation, Technical Working Group 14, Naval Postgraduate School, Monterey, CA, 4 August 2003.
- Goerger, Simon R., Ph.D., *Validation of Cognitive Models for Combat Simulations: Attempting to Avoid the Pitfalls of Human Performance Evaluation*, MOVES Institute Open House, Naval Postgraduate School, Monterey, CA, 6 August 2003.
- Goerger, Simon R., Ph.D., *Validating Computational Human Behavior Models: Consistency and Accuracy Issues*, Dissertation Defense. 26 April 2004.
- Goerger, Simon R., Ph.D., *Validating Computational Human Behavior Models: Consistency and Accuracy Issues*, Doctoral Dissertation, Naval Postgraduate School, Monterey, CA, June 2004.
- Goerger, Simon R. Ph.D., *Analysis of Subject Matter Experts for Validation Human Behavior Models for Combat Simulations*, Military Operations Research Society Symposium (MORSS), Naval Postgraduate School, Monterey, CA, 22 June 2004.
- Goerger, Simon R. Ph.D., *Validating Computational Human Behavior Models: Consistency and Accuracy Issues*, MOVES Institute Open House, Naval Postgraduate School, Monterey, CA, 24-26 August 2004.
- Goerger, S. R., Ph.D., McGinnis, M. L., Ph.D., and Darken, R. P., DSc., *A Validation Methodology for Human Behavior Representation Models*. Paper presented at the Interservice /Industry Training, Simulation, and Education Conference (I/ITSEC) 2004, Orlando, FL, 06-December 2004.
- Goerger, Simon R. Ph.D., *Validating Computational Human Behavior Models: Consistency and Accuracy Issues*, Presentation at the joint Navy Modeling and Simulation Office (NMSO)/Army Modeling and Simulation

Office (AMSO) Verification, Validation & Accreditation, Technical Working Group 20, Salt Lake City, UT, 16 February 2005.

- Goerger, Simon R. Ph.D., *Assessing Human Behavior Representation Models*, Presentation at the International Federation of Operational Research Societies (IFORS), Honolulu, HI, 12 July 2005.
- Goerger, S. R., Ph.D., McGinnis, M. L., Ph.D., and Darken, R. P., DSc., “A *Validation Methodology for Human Behavior Representation Models*”. Pending Publication in *Journal of Defense Modeling and Simulation (JDMS) Special Issue*.

Personnel Briefed:

- Dr. Rudolph P. Darken (MOVES, NPS, Chair, MOVES Academic Committee, Dissertation Supervisor)
- COL Michael L. McGinnis (DSE, USMA, Professor and Head, Committee Member)
- Dr. Michael J. Zyda (MOVES, NPS, Director of MOVES, Committee Member)
- Dr. Nita L. Miller (OR, NPS, Professor of Operations Research, Committee Member)
- Dr. Christian Darken (CS, NPS, Professor of Computer Science, Committee Member)
- Prof. Susan G. Hutchins (IS, NPS, Professor of Information Sciences, Committee Member)

Status: Complete

Distributed Sensor Network (DSN) Simulation Model

DSE Project No.: DSE-R-0532

Client Organization: Sensor and Electron Devices Directorate, Army Research Lab, Adelphi, MD

Senior Investigator: LTC William Bland, Ph.D.

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Mr. John Eicke	Director, Signal and Image Processing Division Sensor and Electron Devices Directorate Army Research Laboratory Adelphi, MD 20783-1197	301-394-5000 ext. 2626	jeicke@arl.army.mil
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Problem Description:

The Sensor and Electron Devices Directorate (SEDD) of the Army Research Laboratory (ARL), one of the principal Army organizations for research and development in sensors and electron devices, is currently conducting extensive research in the area of distributed sensor networks (DSNs). DSNs are sensor fields consisting of intelligent, disparate sensors that are distributed spatially and geographically. Most DSNs include remote, unattended sensors, assets which create new capabilities but also introduce new constraints on power and communications resources. These constraints have created a renewed interest in developing sensor management strategies that increase the efficiency of DSN operations.

For my Ph.D. research, I proposed and evaluated an approximate dynamic programming approach that balanced sensor network performance against power consumption to identify efficient DSN operating policies. I briefed representatives from SEDD on my findings and they expressed an interest in additional research into DSN sensor management strategies. In addition, there are a number of sensor research projects ongoing within the department.

To support my Ph.D. research, I developed a DSN simulation model, called SNOOPS. This model currently handles a single stationary target and does not integrate terrain effects on sensing capabilities or communications. In order to continue my investigation of sensor management issues, and to support other

department sensor research projects, I need to increase the robustness and fidelity of the simulation model.

Results Summary:

During the past year, I modified the seismic, magnetic, and passive infrared sensor representations within the model and improved its ability to track moving targets. I also used SNOOPS to help COL Klimack's Capstone team investigate what sensor mixtures and densities were required for a decision maker to reallocate resources based on reports from unattended ground sensors (UGS). Finally, I am approximately 75 percent complete with a SNOOPS User Manual that will allow other researchers to implement SNOOPS to support their sensor research.

Requirements and Milestones:

- Coordinate with other department sensor researchers to identify and prioritize DSN simulation needs - June 2005 - *Ongoing*
- Consolidate these requirements and compare with current SNOOPS capabilities to identify and prioritize necessary model improvements - June 2005 - *Ongoing*
- Implement the identified model improvements - June 2005 - *Ongoing*
- Prepare a written technical report to serve as the de facto "User Manual" for the SNOOPS DSN simulation model - June 2005 - *Ongoing*

Deliverables and Due Date:

- Technical Report - June 2005

Presentations and Publications:

- Bland, William S. Ph.D., *SNOOPS (Sensor Network Optimal Operations Simulation) User Manual*, Operations Research Center of Excellence, Technical Report No.: DSE-TR-0532, June 2005.

Status: Ongoing

Future Force Warrior Analytical Support

DSE Project No: DSE-R-0542

Client Organization: Program Manager, Future Force Warrior

Senior Investigator: LTC Jeffrey B. Schamburg, Ph.D.

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Mr. Bill Harris	Future Force Warrior Integrated Analysis Co-lead TSM Soldier, Fort Benning, GA 31905	(706) 545-6826	william.harris@benning.army.mil
Mr. Bob O'Brien	Future Force Warrior Systems Engineering Co-lead NSC, Natick, Massachusetts 01760	(508) 233-4924	robert.obrien@natick.army.mil
Ms. Carol Fitzgerald	Program Manager, Future Force Warrior NSC, Fort Belvoir, VA 22060	(703) 704-1427	carol.fitzgerald@peosoldier.army.mil

Problem Description:

The Future Force Warrior (FFW) Advanced Technology Demonstration (ATD) program is a U. S. Army Science and Technology (S&T) initiative that aims to improve soldier and small combat unit capability for 2010 and beyond. FFW is intended to complement the Future Combat System (FCS) program. The desire is to transition the most promising FFW technologies and capabilities into Army acquisition programs for development and fielding. FFW supports the Ground Soldier System (GSS) spiral fielding strategy and thus, parallels the FCS spiral fielding strategy.

Although the FFW ATD is not an acquisition program, FFW also supports Land Warrior (LW) block III. Analysis is being done to determine the appropriate capabilities to recommend for LW block III and to assess the utility of emerging technologies in improving combat effectiveness of the soldier and small combat units.

The FFW program includes three major phases:

1. Phase 1 is the Concept Development Phase. This phase involved a 9 month competitive activity to select the Lead Technology Integrator (LTI) for the following phases of the program. Phase 1 was completed in April 2003 and resulted in the selection of Eagle Enterprise as the FFW LTI.
2. Phase 2 is the Design, Build, and Integration Phase. This phase began in June 2003. In January 2005 the program was re-baselined and reorganized and the LTI management responsibility was migrated to General Dynamics C4 Systems (GDC4S). As a result, phase 2 was broken down into 3 sub-phases. These include:

- a. The Systems Engineering Synchronization sub-phase (April 2005 to August 2005)
 - b. The Incremental Design sub-phase (September 2005 to September 2006)
 - c. The Build, Integrate and Test sub-phase (October 2006 to May 2007)
3. Phase 3 is the Demonstration Phase. Phase 3 is an option that may be executed upon successful completion of phase 2. If this phase is executed, it will be based upon a scope that is negotiated and agreed upon by both the Government and the LTI.

If phase 3 is executed and completed successfully, the Program Executive Office (PEO) Soldier has the option to continue the program even further with a System Development and Demonstration (SDD) phase. Similar to the case with phase 3, the SDD phase, if executed, will be based upon a scope that is negotiated and agreed upon by both the Government and the LTI.

The work described in this report took place during the re-baselining in support of Phase 2, the Design, Build, and Integration Phase. The purpose of the Design, Build, and Integration Phase is to develop FFW System of Systems (SoS) capabilities that greatly improve soldier and small combat unit war-fighting capabilities. These defined capabilities are expected to help shape the Ground Soldier System (GSS) Capability Development Document (CDD) objective capabilities. The most promising and attainable technologies may be selected for early transition to PEO Soldier SDD programs. Furthermore, FFW should be expandable so that developed capabilities can enable future expansion of other emerging Soldier as a System (SaaS) CDDs (for example, air and mounted).

Because the FFW program is an S&T program, it is expected to develop technologies and capabilities that extend those that are currently being developed by existing acquisition programs. Because the FFW technologies and capabilities have not been more fully developed yet, considerable uncertainty exists about which technologies and capabilities are most promising toward increasing soldier and small combat unit capability. Furthermore, the most appropriate Tactics, Techniques, and Procedures (TTPs) have not been fully developed because the FFW design process has not been completed. Therefore simulation, experimentation, and analysis can and should play an important role in the FFW design process.

Proposed Work:

As the primary part of this work, The Operations Research Center of Excellence (ORCEN) of the Systems Engineering Department at the United States Military Academy was tasked to provide the Government co-lead of the FFW Analysis Team with an individual assigned as the Contractor co-lead from GDC4I, the FFW LTI. Duties included:

- General participation and input to the FFW re-organization effort;
- Input to the responsibilities, key interfaces, accountabilities, and authority of the A&ET;

- Revision to the FFW Statement of Objectives (SOO), Work Breakdown Structure (WBS), and planning with respect to the FFW A&ET;
- Coordination of FFW analysis, modeling, simulation, and assessment efforts; and
- Development and implementation of FFW analysis tools, methodologies, and events.

As a secondary part of this work, research will be conducted to help develop an Integrated Analysis and Experimentation Framework to enable improved planning Analysis and Experimentation Team (A&ET) efforts. As an important part of the FFW program, the A&ET performs SoS modeling, closed-loop simulation, Soldier in the Loop (SITL) simulation, virtual simulation, and live experimentation analyses. Within the A&ET, the Analysis Team is directly responsible for these SoS efforts short of live experimentation and demonstrations. The analysis efforts must be integrated into a larger A&ET strategy that supports FFW design and development decision making. The purpose of this work is to develop an Integrated Analysis and Experimentation Framework and an Analysis and Experimentation Plan that will support the Design, Build, and Integration Phase of the FFW program. Furthermore, the Integrated Analysis and Experimentation Framework and Plan are expected to support follow-on phases of the FFW program.

Results Summary:

Some of the key contributions from this work include:

1. A Refined Set of Essential Elements of Analysis (EEAs): This work resulted in the addition of 2 new categories of EEAs (“Flexibility & Interoperability” and “Tactics, Techniques, & Procedures”). These categories were added and additional EEAs were proposed in other categories to provide a more complete list of issues that should be considered for FFW analysis and experimentation. Furthermore, this process resulted in recommended restructuring of existing EEAs to align them more with the categories their respective categories and to make them more focused so that they can be better addressed with A&ET events.
2. Measures of Performance (MOP) Hierarchy: The MOP hierarchy can be used as a tool to help identify and refine the following:
 - a. The EEAs refined as a part of this work.
 - b. The soldier functions identified in this work.
 - c. FFW operational capabilities and functional capabilities.
 - d. Potential technologies that have been over-looked.
3. Lists of Primary Measures of Effectiveness (MOEs) & MOPs and a Composite MOE: The composite MOE (the Mission Response Function) and these lists provide a common set of FFW performance measures so that A&ET results can be integrated and compared. Use of these performance measures will make it easier to relate one A&ET event to another and therefore can make it easier to develop broader generalizations about the

- results of the analyses. This work also helps to define the data collection requirements for the A&ET events.
4. An Integrated Analysis and Experimentation Framework: This framework can be used as a tool to plan and define A&ET events. It helps to identify and select:
 - a. The necessary capabilities for modeling a simulation event or for developing a live experiment.
 - b. The necessary MOPs for data collection and assessing the event.
 - c. The appropriate analysis or experimentation activity.
 5. An Initial A&ET Event Plan for FFW Phase 2: This work provides an initial A&ET Event Plan for Phase 2 of the FFW program. This general plan can be used to improve FFW design and development decision making and can serve as an example for the development of future A&ET Event Plans.
 6. A Methodology for Developing an Integrated Analysis Framework and Analysis & Experimentation Event Plans: Overall, this work provides a methodology for developing an integrated framework and analysis & experimentation event plans. The four phase general methodology can be used for other future S&T or acquisition programs. The general process described in section planning section of the technical report provides the final tasks required to develop analysis and experimentation plans.

Requirements and Milestones:

- Provide background information on FFW expertise and problem definition. Provide presentations on the Generalized Response Surface Methodology and other works relevant to FFW Integrated Analysis, Simulation, and Experimentation (Nov 04) - *Complete*
- Provide method for developing integrated MOE – February 2005 - *Complete*
- Provide MOP Hierarchy (Mar 05)- *Complete*
- Conduct group systems work to improve integrated MOE and MOP Hierarchy – March 2005 - *Complete*
- Provide integrated analysis framework - May 2005 - *Complete*
- Present Holographic Analysis Methodology - May 05 - *Complete*
- Present final recommend A&ET Event Plan and write final report - June 2005 - *Complete*

Deliverables and Due Date:

- Revised Essential Elements of Analysis List – March 2005 - *Complete*
- Integrated MOE and MOP - March 2005 - *Complete*
- MOP Hierarchy - March 2005 - *Complete*

- Holographic Analysis Methodology - May 2005 - *Complete*
- Integrated Analysis and Experimentation Framework - May 2005 - *Complete*
- Integrated Analysis Event Plan - June 2005 - *Complete*
- Final report - June 05 - *Complete*

Presentations and Publications:

- Schamburg, Jeffrey B., Ph.D., “Holographic Analysis of Military Situational Awareness Systems,” Annual Conference of the Institute of Industrial Engineering, Atlanta, Georgia, 2005.
- Schamburg, Jeffrey B., Ph.D. and Brown, D. E., “Generalized Multiple Response Surface Methodology for Complex Computer Simulation Applications,” Winter Simulation Conference 04, 2004.
- Schamburg, Jeffrey B., Ph.D., “Future Force Warrior Integrated Analysis Planning,” Operations Research Center of Excellence Technical Report, Operations Research Center of Excellence, Department of Systems Engineering, United States Military Academy, West Point, New York, 2005.

A Systems View of the USMA Staff Redesign

DSE Project No: DSE-R-0544

Client Organization: Superintendent, USMA, West Point, NY

Senior Investigator: COL Michael L. McGinnis, Ph.D

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
LTG William J. Lennox,	Superintendent US Military Academy, West Point, NY		

Problem Description:

For nearly two years, the United States Military Academy (USMA) and West Point have wrestled with how to internally restructure and realign business processes in response to changes forced upon the Academy by the military-to-civilian (MIL-CIV) conversion of duty positions, and the separation of USMA mission and West Point garrison responsibilities mandated by the Installation Management Agency (IMA).

On September 16, 2004, during a meeting the Superintendent of United States Military Academy, Lieutenant General William J. Lennox, directed the senior investigator to review work done to date, study the problems and make recommendations for dealing with the impact of MIL-CIV and IMA on the Academy

Proposed Work:

- Reorganization of the Superintendent's USMA staff.
- Management of West Point security and tracking progress to improve security analysis and assurance throughout the command.

Results Summary:

Background research revealed that existing USMA staff elements essentially function as separate, activity-centric, stove-piped entities. Stakeholder feedback identified this as a major hindrance to the Academy's pursuit of excellence and higher performance. The report provided to the Superintendent proposes a USMA staff that aligns Academy staffs with requirements to coordinate control and execute West Point missions thereby enhancing the synergy between the USMA staff, lower level staffs and the Garrison Command.

Project Deliverables and Due Date:

- Technical Report - December 2004 - *Complete*

Presentations and Publications:

- McGinnis, Michael L., Ph.D., *A Systems View of the USMA Staff Redesign*, Operations Research Center of Excellence Technical Report No: DSE-TR-0544, DTIC #: ADA433620, December 2004.

Status: Complete

PART VI – Capstone Research Activities – AY05

Bandwidth Allocation Study for the Disposable, Air-droppable, Meteorological Tower Array (DAMTA)

DSE Project No: DSE-CR-0501

Client Organization: Army Research Lab (ARL), Computational and Information Sciences Directorate, Battlefield Environment Division, at White Sands Missile Range (WSMR), New Mexico.

Senior Investigator: LTC Robert A. Powell, Ph.D.

Points of Contact:

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Mr. Bud Dagle Applied Tech Inc.	1120 Delaware Ave. Longmont, CO 80501	Ofc 303.684.8722 Fax 303.684.8773	bud@apptech.com

Problem Description:

Weather and other environmental data are critical information that affects the decision-making abilities of commanders on the battlefield. Disposable, Air-droppable, Meteorological Tower Array (DAMTA) consists of a sensor-based platform that will be dispersed over an area of interest and provide key weather data (e.g., temperature, wind speed, pressure, and humidity) and images to enhance the accuracy of the current Army Forecast Models, provide information on remote areas of the battlefield, provide forecasting for future battlefield operations and gather additional information about out of sector areas. In 2002, the USMA research explored the alternatives that would deliver DAMTA to the battlefield. The 2002 research team recommended the deliverable system (parachute), the configuration of the system and the means (i.e., helicopter) to drop DAMTA to the desired location. In 2003, the research explored the benefits of imagery and the integration of an imagery device on the DAMTA platform. The 2003 research team recommended a miniature camera; identified the imagery configuration for the DAMTA platform and research the role (value) imagery plays for users of the system. This year, ARL/WSMR wants the Department of Systems Engineering (DSE), USMA to develop and examine the best alternative to delivery the data items specifically imagery to users on the battlefield considering the constraints of cost, time (time to receive real time images) and bandwidth. ARL/WSMR also wants DSE to study the bandwidth aspects of the DAMTA network considering the DAMTA must be self-sustaining for at least 30 days with its inherent battery supply. ATI develops core part of DAMTA effort that camera will integrate with.

Proposed Work:

Design team executes the following:

1. Examine the needs of the stakeholders including the constraints of the problems to include: 1) communication capabilities and size, 2) DAMTA size and weight and 3) image resolution and size (list is not inclusive).
2. Develop a model and flow chart for the current DAMTA network including the current size and capability of the bandwidth between entities.
3. Develop a Value Hierarchy which represents the trade-offs associated with transferring data (i.e., images) from the DAMTA terminal.
4. Examine current radio and bandwidth technologies within the military's current sensor arsenal.
5. Examine DAMTA's role on the sensor battlefield and within Future Combat Force structure.
6. Develop several different alternatives (at least 30 alternatives) to transmitting data (specifically images) from the DAMTA sensor array (terminal) to the user on the adhoc network. Alternatives are in detail and should be represented in a 2D model or other type of model.
7. Model and test alternatives based on the trade-offs identified in the Value System Design.
8. Complete cost analysis modeling of the value and cost of each alternative.
9. Make a recommendation on "How to best transfer images from the DAMTA to the user?"
10. Develop a schematic or detailed list of resources needed to implement the recommended alternative (e.g., power, and computer resources; size requirements)

Results Summary:

The purpose of this research project was to investigate different digital cameras to integrate with the current DAMTA system created by Applied Technologies Inc. of Longmont, CO. The DAMTA project encourages the use of off-the-shelf technology. The project group and ARL worked together with experts in the imagery field to develop the criteria in which each camera was tested. The criteria which we selected the best camera are as follows: 1) Radiometric Resolution 2) Spatial Resolution 3) Field of View 4) Power Consumption. After application of the aforementioned criteria and other decision factors, the single chip camera was selected. In addition to the deliverable of recommending the best digital camera to integrate into the DAMTA, the group also made recommendations to alter DAMTA configurations in order to increase the longevity of its operation in the field.

Requirements and Milestones:

- Project Orientation (Fall 2004) - *Complete*
- Initial Engineering Project Management Plan (Fall 2004) - *Complete*
- Data Collection (Spring 2005) - *Complete*
- Interim Progress Review (Fall 2004 / March 2005) - *Complete*
- Client Decision Brief (Spring 2005) - *Complete*

Project Deliverables and Due Date:

- Project Brief (Spring 2005) - *Complete*
- Project Report (Spring 2005) - *Complete*
- Decision Support Tool (Spring 2005) - *Complete*

Status: Complete

Performing Verification and Validation Measures in Prioritizing Construction of Base Camp Facilities and Infrastructure

DSE Project No: DSE-CR-0502

Client Organization: Construction Engineering Research Laboratories (CERL),
Champaign, IL

Senior Investigator: LTC Robert A. Powell, Ph.D.

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER / EMAIL:
Mr. Kirk McGraw	Director Engineer Research and Development Center Construction Engineering Research Laboratories ATTN: CEERD-CF-F (Kirk McGraw) PO Box 9005 Champaign, Ill 61826-9005	Ofc (217) 373-3328 Cell (217) 353-1320 Fax (217) 373-3490	Kirk.D.McGraw@erdc.usace.army.mil

Problem Description:

The military increasingly needs to plan for, and execute, fast deployments of forces in support of the full continuum of military operations, from combat, peace enforcement, peacekeeping, training and stability and support operations. The Army needs the ability to plan quickly the location, layout and operations of the bases to sustain deployed forces. Planners at the theater level require the doctrinal and technological support necessary to plan, construct, operate and close base camps that are secure, efficient and environmentally sound. Future sustainment areas will be placed throughout the depth of the battlefield to include deep, close and rear areas. Base camp development in these areas will need to be fast, while fulfilling mission, security and environmental requirements.

There is currently no doctrine for the construction and dismantling of base camps; however the Engineering Management (EM) Program in the Department of Systems Engineering has begun base camp research in the area of prioritization of construction efforts, which is intended to contribute to military doctrine.

Proposed Work:

The Department of Systems Engineering at USMA will assist CERL in verifying and validating base camp facilities and prioritization factors in an effort to satisfy the needs of field commanders responsible for base camp operations. This project will be accomplished during Academic Year 2005 by a multi-disciplinary team of four individuals – an Operations Research major; a Systems Engineering major, and two Engineering Management majors.

The team will apply the Systems Engineering Management Process to the specific base camp planning issue, incorporating research of existing doctrine and tools, outcomes of the base camp workshop, coordination with/input from key proponents, and past research performed in this area; and apply appropriate tools to deriving a solution useful to the client. The final product is intended to be an integrated product that provides the decision maker with a tool that aids in the design, construction, and operation of base camps considering key infrastructure and environmental concerns, force protection issues, and specific structural requirements.

Results Summary:

The project resulted in the development of a computerized methodology for prioritizing the sequence of construction tasks for Combat, Support, Humanitarian and Peacekeeping missions. This methodology was delivered to the client and given the name “Decision Support Tool” or “DST,” which is essentially a computer based tool to help base camp commanders enumerate and prioritize construction of base camp structures and infrastructures. The preferred delivery mechanism was an interactive Microsoft Excel spreadsheet that allowed the commander to input his weights for key factors or overall mission objectives. For each mission, planners must give a weight assessment of each objective and sub-objective that support a base camp. The final output of the decision support tool will be a prioritized list of sub-objectives, which is generated by taking the product of the weight assessments. Each sub-objective will provide several structures for the commander to consider implementing in his or her base camp.

Testing of the 2004 Capstone product indicates including mission type as a filter and restricting the output to a single prioritized list of possible structures and infrastructures. The tool provides commanders with a prioritized list of sub-objectives based on their input or predetermined (if they choose to accept it) weighting, which produces a “priority of work” that is used by engineers involved in the construction of base camps.

Requirements and Milestones:

- Site Visit to CERL (Fall 2004) - *Complete*
- Initial Engineering Project Management Plan (Fall 2004) - *Complete*
- Data Collection (Fall 2004/Spring 2005) - *Complete*
- Interim Progress Review (Fall 2004/March 2005) - *Complete*
- Client Decision Brief (Spring 2005) - *Complete*

Project Deliverables and Due Date:

- Project Brief (Spring 2005) - *Complete*
- Project Report (Spring 2005) - *Complete*
- Decision Support Tool (Spring 2005) - *Complete*

Presentations and Publications:

- Powell, R. A., M. Gilbert, D. Smith, J. Lee, D. Lao, and C. Keogh.
“Automating the Base Camp Master Planning Process,” 73d MORSS
Conference: Balancing Risk for An Uncertain Future, United States Military
Academy, West Point, New York, 21-23 June 2005.

Status: Complete

A Study of Existing Technologies for Identifying and Assessing Urban Infrastructure/Infrastructure Recon for Urban Operations

DSE Project No: DSE-CR-0503

Client Organization: Construction Engineering Research Laboratories (CERL),
Champaign, IL

Senior Investigator: LTC Robert A. Powell, Ph.D.

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER / EMAIL:
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Dr. Charles Marsh	Engineer Research and Development Center Construction Engineering Research Laboratories ATTN: P.O. Box 9005 Champaign, ILL 61826-9005	Ofc (217) Fax (217) 373-7222	Charles.P.Marsh@erdc.usace.army.mil

Problem Description:

In major operations since World War II, the United States military has preferred to bypass major urban areas to avoid the type of high intensity, close combat expected there. The explosive growth of the world's major urban centers, changes in enemy strategies, and the Global War on Terrorism, however, have made the urban battle space increasingly decisive and virtually unavoidable.

The urban environment blunts many of the advantages that US forces enjoy in more open terrain. It strips away our ability to see farther and more clearly, maneuver faster, and engage more precisely than the enemy. Our challenge is to develop new levels of urban military capability not only to win in the urban battle space, but also to convincingly deter our enemies from even considering fighting in urban terrain.

Given the complexity and challenges of operating in an urban environment, the central theme for joint urban operations is: achieving our desired end state by understanding, controlling, and exploiting the unique elements of the urban environment (e.g., terrain, infrastructure, population, and information); sensing, locating, isolating, and destroying the adversary; controlling the pace and tempo of operations; and applying power precisely and discriminately. Power includes the coherent application of sequential and simultaneous, military and nonmilitary, kinetic and no kinetic means to achieve lethal and no lethal effects.

Success in joint urban operations requires several conditions. First, it requires a holistic understanding of the complexity of the urban environment, including the enemy, friendly forces and the people, systems, and infrastructure that comprise the

modern city. Second, success requires deliberate efforts to shape information and operational environments to set the right conditions for rapid and precise action. Third, distributed effects-based operations require as current and precise knowledge as is possible and focused precision capabilities to destroy or capture critical nodes which underpin the coherence of the enemy force. By continuously consolidating our gains, we are able to apply increasing pressure on the enemy.

Eight principles guide the planning, preparation, deployment, employment, and sustainment for urban operations:

1. Understand the complex urban environment.
2. See first, see clearly, and see in depth.
3. Control the urban environment.
4. Isolate the adversary.
5. Take the initiative and control the tempo of operations
6. Engage the adversary comprehensively.
7. Ensure every action contributes to achieving the desired end state.
8. Balance restraint and overmatching power.

Operations in the urban environment can no longer be considered an “elective” competency of the joint force. Our adversaries have already recognized the potential of using the urban battlespace to mitigate our overwhelming military advantages. The US must move quickly and aggressively to develop the capabilities necessary to establish dominance in this environment as we have in others, deter the enemy from operating there, and defeat him decisively when deterrence fails.

In particular, the proposed work focuses on development of reconnaissance capability in the urban environment. (See bolded points on the bullet list above.) The objective is to collect information regarding several centers of expertise within the Army that have, heretofore, not been required to work together as a group. These centers include: the structural research, the sensors and reconnaissance, and the front-line warfighter.

These areas of research support the academic objectives of the EM program at USMA, and provide a forum for both faculty and cadets to apply the concepts from their studies to a real-world military problem. This enhances the academic and professional development of both faculty and cadets as Army officers.

Proposed Work:

The Department of Systems Engineering at USMA will assist ERDC-CERL in two phases.

First, assist in gathering materials describing pre-existing resources and organizations that ERDC will have to cooperate with to either obtain existing data or field new capabilities. Important points to be tracked down include:

- What resources are currently available?

- What forms of information would be most helpful to the warfighter?
- How can the existing resources be best exploited to fill these needs?

Second, during the process of gathering materials for phase I, propose a strategy(ies) to develop a new application(s) in this area using pre-existing data resources. If it is found that current resources are sufficient to develop one or more new applications, pick one and develop this through the proof-of-concept stage. If it is found that current data resources are insufficient, develop a strategy for a new application that maximizes use of existing reconnaissance resources with minimal new capabilities.

The proposed project has a rather loose specification, but the topic area is relatively new and participants can be assured that a creditable performance will lead to long-term research and development efforts carried out by ERDC for many years.

This project will be accomplished during Academic Year 2005 by a multi-disciplinary team of four individuals – an Operations Research major; a Systems Engineering major, and two Engineering Management majors with a minor in civil engineering and nuclear engineering, respectively.

Results Summary:

This two semester capstone culminated with a matrix of different technologies that will provide the client with a better understanding of recon devices that would aid their overall mission. The information will provide them with a broad understanding of recon technologies, and could ultimately offer them the missing link with current recon capabilities.

Requirements and Milestones:

- Site Visit to CERL/Project Orientation (Fall 2004) - *Complete*
- Initial Engineering Project Management Plan (Fall 2004) - *Complete*
- Data Collection (Fall 2004/Spring 2005) - *Complete*
- Interim Progress Review (Fall 2004/March 2005) - *Complete*
- Client Decision Brief (Spring 2005) - *Complete*

Project Deliverables and Due Date:

- Project Brief (Spring 2005) - *Complete*
- Project Report (Spring 2005) - *Complete*
- Proof of Concept Demonstration (Spring 2005) - *Complete*

Status: Complete

Feasibility Study on Automating Rules of Engagement in Fully Automated Target Engagement Systems

DSE Capstone Project No: DSE-CR-0504

Client Organization: USMA - Department of Systems Engineering

Sr. Investigator: Dr. Patrick J. Driscoll, Ph.D.

Problem Description:

This study focuses on identifying and exploring the feasibility of automating U.S. Army rules of engagement (ROE) within sensor-based targeting systems as one engineering design alternative capable of speeding up the engagement cycle for time sensitive targets. Using a functional decomposition structure based on extensive stakeholder interviews and subsequent analysis, we concluded that this alternative's feasibility was significantly impeded by limitations in target discrimination, issues of trust, public approval, and technical sensor incorporation. Ultimately, while all stakeholders concluded that feasibility under certain operational constraints was certain, complex engagement scenarios in which friendly forces are closely located to enemy force targets remains infeasible.

Scope of Work & Methodology:

- Define major functional areas effecting feasibility of automated ROE systems.
- Define major operational categories of ROE along with their associated targeting processes.
- Develop an effective model to understand and analyze modern battlefield ROE considerations based on stakeholder interviews.

Results Summary:

Over 20 separate interviews were conducted during the first semester, representing major combat commanders at company, battalion and brigade levels from both Army and Marine Corps units taking part in hostile actions in Afghanistan and Iraq. , extensive interviews were conducted with Staff Judge Advocate representatives at Theater, Corps and Department of the Army levels. We developed the framework below (Table 1) for use in the stakeholder interviews in order to discuss complex issues of automating rules of engagement.

Table 1
Stakeholder Interview Framework Matrix

		ROE Options		
		Fully Automated	Partially Automated	No Automation
O P E R A T I O N	Phase 1			
	Phase 2			
	Phase 3			

Fully Automated: Sensors gather intelligence, analyze the intelligence, determine target eligibility, determine firing solution, and engage the enemy target automatically

Partially Automated: Sensors gather information about the enemy, analyze it, determine target eligibility, and provide targeting solution to the soldier.

No Automation: Current System employed by the Army today

Phase 1: Small unit operations before main effort reaches AO

Phase 2: Large-scale operation with conventional forces on ground

Phase 3: Peacekeeping operations (post hostilities)

Two applications of ROE were identified based on the battlefield environment that the sensor system was located in. A process flow was identified for each of these (Figure 1 and Figure 2, respectively), resulting in our ability to identify the exact location at which the proposed automation would enhance the process.

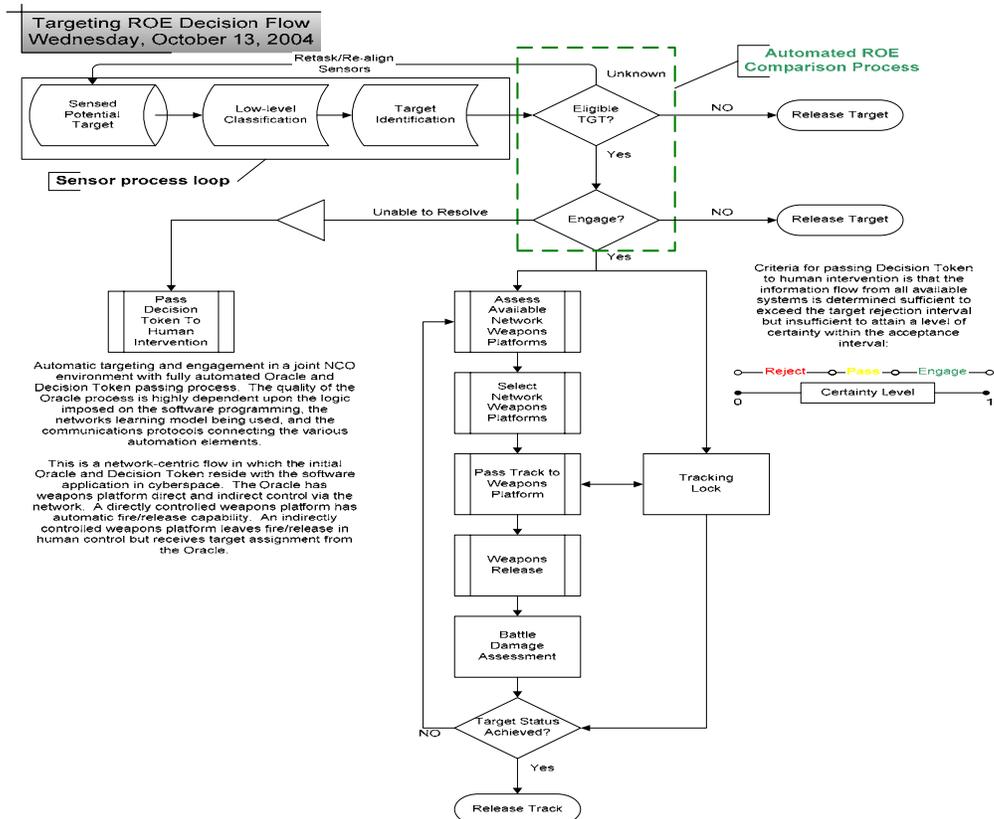


Figure 1 – Automated Rules of Engagement Peacekeeping Operations

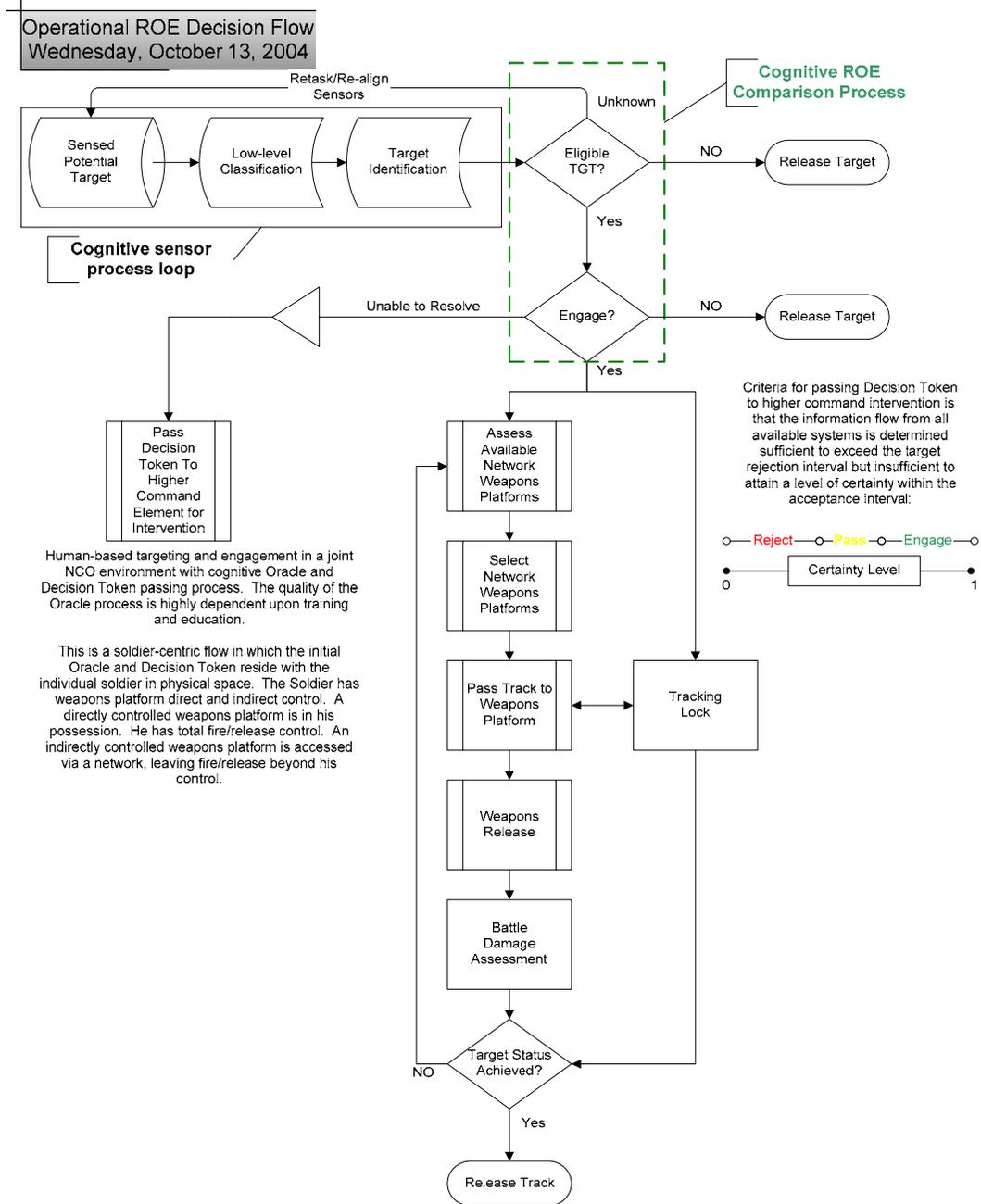


Figure 2 – Cognitive Rules of Engagement for Peacekeeping Operations

Based on our analysis and extensive stakeholder interviews, we determined that feasibility in the seven major functional areas is as follows. Red color coding identifies operational situations in which infeasibility currently exists. Yellow coding identifies operational situations in which automating ROE is feasible but significant areas of concern need to be addressed. Green coding indicates those situations in which complete feasibility exists.

Legal:

		ROE Options		
		Fully Automated	Partially Automated	No Automation
O p e r a t i o n	Phase 1	Yellow	Green	Green
	Phase 2	Red	Green	Green
	Phase 3	Red	Yellow	Green

Political:

		ROE Options		
		Fully Automated	Partially Automated	No Automation
O p e r a t i o n	Phase 1	Red	Yellow	Green
	Phase 2	Red	Yellow	Green
	Phase 3	Red	Yellow	Green

Economical:

		ROE Options		
		Fully Automated	Partially Automated	No Automation
O p e r a t i o n	Phase 1	Yellow	Yellow	Green
	Phase 2	Yellow	Yellow	Green
	Phase 3	Yellow	Yellow	Green

Behavioral:

		ROE Options		
		Fully Automated	Partially Automated	No Automation
O p e r a t i o n	Phase 1	Red	Green	Green
	Phase 2	Red	Yellow	Green
	Phase 3	Red	Yellow	Green

Technical:

		ROE Options		
		Fully Automated	Partially Automated	No Automation
O p e r a t i o n	Phase 1	Yellow	Yellow	Green
	Phase 2	Red	Yellow	Green
	Phase 3	Red	Yellow	Green

Operational:

		ROE Options		
		Fully Automated	Partially Automated	No Automation
O p e r a t i o n	Phase 1	Yellow	Green	Green
	Phase 2	Yellow	Green	Green
	Phase 3	Yellow	Yellow	Yellow

Ethical/Moral:

		ROE Options		
		Fully Automated	Partially Automated	No Automation
O p e r a t i o n	Phase 1	Yellow	Green	Green
	Phase 2	Yellow	Green	Green
	Phase 3	Yellow	Green	Green

Capstone Advisor(s): Patrick J. Driscoll, Ph.D., Professor of Operations Research, USMA – Department of Systems Engineering, (845) 938-6587

Mark D. Welton, J.D., LL.M, S.J.D., Professor of Law, USMA – Department of Law.

Capstone Team Member(s): Cadets Craig Brewer, Dan Maher, Jon Sammon, Nathan Stone

Presentations and Publications:

- *Automating Rules of Engagement Feasibility Study*. Presented at the 2005 Dept of Systems Engineering Capstone Conference, USMA, West Point, NY. Invited presentation to the Center for Professional Military Ethics, USMA, West Point, NY.

Status: Complete

Modeling and Analysis of Retread Tire Supply Chain

DSE Capstone Project No: CR-0505

Client Organization: Tirecenters, Inc. and TACOM Tire Division

Sr. Investigator: Dr. Patrick J. Driscoll, Ph.D.

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
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Mr. Harold "Butch" Jordan, Director of Supply Chain Operations	310 Inglesby Parkway Duncan, South Carolina 29334	(800)603-2430	butch.jordan@tirecenters.com www.tirecenters.com
Mr. Anthony Warrior Acting Chief, Tire Group	US Army TACOM	(586) 574-4294	Anthony.A.Warrior@us.army.mil
Mr. Glenn Gula	US Army TACOM	DSN 786-4259	
Ms. Bonnie Marx	US Army TACOM	DSN 786-4271	

Problem Description:

This project addresses the acquisition supply chain (SC) for retread tire manufacturing by Tirecenters, Inc. (TCI), based in South Carolina. The acquisition process is imbedded within complex SC operation engaged in moving from 14 independent regional locations to a national network operation intended to extend the value chain of new tire manufacturing for Michelin, North America. While large national accounts such as UPS, Penske, and Yellow tend to dominate TCi's customer base demand, we were asked to examine acquisition of casings as it applies to their regional and local customer base to help TCi understand where opportunity exists to improve operations. TACOM had a direct interest in this project because of their on-going retread operations in both Kuwait and Iraq.

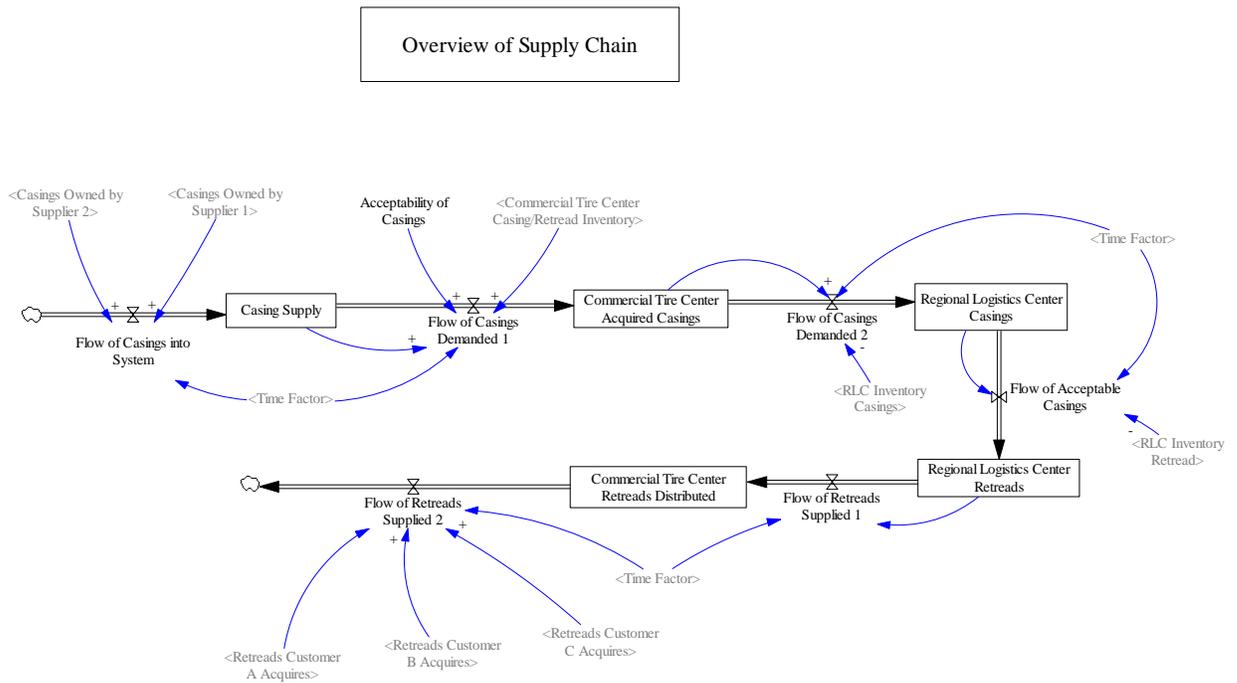
Scope of Work & Methodology:

- Understand the retread process and the roles of the major organizational elements within this process.
- Develop an effective model to understand and analyze the flow of acquired materials within the retread operation.
- Develop an effective model to understand and analyze complex interactive organizational elements affecting decisions within the acquisition process.
- Develop an effective model to understand and analyze the degree to which Tirecenters, Inc. is leveraging information to mitigate risk and enhance competitive advantage within their acquisition process.

Results Summary:

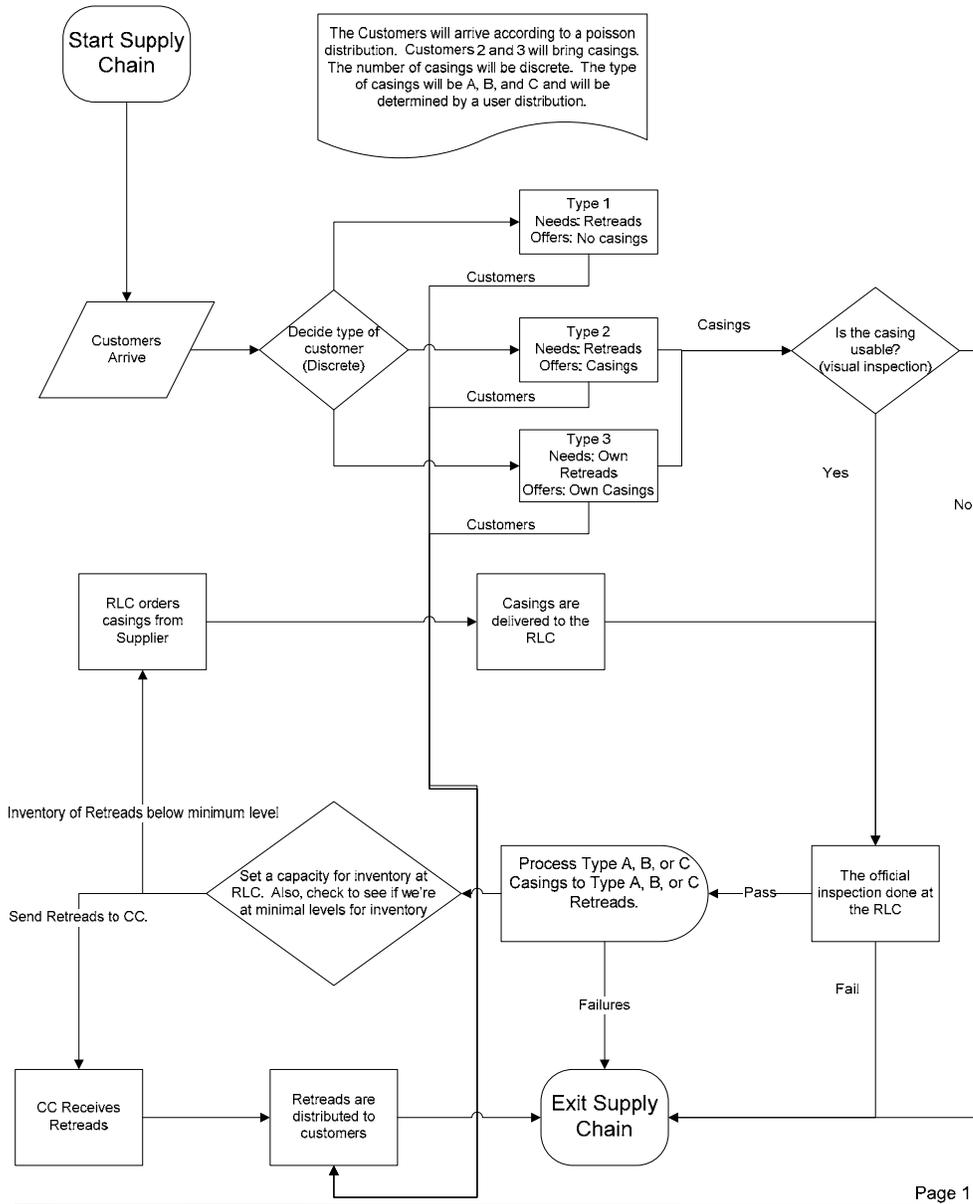
We developed three complementary modeling approaches to address the concerns of the client. First, a system dynamics (SD) model was used to capture the complex interaction of policy and practice influences across the supply chain. This provided significant insights as to where improvements might be made by shifting the nature and intensity of needed interactions. Three of the major SD levels are shown in the following illustrations.

Overall Supply Chain Dynamics:



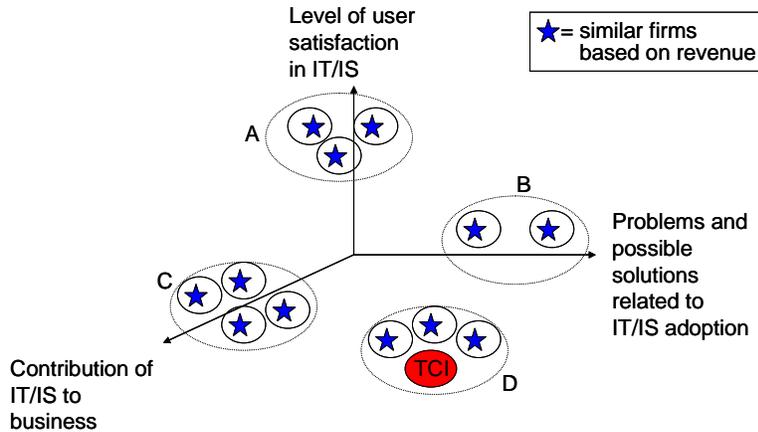
making. Because of time and resource limitations, the Northeast region was selected as representative of the network. The simulation flowchart capturing the movement of materials within the supply chain is shown below. It is important to note that the materials undergoes a transformation from casings to retread tires, hence creating two subsystems that complement each other within the acquisition system.

Supply Chain Flow Chart

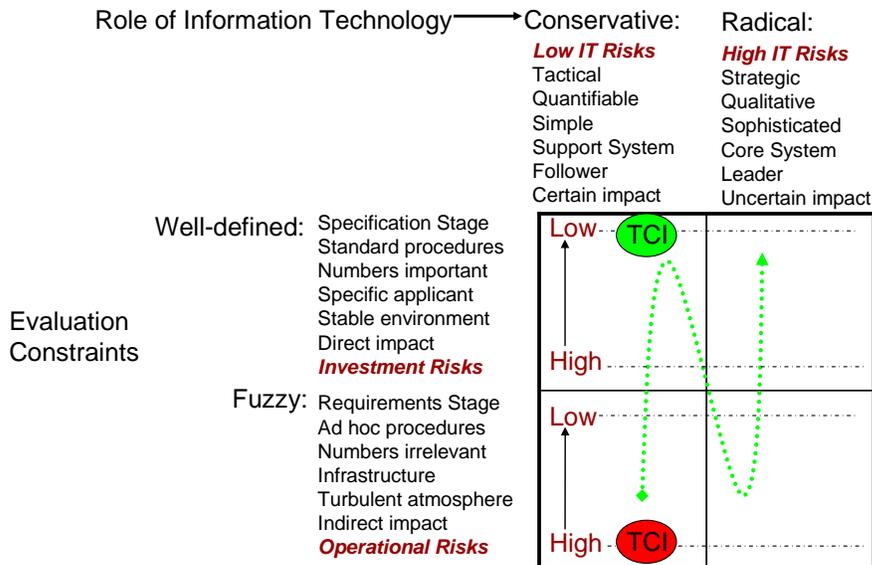


Finally, the companies use of information and information technology within their acquisition process was analyzed against a benchmark of 12 similar industrial companies. Their relative placement was identified relative to three significant dimensions: level of user satisfaction in IT/IS, contribution of the IT/IS to the

business, and problems and possible solutions related to IT/IS adoption. The following illustration shows the results of this analysis.



Additionally, we identified that Tirecenters current deployment and use of IT/IS represented an operational risk due to a significant loss of competitive advantage. We recommended that they take action to acquire and deploy new IT/IS assets in order to convert this risk into a simple investment risk for the company, as shown in the illustration below.



Overall Recommendations:

- Apply systems dynamic model to TCI policy decisions, including supplier relationships.
- Extend ProModel simulation to include all 14 regional operations.
- Leverage IT/IS investment to shift risk from operations to investment category.
- Reduce training requirements and over-dependency on individual knowledge using IT/IS
- Move to a common interface/database for communications and information sharing within the TCI supply chain network

Capstone Advisor(s): Patrick J. Driscoll, Ph. D., Professor of Operations Research, USMA – Department of Systems Engineering, (845) 938-6587

Capstone Team Member(s): Cadets Wade Greenlee, Tae Kim, Tom Peabody, Joel Stewart

Presentations and Publications:

- *Supply Chain Modeling & Analysis*. Presented at the 2005 Dept of Systems Engineering Capstone Conference, USMA, West Point, NY.

Status: Complete

Communications Model Analysis

DSE Capstone Project No.: DSE-CR-0506

Client Organization: Space and Terrestrial Communications Directorate, CERDEC-RDECOM, Ft. Monmouth, NJ

Senior Investigator: LTC William S. Bland, Ph.D.

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Mr. Robert Both	Director, Space and Terrestrial Communications Directorate Communications-Electronics Research, Development, and Engineering Center (CERDEC) Research, Development, and Engineering Command (RDECOM) Ft. Monmouth, NJ 07703	732-427-6203	Bob.Both@us.army.mil

Problem Description:

The Space and Terrestrial Communications Technology Directorate (S&TCD) of the Communications-Electronics Research, Development, and Engineering Center (CERDEC) of the Research, Development, and Engineering Command (RDECOM) has the mission to acquire, develop and integrate secure seamless tactical communications for the digitized battlefield. S&TCD performs research, development, and engineering functions in all aspects of terrestrial, avionics, and space-dependent communications technology.

One of the tools used by S&TCD is the COMSIM Sensor Network Simulator/Analysis Tool. COMSIM uses a complex radio propagation model, called knife-edge, to determine the probability of two sites communicating with each other. COMSIM takes into account the effects of terrain elevation and ground cover on communications ranges and sensor coverage. To create the proper model, a seamless world database was assembled from many sources. The communication simulation model computes the Path Loss Capability (PLC) and compares it to the total attenuation over the path between the transmitter and the receiver. PLC must be greater than total attenuation for successful communication. Each parameter used to compute PLC and total attenuation can be changed in an attempt to optimize their values for some particular cost-benefit function.

The client uses the COMSIM model for sensor development and experimentation, but asked us to create an operational use for the model that could directly benefit warfighters.

Results Summary:

After becoming familiar with the COMSIM model, the team decided to use this communication simulation model as the basis for a decision support system (DSS).

The DSS was intended to provide advice on the employment of a tactical sensor network. In essence, the DSS provides the user a recommendation on the sensor density and sensor mix that would best satisfy the current mission. To provide this recommendation, the DSS first solicits a value model from the user that balanced the importance of search region coverage, network connectivity, and resource utilization for the particular mission. The DSS then searches a database of COMSIM results to determine which combination of parameters (numbers of clusters, number of sensors per cluster, and cluster size) performs best according to the solicited value model.

The DSS is able to provide real-time recommendations because the database was created during the DSS development process, not while the DSS is being used. This database was created by running numerous iterations of the COMSIM model for various values of the parameters identified above, for various terrain conditions. The communications simulation model results were then organized in a database format for easy manipulation by the DSS.

Requirements and Milestones:

- Initial site visit: 3 Sep 04 *Completed*
- CERDEC Lab Tour: 4 Oct 04 *Completed*
- Problem Definition Complete 22 Sep 04 *Completed 24 Sep '05*
- Design and Analysis Complete 23 Nov 04 *Completed 12 Feb '05*
- Decision Making Complete Feb 05 *Completed 15 Apr '05*
- Implementation Complete Apr 05 *Completed 1 May '05*

Project Deliverables and Due Date:

- IPR #1 24 Sep 04 *Completed 24 Sep '04*
- IPR #2 29 Oct 04 *Completed 29 Oct '04*
- IPR #3 1 Dec 04 *Completed 01 Dec '04*
- IPR #4 26 Jan 05 *Completed 11 Feb '05*
- IPR #5 03 Mar 05 *Completed*
- IPR #6 31 Mar 05 *Completed*
- Final Report 10 May 05 *Completed*

Presentations and Publications:

- Costa, Anthony; Larson, Christopher; Morse, Allison; Reinke, John; and Thiele, Matthew, A Simulation-Based Sensor Network Decision Support System, Presentation at the Department of Systems Engineering Projects Day, West Point, NY, 4 May 2005.

- Costa, Anthony; Larson, Christopher; Morse, Allison; Reinke, John; and Thiele, Matthew, A Simulation-Based Sensor Network Decision Support System, Final Report, West Point, NY, 13 May 2005.
- Costa, Anthony; Larson, Christopher; Morse, Allison; Reinke, John; Thiele, Matthew; and Bland, William S. Ph.D. A Simulation-Based Sensor Network Decision Support System, paper scheduled for presentation at the *INFORMS Annual Meeting*, November 2005 (*pending*).

Status: Complete.

Simulation Studies to Support USMA R-Day Design

DSE Project No: DSE-CR-0508

Client Organization: US Corps of Cadets (USCC), USMA, West Point, NY

Principal Analyst: MAJ John Harris, M. S.
Senior Investigator: LTC Simon Goerger, Ph. D.

Problem Description:

The current R-Day operations, particularly events from the time New Cadets arrive at Thayer Hall until the Oath Ceremony at Trophy Point, are not functioning at optimal rates. Specifically, there are areas of Thayer Hall and the Cadet Area USCC would like analyzed to see if back-ups of candidates in Thayer Hall can be alleviated and the process in the Cadet Area streamlined to ensure each candidate is properly measured for and fitted with ME trousers for the Oath Ceremony.

Proposed Work:

Model Thayer Hall and Cadet Areas of the R-Day process to analyze the results with the desire of eliminating the inefficient build-up of candidates, which results in some candidates not being properly trained and properly attired for the Oath Ceremony. Specifically, we will look at the Oath Station flow, the effect of introducing a haircut inspection station in Thayer Hall, and switching the order and location of Stations 4 and 5. Additionally, we will analyze methods for improving the flow of candidates to lunch, Cadet Area issue points, and the barbershop with the same goal. We will also look at the size of training groups and duration of drill and ceremony stations in order to make the Cadet Area activities more efficient. This requires the process and resulting model to be divided into two major areas, the Thayer Hall and the USCC portions. Thayer Hall Reception Day is a very complex system that is formed of various support units consisting of PAO, DOL, DOPS, USCC, Admissions, Directorate of Operations, Plans, and Security, soldiers from 1st Battalion, 1st Infantry, Cadet Mess, Cadet Supply, and many more. These groups and individuals are required in the planning, preparation, and execution of Reception Day. This mixed organizational structure requires a central commander or group of commanders to ensure that coordination and communication is maintained at all times.

Several supporting organizations were involved in the research and development of this R-Day model. Many of these groups are also involved in the actual R-Day. The groups include: Brigade Tactical Department, the United States Corps of Cadets, Department of Logistics, the Cadet Mess Hall, the Cadet Health Clinic, the Systems Engineering Department, the Red Cross, the Cadet Treasurer, and the Boy Scouts. (There were also some other miscellaneous groups.).

Results Summary:

Every year, approximately 1300 cadet candidates are in-processed on Reception Day (R-Day) at the United States Military Academy at West Point. In order to analyze this system, we chose to create a simulation. For our project, we divided R-Day into two general areas of in-processing. The first area consists of the stations within Thayer Hall, and the second area consists of those stations in the cadet area associated with the United States Corps of Cadets (USCC). Although the Thayer Hall portion has been modeled before, our model of R-Day included both the Thayer Hall and the USCC portions of R-Day.

The end result of our project is a ProModel simulation of R-Day along with data analysis of several alternatives that were investigated. We will also produce a range of recommended parameters that will lead to the most beneficial R-Day solution.

Our project had several major milestones. The most important are as follows: the completion of our model of the Thayer Hall, the completion of our model of the USCC, and the completion of our analysis of the alternatives.

The benefits from our project are the suggestions that will allow R-Day to become more efficient. In the end, this means that in-processing will be completed earlier, which will allow more time to prepare for the Oath Ceremony. Technically, our project shows that there is a need to keep more accurate data throughout R-Day.

Requirements and Milestones:

- Problem Definition Complete - 22 September 2004 - *Complete*
- Design and Analysis Complete - 23 November 2004 - *Complete*
- Decision Making Complete - February 2005 - *Complete*
- Implementation Complete - April 2005 - *Complete*

Project Deliverables and Due Date:

- Interim IPRs: IPR #1 - 24 September 2004 - *Complete*
IPR #2 - 29 October 2004 - *Complete*
IPR #3 - 1 December 2004 - *Complete*
IPR #4 - 25/26 January 2005 - *Complete*
IPR #5 - 02/03 March 2005 - *Complete*
IPR #6 - 30/31 March 2005 - *Complete*
- Final Briefing: 9 December 2004 - *Complete*
- Technical Report: 9 December 2004 - *Complete*

Presentations and Publications:

- Fuller, Stephen, Glick, Jeffrey, Kavanaugh, Thomas, and Sheets, Arlan, *US Military Academy Reception-Day Simulation and Optimization*. Presentation at the Hollis Awards Competition, West Point, NY, 26 April 2005.
- Fuller, Stephen, Glick, Jeffrey, Kavanaugh, Thomas, and Sheets, Arlan, *US Military Academy Reception-Day Simulation and Optimization*. Presentation at the Department of Systems Engineering Projects Day, West Point, NY, 4 May 2005.
- Simon R. Goerger, Stephen P. Fuller, Jeffrey D. Glick, Thomas P. Kavanaugh, and Arlan C. Sheets. “Educating Future Systems Engineers: US Military Academy Reception-Day Simulation and Optimization,” Presentation, 8th Annual Systems Engineering Conference, San Diego, CA, 24-27 October 2005.
- Simon R. Goerger, Stephen P. Fuller, Jeffrey D. Glick, Thomas P. Kavanaugh, and Arlan C. Sheets. “Using Commercial Simulation Software to Model Linear and Non-Linear Processes: US Military Academy Reception-Day Simulation and Optimization,” Presentation, 8th Annual Systems Engineering Conference, San Diego, CA, 24-27 October 2005.

Personnel Briefed:

- BG Scaparrotti (USMA, Commandant of Cadets)
- COL Scott (USCC, Brigade Tactical Officer)
- LTC Martis (USCC, 1st Regimental Tactical Officer and OIC R’Day 2005)
- SGM Christensen (USMA Band and NCOIC Thayer Hall for R’Day 2005)

Status: Complete

Analysis of Alternatives for Arming UAVs

DSE Project No: DSE-CR-0517

Client Organization: PEO Aviation, Redstone Arsenal, AL

Senior Investigator: Dr. Roger C. Burk, Ph.D.

Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
COL John D. Burke	Project Manager, Unmanned Aerial Vehicle Systems PEO Aviation Redstone Arsenal, AL 35898	256-895-4449	burkejd@tuav.redstone.army.mil
Mr. Jim Charlton	TUAVS PEO Aviation Redstone Arsenal, AL 35898	256- 895-4365	jim.charlton@tuav.redstone.army.mil

Problem Description:

The Army project manager for UAVs asked for an evaluation of the best near-term option for mounting an air-to-surface missile on an Army UAV. The aircraft options were to include the Shadow, the Hunter, the Predator, and the Firescout; the missiles were to include the Hellfire, the APKWS (Advanced Precision Kill Weapon System), and the Viper Strike. The evaluation criteria were to include payload weight, aeromechanical feasibility, safety, manpower needed, cost (both research & development and life cycle), training requirements, and transport requirements.

This was the third in an annual series of UAV capstone projects undertaken for PEO Aviation.

Proposed Work:

- Evaluate the problem and identify appropriate measures of performance
- Identify and gather data on candidate systems
- Develop parameter-based spreadsheet model to calculate measures
- Compare alternatives and make recommendation

Results Summary:

We completed a functional analysis of an armed UAV system, and developed a value model to evaluate the alternatives, including function-based performance measures as well as additional measures to capture non-performance criteria, such as safety, which were important to the client or to other important stakeholders. Feasibility screening

eliminated the Shadow as a weapon carrier because of low payload capacity. Evaluation of the missiles resulted in selection of the APKWS, largely because its low weight made many operational and logistics functions easier and its smaller warhead was better suited to the low-intensity urban conflicts that were judged most likely in the near future.

Many of the performance data used as input to the value model could be derived directly from published information, client, data, or engineering judgment. However, spreadsheet-based tools were developed to measure performance in three areas: overall system reliability, time required to attack a new target of opportunity, and number of targets missed because all missiles were expended. Detailed evaluation of the final three alternatives (APKWS carried by Firescout, Hunter, or Predator) resulted in a virtual tie in overall value, with the Firescout system having a narrow advantage of only 0.6 units on a scale of 100. The Firescout's capability for vertical flight gave it an advantage in several criteria, and its relatively high speed made it quicker to move to new targets of opportunity. An interesting insight derived from the modeling was that Firescout's short endurance, which is normally seen as a disadvantage, actually worked out as an advantage for the armed system because it provided frequent opportunities to rearm and so fewer potential targets were missed.

Requirements and Milestones:

- Background research on UAVs and missiles (Fall 04) *Complete*
- Development of value model (Fall 04) *Complete*
- Development of models as necessary for evaluation measures not directly available from client or from published data (Spring 05) *Complete*
- Sensitivity analysis (Spring 05) *Complete*
- Write up and present results (Spring 05) *Complete*

Project Deliverables and Due Date:

- IPRs: Oct 04; Dec 04; Feb 05 *Complete*
- Final Briefing: Apr 05 *Complete*
- MORSS Presentation: Jun 05 *Complete*
- Technical Report: Aug 05 *Not required*

Presentation:

- Burk, Roger, Germann, Brandt, Lee, Brian, Severson, Todd, Wesmiller Matthew, *Arming Army UAVs*, MORSS, West Point, NY, 22 Jun 05

Personnel Briefed:

- COL John D. Burke (Project Manager, Unmanned Aerial Vehicle Systems)
- BG Bill Phillips (Deputy PEO Aviation)
- Mr. Walter Hollis (Deputy Under Secretary of the Army for Operations Research)

Status: Complete.

Mini-Baja East

DSE Project No: DSE-CR-0518

Client Organization: Society of Automotive Engineers

Senior Investigator: LTC Robert A. Powell, Ph.D

Problem Description:

The Mini-Baja East competition is held annually by the Society of Automotive Engineers and sponsored by Briggs & Stratton. The purpose is to encourage student engineering creativity. Schools are challenged to build a rugged, four wheel, off road vehicle that can perform in the harshest of conditions.

Proposed Work:

USMA has entered the competition and are required to design and build a durable, single-seat, off road vehicle worthy of a fictitious firm's contract. The vehicle will be able to successfully compete in each of the following areas: speed (acceleration, top speed), traction (pull event), maneuverability, water maneuverability, and durability.

Results Summary:

The project resulted in the development of a rough terrain vehicle that competed successfully in this year's Mini-Baja East competition.

Requirements and Milestones:

- Initial Engineering Project Management Plan (Fall 2004) - ***Complete***
- Vehicle Construction (Fall 2004/Spring 2005) - ***Complete***
- Interim Progress Review (Fall 2004/March 2005) - ***Complete***
- Capstone Presentation (Spring 2005) - ***Complete***

Project Deliverables and Due Date:

- Project Budget (Spring 2005) - ***Complete***
- Project Plan (Spring 2005) - ***Complete***
- High Performance Car (Spring 2005) - ***Complete***

Multi-Sensory Autonomous Ground Vehicle Intercollegiate Competition Team (MAGIC)

DSE Project No: DSE-CR-0520

Client Organization: Oakland University, Rochester, Michigan

Senior Investigator: LTC Robert A. Powell, Ph.D.

Problem Description:

Navigation is a practice that is thousands of years old and is used by hikers and soldiers, on the sea by sailors, and in the air by pilots. Procedures have continuously improved from line-of-sight to moss on trees to dead reckoning to celestial observation to use of the Global Positioning System. For the last ten years, Oakland University has hosted a vehicle intercollegiate competition entitled Intelligent Ground Vehicle Competition. The purpose of this competition is to design and develop a fully autonomous unmanned ground robotic vehicle.

The challenge in this event is for a vehicle to autonomously travel from a starting point to a number of target destinations and return to home base, given only a map showing the coordinates of those targets. Construction barrels, trees, and light poles will be located on the course in such positions that they must be circumvented to reach the waypoints. A fully autonomous unmanned ground robotic vehicle must negotiate around an outdoor obstacle course under a prescribed time while staying within the 5 mph speed limit, and avoiding the obstacles on the track.

Proposed Work:

The Intelligent Ground Vehicle Competition (IGVC) is an annual competition to design and build a small (golf cart sized) autonomous vehicle. The Multi-sensory Autonomous Ground vehicle Intercollegiate Competition (MAGIC) is the project name of West Point's IGVC entry. West Point currently has two vehicles which have entered this competition previously, MAGIC Senior and MAGIC Junior. The competition is broken into three judging categories: Design, Navigation, and Autonomy. Participation in the Design Competition is mandatory and completely separate from the other two competitions which are optional. Design Competition judging is based on a written report, an oral presentation, and an examination of the vehicle. The Navigation Challenge is judged on the vehicle's ability to navigate autonomously from a home base to a set of waypoints, given only a map of the waypoints' coordinates. West Point has never competed in the Navigation Challenge, and will not do so this year. The focus this year is on competing successfully in the Autonomous Challenge. The Autonomous Challenge is a competition judged on the time in which the vehicle can autonomously navigate an outdoor obstacle course. Penalties are assessed if the vehicle exceeds 5 mph, leaves the course, or hits any obstacles. The competition incorporates technologies and skills from mechanical

engineering, computer science, and electrical engineering. It also has the opportunity to incorporate team members from engineering management, graphic design, public relations and business. The resulting technology from the competition is real-world-applicable in the fields of military mobility, intelligent transport systems, and manufacturing.

Results Summary:

The technical results from the project were two fully functioning autonomous vehicles, and an artificial intelligence source code capable of detecting and maneuvering around obstacles, as well as navigate.

Requirements and Milestones:

- Initial Engineering Project Management Plan (Fall 2004) - *Complete*
- Interim Progress Review (Fall 2004/March 2005) - *Complete*
- Decision Brief (Spring 2005) - *Complete*

Project Deliverables and Due Date:

- Project Brief (Spring 2005) - *Complete*
- Project Report (Spring 2005) - *Complete*
- 2 Autonomous Vehicles (Spring 2005) - *Complete*

Status: Complete

PART VII - Faculty Activity, Academic Year 2004-2005

(* Indicates multiple department authors)

BLAND, WILLIAM, PH.D., LIEUTENANT COLONEL

Refereed Journal Publications:

Bland, William S., "A Simulation-Based Policy Iteration Approach to Sensor Management," submitted to Military Operations Research, currently under revision.

Bland, William S., "SNOOPS: A Distributed Sensor Network Simulation Model," submitted to Military Operations Research, currently under revision.

Non-Refereed Publications:

LTC Tim Trainor*, Dr. Greg Parnell*, LTC Brigitte Kwinn*, MAJ John Brence*, CPT Eric Tollefson*, Ms. Robin Burk8, MAJ Patrick Downes*, LTC William Bland8, CPT Jason Wolter*, MAJ John Harris8, USMA Study of the Installation Management Agency CONUS Region Structure, DSE-R-0506, DTIC # ADA-427027, United States Military Academy, November, 2004.

Number of Refereed Journal Publications reviewed: 2

BOYLAN, GREGORY, M.S., Major

Awards:

Nominated for Barchi Prize for best presentation at Military Operations Research Society Symposium.

Non-Refereed Publications:

Tollefson*, Eric S., Boylan*, Gregory L., Foote*, Bobbie. L., – *Simulation Roadmap for Program Executive Office (PEO) Soldier*. Operations Research Center of Excellence Technical Report No: DSE-TR-0421, DTIC No: ADA425648, July 2004

Conference Presentations:

Tollefson*, E. S., Boylan*, G. L., Kwinn8, M. J., Jr., Martin*, P. G., Foote*, B. L., and West*, P. D., 2004, "United We Stand: Leveraging Concurrent Efforts to Support Infantry Soldier System Acquisition," Presentation for the INFORMS Annual Meeting 2004, Denver, CO.

Refereed Conference Proceedings Publications:

Tollefson*, E. S., Kwinn*, M. J., Jr., Boylan*, G. L., Foote*, B. L., and West*, P. D., 2004, "A Needs-based Analysis of Analytical, High-Resolution Infantry Simulations," in the *Proceedings of the 2004 IIE Annual Conference*, Houston, TX.

Tollefson*, E. S., Boylan*, G. L., Kwinn*, M. J., Jr., Foote*, B. L., West*, P. D., and Martin, P. G., 2004, "Using Systems Engineering to Define Simulation Requirements for the Acquisition of Infantry Soldier Systems," to be published in the *Proceedings of the ICSE & INCOSE 2004 Conference*, Las Vegas, NV.

Tollefson*, E. S., Boylan*, G. L., Kwinn*, M. J., Jr., Foote*, B. L., and Martin*, P. G., 2004, "Simulation Modeling Requirements for Determining Soldier Tactical Mission System Effectiveness," published in the Proceedings of the 2004 Winter Simulation Conference, Washington, D.C.

Boylan*, G. L., Tollefson*, E. S., Kwinn*, M. J., Jr., and Martin*, P. G., 2004, "Determining Simulation Requirements and Identifying a Course of Action to More Effectively Support Acquisition Decision-making for the Current and Future Force Infantry Warrior," in the Proceedings of the 24th Army Science Conference, Orlando, FL, 2004.

BURK, ROGER C., PH.D.

Awards:

Nominated for Barchi Prize for best presentation at Military Operations Research Society Symposium.

Non-Refereed Conference Proceedings Publications:

Burk, Roger C. "Selecting Portfolios of R&D Projects," INFORMS Annual Meeting, Denver, CO, 26 October 2004.

Germann, Brandt W., Brian H. Lee, Todd J. Severson, Matthew C. Wesmiller, and Roger C. Burk. "Arming Army UAVs," Military Operations Research Society Symposium, West Point, NY, 22 June 2005

Burk, Roger C. "The R&D Portfolio Problem," Conference of the International Federation of Operational Research Societies, Honolulu, HI, 11 July 2005.

Client Presentations:

Burk, Roger, and John Bilal. "US Military Academy Lunar Base Logistical Support Project Interim Review." To Jack Bullman, director of the Spacecraft and Vehicle Systems Department, Engineering Directorate, NASA Marshall Space Flight Center, Huntsville, AL, 17 June 2005.

Professional Society Officer Positions:

Council Member, Military Applications Society

Number of Refereed Journal Publications Reviewed: 2

DRISCOLL, PATRICK J., PH.D.

Non-Refereed Publications:

Driscoll, Patrick J., Tortorella, Michael. 2005. "Service reliability of NCO information product manufacturing systems," Research Report, Dept of Systems Engineering, Rutgers University, Piscataway, NJ.

Driscoll, Patrick J., Tortorella, Michael. 2005. "Reliability of Information-Fueled Services in Network Centric Operations," *Proceedings* of the 10th International Command and Control Research and Technology Symposium.

Driscoll, Patrick J., Tortorella, M., Pohl, E. 2005. "Information product quality in Network Centric Operations," Research Report to Office of Force Transformation, OSD, Arlington, VA.

Refereed Journal Publications:

Driscoll*, Patrick J., Henderson*, Steven, "A Meta-Model Architecture for Fusing Battlefield Information". In revision for *Military Operations Research Journal*, June 2005. Technical Report delivered to OFT, March 2005.

Conference Presentations:

Driscoll*, Patrick J., Henderson*, Steven, "A Meta-model Architecture for Operational State Inference." Defense Analysis Department, Naval Postgraduate School, Monterey, CA, January 2005.

Driscoll*, Patrick J., Henderson*, Steven, "A Meta-model Architecture for Operational State Inference." NYC INFORMS Professional Chapter, New York, New York, February 2005.

Driscoll*, Patrick J., Henderson*, Steven, "A Meta-model Architecture for Operational State Inference." Office of Force Transformation, Office of Secretary of Defense, Crystal City, Maryland, March 2005.

Driscoll, Patrick J., Tortorella, Michael, Pohl, Edward. "Information Product Quality In Network Centric Operations." Office of Force Transformation, Office of Secretary of Defense, Crystal City, Maryland, March 2005.

Driscoll, Patrick J., Pohl, Edward. "The Impact of Uncertainty in Reliability System Design." INFORMS Annual Conference, Denver, Colorado, October, 2004.

Driscoll, Patrick J., Tortorella, Michael, Pohl, Edward. "Information Reliability & Uncertainty in NCO Systems." INFORMS Annual Conference, Denver, Colorado, October, 2004.

Driscoll, Patrick J., Tortorella, Michael, "Reliability of Information-Fueled Services in Network Centric Operations." 10th International Command and Control Research and Technology Symposium, Tysons Corners, Virginia, June, 2005.

Driscoll, Patrick J., Tortorella, Michael, Pohl, Edward. "Considerations of Quality and Reliability in Designing a Common Operating Picture." International Federation of Operational Research Societies (IFORS) tri-annual conference, Honolulu, HI, July, 2005.

Driscoll, Patrick J., Pohl, Edward, Nachlas, Joel. "Information Uncertainty in a Sense and Respond Logistics Architecture." International Federation of Operational Research Societies (IFORS) tri-annual conference, Honolulu, HI, July, 2005.

Professional Society Officer Positions:

Chairperson, IFORS Military Applications Cluster

Chairperson, INFORMS COMAP Subcommittee

Number of Refereed Journal Publications Reviewed: 3

FOOTE, BOBBIE LEON, PH.D.**Non-Refereed Publications:**

Foote*, Bobbie. L., Tollefson*, Eric S., Boylan*, Gregory L. – *Simulation Roadmap for Program Executive Office (PEO) Soldier*. Operations Research Center of Excellence Technical Report No: DSE-TR-0421, DTIC No: ADA425648, July 2004

Foote, Bobbie L., Kaczynski, William – *A Capabilities Based Measure of Readiness*. Operations Research Center of Excellence Technical Report DSE-TR-0522. May 2005.

Conference Presentations:

Foote*, Bobbie L., Burk*, Roger, Boylan*, Gregory – “Loiter Aircraft as a Capability adder to ABM Systems”. Best presentation in working group 73rd MORSS, West Point, NY, June 2005.

Tollefson*, E. S., Boylan*, G. L., Kwinn*, M. J., Jr., Martin*, P. G., Foote*, B. L., and West*, P. D., 2004, “United We Stand: Leveraging Concurrent Efforts to Support Infantry Soldier System Acquisition,” Presentation for the INFORMS Annual Meeting 2004, Denver, CO.

GOERGER, NIKI C., PH.D.

Awards:

U.S. Army Achievement Medal, awarded by U.S. Army Engineer Research and Development Center, May 2005

U.S. Army Superior Service Medal, awarded by U.S. Army TRADOC Analysis Center, June 2004

Refereed Conference Proceedings Publications:

Curtis L. Blais, Dr. Niki C. Goerger, Dr. Paul W. Richmond, Burhman Gates, and Michael Pace. “Data Mapping and Ontology Design for Common Maneuver Networks,” Simulation Interoperability Workshop, May 2005 (05S-SIW-40).

Jason Wolter*, Roger Burk*, Bob Foote*, Niki Goerger*, Willie McFadden*, and Timothy E. Trainor*, “Development of an Acquisition Management Course,” Proceedings of the 2005 American Society for Engineering Education Annual Conference & Exposition, American Society for Engineering Education, June 2005.

Marsha Gay, Cary Butler, Mark Cowan, Dave Richards, John Nestler, and Niki Goerger. “Agent-Based Framework for Discrete Entity Simulation in Continuous Media,” Summer Simulation Multiconference, July 2005.

Martin*, P. G., Schamburg*, J. B., Goerger*, M. N., and Kwinn*, M. J., Jr., *Modeling and Simulation Terrain Database Management*. Technical Report DSE-R-0504, Operations Research Center of Excellence, United States Military Academy, 2005.

Non-Refereed Conference Presentations:

Niki C. Goerger, “Footprint to Pathfinder: Integration of Urban Characterization, Munitions Effects, and Threat Assessment for Movement Planning,” Urban Operations Summit IV, Portsmouth, Virginia, January 2005.

Simon R. Goerger*, Niki C. Goerger*, Paul West*, & Willie McFadden*. “Exploring Higher-Order Effects of Vehicle Mobility Model Fidelity in M&S,” Presentation, Military Operation Research Society Symposium (MORSS), West Point, NY, 21 June 2005.

Burhman Gates, Dr. Niki Goerger, Dr. Paul Richmond, Mike Pace, and Curt Blais. “Interoperable Common Maneuver Networks for M&S and C2,” Presentation,

Military Operation Research Society Symposium (MORSS), West Point, NY, 21 June 2005.

Simon R. Goerger*, Niki C. Goerger*, Paul West*, & Willie McFadden*. "Assessing Ground Mobility Model Fidelity Effects on Simulation for the Future Force," Presentation, Future Ground Forces: The Next Generation of Warfighters, Arlington, VA, 28 -29 June 2005.

Martin*, P. G., Schamburg*, J. B., Goerger*, M. N., and Kwinn*, M. J., Jr., 2005, "Finding the Right Terrain Database," in the Proceedings of the 73rd Military Operations Research Society Symposium, West Point, NY, 2005.

Client Presentations:

Defense Model and Simulation Office M&S Education Colloquium, August 2004.

USMA Faculty and Staff, U.S. Army Engineer Research and Development Center, October 2004.

GEN Schoomaker, CSA, USMA Lifecycle Acquisition Management Institute, November 2004.

Defense Model and Simulation Office M&S Education Colloquium, December 2004.

Army Digital Terrain Library Update and Working Meeting, December 2004.

Common Maneuver Networks Technical Exchange Meeting, December 2004.

John Gillis, ASAALT (SAAL-ZS), USMA Lifecycle Acquisition Management Institute, January 2005.

Mark Schaeffer, USD(AT&L), USMA Lifecycle Acquisition Management Institute, February 2005.

Brief to MG (ret) Jim Snyder, UAH, and party, March 2005.

GEN Byrnes, CG, TRADOC, USMA Lifecycle Acquisition Management Institute, April 2005.

Army Digital Terrain Library Update and Working Meeting, May 2005.

Tutorials Delivered:

Organizer for the Military Operations Research Society New Analysis Techniques Tutorial, Jan 2005.

Professional Society Officer Positions:

Board of Directors, Military Operations Research Society.

Advances in Military Operations Research, Working Group Chair, Military Operations Research Society.

Publications Committee Chair, Military Operations Research Society.

Number of Refereed Conference Proceedings Publications you reviewed: 1

Number of Prize Papers Reviewed: 10 papers for Barchi Prize selection, Military Operations Research Society, spring 2005.

Proposal Reviews:

Reviewed over 25 proposals seeking funding as member of the Executive Committee for the Urban Operations Focus Area Collaborative Team.

GOERGER, SIMON R., PH.D., Lieutenant Colonel

Awards:

Best Paper in Research and Development Committee, Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC), Orlando, FL, 06-09 December 2004.

Best Paper Nomination for Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC), Orlando, FL, 06-09 December 2004.

Refereed Journal Publications:

Simon R. Goerger*, Michael L. McGinnis*, & Rudolph P. Darken. "A Validation Methodology for Human Behavior Representation Models," To be published in *The Journal of Defense Modeling and Simulation: Applications, Methodology, Technology*, Summer 2005.

Refereed Conference Proceedings Publications:

Simon R. Goerger*, Michael L. McGinnis*, & Rudolph P. Darken. "A Validation Methodology for Human Behavior Representation Models," Presentation, Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC), Orlando, FL, 06-09 December 2004.

Non-Refereed Publications:

Simon R. Goerger*, Michael L. McGinnis*, & Rudolph P. Darken. "A Validation Methodology for Human Behavior Representation Models," Tech Report DSE-R-0531, Operations Research Center of Excellence, West Point, NY, May 2005.

Non-Refereed Conference Presentations:

Simon R. Goerger. "Validating Computational Human Behavior Models: Issues with Subject Matter Experts," Presentation, Navy Modeling and Simulations Office (NMSO) / Army Modeling and Simulations Office (AMSO) Verification, Validation and Accreditation (VV&A), Technical Working Group 20, Salt Lake City, UT, 16 February 2005.

Simon R. Goerger*, Niki C. Goerger*, Paul West*, & Willie McFadden*. "Exploring Higher-Order Effects of Vehicle Mobility Model Fidelity in M&S," Presentation, Military Operation Research Society Symposium (MORSS), West Point, NY, 21 June 2005.

Simon R. Goerger*, Niki C. Goerger*, Paul West*, & Willie McFadden*. "Assessing Ground Mobility Model Fidelity Effects on Simulation for the Future Force," Presentation, Future Ground Forces The Next Generation of Warfighters, Arlington, VA 28 -29 June 2005.

Simon R. Goerger. "Assessing Human Behavior Representation Models," Presentation, International Federation of Operational Research Societies, Honolulu, HI, 12 July 2005.

Professional Society Officer Positions:

Advances in Military Operations Research, Working Group Co-Chair, Military Operations Research Society.

KWINN, MICHAEL J., JR., PH.D., Lieutenant Colonel

Refereed Conference Proceedings Publications:

Martin*, P. G., Schamburg*, J. B., and Kwinn*, M. J., Jr., 2005, "Acquisition-Based Simulation," accepted for the Proceedings of the 2005 Winter Simulation Conference, Orlando, FL, 2005.

Tollefson*, E. S., Boylan*, G. L., Kwinn*, M. J., Jr., Foote*, B. L., and Martin*, P. G., 2004, "Simulation Modeling Requirements for Determining Soldier Tactical Mission System Effectiveness," published in the Proceedings of the 2004 Winter Simulation Conference, Washington, D.C.

Rittenhouse*, Wiley P., Kwinn*, Michael J., and West*, Holly, "The Support Leader's Digital Assistant: A Tool for the Support Platoon Leader", Institute of Industrial Engineers Annual Conference, Atlanta, GA, May 2005.

Martin*, P. G., Schamburg*, J. B., and Kwinn*, M. J., Jr., 2005, "Implementation of a Federation of Simulations for High-Resolution Infantry Simulations," *Annual Conference of the Institute of Industrial Engineering*, Atlanta, Georgia, 2005.

Non-Refereed Publications:

Martin*, P. G., Schamburg*, J. B., Goerger*, M. N., and Kwinn*, M. J., Jr., *Modeling and Simulation Terrain Database Management*. Technical Report DSE-R-0504, Operations Research Center of Excellence, United States Military Academy, 2005.

Martin*, P. G., Schamburg*, J. B., and Kwinn*, M. J., Jr., *PEO Soldier Simulation Roadmap: Initial Steps in Implementation*. Technical Report DSE-R-0501, Operations Research Center of Excellence, United States Military Academy, 2005.

Conference Presentations:

Boylan*, G. L., Tollefson*, E. S., Kwinn*, M. J., Jr., and Martin*, P. G., 2004, "Determining Simulation Requirements and Identifying a Course of Action to More Effectively Support Acquisition Decision-Making for the Current and Future Force Infantry Warrior," in the Proceedings of the 24th Army Science Conference, Orlando, FL, 2004

Martin*, P. G., Schamburg*, J. B., Goerger*, M. N., and Kwinn*, M. J., Jr., 2005, "Finding the Right Terrain Database," in the Proceedings of the 73rd Military Operations Research Society Symposium, West Point, NY, 2005.

Tollefson*, E. S., Boylan*, G. L., Kwinn*, M. J., Jr., Martin*, P. G., Foote*, B. L., and West*, P. D., 2004, "United We Stand: Leveraging Concurrent Efforts to Support Infantry Soldier System Acquisition," Presentation for the INFORMS Annual Meeting 2004, Denver, CO.

Martin*, P. G., Schamburg*, J. B., and Kwinn*, M. J., Jr., 2005, "Implementation of a Federation of Simulations for High-Resolution Infantry Simulations," in the Proceedings of the Annual Conference of the Institute of Industrial Engineering, Atlanta, GA, 2005.

Martin*, P. G., Schamburg*, J. B., and Kwinn*, M. J., Jr., 2005, "Creating Requirements for High-Resolution Infantry Simulations," Presentation at the

17th Triennial Conference of the International Federation of Operational Research Societies (IFORS), 2005, Honolulu, HI.

ROBERT LENZ, M.S., Major

Conference Presentations:

Lenz, Robert J. Jr. "Implementation of Semester-Length Course Projects In Engineering Discipline Courses," American Society of Engineering Education (ASEE) Mid-Atlantic Section Spring 2005 Conference, Fairleigh Dickinson University, Teaneck, NJ, April 2005.

MARTIN, PHILLIP G., M.S., Major

Refereed Conference Proceedings Publications:

Martin*, P. G., Schamburg*, J. B., and Kwinn*, M. J., Jr., 2005, "Acquisition-Based Simulation," accepted for the Proceedings of the 2005 Winter Simulation Conference, Orlando, FL, 2005.

Tollefson*, E. S., Boylan*, G. L., Kwinn*, M. J., Jr., Foote*, B. L., and Martin*, P. G., 2004, "Simulation Modeling Requirements for Determining Soldier Tactical Mission System Effectiveness," published in the Proceedings of the 2004 Winter Simulation Conference, Washington, D.C.

Non-Refereed Publications:

Martin*, P. G., Schamburg*, J. B., Goerger*, M. N., and Kwinn*, M. J., Jr., *Modeling and Simulation Terrain Database Management*. Technical Report DSE-R-0504, Operations Research Center of Excellence, United States Military Academy, 2005.

Martin*, P. G., Schamburg*, J. B., and Kwinn*, M. J., Jr., *PEO Soldier Simulation Roadmap: Initial Steps in Implementation*. Technical Report DSE-R-0501, Operations Research Center of Excellence, United States Military Academy, 2005.

Conference Presentations:

Boylan*, G. L., Tollefson*, E. S., Kwinn*, M. J., Jr., and Martin*, P. G., 2004, "Determining Simulation Requirements and Identifying a Course of Action to More Effectively Support Acquisition Decision-Making for the Current and Future Force Infantry Warrior," in the Proceedings of the 24th Army Science Conference, Orlando, FL, 2004

Martin*, P. G., Schamburg*, J. B., Goerger*, M. N., and Kwinn*, M. J., Jr., 2005, "Finding the Right Terrain Database," in the Proceedings of the 73rd Military Operations Research Society Symposium, West Point, NY, 2005.

Tollefson*, E. S., Boylan*, G. L., Kwinn*, M. J., Jr., Martin*, P. G., Foote*, B. L., and West*, P. D., 2004, "United We Stand: Leveraging Concurrent Efforts to Support Infantry Soldier System Acquisition," Presentation for the INFORMS Annual Meeting 2004, Denver, CO.

Martin*, P. G., Schamburg*, J. B., and Kwinn*, M. J., Jr., 2005, "Implementation of a Federation of Simulations for High-Resolution Infantry Simulations," in the

Proceedings of the Annual Conference of the Institute of Industrial Engineering, Atlanta, GA, 2005.

Martin*, P. G., Schamburg*, J. B., and Kwinn8, M. J., Jr., 2005, "Creating Requirements for High-Resolution Infantry Simulations," Presentation at the 17th Triennial Conference of the International Federation of Operational Research Societies (IFORS), 2005, Honolulu, HI.

Client Presentations:

Martin, Grant. "Army Digital Terrain Library." To COL George Stone, Director, Battle Command, Simulation and Experimentation Directorate (BCSE), Washington, D.C., 15 April 2005.

MCFADDEN, WILLIE, J., III, PH.D., Lieutenant Colonel

Refereed Conference Proceedings Publications:

Jason Wolter*, Roger Burk*, Bob Foote*, Niki Goerger*, Willie McFadden*, and Timothy E. Trainor*, "Development of an Acquisition Management Course," Proceedings of the 2005 American Society for Engineering Education Annual Conference & Exposition, American Society for Engineering Education, June 2005.

Non-Refereed Conference Presentations:

Simon R. Goerger*, Niki C. Goerger*, Paul West*, & Willie McFadden*. "Exploring Higher-Order Effects of Vehicle Mobility Model Fidelity in M&S," Presentation, Military Operation Research Society Symposium (MORSS), West Point, NY, 21 June 2005.

Simon R. Goerger*, Niki C. Goerger*, Paul West*, & Willie McFadden*. "Assessing Ground Mobility Model Fidelity Effects on Simulation for the Future Force," Presentation, Future Ground Forces The Next Generation of Warfighters, Arlington, VA 28 -29 June 2005.

MCGINNIS, MICHAEL L., PH.D., COLONEL

Awards:

Best Paper in Research and Development Committee, Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC), Orlando, FL, 06-09 December 2004.

Best Paper Nomination for Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC), Orlando, FL, 06-09 December 2004.

Refereed Journal Publications:

Simon R. Goerger*, Michael L. McGinnis*, & Rudolph P. Darken. "A Validation Methodology for Human Behavior Representation Models," To be published in *The Journal of Defense Modeling and Simulation: Applications, Methodology, Technology*, Summer 2005.

Refereed Conference Proceedings Publications:

Simon R. Goerger*, Michael L. McGinnis*, & Rudolph P. Darken. "A Validation Methodology for Human Behavior Representation Models," Presentation,

Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC), Orlando, FL, 06-09 December 2004.

Non-Refereed Publications:

Simon R. Goerger*, Michael L. McGinnis*, & Rudolph P. Darken. "A Validation Methodology for Human Behavior Representation Models," Tech Report DSE-TR-0531, Operations Research Center of Excellence, West Point, NY, May 2005.

Michael L. McGinnis "A Systems View of the USMA Staff Redesign," Tech Report DSE-TR-0544, DTIC # ADA433620. Operations Research Center of Excellence, West Point, NY, Dec 2004.

PARNELL, GREGORY S., PH.D.

Refereed Journal Publications:

Buckshaw, D. L., Parnell, G. S., Unkenholz, W. L., Parks, D. L., Wallner, J. M. and Saydjari, O. S., "Mission Oriented Risk and Design Analysis of Critical Information Systems," *Military Operations Research*, 2005, awaiting publication.

Merrick, J., Parnell, G., Barnett, J., Garcia, M., "A Multiple Objective Decision Analysis of Stakeholder Values to Identify Watershed Improvement Needs," *Decision Analysis*, Vol. 2, No. 1, March 2005, pp. 44–57

Refereed Conference Proceedings Publications:

Harris, J. and Parnell, G. S., "BRAC 2005 Implementation," American Society for Engineering Management 25th National Conference, Alexandria, Virginia, October 20-23, 2004

Non-Refereed Publications:

Parnell, G. S., The INFORMS Student Newsletter, Spotlight on Subdivisions of INFORMS: The Decision Analysis Society – The Science of Better (Decisions), Vol 9, Summer/Fall 2005

LTC Tim Trainor*, Dr. Greg Parnell*, LTC Brigitte Kwinn*, MAJ John Brence*, CPT Eric Tollefson*, Ms. Robin Burk*, MAJ Patrick Downes*, LTC William Bland*, CPT Jason Wolter*, MAJ John Harris*, *USMA Study of the Installation Management Agency CONUS Region Structure*, DSE-R-0506, DTIC # ADA-427027, United States Military Academy, November, 2004.

Parnell*, G., Harris*, J. Hoops, B. Gardner, S., and Mounts, R., *BRAC 2005 Implementation Decision Support Tools*, Operations Research Center Technical Report, DSE-TR-0409, DTIC # ADA-426284, United States Military Academy, August 2004.

Conference Presentations:

Parnell, G. S., The INFORMS Student Newsletter, Spotlight on Subdivisions of INFORMS: The Decision Analysis Society – The Science of Better (Decisions), Vol 9, Summer/Fall 2005

LTC Tim Trainor*, Dr. Greg Parnell*, LTC Brigitte Kwinn*, MAJ John Brence*, CPT Eric Tollefson*, Ms. Robin Burk*, MAJ Patrick Downes*, LTC William Bland*, CPT Jason Wolter*, MAJ John Harris*, *USMA Study of the*

Installation Management Agency CONUS Region Structure, DSE-R-0506, DTIC # ADA-427027, United States Military Academy, November, 2004.

Parnell*, G., Harris*, J. Hoops, B. Gardner, S., and Mounts, R., BRAC 2005 Implementation Decision Support Tools, Operations Research Center Technical Report, DSE-TR-0409, DTIC # ADA-426284, United States Military Academy, August 2004.

Professional Society Officer Positions:

Member, Technology Panel of the National Security Agency Advisory Board

President, Decision Analysis Society, Institute for Operations Research and Management Science.

Books or Book Chapters:

Parnell, G. S., *Value-Focused Thinking Using Multiple Objective Decision Analysis*, Methods for Conducting Military Operational Analysis: Best Practices in Use Throughout the Department of Defense, Military Operations Research Society, (Forthcoming Fall 2005)

Parnell, G. S., Dillon, R. L., and Bresnick, T. A., *Integrating Risk Management with Homeland Security and Antiterrorism Resource Allocation Decision-Making*, The McGraw-Hill Handbook of Homeland Security, David Kamien, Editor, (Forthcoming, Fall 2005).

Number of Refereed Journal Publications Reviewed: 3

POWELL, ROBERT A., PH.D., Lieutenant Colonel

Awards:

Who's Who in Engineering Education (2005).

Best Project Award in Decision Analysis track, "Bandwidth Allocation Study for the Disposable, Air-droppable, Meteorological Tower Array." USMA/DSE 2005 Capstone Day competition, May 4, 2005.

Non-Refereed Conference Proceedings Publications:

Powell*, R. A. and Curtis D. Tait*. Developing Engineers in the 21st Century – An Integrative Experience, Integrating Practice into Engineering Education Conference, University of Michigan-Dearborn, Dearborn, Michigan, 3-5 October 2004.

Refereed Journal Publications:

Powell, R.A. and Dennis Buede. "Decision Making for Successful Product Development," submitted to Project Management Journal, 2005

Professional Society Officer Positions:

Secretary, American Society for Engineering Education, Engineering Management Division.

Magazine Article Publications:

Powell, Robert. "Cadets Visit Honduras and Panama," Assembly Magazine 63, no. 3 (January/February 2005): 51.

Conference Presentations:

Powell, R. A. and Dennis M. Beude. *Innovative Systems Engineering: A Creative System Development Approach*, submitted to INCOSE 2006: Systems Engineering: Shining Light on the Tough Issues, Orlando, Florida, 9-13 July 2005.

Powell, R. A., M. Gilbert, D. Smith, J. Lee, D. Lao, and C. Keogh. *Automating the Base Camp Master Planning Process*, 73d MORSS Conference: Balancing Risk for An Uncertain Future, United States Military Academy, West Point, New York, 21-23 June 2005.

Powell, R. A. *Integrating Practice into Engineering Education*, Proceedings of the American Society for Engineering Education 2005 Annual Conference and Exposition, Portland, Oregon, 12-15 June 2005.

Powell, R. A. *Engineering Education: An Integrative Experience*, Proceedings of the American Society for Engineering Education 2005 Annual Conference and Exposition, Portland, Oregon, 12-15 June 2005.

Powell, R. A. *Building an Engineer through a Work-Based Education Program*, Proceedings of the American Society for Engineering Education 2004 Annual Conference and Exposition, Salt Lake City, Utah, 20-23 June 2004

RITTENHOUSE, WILEY P., M.S., Major

Refereed Conference Proceedings Publications:

Rittenhouse*, Wiley P., Kwinn*, Michael J., and West*, Holly, "The Support Leader's Digital Assistant: A Tool for the Support Platoon Leader", Institute of Industrial Engineers Annual Conference, Atlanta, GA, May 2005.

Conference Presentations:

Rittenhouse, Wiley P., "The Support Leader's Digital Assistant: A Tool for the Support Platoon Leader", Military Operations Research Society Symposium, US Military Academy, West Point, NY, June 2005.

Rittenhouse, Wiley P., "Shaping the ROTC Cohort", Accessions Research Consortium, Louisville, KY, June 2005.

Rittenhouse, Wiley P., "The Support Leader's Digital Assistant: A Tool for the Support Platoon Leader", Institute of Industrial Engineers Annual Conference, Atlanta, GA, May 2005.

Invited Lectures:

Rittenhouse, Wiley P., "Mathematics at the US Military Academy", Undergraduate Lecture Series, Department of Mathematics, Kansas State University, Manhattan, KS, November 2004.

Number of Refereed Conference Proceedings Publications Reviewed: 2

SCHAMBURG, JEFFREY B., PH.D., LTC

Refereed Conference Proceedings Publications:

Schamburg J. B., "Holographic Analysis of Military Situational Awareness Systems," *Annual Conference of the Institute of Industrial Engineering*, Atlanta, Georgia, 2005.

Martin*, P. G., Schamburg*, J. B., and Kwinn*, M. J., Jr., 2005, "Implementation of a Federation of Simulations for High-Resolution Infantry Simulations," *Annual Conference of the Institute of Industrial Engineering*, Atlanta, Georgia, 2005.

Schamburg, J. B. and Brown, D. E., "Simulated Annealing for Selection of Experimental Regions in Response Surface Methodology Applications," *Winter Simulation Conference 04*, 2004.

Schamburg, J. B. and Brown, D. E., "Generalized Multiple Response Surface Methodology for Complex Computer Simulation Applications," *Winter Simulation Conference 04*, 2004.

Martin*, P. G., Schamburg*, J. B., and Kwinn*, M. J., Jr., 2005, "Acquisition-Based Simulation," accepted for the Proceedings of the 2005 Winter Simulation Conference, Orlando, FL, 2005

Non-Refereed Publications:

Schamburg, J. B. and Brown, D. E., "A Modified Response Surface Methodology for Knowledge Discovery with Simulations," *Department of Systems and Information Engineering Technical Report*, University of Virginia, Charlottesville, Virginia, 2004.

Schamburg*, J. B. and Ritchey*, H. I., "United States Army Medical Material Center Europe Organizational Analysis," *Operations Research Center of Excellence Technical Report*, Operations Research Center of Excellence, Department of Systems Engineering, United States Military Academy, West Point, New York, 2004.

Schamburg, J. B., "A Modified Response Surface Methodology for Knowledge Discovery," PhD. Dissertation: School of Engineering and Applied Science, University of Virginia, 2004.

Schamburg, J. B., "Future Force Warrior Integrated Analysis Planning," Operations Research Center of Excellence Technical Report, Operations Research Center of Excellence, Department of Systems Engineering, United States Military Academy, West Point, New York, 2005.

Martin*, P. G., Schamburg*, J. B., Goerger*, M. N., and Kwinn*, M. J., Jr., *Modeling and Simulation Terrain Database Management*. Technical Report DSE-R-0504, Operations Research Center of Excellence, United States Military Academy, 2005.

Martin*, P. G., Schamburg*, J. B., and Kwinn*, M. J., Jr., *PEO Soldier Simulation Roadmap: Initial Steps in Implementation*. Technical Report DSE-R-0501, Operations Research Center of Excellence, United States Military Academy, 2005.

Conference Presentations:

Schamburg J. B., "Holographic Analysis of Military Situational Awareness Systems," *Annual Conference of the Institute of Industrial Engineering*, Atlanta, Georgia, 2005.

Martin*, P. G., Schamburg*, J. B., and Kwinn*, M. J., Jr., 2005, "Implementation of a Federation of Simulations for High-Resolution Infantry Simulations," *Annual Conference of the Institute of Industrial Engineering*, Atlanta, Georgia, 2005. (accepted for presentation).

Schamburg, J. B. and Brown, D. E., "Simulated Annealing for Selection of Experimental Regions in Response Surface Methodology Applications," *Winter Simulation Conference 04*, 2004.

Schamburg, J. B. and Brown, D. E., "Generalized Multiple Response Surface Methodology for Complex Computer Simulation Applications," *Winter Simulation Conference 04*, 2004.

Martin*, P. G., Schamburg*, J. B., and Kwinn*, M. J., Jr., 2005, "Creating Requirements for High-Resolution Infantry Simulations," Presentation at the 17th Triennial Conference of the International Federation of Operational Research Societies (IFORS), 2005, Honolulu, HI.

Martin*, P. G., Schamburg*, J. B., Goerger*, M. N., and Kwinn*, M. J., Jr., 2005, "Finding the Right Terrain Database," in the Proceedings of the 73rd Military Operations Research Society Symposium, West Point, NY, 2005.

Client Presentations:

Schamburg, J. B., "Future Force Warrior Integrated Analysis Planning." To Mr. William Harris, Future Force Warrior Analysis and Experimentation Co-lead and Mr. Robert O'Brien, Future Force Warrior Senior Analyst, June 2005.

Schamburg J. B., "Holographic Analysis of Military Situational Awareness Systems," To Mr. William Harris, Future Force Warrior Analysis and Experimentation Co-lead and Mr. Robert O'Brien, Future Force Warrior Senior Analyst, May 2005.

Schamburg, J. B., "Mobile Gun System Reliability Growth Plan Analytical Support," To LTC Scott Flynn, Product Manager, Mobile Gun System, Stryker Brigade Combat Team Product Management Office, June 2005.

Schamburg*, J. B. and Ritchey*, H. I., "United States Army Medical Material Center Europe Organizational Analysis." LTC Christopher V. Roan, Deputy Commander, U.S. Army Medical Material Center, Europe, September 2004.

Professional Society Officer Positions:

Served as chair of the MORS Agent-Based Modeling working group for the workshop on Agent-Based Models and Other Analytic Tools in Support of Stability Operations. Developed the Terms of Reference (TOR) (workshop to take place in October 2005).

Served as chair of the Military Logistics and Urban Modeling session at the Winter Simulation Conference.

Served as chair of the Human Factors session at the Institute of Industrial Engineers (IIE) Conference.

Served on the advisory committee for the International Conference on Industrial Engineering Theory and served as a session chair putting together the session on military simulations (session to take place in December 2005).

Number of Refereed Journal Publications Reviewed: 1

**TOLLEFSON, ERIC S., M.S., Major
Refereed Conference Proceedings Publications:**

Tollefson*, E. S., Boylan*, G. L., Kwinn*, M. J., Jr., Foote*, B. L., and Martin*, P. G., 2004, "Simulation Modeling Requirements for Determining Soldier Tactical Mission System Effectiveness," published in the Proceedings of the 2004 Winter Simulation Conference, Washington, D.C.

Conference Presentations:

Boylan*, G. L., Tollefson*, E. S., Kwinn*, M. J., Jr., and Martin*, P. G., 2004, "Determining Simulation Requirements and Identifying a Course of Action to More Effectively Support Acquisition Decision-Making for the Current and Future Force Infantry Warrior," in the Proceedings of the 24th Army Science Conference, Orlando, FL, 2004

Tollefson*, E. S., Boylan*, G. L., Kwinn*, M. J., Jr., Martin*, P. G., Foote*, B. L., and West*, P. D., 2004, "United We Stand: Leveraging Concurrent Efforts to Support Infantry Soldier System Acquisition," Presentation for the INFORMS Annual Meeting 2004, Denver, CO.

TRAINOR, TIMOTHY, PH.D., Lieutenant Colonel

Refereed Journal Publications:

Trainor*, Timothy E., Gregory Parnell*, Brigitte Kwinn*, John Brence*, Eric Tollefson*, and Patrick Downes*. "Decision Analysis Aids Regional Organizational Design," submitted to *Interfaces*, June 2005.

Refereed Conference Proceedings Publications:

Trainor, Timothy E., Kimberly Caprari, Carson Green, Jason Roth, and Curtis Unger. "Threat and Vulnerability Risk Assessment for the Insurance Industry," *Managing in a Dangerous World*, Proceedings of the 25th National Conference of the American Society for Engineering Management (ASEM). Alexandria, Virginia, October 20-23, 2004, pp. 227-234.

Cushing*, John M., and Timothy E. Trainor*. "Developing Base Camps to Support Military Operations in a Dangerous World," *Managing in a Dangerous World*, Proceedings of the 25th National Conference of the American Society for Engineering Management (ASEM). Alexandria, Virginia, October 20-23, 2004, pp.527-531.

Wolter*, Jason, Roger Burk*, Bob Foote*, Niki Goerger*, Willie McFadden*, and Timothy E. Trainor*. "Development of an Acquisition Management Course," *Proceedings of the 2005 American Society for Engineering Education Annual Conference & Exposition*. ASEE, Portland, Oregon, June 12-15, 2005.

Non-Refereed Publications:

Trainor*, Timothy E., Gregory Parnell*, et.al. *USMA Study of the Installation Management Agency CONUS Structure*. Operations Research Center of Excellence Technical Report DSE-TR-0506, DTIC No. ADA427027. West Point: USMA, November 2004.

Brown, D. Larue, Jr., Joshua R. Drake, Jason T. Mulligan, William C. Murray II, Schuyler Williamson, Timothy E. Trainor. "Transportation Safety and Risk Assessment," *Proceedings of the 2005 Systems and Information Engineering Design Symposium*, Ellen J. Bass, Ed., University of Virginia, Charlottesville, Virginia, April 29, 2005.

Dacunto, P., Doyle, B., Epolito, W., Fleming, S., Guerrie, M., Jordano, J., Klosky, L., Lindberg*, TJ, Manous, J., Trainor*, T., and Welch, R. *A Soldier's Guide for Infrastructure Information & Data Collection (I2DC)*. United States Military Academy, West Point, NY, June 15, 2005.

Betros, Lance, et.al. *USMA Curriculum Committee Report: Improving Foreign Culture Education at West Point*. West Point, New York: United States Military Academy, January 2004.

Conference Presentations:

Trainor*, Timothy E., and Gregory Parnell*. "Organizational Design Using Multiple Objective Decision Analysis," INFORMS Conference on O.R. Practice, Applying Science to the Art of Business, The Institute for Operations Research and the Management Sciences (INFORMS), Palm Springs, California, April 19, 2005.

Trainor, Timothy E., Kimberly Caprari, Carson Green, Jason Roth, and Curtis Unger. "Threat and Vulnerability Risk Assessment for the Insurance Industry," 25th National Conference of the American Society for Engineering Management (ASEM), October 20-23, 2004.

Cushing*, John M., and Timothy E. Trainor*. "Developing Base Camps to Support Military Operations in a Dangerous World," 25th National Conference of the American Society for Engineering Management (ASEM). October 20-23, 2004.

Trainor*, Timothy E., and Gregory Parnell*. "Organizational Design Using Multiple Objective Decision Analysis," INFORMS Conference on O.R. Practice, Applying Science to the Art of Business, The Institute for Operations Research and the Management Sciences (INFORMS), Palm Springs, California, April 19, 2005.

Lindberg*, Travis J., Manous, Joe D., Jr., Trainor*, Timothy E., and Welch, Ronald W. "Infrastructure Assessment Tool," 73rd Military Operations Research Society (MORS) Symposium, West Point, New York, 23 June 2005.

Trainor*, Timothy E., and Gregory Parnell*. "USMA Study of the Installation Management Agency CONUS Region Structure," 73rd Military Operations Research Society (MORS) Symposium, West Point, New York, 22 June 2005.

Client Presentations:

Trainor*, Timothy E., Gregory Parnell*, et.al. "USMA Study of the Installation Management Agency CONUS Region Structure," In-Progress Review Presentation to the Assistant Secretary of the Army (Installations & Environment) and the Assistant Chief of Staff, Installation Management, The Pentagon, 19 July 2004.

Trainor*, Timothy E., Gregory Parnell*, et.al. "USMA Study of the Installation Management Agency CONUS Region Structure," In-Progress Review Presentation to the Director of the Installation Management Agency, Washington, DC, 27 July 2004.

Trainor*, Timothy E., Gregory Parnell*, et.al. "USMA Study of the Installation Management Agency CONUS Region Structure," Study Results Presentation

to the Assistant Secretary of the Army (Installations & Environment), West Point, New York, 13 August 2004.

Professional Society Officer Positions

Secretary / Treasurer of the Military Applications Society (MAS) of the Institute for Operations Research and the Management Sciences (INFORMS)

Member of the Board of Directors of Epsilon Mu Eta, the Engineering Management Honor Society.

Number of Refereed Journal Publications Reviewed: 1.

Number of Refereed Conference Proceedings Publications Reviewed: 2

PART VIII - Distribution List

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Assistant Deputy Chief of Staff for Doctrine, HQ TRADOC	ADCS DOC ATTN:ATDO-ZA Ft. Monroe, VA 23651-5000	1
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US Army Training Support Center Training Support Assistance and Integration Directorate, Asst. Div.	ATTN: ATIC-SAIA-AN Bldg #1529 Ft. Eustis, VA 23604	1
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Commander US Army Test & Evaluation Command	4501 Ford Avenue Alexandria, VA 22302-1458	1
Commander US Army Recruiting Command	ATTN: RCPAE Ft. Knox, KY 40121	1
Commander US Army Space & Missile Defense Command	1941 Jefferson Davis Highway -Suite 900 Arlington, VA 22215-0280	1
Director Army Research Laboratory	2800 Powder Mill Road Adelphi, MD 20783- 1145	1
Director, ARL – Sensors & Electronic Devices Directorate	ATTN: AMSRL-SE-S 2800 Powder Mill Road Adelphi, MD 20783-1197	1
Director Center for Army Analysis	6001 Goethals Road Ft. Belvoir, VA 22060-5230	1
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Director US Army Materiel Systems Analysis Activity	Aberdeen Proving Ground MD 21005-5071	1
Director US Army National Simulation Center	ATTN: ATZL-NSC 410 Kearney Avenue – Building 45 Ft. Leavenworth, KS 66027-1306	1
Director US Army Research Institute for Behavioral and Social Sciences	5001 Eisenhower Avenue Alexandria, VA 22333	1
Director US Army Waterways Experimentation Station	3909 Halls Ferry Road Vicksburg, MS 39180	1
COMMANDER, USA ARMC	ATTN: ATZK-MW Ft. Knox, KY 40121-5000	1
Comdt, USAIS	ATTN: ATZB/WC Ft. Benning, GA 31905-507	1
Comdt, USAFAS	ATTN: ATSF-CBL Ft. Sill, OK 73503-5600	1
Commander, USACAC	ATTN: ATZL-CDB Ft., Leavenworth, KS 66027-5300	1
Commander, USASC (Signal Center)	ATTN: ATZH-BL Ft. Gordon, GA 30905-5299	1
Commander, USAIC&FH (Intel Center)	ATTN: ATZS-FDB Ft. Huachuca, AZ 85613-6000	1
Commander, USACASCOM	ATTN: ATCL-B Ft. Lee, VA 23801-6000	1
HQ USAMANSCEN & Ft. Leonard Wood	ATTN: ATZT-MSBL Ft. Leonard Wood, MO 65473-6620	1
Commander, USAAVNC	ATTN: ATZQ-ABL Ft. Rucker, AL 36362-5000	1
Commander, USASMDC	ATTN: SMDC-BL P.O. Box 1500 Huntsville, AL 35807-3801	1
Commander, USARSPACE	ATTN: SMDC-BL-W 1670 North Newport Road Colorado Springs, CO 80916-2749	1

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Battle Command Ft. Leavenworth Commander, USACAC	ATTN: ATXH-BLT Ft. Leavenworth, KS 66027- 5300	1
Depth & Simultaneous Attack Comdt, USAFAS	ATTN: ATSF-CBL Ft. Sill, OK 73503-5600	1
Battle Command Ft. Gordon Commander, USASC&FG	ATTN: ATZH-BLT Ft. Gordon, GA 30905-5294	1
Mounted Battle Space Commander, USAARMC	ATTN: ATZK-MW Ft. Knox, KY 40121-5000	1
Battle Command Ft. Huachuca Commander, USAIC&FH	ATTN: ATZS-CDT Ft. Huachuca, AZ 85613-6000	1
Dismounted Battle Space Comdt, USAIS	ATTN: ATSH-IWC Ft. Benning, GA 31905-5007	1
Combat Service Support Commander, USACASCOM	ATTN: ATCL-C Ft. Lee, VA 23801-6000	1
Early Entry Lethality and Survivability Commander, USATRADO	ATTN: ATCD-L Ft. Monroe, VA 23651-5000	1
Battle Lab Integration & Technology Directorate Commander, USATRADO	ATTN: ATCD-L Ft. Monroe, VA 23651-5000	1
Command General US Army Materiel Command (AMC)	AMCCG Bldg 1464 Fort Belvoir, VA 22060	1
PM-Logistics Information Systems (LIS)	800 Lee Avenue Fort Lee, VA 23801-1718	1
PM Lead The Fleet (LTF) Army Test & Evaluation	AMRDEC, US Army RDECOM AMSAM-RD, Bldg. 8716 Redstone Arsenal, AL 35898	1
Commander US Joint Forces Command	1562 Mitscher Ave. Suite 200 Norfolk, VA 23551	1
Deputy Chief of Staff for Personnel Army G-1	300 Army Pentagon Washington, DC 20310-0300	1
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Commander US Army Accessions Command (USAAC)	90 Ingalls Road – Bldg. 100 Ft. Monroe, VA 23651	1
Director, Defense Advanced Research Project Agency (DARPA)	3701 North Fairfax Drive Arlington, VA 22203-1714	2
Program Executive Officer (PEO) Soldier	5901 Putnam Road, Bldg 328 Fort Belvoir, VA 22060-5422	1
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	TOTAL	105

REPORT DOCUMENTATION PAGE

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1. REPORT DATE (DD-MM-YYYY) 09-2005		2. REPORT TYPE Annual Report		3. DATES COVERED (From - To) 07-2004 to 05-2005	
4. TITLE AND SUBTITLE ANNUAL REPORT OF THE OPERATIONS RESEARCH CENTER AND DEPARTMENT OF SYSTEMS ENGINEERING FOR ACADEMIC YEAR 2004				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) COLLABORATIVE EFFORT OF THE DEPARTMENT OF SYSTEMS ENGINEERING, ORGANIZED BY THE OPERATIONS RESEARCH CENTER				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Operations Research Center of Excellence Department of Systems Engineering US Military Academy Bldg.#752-Mahan Hall-Rm 305 West Point, NY 10996				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION / AVAILABILITY STATEMENT Distribution A - Approved for Public Release - Distribution Unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT n/a					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES 130	19a. NAME OF RESPONSIBLE PERSON LTC Michael J. Kwinn, Jr.
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER (include area code) 845-938-5529

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18