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2009

STUDENT CAPSTONE CONFERENCE

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Edited by
Catherine M. Banks &
Kaleen J. Lawsure

The Virginia Modeling, Analysis, and Simulation Center

1030 University Boulevard
Suffolk, Virginia 23435

STUDENT CAPSTONE CONFERENCE

Invited Keynote Speakers

Dr. Gabriel Wainer
Carleton University,
Ottawa, Canada

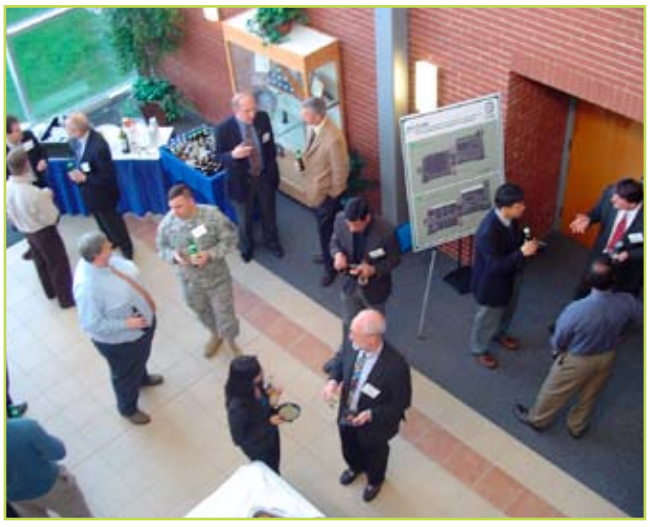
Dr. R. Bowen Loftin
Texas A&M,
Galveston, Texas

Conference General Chairpersons

Dr. Catherine Banks, VMASC
Kaleen Lawsure, VMASC

CREATIVITY is thinking up new things.
INNOVATION is doing new things.

~ Theodore Levitt



Primary Sponsor

The Virginia Modeling, Analysis, and Simulation Center

http://www.vmasc.odu.edu/capstoneconference

Contents

Modeling, Simulation & Gaming • Student Capstone Conference 2009

The Virginia Modeling, Analysis, and Simulation Center is pleased to provide the conference proceeding for the 2009 Modeling, Simulation & Gaming (MS&G) Student Capstone Conference.

This annual conference featured students from universities and colleges across the country. The student research and projects submitted to the conference are central to MS&G. It is here that students are given a venue to present their findings to members of the modeling and simulation community in academe, industry, and government. For many of our students these presentations serve as a culmination of their research and academic careers.

The 2009 conference facilitated six tracks and each track was assigned judges who voted for the first, second, and third outstanding project of that particular track. These students were recognized at the Capstone Banquet the evening of April 9th.

Also participating in the conference were faculty who have volunteered their time to impart direct support to their students' research by facilitating the various conference tracks, serving as referees for papers, serving as judges for each of the tracks, and providing overall assistance to this conference.

keynote speakers

Dr. Gabriel Wainer

Gabriel Wainer, SMSCS, SMIEEE, received the M.Sc. (1993) and Ph.D. degrees (1998, with highest honors) of the University of Buenos Aires (Argentina), and Université Paul Cézanne (Aix-Marseille III, France).

In July 2000, he joined the Department of Systems and Computer Engineering, Carleton University (Ottawa, ON, Canada), where he is now an Associate Professor. He has held positions at the Computer Science Department of the University of Buenos Aires, and visiting positions in numerous places, including the University of Arizona (USA), Ecole Polytéchnique de Marseille, LSIS-CNRS, University of Nice and INRIA Sophia-Antipolis (France). He is author of a book on Real-Time systems, three others on Discrete-Event Simulation and over 190 research articles. He has collaborated in the organization of over 80 conferences in the area.

He was Principal Investigator of different research projects (funded by the National Science and Engineering Research Council of Canada, Precarn, Usenix, the Canadian Foundation of Innovation, CANARIE, and private companies including Hewlett-Packard, IBM, Intel and MDA Corporation). He has been the recipient of various awards (including the IBM Eclipse Innovation Award, a Leadership award by the Society for Modeling and Simulation International –SCS- and a Best Paper award in an international contest organized by CICC, Japan).

He is a member of the Real-Time and Distributed systems lab at Carleton University, a chair of Carleton University's University's Research Centre in Technology Innovation and the head of the Advanced Real-Time Simulation lab within Carleton University Centre for advanced Simulation and Visualization (V-Sim).

He is Special Issues Editor of the Transactions of the SCS, and Associate Editor of the International Journal of Simulation and Process Modeling and the Journal of Defense Modeling and Simulation. He was a member of the Board of Directors of the SCS, and a chairman of the DEVS standardization study group (SISO). He is Director of the Ottawa Center of The McLeod Institute of Simulation Sciences and chair of the Ottawa M&SNet.

His current research interests are related with modelling methodologies and tools, parallel/distributed simulation and real-time systems.

Discovery consists of seeing what everybody has seen and thinking what nobody has thought.

Albert von Szent-Gyorgy

Dr. Bowen Loftin

R. Bowen Loftin holds a B.S. in physics from Texas A&M University (1970) and an M.A. and a Ph.D. in physics from Rice University (1973, 1975). Since May, 2005 Bowen has been Vice President and Chief Executive Officer of Texas A&M University's branch campus in Galveston, Texas where he is also Professor of Maritime Systems Engineering. He also holds a joint appointment as Professor of Industrial and Systems Engineering at Texas A&M University (College Station, Texas). From 2000 to 2005 he was at Old Dominion University in Norfolk, Virginia as Professor of Electrical and Computer Engineering and Professor of Computer Science.

In addition, Bowen was Old Dominion University's Director of Simulation Programs with responsibility for the university's graduate programs in modeling and simulation and Executive Director of the Virginia Modeling, Analysis and Simulation Center. Before coming to Old Dominion University, he was Professor in and Chair of the Department of Computer Science and Director of the NASA Virtual Environments Research Institute at the University of Houston. For over twenty years, Dr. Loftin has been teaching and conducting research in modeling and simulation.

The applications of his research have been in domains as diverse as scientific/engineering data visualization and analysis; astronaut training; hydrocarbon exploration; and defense training, analysis, and mission planning. He is a frequent consultant to both industry and government.

Dr. Loftin serves on advisory committees and panels sponsored by numerous government and professional organizations. His awards include the University of Houston-Downtown Awards for Excellence in Teaching and in Service (twice), the American Association of Artificial Intelligence Award for an Innovative Application of Artificial Intelligence, NASA's Space Act Award, the NASA Public Service Medal, the NASA Invention of the Year Award, and the IEEE Virtual Reality Conference Career Award.

He is the author or co-author of more than one hundred technical publications.

Learning and innovation go hand in hand. The arrogance of success is to think that what you did yesterday will be sufficient for tomorrow.

William Pollard

Conference Tracks

Body of Knowledge/Applied Principles of M&S

The Body of Knowledge is the domain of knowledge and capability that serves to provide identity to the profession of specific discipline. This track focuses on the BoK of M&S, which means presentations should address core elements of the discipline of modeling and simulation. It covers fundamental concept areas (such as theory of simulation, principles of distributed simulation, composability and interoperability, verification and validation) and application domains such as representation techniques, in particular behavior representation in M&S, integration into the application infrastructure, enabling emerging technologies.

General Science

This track encompasses the use of modeling and simulation in the non-medical sciences and is open to all science disciplines. Examples include, but are not limited to, ecology, evolution, paleontology, climate modeling, oceanography, biochemistry and behavior. Any application of modeling and simulation in the life sciences is a candidate for this track.

Homeland Security/Military

This track encompasses modeling and simulation that has been applied in either the military or homeland security domain. It will also include any work done in these domains that interfaces M&S capabilities with command and control systems and M&S work to support operations research, analysis, and visualization of military or homeland security systems or problems.

Medical

This track looks into various aspects of medical modeling and simulation from imaging capability to the augmented standardized patient (using augmented virtual reality). Modeling of physical systems, such as joints and muscles, the virtual operating room, and virtual reality for rehabilitation are also key to this application area. The development of simulators and the validation of those simulators will also be covered in this track.

M&S in Engineering

This track focuses on M&S methodologies and applications in the broader domain of engineering. One aspect is that simulation more and more replaces the traditional experimentation and prototyping. The track looks for such M&S ideas and examples and necessary changes in these traditional disciplines. Examples are, but are not limited to, enterprise decision support, optimization, product design, testing, life cycle support, and more.

Transportation

This track includes applications of modeling and simulation to solving multimodal transportation problems. The development, validation, and application of microscopic and macroscopic traffic simulation, travel demand models, and hardware in the loop simulation are appropriate research topics for surface (road) transportation. Simulations of port facilities, railroads, and the air transportation system are also included in this track.

There's a way to do it better – find it.
Thomas Edison

Track Leaders & Judges

Body of Knowledge/Applied Principles of M&S

Track Leader: Dr. Andreas Tolk, VMASC/ODU College of Engineering and Technology

Judges: Dr. Evelyn Brown, East Carolina State and
Dr. Peter Kemper, College of William and Mary

General Science

Track Leader: Dr. Poornima Madhavan, VMASC/ODU College of Science

Judges: Dr. James Comstock, NASA-Langley Research Center and
Ms. Heather Miller, Lockheed Martin

Homeland Security/Military

Track Leader: Dr. John Sokolowski, Director of Research – VMASC

Judges: Mr. Greg Knapp, JFCOM and
Dr. Mike Bailey, Marine Corps, OAD

Medical

Track Leader: Dr. Gianluca DeLeo, VMASC/ODU College of Health Sciences

Judges: Mr. Brent Smith, Engineering & Computer Simulations, Orlando, FL and
Dr. Donald Combs, Eastern Virginia Medical Center

M&S in Engineering

Track Leader: Dr. Rafael Diaz, VMASC

Judges: Mr. Jeff Laskowski, Lockheed Martin and
Dr. Young-Jun Son, University of Arizona

Transportation

Track Leader: Mr. Mike Robinson, VMASC

Judges: Mr. Bill Cashman, URS Corps., Mr. Bob Kuhns, Clark Nexsen and
Mr. Paul Agnello, Virginia Department of Transportation

The Gene Newman Award
for Excellence in M&S Research

The Gene Newman Award for Excellence in M&S Research was established in recognition of Mr. Eugene G. Newman for his tireless effort in advancing modeling and simulation education, research, and development. Mr. Newman played a significant role in the creation of VMASC (in 1997) by realizing the need for credentialed experts in the M&S workforce in the military and in industry. His foresight has affected both the economic development and the high level of expertise in the M&S community of Hampton Roads. Students receiving this first place award have proven themselves to be outstanding researchers and practitioners of modeling and simulation.

Student Winners

Transportation

1st Peter Foytik, Old Dominion University

2nd Yufei Shen, Joel Hanssen, Old Dominion University

3rd Hongbing Zhang, Old Dominion University

Medical

1st Emin Kugu, Old Dominion University

2nd T. Robert Turner, Old Dominion University

3rd Wenjuan Jiang, Old Dominion University

Homeland Security/Military

1st Cadets Jared Helle, Nate Lauer, Jeff Gamez, Matt Dedmon, U.S. Military Academy

2nd Alexandra B. Proaps, Old Dominion University

3rd Brent D. Morrow, Old Dominion University

M&S in Engineering

1st Jie Wang, Ozhan Unal, Old Dominion University

2nd Saikou Diallo, James Muguira, Old Dominion University

3rd Philip Cho, Ben Lozano, Kevin O'Neill, Jered Smith, U.S. Air Force Academy

Body of Knowledge/Applied Principles of M&S

1st Charles Turnitsa, Old Dominion University

2nd Ross Gore, University of Virginia

3rd James Muguira, Old Dominion University

General Science

1st Justin F. Brunelle, Old Dominion University

2nd Ruth Lamprecht, William & Mary

3rd Felix Portnoy, Old Dominion University

One person with passion is better than forty people merely interested.

E. M. Forster

BODY OF KNOWLEDGE & APPLIED PRINCIPLES OF M&S

A TAXONOMY OF INTEROPERABILITY CHALLENGES

James Muguira

Abstract: Interoperability is an active area of Modeling and Simulation that focuses on connecting systems and components together in order to achieve a goal that a single system or component cannot otherwise achieve. The benefits of interoperability include reduction in development time, cost savings and the promotion of reuse. However, interoperability is not a monolithic function and many taxonomies of interoperability have been developed to classify the levels at which systems interoperate. As a result, there is a better understanding of interoperability and the steps required to achieve a certain level of interoperability. While these taxonomies are important and useful, there are a series of recurrent issues that arise during the actual coupling of systems and components. Many of those issues have been identified in the literature and in general some very clever, but ad-hoc, methods for resolving them are documented. This dissertation derives a method to classify these various challenging situations in a taxonomy and proposes a method to extend it for the future. The proposed taxonomy offers a classification of issues in interoperability, and shows how it can be used early in the federation development cycle to predict, mitigate and account for problems that typically are dealt with later on in the development and/or test cycle. The proposed taxonomy can also be used as a prescriptive guide for developing interoperable systems and components.

KNOWLEDGE REPRESENTATION FOR MODELING AND SIMULATION

Charles Turnitsa

Abstract: The exchange of data between different models is about the exchange of information from within the context of two separate worldviews. This amounts to knowledge (information in context). To represent this knowledge, in any of a number of different ways (meta-data, ontological reference, frames, etc.) there must be a method to bridge the gap between what the worldview of origination can represent and what the worldview of destination can receive. As each separate model is the product of a different perspective by the model's developer, each individual model will have a different worldview. Identifying this world view is crucial towards identifying both the knowledge representation capabilities and requirements that exist in model composability efforts.

THE IMPACT OF STANDARDS ON INTEROPERABILITY: A CASE STUDY USING THE JC3IEDM

Saikou Diallo, James Muguira

Abstract: The emergence of interoperability standards and standardization bodies such as the Simulation Interoperability Standards Organization (SISO) should facilitate the creation and reuse of an interoperable solution. However, as simulation practitioners use existing standards, new challenges have emerged. Issues such as standards implementation, use and reuse of standard solutions, applicability of standards to particular problems and adaptability of reference implementations, have yet to be discussed in depth within the Modeling and Simulation community. Such discussions based on lessons learned would be very beneficial to a standards developer as they provide valuable feedback and a glimpse into the future. This paper will examine the Joint Command, Control and Consultation Information Exchange Data Model (JC3IEDM) which has been recommended as the data model of choice for the Coalition-Battle Management Language (C-BML) group. Originally developed and maintained by the Multilateral Interoperability Programme (MIP), it has been successfully applied to different projects linking C2 and M&S systems. Some of the lessons learned from these applications point to the fact that while systems were using a common logical model, implementation decisions greatly affected the technical interoperability between systems, sometimes leading to a complete redesign of solutions. In this paper, we apply a formal engineering method, Model Based Data Engineering (MBDE) to a use case involving the JC3IEDM to capture and describe the variance in solutions using a common standard. The paper will first describe the projects involved, apply MBDE to derive composites, generate a common language based on the standard, and compare each solution to the common language thus derived. The paper will finally categorize the variances and make recommendations on the way forward.

A SURVEY OF CURRENT APPLICATIONS OF AGENT BASED MODELS IN COMBAT MODELING

Brent Morrow

Abstract: Agent-based models have many applications throughout combat modeling. This paper looks at agent-based models, discusses some characteristics of the models, and briefly describes some of the current applications of agent-based models in the field of combat modeling.

MODELING AND SIMULATION IN THE PROCUREMENT PROCESS: AN UPDATE ON PEO SOLDIER

Anil Ustun, Saikou Diallo

Abstract: Modeling and Simulation (M&S) is significantly changing the military technical decision making. Military forces and many leading companies already use some aspects of M&S applications and a wide-array of simulation models for their purposes. The latest requirement of the U.S. Army's Program Executive Office (PEO) is to acquire a new type of body armor (BA) for the entire force. Traditional acquisition process will cost billions of dollars to determine which type of BA will be the most cost efficient and beneficial to the Force. The PEO Soldier program was instituted to evaluate the use of M&S to support the procurement process and to provide a more cost efficient way to solve complex R&D problems. A review of existing simulations showed that there is no single model that fully represents the acquisition process, thus the need for a federated approach. In the initial phase of the program an integrated solution using the High Level Architecture (HLA) and existing simulations showed how M&S can be used in the acquisition of BA. The resulting architecture was documented using the Model Driven Architecture (MDA). This paper describes the follow on efforts to introduce a common initialization process,

provide Situational Awareness (SA) and a Common Operational Picture (COP) and align the Command and Control (C2) data in the Federation Object Model (FOM) with the Joint Consultation, Command, and Control Information Exchange Data Model (JC3IEDM).

PROGRAM SLICE DISTRIBUTION FUNCTIONS
Ross Gore

Abstract: Unexpected behaviors in simulations require explanation, so that decision makers and subject matter experts can separate valid behaviors from design or coding errors. Validation of unexpected behaviors requires accumulation of insight into the behavior and the conditions under which it arises. Stochastic simulations are known for unexpected behaviors that can be difficult to recreate and explain. To facilitate exploration, analysis and understanding of unexpected behaviors in stochastic simulations I have developed a novel approach called, Program Slice Distribution Functions (PSDFs), for quantifying the uncertainty of the dynamic program slices (simulation executions) causing unexpected behaviors. My use of PSDFs is the first approach to quantifying the uncertainty in program slices for stochastic simulations and extends the state of the art in analysis and informed decision making based on simulation outcomes. I apply PSDFs to a published epidemic simulation and describe how users can apply PSDFs to their own stochastic simulations.

GENERAL SCIENCE

MODELING CALCIUM SIGNALING COMPLEXES IN MOBIUS
Ruth Lamprecht, Gregory D. Smith, Peter Kemper

Abstract: Mathematical models of calcium (Ca^2+) signaling complexes can take the form of compositionally defined Markov chains constructed from single channel models of intracellular Ca^2+ channels. Using the De~Young-Keizer inositol (1,4,5)-trisphosphate receptor/Ca^2+ channel (IP3R) model as modified by Shuai and coworkers, we illustrate how Stochastic Activity Networks (SANs) with state-sharing composition operations can be used to model intracellular Ca^2+-regulated Ca^2+ channels through the specification and replication of channel subunits. We reproduce the single channel behavior investigated by Shuai et al. and explore the parameter sensitivity of the model. The SAN formalism is subsequently used to study the behavior of Ca^2+ signaling complexes composed of multiple stochastically gating De~Young-Keizer IP3Rs coupled to one another through a common local Ca^2+ concentration.

USING PERSISTENCE DISPLAY TO INCREASE CHANGE DETECTION IN GRAPHICAL GAUGES IN A SIMULATED PROCESS CONTROL ROOM ENVIRONMENT
Felix Portnoy, Poornima Madhavan

Abstract: This study investigates the effect of a novel form for display mechanism, named “persistence display”, on visual sensitivity to changes in graphical gauges. The effectiveness of the persistence display was evaluated in a simulated process control environment, uniquely designed for this study. The persistence display was test under different magnitudes of changes in graphical gauges and was compared to traditional displays that are prevalent in the process control industry. The results of this study show that persistence display increased the users’ visual sensitivity such that their ability to detect changes in graphical gauges was greater compared to traditional forms of display across all levels in magnitude change. Further recommendations are made to continue evaluating the effect that persistence display may have on operators training.

VALIDATING A SOCIAL SCIENCE THEORY USING AGENT-BASED APPROACH
Georges M. Arnaout, Shannon Bowling

Abstract: Agent-based modeling is a powerful tool that offers efficient ways to study controversial and unproven theories in most areas of science, specifically social science. One theory that we have is the following: “It has been previously claimed that men having short hair gives them a competitive advantage over men with long hair, at least in hand to hand combat. As societies evolved, the competitive advantage was nullified because conflicts became rarer”. The example used here demonstrates the theory that men’s hair length is influenced by factors in society, one of which is conflict rate. We propose that the small competitive advantage created by having short hair over time yields to a complete adoption of the society to desire that behavior. Not only is the behavior adopted, but is also becomes part of the moral standards of a society. However, once the forcing function is removed (conflict rate) the once dominate behavior begins to wane and societies begin changing behavior or reverting back to less dominant behavior once again. The main objective of the paper is to introduce how agent-based models can be constructed in order to prove theories, or at least give insights in different areas of science such as social science. The use of computer social simulation for building our model is introduced in order to validate the proposed theory. Keywords: Agent-based modeling, combat modeling, simulated experiment, computer social simulation

VIRTUAL REALITY TRAINING FOR IAEA INSPECTORS
Kimberly Gilligan

Abstract: The International Atomic Energy Agency (IAEA) could greatly benefit from the utilization of a virtual reality training system. Inspectors perform a unique function in the nonproliferation regime and need to have an excellent command of many different skills. Virtual reality training would help to ameliorate challenges faced by the IAEA inspectors that are inherent in the organization. This paper serves as an overview of these challenges and the benefits of virtual reality training for the IAEA. The paper then proposes a description of a possible training system.

INTEGRATING PROBLEM-BASED LEARNING AND SIMULATION
Enilda J. Romero, Dr. Ginger S. Watson

Abstract: Problem-based learning (PBL) and simulations are instructional strategies that helped transition the traditional classroom environment, in which the learner does not have a participatory role, to a more prolific and engaging setting where learners have active roles. When combined, these two instructional strategies provide an array of benefits. Specifically, the learner is provided focus in the inquiry learning process coupled with more guided instruction presented by the simulation. The simulation presents the learner with boundaries that help center the focus on the curriculum goals stated by the instructor. In order to successfully integrate problem-based learning and simulation it is essential to have an understanding of the theoretical foundations of both problem-based learning and simulation, most specifically the classification of problems and the different types of simulations. Choosing the correct type of problem for a specific simulation type will prove to be beneficial for both the instructor and the learner. This paper provides a summarized theoretical foundation of problem-based learning and simulation. Because of its recent implementation, simulations for problem-based learning are considered a new instructional strategy. There are many inherent issues that need to be considered when planning to use PBL simulation. In this paper, we refer to the PBL simulation model of Maxwell et al. and address some of the inherent issues instructors will face when using PBL simulation. The paper ends with future research considerations and concerns.

MIBOARD: METACOGNITIVE TRAINING THROUGH GAMING IN ISTART
Justin F. Brunelle, Irwin B. Levinstein, and Chutima Boonthum

Abstract: MiBoard (Multiplayer Interactive Board Game) is an online, turn-based board game, which is a supplement of the iSTART (Interactive Strategy Training for Active Reading and Thinking) application. MiBoard is developed to test the hypothesis that integrating game characteristics (point rewards, game-like interaction, and peer feedback) into the iSTART trainer will significantly improve its effectiveness on students' learning. It was shown by M. Rowe that a physical board game did in fact enhance students' performance. MiBoard is a computer-based version of Rowe's board game that eliminates constraints on locality while retaining the crucial practice components that were the game's objective. MiBoard gives incentives for participation and provides a more enjoyable and social practice environment compared to the online individual practice component of the original trainer.

AN EMPIRICAL COMPARISON OF SPATIAL VERSUS VERBAL DISTRACTIONS ON HUMAN-AUTOMATION INTEGRATED PERFORMANCE
Rachel Phillips, Poornima Madhavan

Abstract: Using a luggage screening (visual) primary task, we examined the impact of including a cross-modal (auditory) distractor task in a competing or non-competing processing code (spatial versus verbal) on performance. For half of the participants, we also examined the influence of including a distractor task on interaction with a 70% reliable automated decision aid. The design was a 2 (aid: aided vs. unaided) x 2 (processing code: spatial vs. verbal) x 2 (distraction: distracted vs. undistracted) mixed design with aid and processing code as between subjects factors, and distraction as the within. Participants were measured for workload, system trust (in the aided condition), compliance and reliance, as well as hit and false alarm rates. Findings revealed a higher false alarm rate in the aided versus unaided condition and, unexpectedly, a lower false alarm rate in the distracted versus undistracted condition. Participant compliance levels (the probability of agreeing with the automation when it said "weapon present") were influenced not only by the presence or absence of a distractor but also by the distractor processing code. Compliance increased with the addition of a spatial distractor but decreased with the addition of the verbal distractor. System calibration, as measured by trust, was moderately affected by distractor processing code, such that those in the verbal condition demonstrated more accurate calibration than those in the spatial. These findings contribute to the understanding of influences on human-automation integrated performance and have implications for both multiple system and environmental design.

HOMELAND SECURITY/MILITARY

EMERGENT LEADERSHIP AND TEAM PERFORMANCE AS A FUNCTION OF TASK DIFFICULTY USING A COMPUTER GAME-BASED ARCHITECTURE
Alexandra Proaps, Dr. James P. Bliss

Abstract: Specialized military field training can be expensive, time-consuming and dangerous. The use of computer game based architectures may help provide a safe, controlled environment in which geographically dispersed military units (i.e., distributed teams) can develop decision-making and leadership skills while rehearsing a specific task, such as building clearing, area reconnaissance, or navigation. Leaders of distributed teams need to know how to perform to overcome the challenges involved in these virtual environment contexts. Current research shows some implications of task difficulty for how distributed team members emerge as leaders within a virtual environment. The purpose of the proposed study is to investigate the influence of task difficulty on emergent leadership and team task performance during a team navigation task using a modified version of the popular video game, Half Life 2 ™. The experimenters will determine how an individual emerges as a leader during a navigation task, whether task difficulty will decrease the speed, level of accuracy and level of efficiency with which the task is completed and whether task difficulty will influence how a leader emerges during the task.

A ROADMAP FOR CONDITIONS BASED MAINTENANCE FOR SMALL ARMS
Cadets Kelvin Espinal, Michael Griffin, Matthew Hanes, Stephan McCarthy

Abstract: The current small arms maintenance system in the U.S. Army repairs weapons after they fail and are rendered non-mission capable. The study proposes a Condition Based Maintenance (CBM)

roadmap for small arms utilizing preemptive measures to monitor, track, and assess the condition of the Army's small arms weapons arsenal. At the request of Program Manager (PM) Soldier Weapons in Picatinny Arsenal, NJ, the goal of the study is to increase the reliability of small arms by reducing unscheduled maintenance; thus, simultaneously increasing scheduled maintenance and soldiers' confidence levels. The M249 Squad Automatic Weapon (SAW), the Army's primary man-portable machine gun, is used as the test bed weapon system for the purposes of this study. The desired outcome is a streamlined Army maintenance system synchronizing the current reactive maintenance system with the preferred preventative maintenance system. Using West Point's Department of Systems Engineering System Decision Process (SDP), the study makes use of several techniques to include stakeholder analysis, functional analysis, value modeling, and computer simulation. Stakeholder buy-in, involvement, feedback, and research are imperative in determining the preferred system. These methods lead to both a quantitative and qualitative solutions which allow for comparison between the current and proposed system. Statistical and sensitivity analysis of the simulation and model output as well as stakeholder feedback drive the final solution and recommendation. The final recommendation includes considerations required for implementing and maintaining the proposed system over its entire life cycle. The solution will require Army-wide doctrinal and procedural changes.

COMBINED SIMULATION PROGRAM FOR DEFENSE STRATEGIES
Cadets Megan Ennenga, Joshua Kassel, Adam Moore, Courtney Wright

Abstract: Concerted efforts to adapt to an unconventional enemy in the United States' ongoing military campaign are imperative to future successes. Our military capabilities, weapon systems, and installations in the current fight are constantly exposed to new and creative enemy threats. Our project relies on past research by former cadets and is in support of the Armament Research, Development and Engineering Center at Picatinny Arsenal. The goal of our project is to accurately simulate unmanned aerial vehicle (UAV) attacks on a company sized forward operating base (FOB) in Iraq in hopes of assessing both the offensive capabilities of the enemy, as well as the defensive plans of friendly forces to counter those attacks. Further, our research synthesizes several computer technologies in order to effectively simulate the uncertainties but real possibilities of the future battlefield. To methodically approach this project, we are applying the Systems Decision Process (SDP), a process developed by the Department of Systems Engineering (DSE), United States Military Academy at West Point, NY. Using stakeholder analysis and research we developed ideas for different types of attacks and defenses, along with the necessary functionality for a simulation. A number of different simulation capabilities are combined in a federated simulation model to analyze our different alternatives, ultimately leading us to a recommendation concerning the developing aerial threat in today's fight.

A SURGE IN AFGHANISTAN – MODELING A FOCUSED SECURITY EFFORT
Brent Morrow

Abstract: This paper discusses a proposed thesis that investigates the insurgency in Afghanistan. The author proposes using agent-based modeling to construct a model and run a simulation that tries to determine if a troop surge emphasizing a Focused Security Effort can be successful in defeating the Neo-Taliban insurgency in Afghanistan.

FORCE STRUCTURE OF THE SHADOW PLATOON
Cadets Justin McCarty, Adrienne Rolle, Dan Szatkowski, Ty Volkman

Abstract: The Shadow is an unmanned aerial vehicle operated as a system by a platoon that provides real time battlefield reconnaissance, surveillance, intelligence and situational awareness. Experience has proven that as the dependence on unmanned systems grows, the ability of the team of operators and maintainers to keep pace with combat requirements is severely stressed. A serious result of this reality are mishaps that result in partial or complete loss of a vehicle, which handicaps the ability of the system to meet the needs of the command and limits the exploitation of the technology across domains and functions. However, mishaps can be prevented, particularly those caused by human error either by the operator or the maintainer. In the high intensity environment of extended combat operations, human error – including fatigue, work overload, and procedural shortcuts – must be managed in order to prevent mishaps and bring the rate of incidents in line with manned aviation. If the organizational structure does not support operational requirements, then the stress of continuous operations above the programmed capability will cause a breakdown in the form of mishaps. An increase in mishaps can directly impact mission accomplishment, or the slow degradation of the performance and morale of the platoon's personnel. The purpose of this research is to recommend changes to the current force structure of the Shadow platoon. Alternative force structures are developed and evaluated using the Systems Decision Process and several modeling techniques, including discrete event simulation.

LEVERAGING RELIABILITY GROWTH FOR SYSTEM O&S LIFE CYCLE COST ESTIMATING
Jared Helle, Nate Lauer, Jeff Gamez, Matt Dedmon

Abstract: We propose a new methodology for leveraging reliability growth models to link time-dependent test and evaluation reliability measures to independent life cycle cost estimates for operating and sustainment costs supporting major DoD systems acquisition projects. Integrating both deterministic and Monte Carlo methods, we demonstrate the effectiveness of this approach on the Block 1 UH-60M Blackhawk helicopter currently in first unit equip (FUE), comparing the results with current LCCE procedures.

CAUSAL LOOP DIAGRAM FOR THE ANALYSIS OF US STATE DEPARTMENT FUNDING FOR THE DEMOCRATIC REPUBLIC OF THE CONGO

Bill Crane

Abstract: This paper provides a review of the funding at the United States Department of State for the Democratic Republic of the Congo (DRC). It uses a causal loop diagram to determine key nodes in the DRC that must be address to help reduce the insurgency and thus help with the stability of the country. Based on these key nodes and the funding, a conclusion will be made as to whether the money is being spent in a manner that supports the critical nodes in the model.

GROUNDWARS 2: DEVELOPING A SMALL UNIT COMBAT SIMULATION

Menion Croll

Abstract: This paper describes the GroundWars 2 model, a small unit combat simulation developed using open source tools, intended for the evaluation of future combat systems. Traditional simulations use probability of hit, P_h, and probability of kill, P_k, tables to determine weapon effectiveness. GroundWars 2 uses trajectory analysis based on weapon characteristics and configurable damage regions, instead of P_h and P_k, to determine engagement outcomes. Monte Carlo simulation is used to compile the results, with the added capability of real-time playback of individual simulation runs for more in depth analysis.

MEDICAL

SINGLE MUSCLE FIBER ACTION POTENTIALS MODELING AND SIMULATIONS

GyuTae Kim, Mohammed Ferdjallah

Abstract: The objective of this paper is to use modeling and simulation concepts to design an electrophysiological single muscle fiber model to investigate the effects of fiber size, electrode location, and volume conduction properties on muscle action potentials and electromyographic signals measured either through invasive or noninvasive electrodes. The long term goal of this model is to design an entire muscle model to access muscle fatigue, ageing process, zero-gravity (space area), and disease effects (obesity, CP) on the anatomy and physiology of the muscle.

THREE MODELS IN IMPROVING COMMUNICATION AMONG CHILDREN WITH AUTISM

Padmaja L. Battagiri

Abstract: Autism is one of the most common neurodevelopmental disorders observed in children impairing their interactive and communication skills. Picture Exchange Communication System (PECS), based on the simple principle of exchanging pictures for conveying messages, is proven to be a powerful tool for communication. PECS being paper-based demands caregivers to draw, print and laminate pictures required which is time-consuming. In order to overcome this difficulty, there are electronic devices designed and available in the market which requires basic skills for operation, making them futile for younger group of children with severe autism. Therefore, a device which is more suitable for target users is desired. It can be designed according to user-centered model involving actual users in the testing process. Since, the actual users of this process are children, and their involvement in the testing is not acceptable, simulation of the users can be done. The teachers involved in training children with autism can be potential proxy users, since they are in direct contact with children, and can easily identify the needs and preferences of the children. Thus, the resultant software interventioning system, called PixTalk, has the operation principle similar to PECS and simulating block similar to that in user-centered model. The system comprises of a Smart-phone, used for browsing and selecting images, and a companion Website for managing children profiles and database of images, uploading customized images, choosing settings etc. Stored sessions in Smart-phone can also be uploaded onto website for analyzing usage of images to determine child's progress.

EVALUATING VISUAL AND HAPTIC FEEDBACK ON A VIRTUAL REALITY SIMULATOR FOR ORTHOPEDIC BONE PINNING

T. Robert Turner, Mark W. Scerbo, Dwight Meglan, and Robert Waddington

Abstract: The Simulation-Based Open Surgery Training System (SOSTS) is a virtual reality simulator designed to provide training on a simulated orthopedic bone pinning procedure. The present version of SOSTS offers five distinct combinations of multi-sensory feedback during training: enhanced visuals/enhanced haptics, enhanced visuals/moderate haptics, enhanced visuals/no haptics, moderate visuals/enhanced haptics, and moderate visuals/moderate haptics. The purpose of this study was to investigate the effects of visual and haptic feedback on participants' ability to place a pin through a fractured tibia on the simulator. Enhanced visual feedback resulted in a significant reduction of pin alignment error, although participants in these conditions took five times longer to achieve proficiency than those in the moderate visual feedback conditions. Any form of haptic feedback resulted in significantly greater pin placement error than no haptic feedback. The findings provide partial support for the proximity compatibility principle for display design.

PROSTATE CANCER BIOMARKER IDENTIFICATION: A COMPARATIVE STUDY

Wenjuan Jiang, Jiang Li and Rick McKenzie

Abstract: With current development in proteomics, the discovery of potential biomarkers has been greatly improved and attracts more and more attentions. In this paper, we implement five classifiers (SVM, Bayesian Classifier, Decision Tree, Random Forest and MLP) to compare their performances for discriminating cancer spectra from normal ones in prostate cancer biomarker identification using MALDI-MS tissue imaging data. We apply the five classification algorithms on 974 spectra (947 normal, 27 cancer) collected at the Eastern Virginia Medical School (EVMS) from one prostate tissue sample, and utilize a cross validation method and a bootstrap technique for the comparison. Experiment results show that the Bayesian classifier performs better than the other four classifiers.

ASSESSMENT OF DENOISING ALGORITHMS BY EVOLVING THE PARETO FRONT

Emin Kugu, Jiang Li

Abstract: Many denoising algorithms exist for image enhancement. There is always a trade-off between denoising and feature preserving for different applications. Features in images, especially edges, can be lost during the denoising process. To avoid losing those features, several edge preserving denoising algorithms have been investigated. Most of the algorithms have one or more parameters. Different configurations of the parameters usually give different preferences to noise suppression or feature preservation. It is very difficult to access different algorithms consistently, partially due to the fact that the importance of noise removal and feature preservation is user and application dependent. Different users may have different preferences for the same application and the same user may have different preferences for different applications. In this paper, we use a multiobjective optimization algorithm, the Strength Pareto Evolutionary Algorithm 2 (SPEA2), to optimize parameters for denoising algorithms, and to assess the algorithms in terms of the Pareto front produced by SPEA2. Pareto front is a curve in objective space, which corresponds to different parameter configurations with which the denoising algorithm can achieve all best possible objectives. We have defined three objectives for denoising algorithms: mean square error (MSE), entropy and second derivative of denoised images. We assessed four denoising algorithms: Gradient Anisotropic Diffusion Filter, Curvature Flow Filter, MinMax curvature flow filter and Directional Filter. Experiments show that the Pareto front is an effective tool for assessing different denoising algorithms.

M&S IN ENGINEERING

ALLOSOURCE: PROCESS SIMULATION AND ANALYSIS

Philip Cho, Ben Lozano, Kevin O'Neill, Jered Smith

Abstract: Allosource is a non-profit provider of bone, skin, and soft tissue allografts, including tendons, ligaments, and entire joints. As a result of rapid growth over the past several years, AlloSource needs to make their processes more efficient. Our goal is to provide an accurate and reliable SimProcess simulation tool that can be used for process analysis. In addition to constructing this simulation tool, our analysis team will look to discover specific choke points and resource utilization rates in order to make potential recommendations with regards to process configuration changes. After performing this initial analysis, our team will pursue different areas of sensitivity analysis. Our analysis team plans on examining how the inclusion of more rooms, processing tools, and employees improves throughput capabilities, overall processing time, and overall processing cost. Construction of this SimProcess model and the subsequent analysis will have an immediate impact on AlloSource, helping them determine the most cost efficient process changes for the future, while also determining how to best deal with continuing operations growth.

SUGGESTION OF AN MDA FRAMEWORK TO SUPPORT SIMULATION BASED PROJECTS

Anil Ustun, Priyanka Kotikalpudi

Abstract: The Model Driven Architecture (MDA) is an approach to IT systems development fostered by the Object Management Group (OMG) and often considered to be a milestone towards model-based development. Conceptual artifacts of MDA must not be seen only as input of generator tools but as the primary means of knowledge transfer and as the basis of the division of labor within a project. This ability can save money and time, and will result in better designs. An MDA framework is described with its conceptual artifacts and how it relates to M&S project lifecycles. The roles of team members of the simulation projects and the use of CIM, PIM and PSM are described in relation to the establishing of integration during the MDA development process. The paper is focusing on dynamic nature of M&S projects and suggests a framework regarding facilitating project management principles to heterogeneous simulation model projects.

THE IMPACT OF STANDARDS ON INTEROPERABILITY: A CASE STUDY USING THE JC3IEDM

Saikou Diallo, James Muguira

Abstract: The emergence of interoperability standards and standardization bodies such as the Simulation Interoperability Standards Organization (SISO) should facilitate the creation and reuse of an interoperable solution. However, as simulation practitioners use existing standards, new challenges have emerged. Issues such as standards implementation, use and reuse of standard solutions, applicability of standards to particular problems and adaptability of reference implementations, have yet to be discussed in depth within the Modeling and Simulation community. Such discussions based on lessons learned would be very beneficial to a standards developer as they provide valuable feedback and a glimpse into the future. This paper will examine the Joint Command, Control and Consultation Information Exchange Data Model (JC3IEDM) which has been recommended as the data model of choice for the Coalition-Battle Management Language (C-BML) group. Originally developed and maintained by the Multilateral Interoperability Programme (MIP), it has been successfully applied to different projects linking C2 and M&S systems. Some of the lessons learned from these applications point to the fact that while systems were using a common logical model, implementation decisions greatly affected the technical interoperability between systems, sometimes leading to a complete redesign of solutions. In this paper, we apply a formal engineering method, Model Based Data Engineering (MBDE) to a use case involving the JC3IEDM to capture and describe the variance in solutions using a common standard. The paper will first describe the projects involved, apply MBDE to derive composites, generate a common language based on the standard, and compare each solution to the common language thus derived. The paper will finally categorize the variances and make recommendations on the way forward.

AUTOMATIC HIGH-FIDELITY ROADWAY GENERATION
Jie Wang, Ozhan Unal, Mecit Cetin, Yuzhong Shen, and Yiannis Papelis

Abstract: Road is an essential feature for our lives. In this paper, a method is proposed to automatically generate the 3D road network geometry. This method minimizes manual labor required by past 3D road model generation process. It also incorporates civil engineering rules into account generating roads which can support civil engineering applications. Road specification, civil engineering rules, terrain information and surrounding environment are used as the inputs of this method and the output of this method is real time 3D road network models. This method will greatly enhance the road modeling in many applications and abundant relevant technicians can take advantage of it.

BUTTERFLY EFFECT ON SYSTEMS: MODELING AND ANALYSIS OF SYSTEMS
Baqer Alali, Abdullah Namankani, Fadi Ayoub, Federico Bermudez, and John Easter

Abstract: Experimental methods and real life representations of complex systems are expensive, tedious or impossible. The purpose of this experiment is to explore complex chaotic systems, utilizing Netlogo to study the behavior of systems; specifically to investigate if small changes to elements or components of a system have dramatic changes to the whole system. By expanding on the "Gas in a Box" model within Netlogo we demonstrate how minor changes in the location of one particle will lead to dramatic changes in the overall system. To expand on the "Gas in a Box" model, a model was created with two sets of particle systems, conditionally independent from each other. We used the same systems' seeds in order to have the two systems start from the same position. The coordinates of one particle in one of the systems was changed by adding 0.005 to the X and Y coordinates, to simulate a small change. After 200 simulations, the experiments indicate that in more complex systems, small changes affect the behavior of the system faster than in less complex systems. Once the change begins to propagate through the system, it propagates until a certain maximum separation among particles is regardless of the complexity of the system.

POTENTIAL READINESS AND ECONOMIC BENEFITS FROM INSTALLATION OF HEALTH AND USAGE MONITORING SYSTEM (HUMS) ON U.S. COAST GUARD HH-65C HELICOPTERS
Kevin M. Wilson, Patrick T. Hester

Abstract: Abstract—The objective of this study is to determine the readiness and economical benefits of installing HUMS on the 102 airframes composing the USCG HH-65C fleet through a deductive, quantitative survey by comparison of continued readiness and costs with and without HUMS. In particular, acquisition of a Health and Usage Monitoring System as a mitigation strategy for the reduction in service life limits and improved safety awareness on the H65C will be examined. Because HUMS has not been previously installed on the U.S. Coast Guard HH-65C helicopter, cost and readiness data from the U.S. Army HUMS initiatives will be used to predict HH-65C costs and benefit drivers.

TRANSPORTATION

WHAT IS THE ROLE OF MULTIPLE SECONDARY INCIDENTS IN TRAFFIC OPERATIONS?
Hongbing Zhang and Asad Khattak

Abstract: Traffic incidents are a major source of uncertainty. Sometimes, a primary incident can result in multiple secondary incidents, which can be problematic. To identify roadways where multiple secondary incidents are more likely to occur and analyze primary and secondary incidents, an innovative analysis method based on a detailed incident dataset from Hampton Roads was developed. Incidents occurring on major freeways are categorized as 1) single incident, 2) one primary-secondary pair, and 3) one primary with two or more secondary incidents in the same and opposite directions. The last category captures large-scale events involving several secondary incidents. Ordinal regression models are estimated to quantify associations with key factors that include incident characteristics, roadway geometry and traffic flows. Furthermore, a deeper analysis of secondary incidents is conducted by examining the time gap between primary and secondary incidents. The time-gap is treated as conditional on the occurrence of secondary incidents and an appropriate statistical method, the Heckman model, is used for estimation. This research contributes to incident management by characterizing and analyzing complex events involving multiple secondary incidents. The results support the planning and operation of service patrols.

FREIGHT TRIP GENERATION AND DISTRIBUTION BASED ON GLOBAL INSIGHT TRANSEARCH DATABASE
Yufei Shen, Joel Hanssen, Yuzhong Shen, Roland Mielke, John Sokolowski, and Mike Robinson

Abstract: In the absence of a Cargo freight model for Hampton Roads, the Transearch Database can be used to obtain truck trip estimates. The Global Insight Transearch Database describing current and projected freight movement in Hampton Roads was acquired from VDOT for use with this project. This paper presents the methods for freight trip generation and distribution based on the Global Insight Transearch database. This database was mined to produce estimates of truck traffic in 2000 and 2030. It provided the freight flow information in Hampton Roads for the subsequent process steps to assess the effects of freight on overall traffic flow of Hampton Roads in 2000 and 2030.

OPTIMIZING PASSENGER FLOW THROUGH AIRPORT CHECKPOINTS USING DISCRETE EVENT SIMULATION
Jeremy Brown, Poornima Madhavan

Abstract: Abstract-The movement of passengers through an airport quickly, safely, and efficiently is the main function of the check-in counters and security checkpoints found in most airports. Humans are an integral part of this process; however, humans are prone to errors. These errors combined with other breakdowns in the complex system of the airport can disrupt passenger flow through the airport leading to lengthy waiting times, missing luggage and missed flights. In this paper we present a model of passenger

flow through an airport using discrete event simulation that will provide a closer look into the possible reasons for breakdowns and their implications for passenger flow. An important goal of this simulation is to present ways to optimize the work force to keep passenger flow smooth even during peak travel times and for emergency preparedness in case of adverse events.

PASSENGER CAR AND SUV CRASHES-DO THE HUMAN FACTORS PLAY A VITAL ROLE?
Faisal Mahmud

Abstract: In recent years, traffic safety has become a major concern for all of us regarding the increase of volume, mobility, speed and economy. From various types of research and studies, it has found that there are several factors that directly or indirectly hamper the safety. The three major factors such as Vehicle factor, Environmental factor and Human factor provide important clues behind all categories of crashes causing fatality and property damage resulting in overall safety problem. In case of vehicle types, SUVs and Passenger Cars are more vulnerable because of their most use in the vicinity. In this research paper, Passenger Car and SUV crashes due to the specific unsafe driving acts (UDAs) or behavioral errors, considering the human factors, will be focused associated with the main reasons behind the crashes and thus resulting in injury severity. National Automotive Sampling System-Crashworthiness Data System (NASS CDS) is used to find out different cases that represented different types of crashes elaborately. One year's worth of data is taken for sampling and analysis by using statistical software following weighted ordered logit model. Corresponding countermeasures are also discussed.

IMPLEMENTING A MESOSCOPIC TRANSPORTATION EVACUATION MODEL
Peter Foytik

Abstract: Large scale transportation planning for events such as evacuations have improved with the help of macroscopic planning tools, but sometimes more information is needed from the results of the simulation. Microscopic simulations provide the desired results, but require excessive time to run. Mesoscopic simulation, tools that are in between micro and macroscopic, can provide some of the behavioral aspects of the micro simulation and the processing time of the macro simulation resulting in a good solution for many transportation planners. This paper will describe the implementation of a hurricane evacuation transportation mesoscopic model within CitiLabs software Cube by creating custom scripts outside the capabilities of the default script generation, describe the strategy used to implement strategies inside Cube, as well as future developments with Cube.

NOTIONAL MODEL FOR FREIGHT FORECASTING
Joel Hanssen

Abstract: The commodity flow structure for modeling freight is rapidly gaining acceptance among transportation planning engineers. However, many aspects of the methodology are still in the development stage. My thesis work is the development of a notional model that illustrates the concept of the commodity flow structure. This paper discusses the progress achieved so far. This author is aware of only one software package that is capable of developing a model using this structure; Cube by Citilabs. Because transportation planning typically involves both freight vehicles and passenger vehicles, the model will be developed in two parts within the Cube environment. Part I of the Notional Model is the well documented Travel Demand Model (or four-step model). This paper will provide a detailed look at a notional Travel Demand Model developed by utilizing programs in the Voyager module of the Cube software package. Part II will provide a step by step explanation of the commodity flow approach to freight modeling by briefly walking through the first five programs of the Cargo Module. The output matrices generated each step of the way by the notional Travel Demand Model and the notional Freight Demand Model could easily be presented in power point presentation or printed format. The Notional Model lays an excellent foundation for future research on this subject. Citilabs has expressed an interest in this model.

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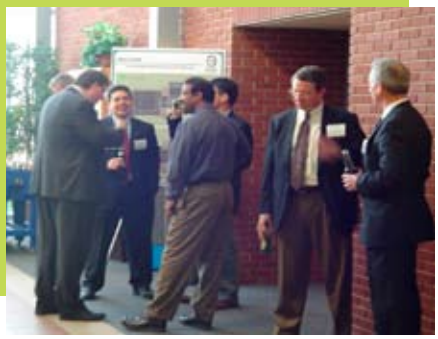

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