Abstracts


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'17


HARNESSING NEW TECHNOLOGIES
TO WIN IN A COMPLEX WORLD

2017 FELLOWS

2017 BEST PAPERS

EDUCATION

EMERGING CONCEPTS & INNOVATIVE TECHNOLOGIES

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REMEMBRANCES OF A SIMULATIONIST: AN EXCITING CAREER OF "MAKE BELIEVE"

2017 IITSEC Paper No. F001

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In this paper, the author chronicles his almost 60 years of experience in the modeling, simulation and training industry. He sets the stage by describing the early simulation environment and the pioneers who contributed to its growth. His professional journey begins with a field service position at Link Aviation, Binghamton, N.Y., supporting the U.S. Air Force, followed by a 32 year career with the U.S. Navy's simulation organization. Intense volunteer work followed, focused on workforce development beginning with K-12 curriculum development.
Numerous changes were made over that time period with many "lessons learned". Under Department of Defense direction, logistic support requirements for simulators underwent a paradigm shift to more focused management. Structured project management became necessary for timely trainer delivery. Simulator technology experienced the revolution from analog to digital computation, requiring immediate management action to develop the necessary skillsets to function effectively in this new environment. The digital revolution opened pathways for new and exciting applications and domains. The commercial market of computers and software presented cost-effective designs. Networking with live-virtual and constructive simulations became possible, adding new dimensions and challenges to training our warfighters. The Instructional Systems Design (ISD) process became institutionalized.
Throughout this period, political, economic and social decisions were made that altered the course of the simulation industry. The move of the Navy's simulation organization from Port Washington, N.Y. to Orlando, FL is discussed. The policy of substituting simulator time for aircraft time is described as a "period of enlightenment". After retiring from the Government, the author conducted research in the private sector. Further, the last 20 years were spent "giving back" to the industry in the form of introducing M&S into K-12 schools and developing a certification program for high school students, qualifying them to seek internships with the simulation industry.
Projections for the future are presented.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320A

BP-1 2017 Best Papers

1030
Creating Effective LVC Training with Augmented Reality (17119) (ECIT)

1100
Perceptual-cognitive & Physiological Assessment of Training Effectiveness (17013) (Training)

1130
Human Systems and Instructional System Design for a Simulator of a Robotic Surgical System (17213) (Education)

Notes

CREATING EFFECTIVE LVC TRAINING WITH AUGMENTED REALITY

2017 IITSEC Paper No. 17119

Nathan Jones & Koren Odermann
MARCORSYCOM PM TRASYS
Orlando, FL

Peter Squire
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While live training is often the preferred method for Marines, Force-On-Force (FoF) training exercises lack the visual cues necessary to effectively train Call for Fire (CFF), Close Air Support (CAS), and other engagements. Imagination has been the method of training and feedback on live ranges for decades when weapons and platforms were not available or limited by costs. Augmented Reality (AR) training systems now offer the opportunity to provide realistic visuals of virtual and/or constructive entities and engagements on the live range.
To ensure that AR technology can be utilized to support FoF training, an assessment of the Augmented Immersive Team Trainer (AITT), an AR training system, was conducted to determine how well AITT supports specified training objectives. The AITT system was developed by Office of Naval Research (ONR) and transitioned to Program Manager Training Systems (PM TRASYS). The program office technical assessment team utilized a task and attribute based approach to assess the simulator and simulation on both the activities an individual is required to do in the performance of a specific job (i.e., tasks) and the fidelity the device is required to provide to support that performance (i.e., attributes).
This paper describes the AITT technology and the assessment conducted to support training objectives. In addition, the paper discusses potential for AR technology to enhance the live component in Live-Virtual-Constructive (LVC) environments. This paper provides discussion points based on lessons learned and required development for AR systems being developed to enable an effective LVC training solution.

PERCEPTUAL-COGNITIVE & PHYSIOLOGICAL ASSESSMENT OF TRAINING EFFECTIVENESS

2017 IITSEC Paper No. 17013

Jaclyn Hoke[1], Christopher Reuter[2], Thomas Romeas[3,4], Maxime Montariol[2], Thomas Schnell[2], & Jocelyn Faubert[4,5]
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Several trends within the simulation and training industry are emphasizing the need for measurable proof that training solutions meet or exceed the requirements for delivering effective training. Cognitive state is a key component of learning, meaning that classification of cognitive state and capacity can provide a measure of training effectiveness. However, accurate classification of trainee state is an extremely challenging task. The more traditional subjective assessment methods have several limitations, while objective assessment methods can be difficult to implement.
We conducted an exploratory study that evaluated the cognitive and physiological load engaged during flight simulation and live flight during maneuvers of three levels of difficulty. The study represents the work performed to date in the first year of a multi-year effort to design a method for assessing the efficacy of training content and devices, including live platforms, that is based on objective cognitive state assessment techniques coupled with control input and mission/platform performance measures. The method employs NeuroTracker, a validated tool for evaluating or training perceptual-cognitive skills, to measure spare cognitive capacity, and physiological measures of workload based on analysis of eye tracking and electrocardiogram data.
This paper briefly summarizes the design, implementation, and initial results of this study. It summarizes the next steps required to further refine the proposed method for assessing training efficacy and describes the planned followon effort. Finally, it discusses additional applications of this method in military and commercial training markets, such as the real-time adaptation of training content to trainee skill level and state.

HUMAN SYSTEMS AND INSTRUCTIONAL SYSTEM DESIGN FOR A SIMULATOR OF A ROBOTIC SURGICAL SYSTEM

2017 IITSEC Paper No. 17213

Danielle Julian, Roger Smith, Alyssa Tanaka, & Ariel Dubin
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Celebration, FL

Traditional spinal surgery procedures are carried out with limited direct visualization and augmented with generous use of fluoroscopic imaging. This imposes limitations on the surgeon's ability to place screws into the spine and exposes the staff to large amounts of cumulative radiation. The Mazor Renaissance robotic system was developed to both improve the accuracy of insertion of the pedicle screw and to reduce the amount of energy exposure to staff and patients. The robot offers a significant advancement in the technology used in spinal surgery, which calls for very specialized training and education programs for surgeons seeking to adopt it. The current standard of training and employment of this device comes with significant constraints on both the trainees and trainers.

Currently, the training must be conducted at specialized training centers that can provide clinical equipment which includes Operating Room (OR) tables and lights, fluoroscopic imaging equipment, cadaveric tissue, surgical instrumentation, certified radiation technicians, tissue storage, and video recording capabilities. These requirements create a learning experience, which can only be supplied to a surgeon a single time and do not support surgeon-initiated refresher training. This suggests that a simulation-based solution may be a valuable supplement to the current training and education model.

This paper describes efforts to apply the theories of human-systems integration (HSI), instructional system design, and simulator engineering to define the requirements for a simulator of a specific robotic surgery system. Specifically, the aim of this project was to outline the instructional opportunities through several instructional analyses that can be filled with a spinal simulator while considering human performance concerns and constraints during the research and design phases of the system. From this, an instructional plan was conducted, to which a HSI driven design document for a simulation system was developed.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM W320A

BP-2 2017 Best Papers

1400
Assessing Submariners' Intuitive Decision-making Skills using Neurocognitive Methods (17090) (Human Performance Analysis and Engineering)

1430
Dynamic Occlusion using Fixed Infrastructure for Augmented Reality (17054) (Simulation)

1500
At the Tipping Point: Learning Science and Technology as Key Strategic Enablers for the Future of Defense and Security (17109) (Policy Standards Management and Acquisition)

Notes

ASSESSING SUBMARINERS' INTUITIVE DECISION-MAKING SKILLS USING NEUROCOGNITIVE METHOD

2017 IITSEC Paper No. 17090

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Military missions pose complex cognitive and perceptual challenges, such as detecting potential improvised explosive devices along the roadside, or detecting anomalous social cues in a crowded market that may suggest an impending attack. Situations such as these do not allow time for extensive deliberation; rather, the ability to make quick and accurate decisions is key to survival. Evans and Stanovich (2013) suggest that, unlike deliberate decision-making, this type of intuitive decision-making is extremely fast and requires little or no working memory. Research has shed light on the neural mechanisms underlying intuitive decision-making. For example, Luu and colleagues (2010) used electroencephalography (EEG)-based techniques to identify a neural signal of intuition during an object detection task. In their study, participants viewed fragmented line drawings and indicated whether each image contained a real object. Participants' event-related potentials (ERPs) differed between correctly identified real objects and correctly rejected non-objects after ~200 milliseconds (ms) and this difference persisted through ~500 ms. The purpose of the current study was to examine the generalizability of this neural signal with a military sample performing both everyday decision tasks (object detection) and military-relevant tasks (course safety decisions). Twenty-seven submariners participated in a rigorously-controlled, within-subjects experiment. Statistical analyses of the participants' brain activity confirmed that the neural signal identified by Luu and colleagues generalizes across tasks. Moreover, this signal reliably differentiates expert submariners from novices. This study is unique in that it validated the existence of a neural indicator of accurate intuitive decision-making across both samples and tasks.

DYNAMIC OCCLUSION USING FIXED INFRASTRUCTURE FOR AUGMENTED REALITY

2017 IITSEC Paper No. 17054

Scott Johnson, John Baker,
Jaime Cisneros, and Juan Castillo
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The U.S. Army Research Laboratory-Human Research and Engineering Directorate, Advanced Simulation Technology Division (ARL-HRED-ATSD) performs research and development in the field of augmented/mixed reality training technology. Within training, the Department of Defense (DoD) has a strong interest in augmented reality (AR) for its ability to combine live and virtual assets to reduce cost, increase safety, and to mitigate unavailability of needed live assets. Answering this is the commercial sector, which is rapidly advancing a host of capabilities to support AR, such as head mounted displays (HMDs). An important capability of AR is the realistic occlusion between live and virtual objects based on their respective depth in the augmented reality scene. Existing solutions use pre-scanned environmental depth information to provide this capability; however, this is only useful for objects that will never move or static objects. This does not address live objects that move or dynamic objects (e.g., live Soldiers). Dynamic objects must be constantly scanned using a depth camera(s) to provide the occlusion information for an AR-enabled system. Of the few commercial sector vendors that provide depth cameras on their HMD, most are lacking the sufficient depth range to adequately support occlusion from the HMD – anything beyond roughly two meters has greatly diminished fidelity. This paper describes a solution that will add a network of fixed infrastructure cameras with a centralized occlusion server to merge the depth images from various sources. This then creates depth images suitable for occlusion on the HMDs at any range with realistic fidelity. The paper will report the use of commercial off the shelf (COTS) computers and cameras that instrument an area such that it can be used for occlusion in a training system. The paper will speak to the performance of fusing data, given resolution and volume. Finally, this paper will show scenes where virtual objects are added to a real scene and how the performance of the occlusion system affects the quality of the visuals for the participants.

AT THE TIPPING POINT: LEARNING SCIENCE AND TECHNOLOGY AS KEY STRATEGIC ENABLERS FOR THE FUTURE OF DEFENSE AND SECURITY

2017 IITSEC Paper No. 17109

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According to former U.S. Secretary of Defense, Ash Carter, today's national security environment is "dramatically different—and more diverse and complex in the scope of its challenges—than the one we've been engaged with for the last 25 years, and it requires new ways of thinking and new ways of acting" (2016, emphasis is ours). These new ways cannot be achieved without significant changes to lifelong (or at least career-long) personnel development. This paper focuses on one aspect of that (r)evolution, i.e., specifically examining the challenges, goals, projects, and recommended actions related to the transformation of training and education in the defense and security sectors.

For more than a decade, training and education professionals have beaten this drum. Researchers and dedicated practitioners have pursued tactical-level programs in cognitive readiness, improved decision-making, adaptability, accelerated learning, instructional excellence, and so on. Small "inkblots" of excellence formed, and many papers were written. These inkblots are now converging, and grassroots efforts are being strengthened by serious top-level patronage and policy direction. Now, strategic-level organizational change seems possible.

All of the U.S. military services, as well as many other security agencies and coalition partners, have released detailed guidance on how to evolve their learning and development processes. This paper summarizes these complementary efforts and then recommends collective actions that may yield meaningful returns in the short- to mid-term. Specifically, these recommendations focus on instructional quality, competencies, credentials, data analytics, data interoperability, personalization, learning on demand, integrated human–machine systems, a technology-enabled continuum of learning providing multiple paths for achievement, and an enterprise approach to talent management.

TUESDAY, 28 NOVEMBER, 2017 ROOM S320 1400

ED1 Best from Around the Globe

NOTES

TUESDAY, 28 NOVEMBER, 2017 ROOM S320D

ED2 Obstacles and Surprises: Overcoming

1600
Overcoming Educational Obstacles to the Achievement of the Future Special Operator Concept (17063)

1630
Black Swans: Disruption of Power (17174)

NOTES

OVERCOMING EDUCATIONAL OBSTACLES TO THE ACHIEVEMENT OF THE FUTURE SPECIAL OPERATOR CONCEPT

2017 IITSEC Paper No. 17063

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USSOCOM's Future Special Operations Forces (SOF) Operator Concept analyzes the competencies that will be expected of SOF decades into the future, and in it great care has been taken to consider "horizontal competencies" which comprise the development of new skills. However, the integration of knowledge, skills, and abilities over time as well as the development of "vertical competencies" – which equate to the expansion of cognitive capacities – has been less-well considered.

This paper discusses three educational pathways that, taken together, could enable a SOF operator to achieve a significant level of cognitive growth and social learning across the arc of his career via: (1) instruction that utilizes educational methods and techniques which increase transfer, the application of formal learning to many different situations in the field, (2) approaches that foster communities of practice, a key source of knowledge for honing one's tradecraft, and (3) more rigorous language and cultural training to support the development of fluent bilingualism, an area which shows potential for enhancing cognitive flexibility and creativity in individuals.

This paper presents a case for the idea that given the volatile, uncertain, complex, and ambiguous (VUCA) nature of today's operational environment, it is essential for leaders of the uniformed services and SOF to better understand educational pathways capable of increasing the cognitive capacities of service members in addition to factors that inhibit learning.

BLACK SWANS: DISRUPTION OF POWER

2017 IITSEC Paper No. 17174

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Norfolk, VA

Against a backdrop of disruptive change, it is tempting to try to categorize and spot patterns early: we have seen a recasting of politics, the upset of established systems, the emergence of new media, challenges to traditional models of learning and an evolution in the nature of knowledge itself. The relentless march of technology masks part of the true nature of this change; while technology is a very visible manifestation of change, it is the underlying sociology, the cohesion of communities, and the evolving forms of power behind them, which really count. In this social age, we are seeing a fundamental evolution in types of power that will disrupt much of the previous power dynamics. This paper builds on previous work that centered on how to re-contextualize scripts and frames to educate organizations to better deal with Black Swans (Stodd, Reitz, Schatz, & Fautua, 2016).

Black Swans are disruptive events, unpredictable and disruptive of formal systems. If the nature of Black Swan events is known, then the ecosystem within which they occur is of key interest; as the ecosystem changes, so too does the nature of disruption, the speed with which it occurs, the groups that cause it, and the inability of formal systems to predict or cope with the results. This paper will contextualize these disruptions in terms of types of power, formal and social systems, and the impacts of these effects on learning and leadership today. We propose a learning concept that focuses on increasing strength through highly engaged, high trust, and reputation led, social communities. Additionally, we will provide case studies of military and non-military organizations that have applied similar concepts: they maintain a dynamic tension between formal and social systems which allows them to learn fast, evolve rapidly, and become highly resilient to future black swans.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320D

ED3 Fostering Workplace Competencies

Notes

VALIDATING COMPETENCIES USING A QUANTITATIVE DATA-BASED APPROACH

2017 IITSEC Paper No. 17105

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Traditionally, job analysis and competency modeling have been viewed as separate efforts with separate purposes and separate audiences (Shippmann, et.al., 2000). A common, simplified distinction is that job analysis is more "workfocused" whereas the competency model is more "worker-focused." The outputs of job analysis are typically used by human resources professionals to determine job duties, develop or validate position descriptions, determine qualification for hiring, and provide other human resources information (Levine & Sanchez, 2007). The outputs of competency models are typically used by learning professionals for developing organizational training and education, for developing and validating career paths, and can also be used for assessing employee performance (Campion et al., 2011). However, greater insights can be generated if job analysis and competency modeling are viewed as complementary vice dichotomic processes. This paper documents a multi-phased, data-driven approach that integrates the rigor of an in-depth job analysis methodology with competency model development and the application of the approach across several levels of employee proficiency. This methodology, which has been applied within a Federal agency, produces large sets of quantitative data which can be used to provide a comprehensive picture of a position, of the competencies needed for successful performance, and of how position tasks and competencies change as the employee develops within a position. The outputs and data that result from this combined approach provide organizations with critical insights, supported by quantitative data, which can be used to prioritize and defend training, simulation, and education resources that are often not possible using separate approaches (Gutman & Dunleavy, 2003). The outputs can also be used to support other human capital functions and processes needed to improve organizational performance, including workforce planning, hiring, and promotion. The methodology presented in this paper is wellsuited for understanding positions which are mission-critical, positions which have a wide range of complexity, and positions which have specialized roles within a job series or position.

A DYNAMIC LEARNING APPROACH TO TRAINING DIGITAL ACQUISITION PROFESSIONALS

2017 IITSEC Paper No. 17264

Faith Powers & Lauren Tindall
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Current Federal procurement practices largely do not provide the flexibility required to buy and deliver modern digital services. Meanwhile, the pace of technological change continues to accelerate while citizen demand for Federal digital services increases. To meet this demand, the Office of Federal Procurement Policy and the U.S. Digital Service needed an immersive development and training program to enhance digital services acquisition expertise across government agencies.

This paper addresses the question: How do you design an effective training program while also being flexible to address evolving learning needs over time? Agile Learning and Human-Centered Design principles were used to design a curriculum that is adaptive to the needs of each participant, while promoting progress against established learning objectives. To address the constant evolution of the subject matter, approximately 60% of the curriculum supports defined learning objectives, while 40% of the curriculum is responsive to the needs of participants. The responsive portion is informed by data from pre-assessments that participants complete at the start of each segment of instruction and that are used to generate participant-specific learning paths. Participants also complete post-assessments at the end of each segment to measure knowledge and skill gains and to support customized remediation. The program includes a mix of instructional strategies to promote comprehension, experiential and problem-based learning, and practice of knowledge and skills, and to engage stakeholders to contribute to the overall acquisition culture change.

This paper will also discuss the results and lessons learned after completing two deliveries of the program and certifying 50+ digital services acquisition professionals. Four months after the first delivery, 83% of participants reported a positive change in their job behavior or role. 91% of participants had been asked to provide advisory services to a Digital Service team at their agency.

A MOBILE STRATEGY FOR SELF-DIRECTED LEARNING IN THE WORKPLACE

2017 IITSEC Paper No. 17265

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Traditional approaches to workplace training often treat learners as equally prepared, drive them through too much content in too short a time, and conclude before ensuring retention. These departures from ideal instructional practice have a common cause—the need to fit learning activities into constrained episodes such as classroom presentations and e-learning courses. Fortunately, advances in mobile technology, learning science, and artificial intelligence are making it possible to deliver learning experiences in less constrained conditions, with reduced risk of overload, and better alignment with an individual's mental and situational readiness to learn.

We developed a mobile strategy that leverages these advances to support adult learning, and implemented this strategy in PERLS, a mobile application that recommends bite-sized learning materials—or microcontent—through a deck of electronic cards. An intelligent algorithm tracks progress and recommends content based on principles of self-regulated learning, goal-setting, and adult learning motivation. Essentially, PERLS aims to engage users in becoming better self-regulated learners on the job.

In this paper, we describe the PERLS mobile learning strategy and results of an evaluation of user satisfaction with the technology and pilot testing of several instruments for continuous improvement. The mobile app was deployed to support training of Defense Support for Civil Authorities (DSCA). By drawing from observations, online usage data, learning outcome measures, and surveys of learner characteristics and attitudes, this paper provides evidence of the feasibility of using this approach to enhance self-directed learning activity among military personnel.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320D

ED4 STEM – Innovated Tools

1400
Enhanced STEM Subject Outcomes from the Use of Intelligent Tutors (17236)

1430
Implementing Innovative Constructivism: An Architected Approach to Enhancing STEM Education (17017)

1500
Mathematical Simulations – Students No Longer Lost in Two-dimensional Space (17127)

Notes

ENHANCED STEM SUBJECT OUTCOMES FROM THE USE OF INTELLIGENT TUTORS

2017 IITSEC Paper No. 17236

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The military training and education community spends hundreds of hours a year on training warfighters not just for the job in front of them, but their next job, and contingencies foreseen and unforeseen. This training and education process requires a strong foundation of understanding Joint or Service procedures, and is dependent on each warfighter's area of specialization. There are highly technical skill-sets that can decay if unused or un-refreshed on a regular basis. Refresher training is often conducted as a standard process, untailored to each individual's unique skill-set. School age children are, in the end, no different in this learning challenge. A student's proficiency in foundational arithmetic and algebraic skills is critical for success in algebra and higher-level math courses.

Building on data from previous STEM-focused learning interventions, this paper will discuss a case study for applying diagnostic measures as a way to enhance and adapt future learning, focused on application of this technique for 7th and 8th grade foundational math; it will also propose integration techniques with current military data collection concepts such as xAPI. Application of this intervention process proved that use of the intelligent tutor makes for better grades, but also helps to develop and maintain those critical building blocks in the path to success in future STEM pursuits. The framework is currently populated with math content to create an Algebra Readiness Program, whose results will be discussed, but the framework is content agnostic so it can be used to develop effective teaching tools for other subject domains for which proficiency is dependent on learning and retaining declarative knowledge. As the STEM community puts these structured interventions to use, the extrapolation of these techniques to all stages of the military learning environment is crucial.

IMPLEMENTING INNOVATIVE CONSTRUCTIVISM: AN ARCHITECTED APPROACH TO ENHANCING STEM EDUCATION

2017 IITSEC Paper No. 17017

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Constructivism in education is a well recognized approach to teaching science, but often fails to achieve its goals, especially among students who have not been inculcated with cultural norms that emphasize the importance of aggressive inquiry and the challenge of existing dogma. The primary author has developed and implemented an approach, founded in constructivist theory, which provides a carefully architected framework in which the students can learn by engaging in scientific inquiry, rather than memorizing facts in a didactic environment. The need for and benefits of the architected framework are laid out. The applicability of this approach to DoD education, ranging all the way from the DoD Education Activity up to the Staff Colleges, is discussed and justified. The authors' assert that modern warfare has driven the need for pervasive education into all ranks. The initial instantiation of the method was conducted in Biology classes in a school district in the Los Angeles basin, whose student population was extremely diverse, in both ethnicity and socio-economic status. The authors present the basic method implemented, discuss its development, adduce data on its impact on students and comment on its maintenance over time. Further, they discuss the extensibility to other sciences, to other educational levels and to DoD education. A short review of current parallel efforts to improve science education is presented, with analyses as to the compatibility of this approach with others. The issue of the potential requirement of a charismatic "hero teacher" for success of various approaches is considered. Acknowledging the move toward serious games and on-line instruction, the authors present their experience in distributed simulations and the utility of them in educational contexts. The implementation of this approach in either the serious game or on-line education environment is explored. On-going and future research is outlined and various options are analyzed.

MATHEMATICAL SIMULATIONS – STUDENTS NO LONGER LOST IN TWO-DIMENSIONAL SPACE

2017 IITSEC Paper No. 17127

Stephen Chapman, Matthew Mason, & Lindsey Spalding
Modeling, Simulation, and Data Analysis
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In his 2013 study on The Effects of Implementing Technology in a High School Math Classroom, Murphy asserts "there is still a great need to continually evaluate what methods are working in the mathematics classroom… educators need to look at possible areas of improvement of the pedagogy of mathematics to a higher-order thinking to motivate and inspire students to learn mathematics, but also see the practical uses of mathematics in the realworld." Empirically, he found only 26% of "high school seniors had shown a strong knowledge with accuracy of [given] mathematical concepts" (Perry & Steck, 2015), (Murphy, 2016). Experiential learning simulations, paired with traditional instructional methods, will yield a greater conceptual understanding and retention of taught material, enabling students to better visualize abstract concepts and apply them in real world situations.

Multiple simulations were created for student interaction in Autodesk Inventor 2016. In addition to interactive simulations, three-dimensional models were created to visually demonstrate conceptual knowledge otherwise lost in two-dimensional space. These models served as an aid for students to fully grasp rotating two-dimensional cross sections defined by the intersection of curves around various axes. Students self-rated their understanding of the material before and after their exposure to the computer simulations. They also took a two-question quiz testing the content area of Volumes by Revolution. Both quantitative and qualitative metrics showed positive correlation between the use of computer simulations and increased student understanding. Quantitatively speaking, a 27-point increase was observed—on average—on participants' scores, with scores out of 100, with a p-value of 2.349%. With a 95% confidence interval, one can expect to see a range of at least a 3.0848-point increase on participants' scores and at most a 50.7613-point increase in participants' scores; with the data supporting the hypothesis.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320D

ED5 Future Leaders

1600

Students from around the country present papers on the projects demonstrated in the Future Leaders Pavilion (FLP). Visit them in Booth #2881 and stand by to be overwhelmed by the depth of their research papers during this session.

THURSDAY, 30 NOVEMBER, 2017 ROOM S320D

ED6 Courseware Creativity: Delivering a Better Experience

0830
How Video Lectures Can Free Up Time for Other Learning Activities (17201)

0900
Teaching and Learning Differently: Personalized E-Books for Learning (PEBL) (17272)

0930
Adapting Online Courseware to Decrease Time, Engage and Improve Performance (17284)

Notes

HOW VIDEO LECTURES CAN FREE UP TIME FOR OTHER LEARNING ACTIVITIES

2017 IITSEC Paper No. 17201

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The Norwegian Defense University College (NDUC) is continuously challenged with cost reduction while increasing instructional quality within the educational system. Specifically, in 2017, the educational sector within the Armed Forces was challenged with reducing overall training costs by 65 million US dollars over the next few years. Less money, fewer instructors and constrained student training time forced the NoD to rethink resident training requirements and leverage online courses.

This paper highlights how video lectures have begun to replace the traditional classroom Power Point-based lectures in the Norwegian military. Furthermore, this paper discusses how NDUC, based on well-known learning principles and instructional science, uses an in-house video studio to produce video lectures in close cooperation with the Subject Matter Experts (SME). Finally, the paper presents the evaluation results from NDUC students engaging in online video lectures and recommends development guidelines for producing online video lectures to maintain, if not increase, instructional quality and decrease overall costs.

TEACHING AND LEARNING DIFFERENTLY: PERSONALIZED E-BOOKS FOR LEARNING (PEBL)

2017 IITSEC Paper No. 17272

Elliot Robson & Peter Berking
Eduworks Corporation
Corvallis, Oregon

Although current eBooks are little more than print shown in an e-reader, as a mobile, connected platform, eBooks have the unrealized potential to support more pedagogical approaches than traditional books, including experiential, problem-based, dynamic, and social learning. To realize this potential, the Personalized eBooks for Learning (PEBL) project has developed a specification that enables new capabilities in eBooks while maintaining the advantages of the "book" format. The PEBL project, funded by the US Advanced Distributed Learning (ADL) Initiative, has extended the standard EPUB3 format to enable eBooks to communicate with other systems in live, virtual, simulated, and constructive environments; to embed and exchange data with simulations, games, and intelligent tutoring systems; and to serve as competency-based training environments.

This paper describes new pedagogical approaches that are enabled by PEBL that go beyond the affordances of current eBooks, and outlines the modular and expandable structure of the PEBL specification. New capabilities include: book content triggered by the learner skills and competency levels; instructor-driven content brokering; dynamic individual and team progress dashboards and native analytics; and exercises in which learners communicate and collaborate with each other. These can each be separately provided by different learning technologies, but not all together in the convenient, media-rich, portable eBooks.

To demonstrate these capabilities, this paper reports on a next-generation cyber security eBook that contains examples of many of the new features and functionality available through PEBL-compliant eBooks and eReaders. We discuss both the pedagogic approaches and technical implementations used in the Cybersecurity demonstration PEBL eBook, and how this eBook has integrated with other technologies using the ADL's Total Learning Architecture (TLA). Finally, this paper outlines the possibilities for using PEBL-enabled eBooks in conjunction with virtual and mixed reality training, and we outline other implementations and specifications related to PEBL that have resulted from the Institute of Electrical and Electronics Engineers (IEEE) Actionable Data Book Industry Connections activity.

ADAPTING ONLINE COURSEWARE TO DECREASE TIME, ENGAGE AND IMPROVE PERFORMANCE

2017 IITSEC Paper No. 17284

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United States Army military and civilian supervisors who manage civilian employees must complete the Supervisor Development Course (SDC) upon appointment, and every three years after their appointment. The original SDC online course focused on standardizing course content for supervisors across the Army, and the SDC provided quality information for new and experienced supervisors. While the SDC online content was informative, thorough, and helped to standardize the lesson material Army wide, it had challenges. The Army recognized the need to create new content and application exercises that better engaged learners, and reduced the amount of time supervisors spend to meet refresher training requirements. This paper describes the Supervisor Development Course-Refresher (SDC-R) effort that aims to address several overarching challenges that include: decreasing delivery time while refining instructional integrity, increasing interactivity within the constraints of an online learning environment, evaluating performance, and integrating SDC-R software with the Army Learning Management System (ALMS). Additionally, this paper presents a user study comparing two groups: one completing the original SDC course and the other completing the redesigned SDC-R course. Results compared the original SDC and new SDC-R courses including: participant time for course completion, the number of attempts to pass module posttests, and qualitative reactions to the respective courses. Preliminary results indicate that participants took significantly less time and fewer attempts to complete the SDC-R course compared to the original SDC. Finally, participant feedback suggests that the SDC-R significantly increases opportunities to apply their knowledge.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320D

ED7 Virtualizing the Schoolhouse Around the Globe

0830
U.S. Navy Virtual World Schoolhouse Case Study (17118)

0900
Using Virtual Simulation for Training the Brazilian Armored Tactics, Techniques and Procedures (17143)

0930
Virtual Learning Spaces at the Royal Danish Defence College: Emerging Practices (17172)

Notes

US NAVY VIRTUAL WORLD SCHOOLHOUSE CASE STUDY

2017 IITSEC Paper No. 17118

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In recent years, the United States Navy has been using virtual world technology to deliver training. The initial Navy course taught in the virtual world was on sonobuoy deployment from surface ships. This course is intended to teach sailors the basic principles of sonar detection and tracking. The virtual world technology used in this course enabled distributed instruction and access to a live tactical trainer between United States East Coast and West Coast learning sites at "full fidelity." The curriculum included classroom instruction, custom visualizations, and access to remote training systems. The effectiveness of this training was assessed using student written tests and student feedback questionnaires, similar to those used in the traditional classroom setting. The presenters will discuss the results of the tests and student feedback, challenges associated with instructor preparation, student engagement and the impact of class size, and course development with instructors and subject matter expert involvement.

USING VIRTUAL SIMULATION FOR TRAINING THE BRAZILIAN ARMORED TTP

2017 IITSEC Paper No. 17143

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Brazilian Army
Santa Maria, RS/Brazil

The Brazilian Army has been pushing the use of simulation technology as a key component during training across its different training establishments. One of the first schools inside the Brazilian Army to adopt the use of simulation technology was the Brazilian Armor School (CI Bld - Centro de Instrução de Blindados). During training, CI Bld instructors use virtual simulators to train students to the latest knowledge of the Brazilian Armored Tactics, Techniques and Procedures (TTP) at the company level. Training exercises have a very tight schedule, which include up-to-date TTP subjects using virtual simulators and a tailored after action review. The exercises with virtual simulators have been taking place since 2012. Since then, more than 1000 students have attended the exercise. This work presents the methodology used in the exercises at CI Bld and how it has improved training at the Brazilian Armored Tactics, Techniques and Procedures. Moreover, changes carried out to enhance the training exercises during these years are discussed.

VIRTUAL LEARNING SPACES AT THE ROYAL DANISH DEFENCE COLLEGE: EMERGING PRACTICES

2017 IITSEC Paper No. 17172

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A growing proportion of today's educational activity, civilian as well as military, takes place in virtual learning environments. A corollary of this growth is the emerging concern that the educational value of information and communication technology (ICT) is under-used by educators. There are also professional concerns that ICT may even undermine the effectiveness of teaching in some instances. A recent report notes that our educational institutions are ill-prepared pedagogically for making the most of technology. It asserts that simply adding twenty first century technologies to twentieth century teaching practices will "dilute the effectiveness of teaching".

Since our military institutions are currently adopting new technologies extensively, this issue is a pressing one. We need a deeper understanding of how e-learning affects learners in a military context. For this reason, the present study has used a series of qualitative interviews to map the learning experiences of officers from the Royal Danish Defence College. A number of questions animate the study. Firstly, can we identify certain factors that have created increased learning benefit when we come to evaluate the strategies, methods, and media employed in our teaching? Moreover, what are the salient features of the way officers – in this instance, Danish officers – perceive their own learning cultures and styles? In turn, how should this affect our course design?

The study reveals that learners' engagement levels, and the likelihood of them harbouring frustrations, often relate to their course's capacity to offer forms of collaboration. The data suggests that these learners deem collaboration to be part of a military ethos. Hence, unless the didactics underpinning our virtual learning environments align with cultural traits of this kind, they are likely to induce frustration rather than engagement. In view of these results, the paper will make recommendations on course design and pedagogical development in the context of military blended learning.

THURSDAY, 30 NOVEMBER, 2017 ROOM S320D

ED8 Targeting Learning: Developing Behaviors

1330	1400	1430
Leading Learning in the Workplace: Who's in Charge? (17011)	Improving Assessment with Text Mining (17191)	Adaptive Facilitation Skills for Army Instructors (17125)

Notes

LEADING LEARNING IN THE WORKPLACE: WHO'S IN CHARGE?

2017 IITSEC Paper No. 17011

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In 2014 – 16, UK Ministry of Defence (MOD) commissioned a research study into the benefits of embedding a continuous learning culture (CLC), where the whole workforce is actively engaged in promoting and supporting workplace learning. The study identified key benefits associated with a CLC, which related to development of trainer capability, delivery of effective and efficient training, and wider enablement of organisational learning. Leadership of learning was identified as a critical factor in realising these benefits, as it put in place the necessary organisational conditions, mechanisms and hierarchies that enabled a CLC to develop and thrive. The study recommended that roles and responsibilities for leading learning should be made explicit in the workplace, and individuals should be equipped with the right knowledge, skills and resources to be able to engage effectively with these roles. This paper draws on new research undertaken during 2016 – 17 on behalf of UK MOD by RINA Consulting Defence Ltd (formerly Edif ERA) and the University of Leicester, which followed up on the findings of this earlier research with a focus on developing leadership of learning in the workplace. Literature review and case study research with both military and civilian organisations was used to gather qualitative data on the behaviours used by leaders of learning at different levels of management, from senior manager to work supervisor. Options were then considered for developing leadership of learning behaviours across Defence organisations, using learning pathways which included both formal training interventions and informal workplace learning activities. The paper describes leadership of learning behaviours and their impact on organisational learning culture, and explains how organisations could develop these behaviours in the workforce using learning pathways which exploit the organisation's existing leadership and management training resources. The findings have applicability for all organisations seeking to develop a learning culture that fosters innovation and organisational competitiveness.

IMPROVING ASSESSMENT WITH TEXT MINING

2017 IITSEC Paper No. 17191

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Randy Brou
Army Research Institute
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Assessment is a key component of education across society. Regardless of whether the setting is academia, industry, military, or non-profit organizations, assessment is essential for gauging educational effectiveness, providing remediation to students, and informing policy and decision-making. However, the use of thorough assessments can be resource intensive. For example, instructors must devote time and effort into scoring/grading assessments. This can be especially costly when teaching complex skills that are not easily measured by convenient means such as multiple choice examinations (e.g., leadership, problem solving, critical thinking, communication). However, one can argue that these kinds of complex tasks are the ultimate goal of any educational system.

Computing holds great potential for reducing the burdens associated with assessment tools designed to measure complex skills. As a case in point, consider the Consequences test (Christensen, Merrifield & Guilford, 1953). It has been used to predict meaningful outcomes for military Officers, but the scoring of the test is extremely time-consuming as it requires test administrators to read and categorize test-taker-generated statements involving the outcomes of hypothetical scenarios. If the scoring of such statements could be automated, the test would become much easier to administer widely as the costs of the assessment would be drastically reduced. The challenge to implementing such a solution has been that computationally processing natural language, especially the kind of free form, conversational responses common in everyday life, is complicated. Nonetheless, tools already exist that show potential for utilization in assessment systems that necessarily use highly unstructured, free text input. In this paper, we discuss the use of open source Python libraries for assessing short answer, free form responses in the Consequences test. Using Latent Semantic Analysis, a well-established technique that has been around since 1988, we were able achieve human computer response categorization interrater reliabilities comparable to human-human interrater reliabilities.

ADAPTIVE FACILITATION SKILLS FOR ARMY INSTRUCTORS

2017 IITSEC Paper No. 17125

Tatiana H. Toumbeva & Krista L. Ratwani	Frederick J. Diedrich & Scott M. Flanagan Sophia Speira	Jennifer Murphy	Louis C. Miller
Aptima, Inc	Carthage, NC	Quantum Improvements Consulting Institute	Army Research
Woburn, MA		Orlando, FL	Ft. Benning, GA

Given diverse learning populations, to increase the efficiency and effectiveness of training, instructors must meet individual student needs and deliver customized training at the point of need (Martin, 2015). The process of adapting instruction is not a trivial challenge and places many demands on instructors. Given the learner-centric approach described in the U.S. Army Learning Concept for Training and Education 2020-2040 (U.S. Department of the Army, 2017), the Army is one of the many organizations attempting to meet this challenge. Although the majority of Army instructors attend the Foundation Instructor/Facilitator Course (FIFC) and learn a variety of instructional techniques, additional tools are needed to help instructors tailor their small group instruction to the individual Soldier. Compounding the issue, instructors often face schedule, time, and resource constraints, as well as understaffing. Thus, instructors may struggle to adopt a learner-centric approach that facilitates career-long learning. This paper showcases a multi-phase process through which a tool was iteratively developed to help instructors meet these challenges. Army instructors within the Abrams Tank Maintenance Advanced Individual Training (AIT) program served as a use case for investigating how instructors recognize and diagnose individual learner problems, and adaptively employ instructional techniques in near real-time to correct those problems. Following a thorough review of academic and military literature, extensive quantitative and qualitative data were gathered through a series of observations, surveys, and knowledge elicitation sessions with instructors and students. These data helped to pinpoint top challenges students face in the course, associated observable student behaviors, diagnostic techniques, and recommended instructional strategies. Finally, findings from an empirical evaluation study indicated that the instructional tool was found helpful, especially for brand-new or novice instructors. The full process, final tool, evaluation results, and theoretical and practical implications (including the generalizability to other contexts) are presented and discussed.

TUESDAY, 28 NOVEMBER, 2017 ROOM S320C

EC1 Trouble with Data

1400	1430	1500
GeoPackage: Unifying Modeling and Simulation with Mission Command Geospatial Data (17065)	3D Scanning and Navy Ships: An Immediate and Outward Look at Utilization (17052)	Marine Forensics: The Art and Science of Simulating Ships in Storms (17086)

Notes

GEOPACKAGE: UNIFYING MODELING AND SIMULATION WITH MISSION COMMAND GEOSPATIAL DATA

2017 IITSEC Paper No. 17065

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Michala Hill & Ronald Moore
Leidos
Orlando, Florida

Mark Johnson
Optimal Solutions and Technologies (OST) Inc.
Orlando, Florida

OpenFlight™ (a trademark of Presagis, Inc.), the de-facto standard for 3D models and terrain for simulation and training, has been in common use for decades. Despite revisions and expansion over the years, the format remains largely unchanged. The OpenFlight format does not lend itself to storage of abstract feature data and relationships between 3D visual objects and related abstract objects. A typical OpenFlight terrain database or 3D model built for one Image Generator (IG) may lack collision volumes or trafficability rules needed by another system. The OpenFlight database cannot preserve the relationship of polygons to the source features they were built from. Modern SAFs and specific gaming systems all require conceptually different data models, meaning many output files and formats are required to support a confederate of training and simulation platforms. Meanwhile, the Open Geospatial Consortium has adopted the GeoPackage format for Geographic Information Systems (GIS) data. GeoPackage provides a data model and consistency across applications. GeoPackage is built on SQLite, an open source, self-contained, cross-platform embedded database engine. As such, GeoPackage is ideal for expansion in support of the simulation industry. By storing abstract features with relationships to their specific counterparts, a single GeoPackage file could be used to exchange correlated data for simulation systems as well as mission command and GIS applications. A single feature stored in a GeoPackage file can have a relationship to a 3D model used in a legacy image generator and also a model designed for use in a gaming system or SAF.
This paper reports on SE Core's investigation into expanding on the GeoPackage standard for use in simulation and training. We present a demonstration where a single database with visual and abstract objects can provide all the intermediate data necessary to create database products for use in production.

3D SCANNING AND NAVY SHIPS: AN IMMEDIATE AND OUTWARD LOOK AT UTILIZATION

2017 IITSEC Paper No. 17052

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While 3D scanning technologies promise to revolutionize the documentation for worksites, its adoption into Navy processes has been slow and isolated to niche use cases (e.g. 3D models for training, antenna masking analysis on ships, load planning, space capsule recovery design for LPDs). Government labs are popping up that are pursuing these current and new use cases and are working largely independent of one another. With no knowledge or data sharing repository, efforts are not accelerating as fast as they could. Our efforts started off as another example of this story, the intention of this manuscript is to convey our individual use case of the utilization of 3d scanning in ship installation; however we will further provide a shared vision, based on our conversations with other labs, of how the Navy should share this scan data to obtain the most capability from it.

MARINE FORENSICS: THE ART AND SCIENCE OF SIMULATING SHIPS IN STORM CONDITIONS

2017 IITSEC Paper No. 17086

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Historic vessels provide useful surrogates for modern vessels that can be discussed in the open literature with reduced concern for security or proprietary material. Simulating the motions of a vessel in waves, and the effects on the hull and everything aboard is a fairly complicated process. This paper describes the author's pioneering work extending those analyses to ships in severe weather conditions where non-linear waves, combined with hurricane force winds illicit non-linear responses. Some of the unusual methodologies used to build out the simulation models will be discussed as they apply to the 4 vessels selected for this paper.

TUESDAY, 28 NOVEMBER, 2017 ROOM S320C

EC2 Discovering Transformative Architectures

1600	1630	1700
IDE-Forward: A Persistent Force-On-Force Training Field Test Environment (17184)	Emerging Network and Architecture Technology Enhancements to Support Future Training Environments (17033)	Innovation through Discovery Experimentation (17317)

Notes

IDE-FORWARD: A PERSISTENT FORCE-ON-FORCE TRAINING FIELD TEST ENVIRONMENT

2017 IITSEC Paper No. 17184

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Gary Hall
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Project Manager Training Devices (PM TRADE) has committed to an open architecture, component-based acquisition methodology enabled through the Live Training Transformation (LT2) product line, which is built upon a number of open standards & processes. First, LT2 products use the Common Training Instrumentation Architecture (CTIA) to define interoperability standards among training applications to support live training. PM TRADE then developed the Live Training Engagement Composition (LTEC) to provide an open architecture solution for communication for Tactical Engagement Simulation Systems (TESS) components. This flexible architecture will drive innovation and lower acquisition costs by making it possible for systems to operate in the same training environment given an adherence to the LT2 LTEC Interface Control Document. As a result of open standards and a product-line approach, PM TRADE was able to quickly and efficiently develop, field, and operate an instantiation by integrating the open standards, architecture, and applications of the LT2 product line to create the Integration and Development Environment – Forward (IDEF). IDEF (formerly known as L-FITE) is a persistent training environment that enables proof of principle concepts and emerging capabilities to be utilized during Force-on-Force training events for Soldier feedback prior to full implementation into Army "Live" System Programs of Record.

This paper will begin by with a brief history of Force-on-Force training. Then, it will describe the concept, process, and strategy for IDEF development and operations. In addition, the paper will document results and lessons learned from a number of testing and integration events leveraging IDEF in a land navigation course use case. Finally, this paper will discuss the framework created for IDEF to evolve to provide a verification and validation methodology for future training systems, inform future Army source selections and Programs of Record (POR), and provide the capability to continually review the relevance of fielded training systems.

EMERGING NETWORK AND ARCHITECTURE TECHNOLOGY ENHANCEMENTS TO SUPPORT FUTURE TRAINING ENVIRONMENTS

2017 IITSEC Paper No. 17033

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Paul Dumanoir &
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The Operational Environment (OE) has become increasingly complex, with challenging human factors, exponential proliferation of technology, and an increasingly determined, adaptive threat. Training Army Soldiers, leaders and units in a complex world requires modernized, integrated, realistic, and adaptive training capabilities. The Army must leverage emerging technologies to transform the way it develops and delivers training to enable agile and adaptive Soldiers, leaders and versatile units. It must provide a consistent, persistent ability to train at the point of need (PON) for both current and future operations as part of a Joint, Inter-organizational, and Multinational (JIM) force. The training venues must allow the Army to train as it fights, using its wartime systems on its operational networks and all training environments must replicate the OE to the greatest extent possible.

To address this reality, the U.S. Army Program Executive Office for Simulation, Training and Instrumentation (PEO STRI) and the University of Central Florida (UCF), Institute for Simulation and Training (IST) are conducting research to create new capabilities that support both operations and training while enabling software application migration to Army enterprise data centers and cloud environments. This research pivots on Army directives that focus on modernizing information technology systems and applications. To achieve the distributed nature of this vision, technical enhancements to the underlying Army Enterprise Network (AEN) must be made in the next few years.

This paper investigates potential gaps in simulation enterprise network architectures and describes research results in three major technical areas that address these gaps and will benefit future simulation and network architectures. The research topics include technologies that: (1) efficiently delivers simulations from cloud-like environments using Software Defined Networks (SDNs); (2) facilitates individual and collective home station or field-based training through the use of thin clients; and (3) optimizes computational resources through load-balancing techniques and processes.

INNOVATION THROUGH DISCOVERY EXPERIMENTATION
2017 IITSEC Paper No. 17317

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As the military refocuses its training and acquisition from the counter-insurgency conflicts in Iraq and Afghanistan to the potential for major military conflict in an era of new technologies, there is a need to explore new concepts for using these new technologies. These explorations are essential for developing new tactics, techniques and procedures (TTPs), integrating new capabilities into existing forces, but are also critical in the choices of which technologies to mature and acquire. Discovery experimentation is a process for using simulation to place emerging technologies in the hands of warfighters engaged in virtual battlefields to explore the military utility of new concepts for using emerging systems. Discovery experimentation is designed to allow learning and modification from trial to trial and in that way differs significantly for both traditional scientific experimentation and technology demonstrations. In support of the US Air Force, research staff from the Institute for Defense Analyses conducted a multi-trial, discovery experiment to explore new concepts in close air support (CAS) employing Network-Enabled weapons. This paper will use this experiment to further define discovery experimentation; how it can use existing facilities and simulations with modifications to conduct the exploration; identify potential adversary counters, and how the data acquisition and results of progressive trials altered the initial concept to extract new TTPs and define requirements for supporting equipment. A small team of CAS experts (instructor level) experimented with the new technology in a stressing threat environment responding to the call for fires from an experienced military commander and fires officer. The concept and supporting data that emerged provides initial evidence that the new approach might be capable of addressing more targets in less time than had been possible with traditional tactics might be possible.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320C

EC3 Big Data: Size Matters

0830
Deep Learning for Training with Noise in Expert Systems (17034)

0900
Human Activity Synthetic Data Generation (17059)

0930
A Genetic Model of the Development of Modeling and Simulation (17077)

Notes

DEEP LEARNING FOR TRAINING WITH NOISE IN EXPERT SYSTEMS

2017 IITSEC Paper No. 17034

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Deep learning systems have achieved a remarkable human-machine parity for some key training tasks, including machines that can speak, listen and see at an expert human level. For image recognition, the state-of-the-art features deep convolutional neural networks (CNN). This paper benchmarks their performance on key recognition objectives: 1) automating large-scale image classification, and 2) identifying types of noisy training data that can improve testing outcomes. This benchmarking relies on two classically hard image problems: 1) distinguishing similar objects, and 2) classifying tiny low-resolution icons. The teacher-based recognition embodies supervised learning since image class labels are known. When deployed using Google's Tensorflow framework, the CNN learns both similar classes and tiny icons with 95.3% and 89.5% accuracy respectively. This paper further explores two competing hypotheses of training noise. The first role for noise may improve outcomes if the noise reduces overfitting. The competing role, however, may diminish learning if noise masks some key object features. We inject quantifiable impulse (or spike) noise to disrupt local object patterns (convolution) and to benchmark learning changes. This choice of localized interference attacks a fundamental assumption underpinning CNN performance, namely that neighboring pixels dominate remote ones. One surprising outcome is that by adding impulse noise to training images, overall classification improves compared to training on unmodified test images (95.4%). The basic principle can be understood as noise benefiting image-based training when it augments data size and diversity or when it obscures background relative to foreground targets. When we apply convolutional neural nets to large-scale image classification, the accuracy compares favorably to the state-of-the-art in published literature and public global data competitions. At least in the case of some multi-class image problems, CNN accuracy exceeds the recognition capabilities of human experts.

HUMAN ACTIVITY SYNTHETIC DATA GENERATION

2017 IITSEC Paper No. 17059

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Data availability often becomes a major hindrance to the development of human centric, computer-vision based technologies, as a large amount of data is usually required for algorithm training and validation, especially when deep learning is used to develop algorithms. Synthetic data which are produced by modeling and simulation could be used to expand and/or supplement real world data which are otherwise not available. While human activity modeling and simulation has achieved success in creating synthetic environments for simulation based training and virtual reality, whether it can be used to generate synthetic data which satisfy requirements for machine learning is yet to be proved.

In this paper, using human activity modeling and simulation to generate synthetic human activity data for machine learning is investigated. The needs for synthetic data are identified from the perspective of human centric, computervision based technology development. The basic requirements of synthetic data are defined in light of machine learning. Factors that contribute to the fidelity and applicability of synthetic data are analyzed. In particular, two factors related to human activity modeling and simulation, bio-fidelity and variability are investigated. Several modeling and simulation tools and game engines (e.g., 3dsMAX, Unity, and NVIG) are used for data generation, and their performances are compared and evaluated. Synthetic full motion videos are generated in electric-optical and infrared modes and tested by machine learning algorithms. The testing results along with examples of synthetic imagery are illustrated in the paper.

Keywords: human activity, modeling and simulation, synthetic image, synthetic full motion video, machine learning

A GENETIC MODEL OF THE DEVELOPMENT OF MODELING AND SIMULATION
2017 IITSEC Paper No. 17077

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Complex technologies, like Modeling and Simulation (M&S), show evidence of an evolutionary speciation that occurs when the technology is used by different companies in different geographical locations and for different purposes. In this paper we describe "patent genomics," a genetic model of technology evolution that uses the patent database of the U.S. Patent and Trademark Office (USPTO) and its "class codes," to create an "Innovation Genotype" that provides a genetic code of a technology in terms of the areas of knowledge contained in its patented inventions. Using class codes as genetic markers, we have analyzed ten years of M&S patents by all the companies doing M&S in four states, Alabama, Florida, Michigan, and Texas and show that M&S has evolved into different "species" by the insertion of company-dependent "genes" into the knowledge base of the companies in these states. We have also analyzed this speciation in time, to show how different knowledge components may grow or decay. In addition, we create inventor networks for individual companies whose nodes are inventors and whose links are the inventions they have created. Using these networks we identify the sources of innovation and the flow of knowledge in a company. The patent analysis across a state gives us the long-term evolutionary character of a technology while the inventor networks within a company give us the short-term developmental characteristics of a technology. This form of genetic analysis helps to identify the emergence of synergies within a company and between companies that can be applied both to solving new and complex problems and enabling the discovery of disruptive technologies. In short, we may discover the gene for "blackness" among a group of white swans that leads to a method of addressing a potential black swan event.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320C

EC4 Realistic and Effective Action: How Do We Decide?

1030	1100	1130
Modeling Environmental Impacts on Cognitive Performance for Artificially Intelligent Entities (17176)	Optimizing Cooperative Games for Cognitive Communication UAVs with Q-Learning (17132)	Controlling CGF-Generated Entities Using a Fuzzy Logic-based System (17040)

Notes

MODELING ENVIRONMENTAL IMPACTS ON COGNITIVE PERFORMANCE FOR ARTIFICIALLY INTELLIGENT ENTITIES

2017 IITSEC Paper No. 17176

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The Marine Corps utilizes virtual simulations as a training tool for ground combat operations. Currently, the artificial intelligence of the entities within these simulations do not exhibit appropriate performance degradation due to environmental conditions such as heat and humidity. These gaps impact training fidelity and can adversely impact transfer of training. To address these gaps, this paper reviews existing approaches to modeling the influence of environmental factors, specifically heat and humidity, on human performance in vigilance and attention tasks. We also explore existing environmental modeling and path finding behaviors within relevant military simulations in order to refine the scope of the problem. We present a novel agent behavior model which incorporates a modified A* search pathfinding algorithm based on empirical evidence of human information processing under the specified environmental conditions. Next, an implementation of the agent behavior model is presented in a military relevant virtual game environment. We then outline a quantitative approach to testing the agent behavior model within the virtual environment. Results show that our human information processing-based agent behavior model demonstrates plausible agent performance degradation in hot, humid temperature environments when compared to paths around the danger area in mild temperature environments. We also present a technique for demonstrating to adjacent agents the environmental temperature condition currently felt by agents in the environment. Doing so will allow for trainees to recognize a potential source of negative performance from members of their unit, and allow for better training on how to operate in spite of these challenges. The results of this research provide an approach for implementing an agent behavior model that accounts for environmental impacts on cognitive performance. We recommend future work to validate the model in a human subjects experiment to facilitate improving the realism of simulation training.

OPTIMIZING COOPERATIVE GAMES FOR COGNITIVE COMMUNICATION UAVS WITH Q-LEARNING

2017 IITSEC Paper No. 17132

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Currently, distributed communications networks based on multiple unmanned aerial vehicles (UAVs) are limited in terms of reliability and network availability. The capacity for each UAV to serve as a node in the network is constrained by limited energy stores, dynamic changes in the network topology, and latency/jitter issues. Typical approaches to address these challenges have focused on partitioning of the network to work around the failed nodes, but the attendant degraded communications links and lengthy network outages underscore the need for a better solution. An innovative approach based on the use of a self-forming, self-organizing, cooperative, autonomous system of distributed UAV communication nodes is being investigated. By enabling each UAV to act collectively and cooperatively, a multi-UAV network's communication links can be made more resilient, resulting in enhanced levels of network availability and improved service quality. To achieve this, we investigated the concept of opportunistic arrays to aid in the development of a cooperative, cognitive system encompassing multiple vehicles. Based on simulations, we have also been able to demonstrate that optimal vehicle positions can be directed using decision algorithms that embody elements of game theory. In addition, by implementing a cooperative reasoning engine for system-level oversight or harmonization, we were able to ensure optimal performance of the overall system and achieve enhanced levels of service quality based on multiple measures of effectiveness.

CONTROLLING CGF-GENERATED ENTITIES USING A FUZZY LOGIC-BASED SYSTEM
2017 IITSEC Paper No. 17040

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Computer Generated Forces (CGF) is a key component in virtual and constructive simulations and offers a costeffective way to enhance realism by providing methods to control simulated entities. CGF is becoming an essential tool for tactical training, especially for mission rehearsal. CGF facilitates mission training by providing the means to design training scenarios. A training scenario consists of a set of predefined events that occurs during training, which involves setting a number of parameters of the computer-controlled simulation models. On one hand, CGF scenarios tend to be static. Once trainees have completed a scenario, they will likely know how it will behave during the next training session, thereby reducing or removing the reuse value of the scenario. On the other hand, a fundamental characteristic of CGF is decision-making based on artificial intelligence (AI). Current AI decision-making implementations are commonly simplistic, using a fixed set of "Rules of Engagement." The nature of this behavior makes it easy for trainees to distinguish between computer-controlled and human-controlled entities in a simulated environment. These specific CGF characteristics can result in ineffective or negative training because trainees are able to quickly familiarize with the behaviors of the simulated entities and then easily defeat them, which would not occur with human-controlled opponents.
In this paper, we propose a method to control the behavior of constructive entities generated from a synthetic environment. This novel method makes essential use of a fuzzy logic-based system. We illustrate the proposed method with a simulation of an Air Defense Missile System (ADMS). The ADMS simulation computes the missile launch envelope and uses the simulation results to determine the "in-range" condition of hostile air targets. The result of the ADMS simulation demonstrated that the fuzzy logic-based system is suitable to emulate the decision-making process of a human ADMS operator.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320C
EC5 Super Smarts: The Power of Processing

1400
Mind Flight: Brain-Computer Interface-Driven Design of Simulated Aircraft Control Frameworks (17150)

1430
Operational Learning: Leveraging Mission Data to Optimize Skill Development (17226)

1500
Acceleration of Digital Radar Landmass Simulation on Multi-core CPU and GPGPU Computer (17235)

Notes

MINDFLIGHT: BRAIN-COMPUTER INTERFACE-DRIVEN DESIGN OF SIMULATED AIRCRAFT CONTROL FRAMEWORKS

2017 IITSEC Paper No. 17150

Matthew Rich, Johnathan Pino, Zachary Koterba, David Handelman, PhD, Robert Ide, Matthew Fifer, PhD, Brendan John, Nathan Turner, Daniel Cybyk, Jonathan Ellsworth, Denise D'Angelo, Brock Wester, PhD, Eric Pohlmeyer, PhD, James Beaty, PhD, Francesco Tenore, PhD & Michael McLoughlin
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As the complexity of military systems advances, so too must the human-machine interfaces that operators use to control those systems. In support of DARPA's Revolutionizing Prosthetics Program, we developed a method and associated technologies to test the efficacy of novel control interfaces with scalable virtual and live aircraft control frameworks. The design of these test frameworks supports compatibility with multiple control modalities, ranging in complexity from joysticks, eye-tracking, and electromyography sensors, to the direct decoding of neural activity within the brain. MindFlight's virtual fixed-wing aircraft control framework leverages a commercial-off-the-shelf simulation and visualization platform commonly used for civilian and military aviation training. Early control evaluations featured basic aircraft control tasks, such as two-degree-of-freedom control of a single aircraft in free flight. Additional features provided support for increasingly complex test paradigms involving navigation through hoops courses or simultaneous control of multiple aircraft. The test system also supports tasks in which the pilot must make control decisions based on novel information provided via visual cues, vibrotactile stimulation of the skin, or even intracortical microstimulation of neurons. Several tests with this platform have shown its usefulness for assessing brain-computer interface control of simulated aircraft.

Proof of concept demonstrations involving live aircraft will be critical to assessing the effectiveness of MindFlight's method for evaluating the operational utility of novel control interfaces. A custom-built live aircraft test framework enables control of one or multiple quadrotor unmanned aerial vehicles (UAVs) by a single operator using any of the same control modalities and interfaces as the virtual fixed-wing aircraft control framework. The quadrotor framework supports multiple control modes and enables test operations from a remote control site via an internet connection. Additionally, it provides a virtual representation of the live quadrotor UAV system for operator training prior to live flight.

OPERATIONAL LEARNING: LEVERAGING MISSION DATA TO OPTIMIZE SKILL DEVELOPMENT

2017 IITSEC Paper No. 17226

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During a military career, frequently exercised skills appreciate into expertise, while infrequently exercised skills can decay. Decay can be caused by inattention to the skill, which in turn can be caused by infrequent tracking. Although trainee skill states are systematically measured and monitored during formal training (e.g., school house, Initial Qualification Training (IQT), and Mission Qualification Training (MQT)), once trainees are qualified and assigned to operational missions, assessment is less frequent. Training sustainment programs intended to maintain skill proficiency (e.g., Continuation Training (CT)) only require that tasks be accomplished without systematically measuring, storing, or analyzing skill proficiency data. Thus, the problem this paper addresses is that trainee data is not sufficient to determine the nature and magnitude of the skill decay, making it difficult to know the true skill state of military operators at any given time. Fortunately, military operational databases are filled with information related to missions executed, tasks accomplished, tools/platforms used, etc., and can be a rich source of data from which operator skill states can be inferred. In this work, we describe a suite of machine learning data mining algorithms that operate not only on training data stored in Learning Management Systems (LMSs), but also on operational databases, to make inferences about operator skills states that can be used to personalize learning to ensure that only deficient skills are trained. This innovative approach to leverage operational mission data will allow keen insights into operational learning, or the learning that occurs when formal training ends.

ACCELERATION OF DIGITAL RADAR LANDMASS SIMULATION ON MULTI-CORE CPU AND GPGPU COMPUTER

2017 IITSEC Paper No. 17235

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Digital Radar Landmass Simulation (DRLMS) for the purpose of training radar operators is a challenging computationally-intensive task. To improve fidelity, the databases are continuously increasing in resolution and density. Moreover, the radar simulation involves increasingly sophisticated physics-based models. One of them is the application of the radar antenna radiation pattern illuminating a particular region composed of landmass, sea clutter, precipitation and targets. To achieve real-time, a number of approximations are used in current simulations, which includes modeling a narrow antenna radiation pattern and employing a coarse sampling of the illuminated region. However, this harms the simulation fidelity.

To avoid these approximations while respecting the real-time constraints, this paper proposes a multi-level parallelization approach of landmass simulation applicable to multi-core Central Processing Unit (CPU) and General-Purpose Graphics Processing Unit (GPGPU). At the first level, the processing is divided into two parallel pipelines: (1) the power accumulation, which involves database processing and (2) the antenna pattern convolution. At the second level, the convolution is divided into several threads running in parallel. Two implementations are compared: one on multi-core CPU and one on GPGPU.

As benefits for training, we improve considerably the simulation performances as we are capable to apply a more detailed radar antenna pattern and support more complex databases, both contributing to more realistic radar images. The improved DRLMS shows respectively, a speedup of 12x on multi-core CPU running 16 threads, and a speedup of around 250x on a contemporary high-end graphics card over a one-thread execution on CPU.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320C

EC6 Marking Smart Decisions

1600
Developing a Financial Readiness Mobile Personal Assistant for Learning (17252)

1630
MentorPal: Interactive Virtual Mentors Based on Real-life STEM Professionals (17263)

1700
Developing a Naturalistic Categorization Task for Testing Intuitive Decision Making (17146)

Notes

DEVELOPING A FINANCIAL READINESS MOBILE PERSONAL ASSISTANT FOR LEARNING

2017 IITSEC Paper No. 17252

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While Service members and their families receive unique financial benefits as a result of their service, few are well educated in the best ways to manage their finances. Consequently, they may fall prey to predatory lending practices, high pressure sales pitches, and other financial pitfalls. Adding to the complexity of this problem is the fact that Service members' financial priorities change throughout their lives, both during service and after separation. 10 U.S. Code § 992 requires financial literacy training to be provided at specific points in Service members' careers, including significant life events, at promotion, and in concert with deployments. However, there is no guidance for what specific training content should be provided or when. Further, there is no solution to provide Service members complete access to financial literacy information. Due to the breadth of the financial domain, an effective solution must tailor content to the individual Service member, providing the right information in a timely way, and in an engaging and effective way. Although adaptive training is not a new concept, it is rarely designed to provide lifelong support to learners. Even less frequently are these solutions designed for mobile devices. In this paper, we describe research that designs and develops a mobile Personal Assistant for Learning to support Service member financial literacy. First, we describe the front-end analysis conducted to determine the scope of the domain and identification of learning objectives. Second, we discuss the process to develop a framework mapping the content to specific points in a Service member's career to enable an adaptive learning experience. We also present research findings to support our approach. Our goal with this paper is to share the process used to design adaptive content to support lifelong learning and discuss lessons learned through our research.

MENTORPAL: INTERACTIVE VIRTUAL MENTORS BASED ON REAL-LIFE STEM PROFESSIONALS

2017 IITSEC Paper No. 17263

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In an ideal world, all students could meet STEM role models as they explore different careers. However, events such as career fairs do not scale well: professionals have limited time and effective mentors are not readily available in all fields. The result is that students' understanding is minimal about what professionals in STEM fields do every day, what education is needed, and even what STEM fields exist. Moreover, since in-person interactions rely on finding people engaged in current STEM careers, students may form career goals for stagnant fields rather than growing fields (e.g., projected workforce needs). To address this problem, we are designing a scalable tablet-based app that gives students the opportunity to converse with interactive recordings of real-life STEM professionals. These conversational virtual agents will emulate a question-and-answer session with STEM professionals who have Navy ties and who are engaging, enthusiastic, and effective mentors. These interactions will allow students to have a lifelike informational interview with a virtual agent whose responses are directly drawn from a specific real professional's video-recorded interview. This work differs from prior research on career guides by capturing the experiences of a collection of unique mentors, which should be more authentic and engaging than a generic agent or resource which speaks only about the average experience. This paper will discuss the process of creating the first such virtual STEM mentor prototype, including the development of an extensive mentoring question bank (approximately 500 questions); key mentoring topics that intersect STEM, DoD, and civilian life; techniques for cost-effective recording of remote mentors; and the process of training and verifying a natural language dialogue model for answering and suggesting career questions. Finally, we conclude with implications, strengths, and drawbacks of virtualizing the experience of talking with specific mentors, from the perspectives of efficacy, scalability, and maintainability.

DEVELOPING A NATURALISTIC CATEGORIZATION TASK FOR TESTING INTUITIVE DECISION MAKING

2017 IITSEC Paper No. 17146

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Intuitive Decision Making (IDM) depends on knowledge that cannot be easily articulated. It does not reflect explicitly learned rules and guidelines. Rather, it is hypothesized to rely on implicit learning (IL). Basic science research on the phenomenon of IL provides a theoretical framework for understanding the acquisition of knowledge outside of conscious awareness from practical experience. This framework has the potential to accelerate the development of IDM during training and speed the acquisition of expertise. Here we describe a procedure and present a program of research based on adapting a more operationally relevant task to controlled laboratory conditions to bridge basic science and enhanced simulation-based training. The underlying task is one in which a complex decision is made based on environmental terrain characteristics, such as the formation in which to proceed with a patrolling infantry squad. This decision process is analogous to laboratory tasks in which participants learn to discriminate among a set of visual categories, but requires a new kind of task in which the visual stimuli are constructed from complex terrain dimensions. We defined a stimulus space based on four environmental dimensions: vegetation density, topography (hilliness), time of day and weather conditions. An artificial category structure was then defined within this stimulus space around three hidden prototypes. Participants learned these categories through trial-and-error with feedback about their decisions. Across three experiments, participants exhibited learning, increasing their decision accuracy across a range of task parameters selected to promote reliance on IL and use IDM. The resulting protocol will serve as a testbed for quantification of IDM effects and allow future work to examine training and educational interventions aimed at improving effective use of IDM. In addition, the task development process can serve as a model for bridging basic science research and operationally relevant domains.

THURSDAY, 30 NOVEMBER, 2017 ROOM S320C

EC7 Audio, Aptitude and Areas

0830
3D Spatial Audio Extraction and Demonstration System for Augmented/Mixed Reality Simulations (17009)

0900
Predicting Manufacturing Aptitude using Augmented Reality Work Instructions (17224)

0930
Real -time Coverage Area and Danger Zones Estimation (17185)

Notes

3D SPATIAL AUDIO EXTRACTION AND DEMONSTRATION SYSTEM FOR AUGMENTED/MIXED REALITY SIMULATIONS

2017 IITSEC Paper No. 17009

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The U.S. Army Research Laboratory-Human Research and Engineering Directorate, Advanced Simulation Technology Division (ARL-HRED-ATSD) performs research and development in the field of augmented/mixed reality training technology. As part of this continuing research, 3D spatial audio concepts previously developed have been further matured culminating in a desktop demonstration system and a set of novel real-time approximations for sound propagation in a true 3D environment. While much attention has been given to the visual representations in augmented/mixed reality systems, true 3D spatial audio has generally been overlooked. The 3D spatial audio simulation has tremendous utility in immersive environments used for augmented/mixed reality training. This technical challenge has been thoroughly researched for many years and many approaches have been designed, developed and studied over the years but yet still a viable system is lacking which exploits the availability of high fidelity and low-cost gaming engines. The basis of these studies is that while immersed into an augmented/mixed reality training environment, a soldier must be able to sense the direction and distance of sound sources from virtual components as he moves through the augmented world. The developed concept is based on true 3D geometry computations and virtual mixers which preserve the sound source implementations. Representation of the 3D spatial audio field is demonstrated using a discrete transducer desktop system which fully supports all six primary sound field directions; up, down, left, right, front, and back. This paper describes the implementation of real-time approximations to sound propagation in realistic dismounted environments, a novel demonstration system to produce the 3D sound, and presents the remaining challenges to be overcome. Designs for the next phase of experimentation are also discussed along with the remaining challenges required to provide 3D spatial representation in real-time to immersed humans on the move in augmented/mixed reality training systems.

PREDICTING MANUFACTURING APTITUDE USING AUGMENTED REALITY WORK INSTRUCTIONS

2017 IITSEC Paper No. 17224

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The complexity of manufactured equipment for the U.S. military has increased substantially over the past decade. As more complex technology is integrated into battlefield equipment, it is more important than ever that workers manufacturing this equipment have the necessary skills. These specialized manufacturing skills require careful workforce selection and training. However, traditionally, workers are assigned roles based on instructor evaluation and qualitative self-assessments. Unfortunately, these assessments provide limited detail about a candidate's aptitude. By using more detailed data captured from assembly operations, a more complete profile of an operator's skills can be developed. This profile can then guide assignment of a worker to maximize productivity. This paper develops a Bayesian Network (BN) to predict worker performance using data captured from 75 participants via augmented reality guided assembly instructions. Information collected included step completion times, spatial abilities, and time spent on different assembly operations. For analysis, participant data was divided into training and testing sets. The data was mined for trends that could statistically predict measures of performance like errors or completion time. Based on these trends, the training set was used to construct the BN. The authors found that the model could predict some aspects of performance accurately, such as assembly completion time in the testing set. While these results were encouraging, further analysis demonstrated the network was biased by probabilities that were greatly influenced by the number of data points present in a category. The results highlight that, with small data sets, there is often not enough observed evidence to produce accurate predictions with BN. This suggests that a method of data simulation or generation is required to increase the number of training set samples. This would enable powerful BN tools to be used in real world manufacturing applications were collecting hundreds-of-thousands of data points is not feasible.

REAL-TIME COVERAGE AREA AND DANGER ZONES ESTIMATION

2017 IITSEC Paper No. 17185

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Coverage area analysis is a challenging research topic in military applications especially for naval operational area. Each unit estimates its own coverage area via visual contact and sensors such as radars and shares it with allied forces. The chief of naval operation manages the operation, gets precautions and plans his attack considering both where his units enlighten on and where the possible threads such as assault boats and warplanes attack from. 3D real-time simulation of the naval operational area just before or during the operation is very useful for decision makers. Unfortunately, modeling the virtual operational area and estimating coverage area require intense computations like line-of-sight tests and ray-shooting implementations.

Our aim is to find where enemy may attack from with assault boats or warplanes in highly obscured naval operational areas near coastline or between islands since the response time for a close or unexpected attack is so limited in such environments. In this paper, we propose an efficient decision support system tool that estimates the coverage area of allied units in naval operational area for real-time simulations. We firstly modeled the operational area by using its digital terrain model in Unity 3D. Then, we proposed a visibility culling method based on occlusion horizon for the estimation of coverage area considering 2½D properties of the environment rather than using ray shooting approach. As a result, we obtained 3D coverage area of each unit in the naval operational area and significantly reduced the cost of coverage area estimation to O(mLog(n)) complexity where m is the amount of land quadrants inside the range and n is the total amount of land quadrants.

Keywords—coverage area; visibility; naval operational area; real-time simulation

THURSDAY, 30 NOVEMBER, 2017 ROOM S320C

EC8 Virtually Forging Foreign Ties

1030	1100	1130
Modeling and Simulation as a Service from End User Perspective (17209)	Communications, Networking and Cyber Modelling and Simulation Support Defence (17120)	Web-Based GUI System for Controlling Entities in Constructive Simulations (17043)

Notes

MODELLING AND SIMULATION AS A SERVICE FROM END USER PERSPECTIVE

2017 IITSEC Paper No. 17209

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Modelling and Simulation as a Service (MSaaS) is a new approach being explored by NATO Science and Technology Organization (STO) Modelling & Simulation Group (MSG) Panel for a permanently available, flexible, service-based framework to provide more cost effective availability of Modelling and Simulation (M&S) products, data and processes to a large number of users on-demand. This Research Task Group is working on the development of the implementation of this framework, defining policies, stakeholders' roles, services and reference architecture and reference engineering processes. MSaaS can be defined as "enterprise-based level architecture for discovery, orchestration, deployment, delivery and management of M&S services".
The University of Defence of the Czech Republic and the NATO M&S Centre of Excellence are investigating and proposing an approach to contribute to the definition of the MSaaS from an End User perspective. The paper proposes definition of M&S Software as a Service (MSSaaS), M&S Platform as a Service (MSPaaS) and M&S Infrastructure as a Service (MSIaaS) to introduce new roles and new business connections taking also into consideration Service Oriented Architecture (SOA) definitions and those definitions stated in NATO Modelling and Simulation Master Plan (NMSMP). In particular the authors propose a contribution to the definition of the different stakeholders' roles and their relationships, starting from those of the MSG 136 group (M&S Group 136, Modelling and Simulation as a Service) and introducing new roles regarding the End User.
In conclusion, this research and study activity proposes, in addition to the existing definitions, a taxonomy comparing roles across service models (MSSaaS, MSPaaS and MSIaaS). Furthermore, the M&S services' classification is analysed in the framework of the MSG 136 Operational Concept draft, in order to identify the services which are to be properly composed and orchestrated to satisfy the End User requirements.

COMMUNICATIONS, NETWORKING AND CYBER MODELLING AND SIMULATION SUPPORT DEFENCE

2017 IITSEC Paper No. 17120

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The exponential growth in the today's communication and network infrastructures (wired, wireless, radio and satellite network) introduces high technological content and evolution in the Defence network and the related cyber defence aspects. It is necessary to make forecasting and proactive end-to-end performance analysis to evaluate the acquisition process of the Defence network technological evolution and the protection of the information exchange in case of cyber operations. This paper discusses the Communication, Networking and Cyber Modelling and Simulation (CN&C M&S) concept to support military M&S aspect for the technology innovation, data protection, evolution, development and acquisition of new defence capabilities. The authors illustrates how CN&C M&S is utilized to support the definition of the operating technical requirements for the evolution and rationalization of a Defence telecommunication network. This approach allowed the definition of a possible support to the procurement model that would reduce the risks in the acquisition process by evaluating the proposed solution in a simulated environment before its implementation. From a cyber defence point of view, the paper illustrates a National Research Military Project namely "Cyber Security Simulation Environment (CSSE)" where the reuse of Defence network model support the modelling and simulation in the field of Cyber Defence to demonstrate the effects of a Cyber Operation on a command and control systems (C2). Finally, the aspects of Communication, Networking and Cyber Modelling and Simulation discussed in this paper may constitute a support tool for the evaluation of applications and the related use of this capability in the Defence fields.

WEB-BASED GUI SYSTEM FOR CONTROLLING ENTITIES IN CONSTRUCTIVE SIMULATIONS

2017 IITSEC Paper No. 17043

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At the Norwegian Defence Research Establishment (FFI) we investigate how to increase combat effectiveness in land force operations. As part of this work we need to conduct detailed, entity-level simulations of battalion to brigade level operations, to assess the performance of different land force structures and operational concepts.
Traditional constructive simulation systems often do not have the required level of resolution, are too complex and cumbersome to use, or are not flexible enough with respect to representation of new technologies (e.g. new sensor systems, weapon systems, and protection systems). Previously, we have successfully employed Virtual Battlespace (VBS) for several smaller-sized (platoon to company) virtual simulation experiments for evaluating the operational benefit of new technologies and new concepts. Recent improvements allow simulation of more than a thousand constructive, semi-automated entities in VBS, but it currently lacks an appropriate user interface for controlling constructive entities.
We are developing an easy-to-use, web-based graphical user interface (GUI) system for controlling constructive entities simulated in VBS. So far we have developed functionality for controlling indirect fire entities and maneuver entities. In the future we plan to extend the system with functionality for controlling combat service and support entities simulated in VBS, and air and air defense entities possibly simulated in VR-Forces. Since we conduct simulations for experimentation and analysis purposes, and not command and staff training, the system has been designed to only require a minimum amount of input from the operators. It is a goal that military officers should be able to control the entities with minimal instruction. In addition, the simulations should be conducted with a minimum number of operators on each side.

In this paper we describe the overall design and implementation of the GUI system, as well as the experiences from the initial experiments with the system.

THURSDAY, 30 NOVEMBER, 2017 ROOM S320C

EC9 Waiting to Exhale with My Imaginary Friends

1330
Increased System Fidelity for Navy Aviation Hypoxia Training (17225)

1400
Crew Role-players Enabled by Automated Technology Enhancements (17219)

1430
Expanding the Use of Simulators in Robotic Surgery Training (17060)

Notes

INCREASED SYSTEM FIDELITY FOR NAVY AVIATION HYPOXIA TRAINING

2017 IITSEC Paper No. 17225

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In 2009, the Naval Aviation Survival Training Program (NASTP) Trainer Management Team (TMT) identified a need for a next-generation normobaric mask-on hypoxia trainer with enhanced capabilities due to the lack of positive air pressure provided by existing capabilities. The lack of a positive pressure-on-demand airflow delivery for current mask-on hypoxia training has been cited as a potential training gap wherein 44% of students experience air hunger (Artino, Folga, & Vacchiano, 2009). As a result, it is unclear whether students are able to recognize more subtle symptoms of hypoxia or if they are masked by air hunger. To address this, researchers have investigated an innovative technology solution to deliver representative pressure-on-demand flow rates, thereby increasing training fidelity by replicating the air delivery method of aircraft systems. This research also provided an opportunity to seek additional novel advances. Reducing the logisitical footprint and increasing portability by removing the need for compressed gases was a goal to ease implementation within higher fidelity training simulators with limited space to increase immersive training opportunities. This paper will provide an overview of the training need and the technical approach to the training device development. Additionally, the authors will discuss the engineering and human subjects testing conducted to evaluate the system. The results will include how symptoms experienced using this novel device compare to historical data from other training systems, in addition to whether the system reduces or eliminates air hunger issues.

CREW ROLE-PLAYERS ENABLED BY AUTOMATED TECHNOLOGY ENHANCEMENTS

2017 IITSEC Paper No. 17219

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U.S. Naval aviation, similar to units in its sister services, uses the family of simulators approach to training that enables trainees to build on skills progressively throughout the training pipeline. The progression begins with system skills (e.g., buttonology), continues to individual tasks (e.g., understanding radar data), and concludes with aircrew coordination for tactical proficiency (e.g., prosecuting an anti-submarine warfare mission). However, this approach requires workarounds (e.g., instructor role-players) or a tradeoff in fidelity when trainees reach a point in skills training that requires communication from other crewmembers while still conducting standalone training tasks. With recent technological advances in speech recognition (Stensrud, Newton, Atkinson & Killilea, 2015), the feasibility of incorporating synthetic role-playing crewmembers into a dynamic training event has increased. This paper highlights the need for this technology within the target transition community, the P-8A Poseidon, as part of its part-task training simulator. Successful integration will promote efficient use of resources (e.g., manpower), increased fidelity through the availability of realistic crew communication and coordination, and flexibility in crew composition availability. The prototype architecture is discussed, including the integration of speech capabilities (e.g., recognition, dialog, understanding, synthesis) and behavior modeling to yield an interactive model for P-8A crewmember agents. Next, the authors provide lessons learned and challenges to the technological implementation, as well as the sustainment, given the rapid pace of tactic and protocol changes that will impact the underlying technologies. Additionally, the authors provide results of a preliminary usability analysis of the system, including primary stakeholder fleet evaluations regarding system reliability and synthetic voice analysis. Finally, the authors highlight the importance of performance testing, offer suggestions for adapting the technology to other use cases, and discuss future directions for interactive system research and development.

EXPANDING THE USE OF SIMULATORS IN ROBOTIC SURGERY TRAINING

2017 IITSEC Paper No. 17060

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The Mako Rio surgical robot was created to provide robotic assistance and computer-assisted planning to orthopedic surgeons performing hip and knee replacement procedures. Training to use this device is conducted in traditional face-to-face, instructor-led courses with the real robotic system on synthetic and cadaveric tissue. This form of training is expensive to produce and does not support reinforcement or repeated learning for the surgeon. This paper describes the analysis and design process for a simulator device that can supplement the current training methodology and allow for surgeon-initiated refreshment and repetitive training. The design process identified two different avenues for advancement in this field. First, existing surgical simulators were analyzed for technologies and capabilities that could be applied to a simulator for the Mako Rio. This included the capabilities of the hardware in 3D vision, 3D manipulation, and system operations; as well as the functionality of the software in VR exercises, validated scoring and metrics, system administration, student record management, and data export and reporting. This analysis identified two existing simulators that are viable platforms from which to create a Mako simulator – the Mimic dV-Trainer and the OSSIM coupled with a 3D vision system. Second, the study identified a much broader set of training needs surrounding all of robotic surgery education. All current simulators focus on basic surgical skills or surgical procedural skills. However modern immersive VR systems with haptic controls can provide a platform for simulation-based training that includes robotic mechanical control, surgical procedure planning, patient imagery analysis and selection, OR equipment and human patient placement, instrument table layout, and recovery from complications. None of these scenarios are available in any simulator device, though modern simulator systems have the capability to represent all of them. The results of this study indicate that medical and surgical simulator manufacturers and educators need to broaden the scope of the services offered to surgical educators.

TUESDAY, 28 NOVEMBER, 2017 ROOM S320A

H1 Hear, See and Sense No Evil

1400	1430	1500
Auditory Performance of Individuals with Reduced Hearing Capability in Virtual Reality Environment (17039)	Eye Tracking Feedback to Enhance Visual Search Training (17275)	Multimodal Assessment of Pilots' Affective States using Psycho Physiological Sensor Signals and Facial Recognition Analysis (17008)

Notes

AUDITORY PERFORMANCE OF INDIVIDUALS WITH REDUCED HEARING CAPABILITY IN VIRTUAL REALITY ENVIRONMENT

2017 IITSEC Paper No. 17039

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The effort to apply Virtual Reality (VR) technology to advance the fields of medicine, education, engineering, and entertainment is currently underway. The military uses VR to carry out training such as aircraft maintenance or virtual war scenarios. Despite important progress made in display technologies, a complete immersion in VR space is not possible without an auditory representation of the simulated environment. Sound is important in an immersive virtual environment because it enhances the sense of presence (Freeman, Lessiter, 2001) and improves situational awareness by providing feedback for situations that are not in the listener's field of view (Kukka et al., 2016). Additionally, the degree of presence experienced by an individual affects the performance of the training tasks (Stevens, Kincaid, 2015).
In order to synthesize a functional auditory environment, it is important to obtain a better understanding of how ears receive and process sound. To assess human training performance, it is essential to understand how the perception of the simulated sound environment is impaired for individuals with reduced hearing capability, which can be caused either by natural factors (e.g., age-related hearing loss [presbycusis]) or by external agents (e.g., noise-induced hearing loss). This paper provides a literature review for identifying limitations in auditory perception for individuals with sensorineural hearing loss (SHL). We reviewed hearing impairments due to SHL, which will likely affect auditory performance in a virtual environment. Using an ecological approach to explain the relationship between hearing impairments and auditory demands, we analyzed how this relationship affects human training performance. Finally, we provide guidelines to effectively design and implement VR environments, while taking into account human auditory performance, including individuals with reduced hearing capability.

EYE TRACKING FEEDBACK TO ENHANCE VISUAL SEARCH TRAINING

2017 IITSEC Paper No. 17275

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Law enforcement officers (LEOs) need to develop the visual search skills necessary to compare facial features of individuals to identification document (ID) photos and determine whether or not the individual is an imposter. This task presents a challenge, as individuals may differ in age and appearance compared to the provided ID photo. Training LEOs to effectively gain these visual search skills is typically accomplished through instructor-led presentations in a classroom setting, with instructors describing the techniques and highlighting the critical visual cues (e.g., facial features) needed to perform the task. However, trainees do not currently have a means to visualize performance during the task, and obtain objective feedback of how well they visually interrogated critical cues or if they followed the recommended process or procedure in the sequence or execution of the task. Eye tracking technology provides the capability to visualize search patterns and associate those to critical visual cues, thereby providing individualized feedback on objectively measured performance that allows trainees to see their strengths and areas for improvement. The current investigation was a feasibility study to determine if presenting eye tracking feedback to trainees learning the imposter detection task enhanced learning. A total of 95 new-hire LEO trainees viewed image pairs to detect imposters. After each trial, trainees were able to view eye tracking overlays of scan patterns to visualize critical cues that were and were not attended. Trainees participated in three sessions of seven minutes each, with the first session used to acclimate to the task and training system and accommodate any learning curve. Limitations of the study included a lack of a control group and time available to train. Despite these limitations, instructors and trainees reported significant value of training with objective feedback, and demonstrated improved performance from second to third training sessions through an increase in sensitivity (A′) and impostor detection (hit rate), and a decrease in average response time. Future research will empirically examine skill transfer to a live scenario-based training task.

MULTIMODAL ASSESSMENT OF PILOTS' AFFECTIVE STATES USING PSYCHOPHYSIOLOGICAL SENSOR SIGNALS AND FACIAL RECOGNITION ANALYSIS

2017 IITSEC Paper No. 17008

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Human error in aviation can lead to catastrophic results. Since 1959, the majority of fatal airplane accidents worldwide occurred during the takeoff and landing phases of flight and upwards of 60% are attributed to pilot error. Psychologists Robert Yerkes and John Dodson proposed an empirical relationship (Yerkes-Dodson law) that performance increases with physiological or mental arousal, but only up to a point, after which it decreases. Understanding a pilot's arousal during flight and its relationship with performance can ultimately contribute to the design of improved flight safety and flight training systems.

The objective of this research is to provide guidelines for the multimodal assessment of pilots' arousal level and affective states using noninvasive biosensors to answer the following three questions: i) Which data processing approach must be adopted to track pilots' arousal; ii) What affective/cognitive model can be used to interpret these measurements; and iii) How can these measurements be used as training assessment criteria?

This paper reports on an experimental study we conducted in a full-flight simulator to explore the answers to the above questions. Pilots' heart rate and galvanic skin response (GSR) were non-invasively and continuously recorded using a wristwatch biosensors during a 45 min flight of varying levels of complexity. Their facial expressions were recorded using a cockpit webcam to enable facial recognition analysis. Results revealed that physiological patterns may be related to the complexity level of the flight phase and to the pilots' performance and experience. Specifically, the mean amplitude sum of the GSR phasic component revealed the pilot arousal level while the valence of the pilot's affective state was captured through facial emotion recognition. These results can be mapped to the Circumplex Model of Affect as a framework to assess both individual and group performance.

TUESDAY, 28 NOVEMBER, 2017 ROOM S320A

H2 Build, Test and Perform

1600	1630	1700
Comparing Visual Assembly Aids for Augmented Reality Work Instructions (17208)	A Multi-method Approach to Evaluating Human-system Interactions during Operational Testing (17267)	Reprocessability and Engagement: Comparing Text to Human Forms for Information Conveyance (17187)

Notes

COMPARING VISUAL ASSEMBLY AIDS FOR AUGMENTED REALITY WORK INSTRUCTIONS

2017 IITSEC Paper No. 17208

Anastacia MacAllister, Melynda Hoover, Stephen Gibert, James Oliver, Rafael Radkowski, Timothy Garrett, Joseph Holub, & Eliot Winer
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Scott Terry & Paul Davies
The Boeing Company
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Increased product complexity and the focus on zero defects, especially when manufacturing complex engineered products, means new tools are required for helping workers conduct challenging assembly tasks. Augmented reality (AR) has shown considerable promise in delivering work instructions over traditional methods. Many proof-ofconcept systems have demonstrated the feasibility of AR but little work has been devoted to understanding how users perceive different AR work instruction interface elements. This paper presents a between-subjects study looking at how interface elements for object depth placement in a scene impact a user's ability to quickly and accurately assemble a mock aircraft wing in a standard work cell. For object depth placement, modes with varying degrees of 3D modeled occlusion were tested, including a control group with no occlusion, virtual occlusion, and occlusion by contours. Results for total assembly time and total errors indicated no statistically significant difference between interfaces, leading the authors to conclude a floor has been reached for optimizing the current assembly when using AR for work instruction delivery. However, looking at a handful of highly error prone steps showed the impact different types of occlusion have on helping users correctly complete an assembly task. The results of the study provide insight into how to construct an interface for delivering AR work instructions using occlusion. Based on these results, the authors recommend customizing the occlusion method based on the features of the required assembly task. The authors also identified a floor effect for the steps of the assembly process, which involved picking the necessary parts from tables and bins. The authors recommend using vibrant outlines and large textural cues (e.g., numbers on parts bins) as interface elements to guide users during these types of "picking" steps.

A MULTI-METHOD APPROACH TO EVALUATING HUMAN-SYSTEM INTERACTIONS DURING OPERATIONAL TESTING

2017 IITSEC Paper No. 17267

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The quality of human-system interactions is a key determinant of mission success for military systems. However, operational testers rarely approach the evaluation of human-system interactions with the same rigor that they approach the evaluation of physical system requirements, such as miss distance or interoperability. Often, testers evaluate human-system interactions using solely survey instruments (e.g., NASA-Task Load Index (NASA-TLX)), excluding other methods entirely. In this paper, we argue that a multi-method evaluation approach that leverages methodological triangulation to address a research question provides greater insights into the quality of humansystem interactions during operational testing and its potential impact on operations. Specifically, we present data from an operational test in which a multi-method approach was used. Ten attack helicopter pilots identified and responded to threats under four conditions: high vs. low threat density and presence vs. absence of a threat detection technology. Testers recorded two primary measures of pilot workload: time to detect first threat and the NASATLX. Pilots took significantly longer to detect threats under low threat density than high threat density when the threat detection technology was absent. However, there was no difference in time to detect threats when the threat detection technology was present. The NASA-TLX data showed a similar pattern of results, suggesting that the observed effect is a result of pilot workload rather than the method used to measure workload – i.e., survey instrument vs. behavioral metric. Triangulating methods in this way provides a more rigorous and defensible test of the research question, and when combined with qualitative methods, provides useful information for identifying whether degradations in performance should be addressed through additional training or interface redesign.

REPROCESSABILITY AND ENGAGEMENT: COMPARING TEXT TO HUMAN FORMS FOR INFORMATION CONVEYANCE

2017 IITSEC Paper No. 17187

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With the increasing pace of change, employee training is an important element in maintaining an organization's competitiveness. One avenue to efficiently address this need is to use information and communication technologies (ICT) to support technology mediated learning (TML). The use of TML is cost effective relative to other approaches such as formal training by human instructors (Gupta & Bostrom, 2009). Developers of TMLs tend to design increasingly complex user interfaces before research can support the efficacy of these designs which motivates this study. This study provides a foundational step toward understanding the design of ICTs for conveyance of information.

This research draws upon Media Synchronicity Theory (MST) to examine the mode of information presentation in a task-performance context and evaluates how the mode of information presentation impacts user engagement, task performance, and satisfaction. We conducted an experiment with 147 participants, testing the relationship between four increasingly human modes of presentation (text, audio, embodied agent, and video). Our findings indicate that text increases engagement and that engagement mediates the relationship to task performance and task satisfaction. Specifically, this research found that in the context of information conveyance for task completion, text increased engagement resulting in increased task performance and satisfaction over other increasingly human modes of presentation. The findings indicate limitations on the use of embodied computer agents (Avatars) for conveying information for task completion due to the need for reprocessabilty of the information being conveyed.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320A

H3 Learning Operability: All Together Now

0830	0900	0930
Interoperable Assessments using HPML: A Novice Conning Skills Acquisition Use Case (17072)	Total Learning Architecture Development: A Design-based Research Approach (17117)	Using Competencies to Map Performance Across Multiple Activities (17139)

Notes

INTEROPERABLE ASSESSMENTS USING HPML: A NOVICE CONNING SKILLS ACQUISITION USE CASE.

2017 IITSEC Paper No. 17072

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Demands in training require organizations to maximize access to adaptive training through high and low-fidelity simulations. However, an increase of learning opportunities through simulations must also be associated with a high level of efficiency and efficacy of the training system as a whole (Atkinson & Killilea, 2015). To avoid the risk of creating a collection of practice simulators instead of objective-based training environments (Stacy, Merket, Freeman, Wiese, & Jackson, 2005), training simulators must provide a precise yet comprehensible means to express and manipulate measurements, and assessments across a range of learning opportunities (Stacy, Ayers, Freeman, & Haimson, 2006). The motivation for the work reported in this paper originated from the need to redeploy measure and assessment software from a training simulation application to another. Given our interest to repurpose investments in learning design, the main research questions the current paper seeks to address consist of determining: 1) what approach would best fit interoperable measure and assessment computations, and, 2) to what extent the selected approach is adequate to represent specific measures and assessments we had implemented in our training simulation. The first section briefly presents major interoperable assessment initiatives. The section concludes that the Human Performance Markup Language (HPML) seems to best fit our interoperable measure and assessment needs, which is to repurpose and allow interoperability of measure and assessment computations. The Human Performance Markup Language (HPML) aims at fulfilling this purpose by providing a simple and reusable way to represent the performance of individuals and teams in those systems (Walker, Tolland, & Stacy, 2015). HPML supports the representation of measurements and assessments, and how they relate to performance and learning data, as well as training objectives. In the latter case, the HPML training objective package for instance, provides a scalable formal mechanism to document and manage training objectives, their relationships to scenario conditions, and performance measures (Stacy & Freeman, 2016). The second section gives an overview of HPML, followed by a presentation of a target use case, a training simulation for novice ship conning skill acquisition. The third section discusses how some HPML assessment templates can be applied to the use case. The application of HPML to the use case indicated that most of the assessment computations that were used in the training simulation for novice ship conning skill acquisition could be represented. A possible extension to HPML for expressing otherwise cases in category selection was identified, which would simplify assessment templates. However, the sparse HPML documentation, and low number of examples available made it difficult at times to determine if the analysis of our use case respected the intention of the HPML standard proposal. …..

TOTAL LEARNING ARCHITECTURE DEVELOPMENT: A DESIGN-BASED RESEARCH APPROACH

2017 IITSEC Paper No. 17117

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Organizations that use learning technology to educate and train are facing a new set of interoperability problems. Many new products—including adaptive systems, intelligent digital tutors, real-time data analytics, and interactive e-books—offer dramatic learning benefits. However, these products primarily "stand alone" and work outside of typical browser-based delivery environments controlled by traditional learning management systems. Yet, these intelligent systems' effectiveness often depends on their access to data generated and stored in other systems.

The U.S. DoD Advanced Distributed Learning (ADL) Initiative is designing a framework of specifications, called the Total Learning Architecture (TLA), to ultimately enable "plug-and-play" interoperability of learning technologies. That is, the TLA will allow these new products to interoperate with each other, with other existing learning systems, and even human capital management technologies to not only track learner activity while managing learner roles and identities but to share intelligent or inferential data and adapt their behavior accordingly. Because of the rapid rate of innovation in such distributed technologies, we adopted a multiyear design-based research approach. During the project's first year, an initial set of specifications have been developed and evaluated for technical and functional adequacy using a multi-round Delphi approach with a panel of international participants (n = 54). Also, in partnership with the U.S. Army JFK Special Warfare Center and School's Special Warfare Education Group, we conducted a live prototype test and demonstration with Special Operations Soldiers (n = 73). This yielded data on the nascent system's functionality, performance, user experience, and learning potential. Analysis of these data will lead to recommendations, which in turn will inform the second cycle of TLA development process. This paper summarizes the TLA concept, development process, first-year analysis efforts and outcomes, and lessons learned leading to design improvements for the second year of TLA development.

USING COMPETENCIES TO MAP PERFORMANCE ACROSS MULTIPLE ACTIVITIES
2017 IITSEC Paper No. 17139

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When a single training system accumulates data on learner performance, the data are stored in a way determined by the system's designers. This enables the system to access these data and to apply them to its interactions with learners. In environments such as live-virtual-constructive federations, each component may store performance data in its own way, making it difficult for one component to access and use data produced by another. To enable cross-component sharing of performance data, it is necessary to establish shared definitions of skills and outcomes; create a common language for expressing performance data; interpret data produced at differing levels of granularity; and (in some cases) satisfy a large array of security and privacy requirements.

This paper is based on work done by the US Advanced Distributed Learning (ADL) Initiative, the Credential Engine foundation, and several standards bodies. It starts by discussing the above challenges and their manifestations in use cases ranging from federations of different learning environments to more traditional online learning environments. The paper then describes a potential solution for collecting and processing assertions of competency, skills, and performance from multiple sources. Each assertion is of the form "Learner X has (or has not) achieved competency Y at level Z with confidence p based on evidence E." "Competencies" are drawn from shared, machine-readable frameworks that can represent knowledge, skills, ability, and objectives. Assertions can be collected directly or generated by ingesting granular performance data and correlating it to competencies, enabling algorithms that use explicit rules and relationships to draw further inferences.

This paper ends with a description of a system that implements the suggested solution and its application in the context of live trials with 73 subjects run as part of a design-based research effort.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320A

H4 Is It Live or Is It Memorex?

1600	1630	1700
Live-Virtual Laboratory Assessment of Behaviors in Occupational Roles (LABOR) (17006)	Performance Measurement Considerations for Live, Virtual, and Constructive (LVC) Training (17091)	Modeling Operator Performance through Task-oriented Machine Learning (17038)

Notes

LIVE-VIRTUAL LABORATORY ASSESSMENT OF BEHAVIORS IN OCCUPATIONAL ROLES (LABOR)

2017 IITSEC Paper No. 17006

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Attention-deficit/hyperactivity disorder (ADHD) is a commonly diagnosed neuro-developmental disorder that is chronic, persists into adulthood, and causes impairment in social, educational, and occupational functioning. While the educational and social impairments of ADHD are well understood, far less is known about the occupational impairments that affect young adults with ADHD, who are known to earn less and change jobs more frequently than their typical peers. Thus, it is vital to understand the type and intensity of functional problems within workplace settings with a goal of reducing occupational impairment.

To analyze this critical human performance deficiency, we have developed an analog single-Laboratory restaurant setting: a hybrid Live-Virtual "pizza place" training environment. A total of forty-nine young adults (24 ADHD, 25 Typical) were recruited to participate in a simulated workday doing typical job tasks: receive food requests, provide customer service (using confederates), prepare food orders, plan the most efficient driving route to make food deliveries, "deliver" the orders, and make appropriate change, and settle up finances once "returned" to the restaurant. Stated tasks require working memory, sequencing, sustained attention, direction-following, cognitive flexibility, and problem-solving. To identify specific areas of impairment for food order deliveries, we have computationally modeled a residential neighborhood to be endeavored upon a high-fidelity driving simulator. During the delivery cycle, the efficiency of the route, an evaluation of correct delivery and money management, and quantifiable simulator metrics (e.g., speeding, failure to stop at signs and signals) are observed as dependent variables. We likewise solicit feedback on the fidelity/usability of the analog setting (i.e., user experience), including suggested improvements for future work. In this paper, our discussion will emphasize critical Modeling & Simulation (M&S) engineering details of the simulator environment design and implementation. Likewise, our multi-measure data analysis methods will focus on measuring human performance and effectiveness within the Live-Virtual environment, and comparing preliminary observations from both cohorts.

PERFORMANCE MEASUREMENT CONSIDERATIONS FOR LIVE, VIRTUAL, AND CONSTRUCTIVE (LVC) TRAINING

2017 IITSEC Paper No. 17091

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Performance measurement is a critical component of training because it can help to diagnose the causes of effective vs. ineffective performance and suggest appropriate remediation strategies. It is particularly important during combined Live, Virtual, and Constructive (LVC) training because such exercises can be extremely resource intensive, thereby limiting the number of training opportunities. Additionally, large computer networks often produce an "online disinhibition effect," which increases the chances that learners may misbehave during training.

This paper presents four categories of unclassified performance metrics, along with specific examples of each, that were tested during the Operation Blended Warrior (OBW) 2015 and 2016 demonstration events. All of the measures were collected automatically and unobtrusively from the Distributed Interactive Simulation (DIS) network. The first category concerns measures of learner proficiency, such as force preservation and efficiency of fires. The second category concerns training rule (TR) violations, such as maintaining appropriate physical separation between assets and avoiding supersonic travel over populated areas. The third category concerns rules of engagement (ROE) violations, such as prohibitions against unprovoked attacks. The final category concerns network violations, such as not overloading the network with irrelevant traffic. The software code for these measures is freely available to the LVC community, upon request.

While these four categories of performance metrics provide very different information to different constituencies, collectively they help to make sense of what happened during the training event. As a result, we believe that they will be useful to the LVC community-at-large. Although many of these measures were tailored to the OBW air battle, we believe that they are generalizable to other LVC events and mission types. The paper concludes with lessons learned to help LVC event planners obtain the best value from their performance measurement-related efforts.

MODELING OPERATOR PERFORMANCE THROUGH TASK-ORIENTED MACHINE LEARNING

2017 IITSEC Paper No. 17038

Bryan Vandrovec	Robert Lutz	Timothy Bagnall	Tracy Sanders
RED-INC	The Johns Hopkins University	Mosaic ATM	The MITRE Corporation
Human Systems Division	Applied Physics Laboratory	Leesburg, VA	McLean, VA
California, MD	Laurel, MD		

Autonomous systems are quickly evolving to provide a versatile and essential capability in both military operations and commercial applications. From a human-systems perspective, these recent technological developments are changing the role of human operators into that of supervisory controllers of complex automated and autonomous systems who must maintain situation awareness (SA), and be ready to rapidly intercede in complex or critical situations that require human judgment and general intelligence. Unfortunately, this rapidly advancing technology has exceeded the ability of traditional methods, often relying on expertise and intuition, to predict how operators will perform and interact.

In support of U.S. Navy unmanned aircraft system (UAS) airspace integration initiatives, a high-fidelity simulated representation of air vehicle operator (AVO) behavior and performance is in development. The Operator Model (OM) employs machine learning (ML) and other artificial intelligence techniques for characterizing observed responses of AVOs to air traffic encounters, along with a means to reproduce and generalize those responses for use in faster-thanreal-time constructive computer simulations. In doing so, this model addresses several needs, such as providing an economical means of generating the volume and variety of human-performance data required for platform certification, and informing future design and training decisions.

The OM represents a significant new capability for unmanned aviation-systems development. It combines task analysis and experimental psychology with advances in machine learning to support simulation-based acquisition in a complementary and cost-effective manner, enabling certification of defense systems with higher levels of autonomy and more complex patterns of human-computer interaction (HCI). This paper will provide an overview of the OM hardware and software architecture, and highlight the Live-Virtual-Constructive (LVC) trials that have been performed at the Naval Air Warfare Center, Aircraft Division (NAWCAD) to validate UAS sense-and-avoid (SAA) capabilities. Phase 1 results indicate a strong agreement between LVC and OM measures of effectiveness (MOEs).

THURSDAY, 30 NOVEMBER, 2017 ROOM S320A

H5 Team Up and Decide

1030	1100	1130
Training and Performance of Multi-team Systems in Naval Warfare Environments (17234)	Cockpit Team Coordination Skills: The Role of Monitoring and Backup (17012)	Assessing Military Perceptual Expertise with Drift Diffusion Modeling (17202)

Notes

TRAINING AND PERFORMANCE OF MULTITEAM SYSTEMS IN NAVAL WARFARE ENVIRONMENTS

2017 IITSEC Paper No. 17234

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Multiteam systems (MTSs) often provide benefits over traditional teams when completing work or tasks in the context of complex and dynamic environments. However, challenges still exist in understanding and capturing the processes driving successful MTS performance. In the current effort, a cognitive task analysis (CTA) methodology was utilized to explore the driving antecedents of successful MTS coordination and integration within a carrier strike group (CSG) operating in a Naval warfare environment. The CTA identified critical incidents and emergent themes through structured interviews of 59 subject matter experts across Naval surface and air units operating in warfare environments. Researchers utilized a top down approach, leveraging existing frameworks (Ishak & Ballard, 2012; Marks, Mathieu, Zaccaro, 2001; Mathieu, Maynard, Rapp, & Gilson, 2008; Pagan, Kaste, Zemen, Walwanis, Wood, & Jorett, 2015; Wildman et al., 2012) of team knowledge, skills, and attitudes (KSAs) to be applied to the multiteam domain of the CSG. The framework was used to code CTA data to determine the KSAs necessary for successful MTS performance and modified to reflect domain specificity as required. The KSA framework was then used as guidance to provide recommendations for MTS training and performance measurement. These recommendations are currently being used to develop specific, multilevel performance measures of the KSAs needed to effectively operate in changing, complex environments. The development of these performance measures also coincides with efforts to develop training to provide feedback on coordination, information exchange, and other elements of MTS performance. Finally, efforts are also being conducted towards the development of experimental, quasi-experimental, and agent-based modeling in order to evaluate the recommendations and performance measurement criteria. Execution of these recommendations, performance measures, and training are expected to improve decision-making and information exchange of the CSG as a whole within these complex

COCKPIT TEAM COORDINATION SKILLS: THE ROLE OF MONITORING AND BACKUP

2017 IITSEC Paper No. 17012

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Successful flight crew team performance in today's advanced technology cockpits is essential for mission accomplishment and contingent on crewmembers monitoring each other and providing the appropriate backup (Kontogiannis & Malakis, 2009; Tullo, 2010). Flight crew monitoring can serve as the last line of defense against aviation accidents and monitoring failures are evident in many recent accidents (Dismukes & Berman, 2010; FAA, 2017). In our study, thirty U.S. Coast Guard cockpit flight crews flew automated and non-automated instrument takeoffs as both pilot flying and pilot monitoring in the Coast Guard's MH-65 Operational Flight Trainer. We explored the effects of shared situational awareness, aviation experience, and level of cockpit automation on monitoring and backup performance. Instructor pilots observed the interaction of the cockpit flight crews to evaluate the level of monitoring and backup during the nighttime overwater instrument takeoffs. Based on the study's findings, the U.S. Coast Guard is redefining monitoring and backup in aircraft cockpits, defining critical behaviors for effective cockpit automation management, and changing how Coast Guard pilots are trained and evaluated to successfully perform in advanced technology multi-piloted cockpits.

ASSESSING MILITARY PERCEPTUAL EXPERTISE WITH DRIFT DIFFUSION MODELING
2017 IITSEC Paper No. 17202

Webb Stacy, Jeff Beaubien & Sterling Wiggins
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One way to assess military perceptual expertise is to present brief stimuli to military experts and novices and to ask them to make a 2-choice expertise-related judgment as quickly and accurately as they can. The differences in the distributions of their reaction times and errors can then reveal differences in their perceptual expertise. The difficulty is that reaction times and errors are often not independent. In some cases, participants make a speed-for-accuracy tradeoff. In other cases, correct responses occur quickly but error responses require a lot of perceptual processing. Either way, an analysis of reaction times or errors by themselves can produce misleading results. An increasingly popular solution is to use reaction time and error distributions together to perform a Drift Diffusion Model (DDM) analysis. This approach yields a profile of several cognitively meaningful components, including an estimate of the speed of processing, the level of the response threshold (indicating how much information the participants needed in order to make a perceptual decision), and the amount non-decision time, which often translates to the amount of time it takes to encode the stimulus. By comparison, traditional methods for assessing reaction time and accuracy (separately) do not differentiate the component cognitive processes of encoding, decision-making, and response execution, respectively. These components can yield surprising results. For example, DDM has shown that the main culprits in aging are increases in response threshold and in non-decision time but not speed of processing. Moreover, speed of processing, but not response threshold or non-decision time, is related to working memory capacity and reasoning ability in adults of all ages. In this paper we will discuss strategy and techniques of DDM analysis. We will then illustrate them by discussing an experiment we performed with military experts and novices using this methodology, with the aim of encouraging other researchers to adapt the approach for their own research issues.

TUESDAY, 28 NOVEMBER, 2017 ROOM S320F

P1 Data and Delivery: Addressing the Challenges

1400	1430	1500
Achieving Actionable Information in a Complex Operational Environment (17153)	Considering Training (Effectiveness) as a Service as an Acquisition Strategy (17156)	A Cloud Computing Business Case Analysis for Existing Training Systems (17053)

Notes

ACHIEVING ACTIONABLE INFORMATION IN A COMPLEX OPERATIONAL ENVIRONMENT

2017 IITSEC Paper No. 17153

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During operations in Iraq, Afghanistan, and elsewhere over the last decade, one significant lesson has been learned: a failure to recognize, acknowledge, and accurately define the operational environment (OE) led to a mismatch between forces, capabilities, missions, and goals. Fortunately, warfighters and senior leaders were able to overcome the information technology (IT) capability shortfalls through materiel and non-materiel solutions -- building relationships with the local population and key leader engagements, creating fusion cells to assimilate operations and intelligence information, and expanding the use of liaison officers. The Afghan Mission Network (AMN) (Serena, Porche, Predd, Osburg, & Lossing, 2014) is one solution which has had long-lasting impacts on how we, as a joint and multinational force, come together to share data. It has led to the NATO Federated Mission Networking (FMN) concepts, and the US contribution to FMN, the Mission Partner Environment (MPE).

Sharing OE information with mission partners in an FMN/MPE promotes unity of effort and effectiveness across interagency, coalition, host-nation partners, think tanks, academia, commercial entities, and non-governmental organizations. Fielding IT data services in an enterprise environment that automates mining and extracting missionrelevant data from vast amounts of restricted and open source repositories is prerequisite to fully understanding a complex OE. This political, military, economic, social, information, and infrastructure (PMESII) data about a specific geospatial location at a point in time must be integrated and transformed into actionable information that considers second-order effects.

This paper will describe the Joint Staff and Army's collaborative approach to leverage and horizontally integrate Combatant Command, military Service, DOD Agency, and multinational capabilities as enterprise solutions that advance a comprehensive understanding of a complex OE; supporting decision making with actionable information, and promote information superiority over trans-regional, multi-domain, and multi-functional adversaries.

CONSIDERING TRAINING AS A SERVICE WITHIN THE ACQUISITION STRATEGY

2017 IITSEC Paper No. 17156

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Recently, the US Army Human Dimension Concept (2014) and US Army Warfighting Challenges (2017) have called for a more flexible, adaptive, and effective training strategy and technologies that accelerate acquiring collective team skills to keep pace with rapidly changing, and complex warfare requirements. Currently, reviews of the Army's nonsystem training devices indicate large footprint training simulators target just a small portion of collective skills, have high sustainment costs and low usage rates, and training effectiveness is difficult to track (United States General Accounting Office, 2016). To address these issues the Army has proposed the single Synthetic Training Environment with the vision of providing greater training flexibility at reduced cost through low footprint, mobile, reconfigurable, immersive simulators that provide the right level of cognitive fidelity tailored to learning requirements specified by end-users at the Point of Need (PoN). The purpose of this paper is to discuss the requirements for an effective PoN capability. We describe how the Training as a Service (TaaS) paradigm could support the PoN and argue for an innovative concept of TaaS within the acquisition strategy. For example, providing evidence of training effectiveness could be built into the requirements for delivering a service, and could be employed as procurement selection criteria. To illustrate, we describe a use case example and a concept for a Collective Training Management Architecture (CTMA) that we propose will be necessary to implement TaaS to achieve a PoN solution.

A CLOUD COMPUTING BUSINESS CASE ANALYSIS FOR EXISTING TRAINING SYSTEMS
2017 IITSEC Paper No. 17053

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The US Army has published several documents and directives that establish the overarching strategies, guidance, and an implementation plan for the rationalization and modernization of the Army's information technology (IT) systems and applications. The guidance and implementation plan mandate a Business Case Analysis (BCA) be performed when assessing the migration of IT systems and applications to approved hosting environments, and closing or consolidating data centers. These overarching strategies, guidance, and implementation directive impact how the Army's Integrated Training Environment (ITE) will be hosted in the future. The individual training devices and simulations that comprise the ITE have existed for some time, and some of the architectures may not support effective homestation training if they are hosted in a distant enterprise data center. This paper reports on the analysis performed to assess the main systems that comprise the ITE System of Systems (SoS), and conduct a BCA in accordance with the Army guidance. The technical assessment framework that was developed for the characterization and technical assessment of training and simulation systems is described. The paper then discusses how the framework was utilized to characterize and assess each of the systems, including critical system-of-systems aspects, and generate the technical rationale for feasible cloud migration alternatives. The approach and methodology for the BCA are described, and the calculated cost and economic viability are presented for each of the feasible migration alternatives. Sensitivity analysis results are shown illustrating the extent to which alternative rankings change as a result of varying certain factors and/or assumptions. Finally, the paper discusses how the technical assessment and BCA provide PM ITE with the information necessary to support planning, budgeting, and architectural evolution for the migration of the ITE to the cloud.

TUESDAY, 28 NOVEMBER, 2017 ROOM S320F

P2 Standards and Policy Setting the Bar

1600
Exploration of Next Generation Technology Application to Modeling and Simulation Study Group (17045)

1630
Standardizing Human Performance Measurement for Ease of Data Analytics (17223)

1700
Measuring Display System Resolution Precisely (17016)

Notes

EXPLORATION OF NEXT GENERATION TECHNOLOGY APPLICATION TO MODELING AND SIMULATION STUDY GROUP

2017 IITSEC Paper No. 17045

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The rapid pace of commercial technology advancements applicable to the Modeling and Simulation (M&S) communities is staggering. However, those technology advancements are not based on (or influenced by) the current state of M&S and its programs. M&S has much to gain in leveraging technology advances, such as Wearable Technology Synched with Computing, Streaming, Advanced Hardware, Cloud Services, and Data Sharing. In order to better understand the implications to M&S and standardization, the Simulation Interoperability Standards Organization (SISO) has established the Exploration of Next Generation Technology Applications to Modeling and Simulation (ENGTAM) Study Group (SG), which began in December 2015.

The purpose of the ENGTAM SG is to capture the technical concepts, to learn from examples applicable to the M&S domain, and to continue to elucidate a better understanding of how the latest and greatest technology can help M&S. The SG is also examining how to minimize the struggles that are typical when trying to adopt new technology, including: the risk of the unknown; expensive changing of processes based on that risk; and understanding enough about the technology to take full advantage. Moreover, it is exploring other undiscovered struggles of large organizations taking on new, and hopefully useful, technology.

This paper covers findings from nearly two years of examination in order to capture the latest industry technology trends and available solutions, specifically focused on their applicability to the M&S domain. We explain a slight change in SG focus towards technology adoption, and present the next steps for continuing the education and documentation of best practices for large organizations to examine, adopt, and utilize the newest technologies for M&S as the technologies present themselves.

The advances in technology will not be slowing down. M&S practitioners must adopt a strategy that supports properly leveraging these advancements in order to enable reuse, cost savings and interoperability.

STANDARDIZING HUMAN PERFORMANCE MEASUREMENT FOR EASE OF DATA ANALYTICS

2017 IITSEC Paper No. 17223

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As interest grows for big data analytics within the Department of Defense (DoD), one prime opportunity to leverage existing data sources is performance assessment. Specifically, the use of quantitative performance data for determining skill levels of trainees supports diagnostic feedback, targeted remediation, and identification of opportunities to accelerate or tailor training to student learning progress. The successful implementation of automated, system-based performance measures within DoD training systems for assessment and trend analysis purposes, however, necessitates standardization in implementation to ensure success. Based on on-going efforts, the authors propose two areas for consideration: 1) adoption of standards for hardware and software simulation interoperability, and 2) an approach to measurement definition that is flexible to the military's crawl-walk-run approach to training and conducive to trend analysis. Currently, the simulation community lacks a standardized way to represent human performance data requirements that are generalizable, scalable, interoperable, and transparent. Because of this gap in standards, developers are challenged with finding ways to implement technology in environments that lack the right type of data. The first step toward increased consistency would be an industry standard for interoperability. As such, this paper will outline a proposed human performance measurement standard under consideration by the Simulation Interoperability Standards Organization (SISO). This standard provides a framework for defining how a system can utilize available data to determine if trainees achieve desired outcomes based on the mission context. However, because not all facets of human performance measurement can be defined by a standard, researchers and developers must consider other factors during measure implementation. For example, measures may be presented in the form of raw data to inform instructor formulated assessments (e.g., number of kills), or assigned values to automatically classify calculations (e.g., percentage, expert vs. novice). Both of these forms of measurement provide unique data benefits throughout the training lifecycle, but a theoretical approach to defining and implementing performance measurement for trend analysis is required to fully realize those benefits. Therefore, in addition to a proposed interoperability standard, the authors will provide lessons learned and best practices for performance measurement when long-term goals include pursuing big data analytics.

MEASURING DISPLAY SYSTEM RESOLUTION PRECISELY
2017 IITSEC Paper No. 17016

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Spatial resolution is arguably the most important determinant of display system performance. However, the simulation training industry currently uses variations of low precision subjective measures of resolution to evaluate training display systems. Furthermore, these subjective methods are not applied consistently across programs or over the life of a single training device. Meanwhile, far more precise objective measures are commonly used to specify other lessinfluential display system attributes such as geometry, luminance, and white point.

This paper summarizes the results of a series of papers describing the research, development, and testing of an objective metric of display system resolution designed specifically to meet the needs of the simulation training industry. This multi-year R&D effort culminated in the development of a proposed standard Metric description, Test pattern definition, and measurement Procedure (MTP) that is provided for consideration by the simulation training community. Test results indicate the standard deviation of repeated measurements made using the proposed method is 1/12th of that obtained using the current subjective methods and the correlation between the proposed and current methods is strong (R2 = 0.79, 17 df). Multiple resolution measurements can be made across the field of view of a display system using a simple pan-tilt unit in 1/14th the time required using the current methods.

The substantial improvement in the precision of resolution measurements is expected to increase the probability that delivered systems will meet customer expectations and reduce arguments and delays during the acquisition of these complex systems. The significant improvement in measurement speed translates into the ability to make comprehensive measurements of complex display systems consistently across programs and over time.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320F

P3 Technology and Workforce: Tying it all Together

0830
Developing U.S. Service M&S Professionals: Inter-Service Differences in the Education, Training, and Management of Uniform and Government M&S Personnel (17178)

0900
Patent Law and Defense Technology: Original Intent and Current Practice (17035)

0930
A National Approach to achieve International Distributed Simulation Interoperability Certification (17044)

Notes

DEVELOPING U.S. SERVICE M&S PROFESSIONALS: INTER-SERVICE DIFFERENCES IN THE EDUCATION, TRAINING, AND MANAGEMENT OF UNIFORM AND GOVERNMENT M&S PERSONNEL

2017 IITSEC Paper No. 17178

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It is said time and time again: "We are only as good as our people." It is critical to have uniformed officers and government service personnel significantly involved in properly shaping modeling and simulation (M&S) programs as the services increasingly adopt M&S; live, virtual, and constructive (LVC) simulations, virtual environments (VEs) and digital engineering (DE) solutions that address training, acquisition, and assessment missions. Yet, investment by the defense establishment and the military services in recruiting, educating, promoting, retaining and utilizing uniformed and government M&S professionals is mixed at best. Each service designates these officers and civilians differently, with the Army having a functional area (57) and career program (36), the Navy a subspecialty (6202), the Marine Corps a military occupational specialty (8825), and the Air Force identifies three special experience identifiers for M&S that cover positions that require awareness, management or senior leadership skills. However, these differences are more than semantics. The differences between the Army and Navy show just how dissimilar different service approaches can be. For example, the Army has scores of billets requiring an FA-57, and once Army officers become FA-57s they will almost always fill an M&S billet. In contrast, the Navy has significantly reduced the number of billets requiring an M&S subspecialty code, and Navy officers who receive that designation may never serve in an M&S position during the remainder of their careers. This paper describes the education, training and workforce management of uniformed and government M&S professionals in the U.S. military services. It then presents applicable insights and lessons learned, looking specifically at similarities and differences in how the services recruit, educate, train and manage their M&S workforces. The goal is to better educate and empower warfighting simulation professionals.

PATENT LAW AND DEFENSE TECHNOLOGY: ORIGINAL INTENT AND CURRENT PRACTICE

2017 IITSEC Paper No. 17035

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The protection of inventions and other intellectual property (IP) is provided for in Article I of the U.S. Constitution, but the passage of time and the evolution of society has clouded the original goals and obfuscated the vision of promoting progress. Using diverse points of view, the authors present the history and the current impact of the patent system on the development and deployment of technology, especially as these relate to national defense issues. This paper begins with a quick review of the inherent need for the protection of IP, the founders' intent, and the ways in which the legal processes have altered over the decades. They justify their assertion that not all of these changes have been salutary and discuss times when they have become impediments to or destructive of progress. Some feel that protection of the lone inventor has given way to providing weapons for organized interlopers and requiring defensive tactics by large corporations. Patent grants have exploded to unimaginable levels. Data will be presented on the number and complexity of patents. The paper will follow that with an analysis of the pressures that have caused that drift from the original goals. There is a review of thought concerning the current practice and future changes to encourage creative endeavors from the point of view of legal, technical and academic participants. A brief outline is given of international issues and the impact of various countries' approach to this problem and steps that the U.S. might take to enhance the rule of law and the global protection of IP. This is discussed in relation to its being necessary for a strong defense environment for the nation and its allies. The paper closes with possible areas of future change.

A NATIONAL APPROACH TO ACHIEVE INTERNATIONAL DISTRIBUTED SIMULATION INTEROPERABILITY CERTIFICATION

2017 IITSEC Paper No. 17044

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As the capability and utility of simulation across Defense grows, it is becoming increasingly important to understand if each simulation system is fit for purpose, well understood and meets distributed simulation interoperability requirements. To support this, the UK Ministry of Defence's (MoD) Defence Training and Education Coherence (DTEC) approach has developed a set of compliance rules and identified a number of international standards that must be employed, or at the very least demonstrate (from the Enterprise level Value for Money perspective) why they have been discarded. These rules compel system developers to investigate and employ the standards, best practices and resources in which UK MoD has invested. To further support these developments UK MoD is beginning to develop Defense-wide capabilities, delivered as services, to provide common simulation components and resources.

Distributed simulation offers increased opportunity to train collaboratively across national boundaries. With the High Level Architecture (HLA) the preferred NATO interoperability standard, initiatives (such as MSG-134 Distributed Simulation Architecture & Design, Compliance Testing and Certification) are investigating and developing tools for HLA certification. The MSG-134 output will support interoperability testing enabling national and international activities. There is also potential for the development of a UK Distributed Simulation Management Service for Defense that could, for example, manage interoperability software (e.g. the HLA Run Time Interfaces (RTIs)), network performance, interoperability exchange definitions (e.g. the NATO Education Training Network (NETN) Federation Object Model (FOM) modules) and the certification of HLA federations.

This paper describes a potential option that the UK MoD is investigating to develop a coherent testing capability that will support the evaluation of simulation components and the certification of simulation systems interoperability at a national and international participant level. The paper highlights key programs where certification would be required, outlines what a certification service might look like and identifies initiatives that will support the development of such a service.

TUESDAY, 28 NOVEMBER, 2017 ROOM S320B

S1 Augmented Reality

1400
Analyzing SLAM Algorithm Performance for Tracking in Augmented Reality Systems (17161)

1430
Most Effective Capabilities of Head Mounted Displays for Dismounted Soldier Training Using Augmented Reality (17055)

1500
Expert-Assisted Field Maintenance using Augmented Reality (17262)

Notes

ANALYZING SLAM ALGORITHM PERFORMANCE FOR TRACKING IN AUGMENTED REALITY SYSTEMS

2017 IITSEC Paper No. 17161

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In developing augmented reality based tutoring scenarios difficult issues can arise if the environment used is not initially known. Lacking in pre-determined fiducial markers, the tracking of the user's position and orientation relative to their starting point can easily be lost. A potential solution lies within the robotics field: simultaneous localization and mapping (or SLAM) algorithms which rely on visual tracking methods to both determine the layout of the environment and the robot's current position and orientation given the previous estimate. However, when applied to a human subject in an augmented reality environment, the agility of their movement during performance activities can lead to issues. In this paper, we discuss the framework used to test a set of SLAM algorithms and determine their capabilities of tracking a human subject performing a variety of movements. We detail the SLAM algorithms analyzed and explain their potential usage given equipment combinations that may be developed in a lab environment. We also go through each movement set, detailing the hardware used in the recording process and how the user's movements are designed to test the limits of a SLAM algorithm. By developing a networked framework, we show how the system is easily adapted to test an algorithm with minimal changes to its code and how it may be used to evaluate future SLAM research. In the end, our framework shows the capabilities and limits of SLAM algorithms when tracking a human user in an augmented reality system.

MOST EFFECTIVE CAPABILITIES OF HEAD MOUNTED DISPLAYS FOR DISMOUNTED SOLDIER TRAINING USING AUGMENTED REALITY

2017 IITSEC Paper No. 17055

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Within training, the Department of Defense (DoD) has a strong interest in augmented reality (AR) for its ability to combine live and virtual assets to reduce cost, increase safety, and to mitigate unavailability of needed live assets. During the past two years, a rapid increase of interest in AR for consumer use has spawned a multitude of innovations for head mounted displays (HMD). Increased fields of view (FOV), tetherless computing, integrated depth-sensing, external spatial audio, and simultaneous location and mapping (SLAM) are just a few features that have become a boon for military use, such as dismounted Soldier training. However, the usefulness of these features varies for the dismounted Soldier training use case. This paper examines features from nearly a dozen of today's consumer AR HMDs and contrasts the tradeoffs required to reap their benefits. We evaluated these HMDs primarily against key tactics and skills required in ATP 3-21.8 'The Infantry Rifle Platoon and Squad' doctrinal framework – specifically employing fires, offensive operations, defensive operations, and patrolling. Finally, this paper explores what features are missing or are suboptimal on these HMDs for dismounted Soldier training use.

EXPERT-ASSISTED FIELD MAINTENANCE USING AUGMENTED REALITY

2017 IITSEC Paper No. 17262

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In 2016, the US military had an operation and maintenance budget of almost USD $200 billion, the largest budget of any appropriation category. As such, it is imperative to minimize errors and costs when performing maintenance tasks. Unfortunately, the military may not always have enough skilled technicians on hand to send to all maintenance sites. Because of this, warfighters must often perform maintenance on systems outside their area of expertise. Augmented reality (AR) has been shown to effectively deliver context-aware instructions, reducing the time needed to identify suitable maintenance steps by more than 50%. However, even with the use of AR, it would be impractical to create maintenance instructions for each unique piece of machinery. By connecting a remote warfighter to a skilled technician, a plethora of maintenance knowledge can be quickly transferred in a targeted manner.

This paper details a mobile application that puts both the power of AR and the knowledge of a technician directly into the hands of a warfighter in the field. A mobile application was developed using the Unity3D game engine that enables technicians to use AR to visually share maintenance knowledge with a remote warfighter. A live camera feed of the warfighter's immediate area is streamed to the technician. Observing this feed, the technician sends back real-time maintenance guidance in the form of augmented 3D models and animations, selected from a list or created dynamically. Once received by the remote warfighter, the augmentations are overlaid onto the physical object, and the technician-recommended maintenance step is visible to the warfighter. While there has been ample research regarding AR-assisted processes, little focus has been given to leveraging the detailed knowledge of existing personnel. This paper discusses the application development and technical evaluation to ensure real-time connectivity in geographically distributed locations.

TUESDAY, 28 NOVEMBER, 2017 ROOM W320B

S2 Radar Simulation

1600
GPU Ray Tracing-based Method for Real-time ISAR simulation (17237)

1630
Enhanced Aerial Radar Line of Sight Performance (17051)

Notes

GPU RAY TRACING-BASED METHOD FOR REAL-TIME ISAR SIMULATION

2017 IITSEC Paper No. 17237

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The Inverse Synthetic Aperture Radar (ISAR) technique serves to identify and/or classify targets such as aircraft, ships and ground vehicles. In the context of radar operator training, ISAR simulation is a complex CPU-intensive process since it needs to compute and update a target's range-Doppler signature for constantly varying aspect angles. The main challenge is to generate a reliable ISAR image in real-time. To do so, current simulators employ several approximations. These commonly consist of (1) computing only direct reflections and tuning manually some reflection features by editing the 3D models, (2) coarsening the target mesh to reduce the number of intersected polygons or (3) undersampling the integration time by ignoring intermediate aspect angles.
In this work, we present a solution where we implement a modified visual ray tracing method as an analogy to simulate the radar wave scattering. The objective is to improve real-time simulation of the ISAR imagery for the purpose of radar operator training. The method presented here has the ability to compute multiple reflections. Consequently, intense flashes produced by corner reflectors are naturally depicted. The method also allows using complex 3D models directly without offline preprocessing or manual modifications of the models. Real time is achieved by implementing a ray tracing-based algorithm written in CUDA running on GPU. This takes advantage of the massive number of parallel threads that can run on current GPUs. Moreover, the general-purpose programming model supported by CUDA offers a more flexible implementation with more appropriate data structures.
The proposed solution can generate realistic ISAR images of a ship at sea including effects of multiple reflections on a mid-range graphics card. Since this solution does not require preprocessing or manual alteration of the 3D models to add scatterers, it makes training on realistic ISAR simulation more accessible.

ENHANCED AERIAL RADAR LINE OF SIGHT PERFORMANCE

2017 IITSEC Paper No. 17051

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Airborne Aerial Radars are often required to track a large number of ground vehicles moving within a specific area. When simulating such a radar, detection computation must consider the existence of line of sight between the radar and each of the simulated ground platforms, resulting in multiple long range LOS computations performed simultaneously, from a single aerial point. When using very high resolution terrain with ground vehicles scattered over large areas (hundreds of square miles) in dense vegetation, urban structures and mountainous terrain, the polygon count required for geometry intersection calculations used by each LOS query can be very high. In some cases, processing multiple LOS queries, results in poor simulation performance. This paper suggests a simple approach for reducing the number of required LOS calculations, where multiple long-range LOS queries originate from the same aerial point. By using a shadow map generation method and positioning the source of light at the LOS origin point, Ground points that are inside a shadow can then be filtered out from further LOS computations. The more ground points there are the better cost effective this method is.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM W320B

S3 Cyber Simulation and Training

0830	0900	0930
Cyber Effects within a Kinetic Model (17181)	A Cyber Warfare Prototype for Live, Virtual, & Constructive Simulations (17015)	The DARPA CODE White Force Network (17018)

Notes

CYBER EFFECTS WITHIN A KINETIC MODEL

2017 IITSEC Paper No. 17181

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Often when the military talks about cyber training, the focus is on a "cyber range" in which operators practice their skills and test new tools and techniques. This level of training is necessary but not sufficient to prepare US forces to dominate a tactical battlefield against a cyber-savvy adversary in a Multi-Domain Battle environment (Shrinkman, 2016). Stimulating staffs by integrating cyber and traditional military operations is critical. Cyber operations at the tactical level involve both offensive and defensive actions – integrated and supporting traditional military operations – where cyber may be the supported operation within traditional military operations, and vice versa.

There are limited means of representing cyber operations and effects – beyond simple models of communication and network degradation – within most simulations. The Army has funded the architecture prototype implementation to link cyber and kinetic simulations leveraging the strengths of each simulation without trying to force both sets of capabilities into a single model. Cyber actions (e.g., SQL injection attacks to gain control of a supervisory control and data acquisition (SCADA) systems) are best represented in live or synthetic cyber simulations. Cyber effects (e.g., the cyber operator shuts off the power to an area of interest) are then represented in a constructive simulation.

The integration of the cyber simulation with constructive simulation allows realization of the effects from cyber operations on the kinetic domain and the effects from kinetic operations on the cyber domain. The interface between the cyber simulation and constructive simulation was standardized, allowing improved and reliable integration. As this interface matures, it may be used to link any arbitrary cyber and kinetic simulations that comply with the interface. The constructive simulation was enhanced to model streetlights, searchlights, cameras, and controller systems (e.g. SCADA). Additionally, 2D and 3D displays were enhanced for visual representation of the cyber effects. In this paper, we discuss the architecture, integration, enhancements, use cases, and demonstration capabilities implemented for representing cyber effects within a kinetic model.

A CYBER WARFARE PROTOTYPE FOR LIVE, VIRTUAL, & CONSTRUCTIVE SIMULATIONS

2017 IITSEC Paper No. 17015

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Cyber warfare has quickly moved to the forefront of the Army's training needs. With the realization that cyberspace is now a warfighting domain, simulation and training program managers are left struggling to identify the best solution for implementing cyber warfare effects into the training domain. The term cyber itself can imply a broad range of possibilities including electronic warfare (e.g. jamming), kinetic warfare (e.g. destroying systems), hacking attacks, and insider threats. Current major training simulations among the Live, Virtual, Constructive, and Gaming (LVC&G) domains lack a cyber implementation, with the exception of a low fidelity cyber warfare effects simulation in the One Semi-Automated Forces (OneSAF) program. It is necessary to train in this warfighting domain, but the requirements and best strategies for conducting cyber training have created a challenging technical gap for the simulation and training communities. Presently, the Army's Cyber Mission Force teams require cyber range training to provide the realistic data exchanges necessary to develop their skills. This type of training is commonly referred to as "cyber for cyber." The rest of the Army falls into another category of cyber training commonly referred to as "cyber for others." After talking with numerous stakeholders, we decided to develop a prototype system for training the "cyber for others" group to experience cyber-attacks on their tactical mission command systems and to make recovery decisions. This prototype, called Cyber Operations Battlefield Web Service (COBWebS), provides the capability to simulate the effects of various cyber-attacks on command and control communication between the synthetic entities and the Blue Force's mission command systems. Our prototype leverages the OneSAF Mission Command Adapter Web Service (MCA-WS) and adds cyber warfare effects modeling. We will share our experience developing and field testing this cyber warfare training capability.

THE DARPA CODE WHITE FORCE NETWORK

2017 IITSEC Paper No. 17018

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The DARPA Collaborative Operations in Denied Environments (CODE) program is developing highly advanced collaborative autonomy capabilities that will allow unmanned aircraft systems (UAS) to successfully engage mobile targets in denied or contested electromagnetic environments. The core goal is for CODE enabled Air Vehicles (AVs) to autonomously sense and evaluate the state of its operational environment, form teams, and carry out defined mission objectives with limited human supervision.

The testing of CODE capabilities on live ranges requires an interacting set of live, virtual, and constructive (LVC) assets to provide the necessary stimulus to the system under test (SUT). The CODE White Force Network (WFN) is designed to dynamically interject operationally-relevant effects, such as denial of communications or GPS, into the CODE software during flight as a means of stimulating and then verifying the performance of CODE autonomy algorithms. The WFN also allows large numbers of high fidelity virtual assets running the actual CODE software to be part of the test scenarios. In addition, the WFN ground station provides synthetic forces generation services and various control, visualization, and logging functions that interact in real-time with the on-board WFN flight software to create the desired effects.

This paper provides an overview of the WFN design and describes how the WFN was integrated into recent CODE test campaigns at NAWC-WD in China Lake, CA. The paper also discusses the increase in complexity planned for the next CODE phase test environment and how the WFN will address the associated technical challenges.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320B

S4 Modeling and Virtualization

1030
Full 3D Visuals for Advanced Training in Single-seat Fighters (17050)

1100
3D Visualization for Point of Need and Cloud Based Training (17067)

1130
Optimization of Computer Generated Three Dimensional Models for Decreased Latency in Virtual Environments (17170)

Notes

FULL 3D VISUALS FOR ADVANCED TRAINING IN SINGLE-SEAT FIGHTERS

2017 IITSEC Paper No. 17050

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For 5th Generation fighters such as the F-35, two-seat configurations are not available. Therefore, training relies heavily on ground simulators to prepare new pilots. Instructors have long noted that simulators have shortfalls in visual cues provided to the pilot, which are especially important for tasks where the pilot is required to visually maneuver the aircraft in relation to an outside object. One of the most obvious examples of this is aerial refueling, which has become increasingly important as 5th Generation aircraft tend to fly longer missions and in order to maintain stealth do not carry external fuel tanks. These two factors combine to drive much higher rates of aerial refueling. For single-seat fighter aircraft it is more difficult for new pilots to receive the necessary training given the absence of 3D cues in current simulators. The important visual cues for aerial refueling are stereopsis (different view to each eye) and head motion parallax (head movement to look around objects). An emerging class of light field displays offers a way to reproduce these cues at suitable fidelity. This paper discusses the requirements for a 5th Generation part task trainer with an emphasis on visual cues. Types and characteristics of different forms of 3D display are discussed with regard to their suitability for use in part task trainers. While it would be highly desirable to have true 3D displays in full-mission simulators, this could be extremely expensive and only useful for certain tasks. A part task trainer with a suitable 3D display could be extremely cost effective for training in such tasks as air-to-air refueling, takeoff and landing (in particular carrier landings), close air support, and extreme low level flight. Display requirements for a part task trainer able to simulate these situations are discussed.

Keywords – part task trainer, single-seat fighter, visual cues, receiver aerial refueling, light field displays

3D VISUALIZATION FOR POINT OF NEED AND CLOUD BASED TRAINING

2017 IITSEC Paper No. 17067

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US Army Modeling, Simulation, and Training (MS&T) is moving toward cloud based solutions to meet the future training needs of the Warfighter. Cloud based solutions will need to provide easily accessible synthetic training tools that will enable soldiers all over the world to train together. The Army is investing in cloud technologies and leveraging research to provide Point of Need (PoN) training services and reduce the cost of deployment and sustainment. This paper captures the lessons learned from a government funded effort to develop an open source light weight cloud based 3D visualization tool for MS&T applications. In addition to looking at broader applications, our effort is specifically targeting needs of the Army's Live Virtual Constructive – Integration and Architecture (LVC-IA) program as a transition target. Our work has resulted in a thin client 3D viewer that runs in a browser and leverages common US Army standards and components for exercise data, terrain, and model data. We will discuss how open solutions and leveraging new government developed technologies can provide a cost-effective solution while still achieving commonality and interoperability. We will discuss the approaches used, such as streaming terrain elevation data, ground surface imagery, and 3D models from cloud based servers to thin client 3D viewers and examine different technologies for rendering a 3D scene in a web browser. We discuss the practical challenges of transitioning this technology to meet cloud requirements of LVC-IA and other Programs of Record. Lessons learned will be presented regarding implementation and fielding of a web based solution into a large, complex training environment.

OPTIMIZATION OF COMPUTER GENERATED THREE DIMENSIONAL MODELS FOR DECREASED LATENCY IN VIRTUAL ENVIRONMENTS

2017 IITSEC Paper No. 17170

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Due to demand for realism and high-fidelity experiences by today's users, rendering virtual environments proves to be a computational challenge for lightweight computing platforms (e.g. mobile devices). Traditional simulated environments typically use as much processing power as available to render the entire scene in high detail, limiting simulations to higher end computers. One approach to optimize processing power for three dimensional models is to use varying, decreased, level of detail (LOD) for distant representations (Sik & Pattanaik, 2011). This research attempts to future optimize resources by expanding the adaptive LOD approach based on the object's location in the field of view (FOV) in addition to the object's distance. Such FOV adaptation would take advantage of state-of-theart head and gaze tracking capabilities. This paper presents results from an initial investigation focused on identifying the minimal LOD that objects can be reduced to before the they become unrecognizable. A simulation was designed that presented randomized sets of objects of various LOD. Subjects were asked to choose an object from the group based on an on-screen prompt. The speed and accuracy of each subject's response was recorded to determine the LOD at which there was no difference in recognition from the full-detail objects. The researchers concluded that the minimum required LOD for recognition without sacrificing speed or accuracy lies between 20% and 80% depending on the shape and distinct features of each object. Specific levels of detail were determined for six objects of different feature complexity to be used in further research studies.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320F

S5 Terrain Modeling

1030
Whole Earth Rendering (17285)

1100
Unearthing the Modeling and Simulation Underground with Voxels (17100)

1130
Terrain Database Correlation Assessment Using an Open Source Tool (17004)

Notes

LARGE AREA HIGH RESOLUTION GEOTYPICAL TERRAIN DECORATION

2017 IITSEC Paper No. 17285

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Complex and large area training scenarios place very challenging requirements on the training and simulation synthetic environment. Terrain texture resolutions are commonly required at 50 centimeters and higher. Correlated 3D feature placement is also a common expectation in today's scenarios. In addition, time-of-day and seasonal variations are also necessary. Often a correlated sensor classification is also required. While high-resolution geospecific aerial-imagery and associated 3D feature-model databases are routinely constructed for given areas of interest, covering the globe or large areas with such data is prohibitively expensive. This paper will explore a method for procedurally synthesizing both high-resolution terrain textures and correlated 3D feature-models over the entire globe while minimizing objectionable repetition patterns.

The set of procedures, algorithms, data structures, and memory-management mechanisms for both off-line preprocessing and run-time processing will be discussed. The set of source data to create the library of generic 2D and correlated 3D feature models will also be explored. Using regions around the globe will allow variety and more geospecific look in the generic textures and 3D feature-models incorporated in the Whole Earth rendering. By using these algorithms with the library of data they can self-repeat for a continuous tiling effect, but are sufficiently large so that even at high training altitudes, very little repetition is discernable. Thus large areas of high resolution terrain with correlated 3D feature placement can be achieved at a relatively low cost. Lastly, this paper will present a mechanism on how to integrate custom geo-specific imagery and geo-specific 3D feature models within the Whole Earth procedural rendering.

UNEARTHING THE MODELING AND SIMULATION UNDERGROUND WITH VOXELS

2017 IITSEC Paper No. 17100

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Adequate representation of underground structures is necessary for modeling and simulation (M&S) applications to provide quality training for both military and civilian use cases. Urban and asymmetric warfare is becoming more predominant, and training applications require technological advances in order to replicate the complexities of these urban environments. Underground roadways, basements, subways, sewer systems, and even subsurface multilevel buildings or garages are examples of the underground elements that play a role in urban and asymmetric warfare. Underground structures are important outside of urban environments as well. Naturally occurring underground features, such as cave systems, present special case challenges to existing synthetic environment algorithms that are tailored around open environments or structured building interiors. Given the prominence of aerial bombing to prepare for a ground invasion, complex military infrastructure will increasingly be found underground in bunkers or cave systems. In urban environments, infrastructure such as power, water, internet, and sewage, are already primarily underground, and require modeling to realistically replicate the urban battlespace. Simulations that include underground environments need to consider environmental effects, infrastructure interruptions, propagation of smoke and sound, fire propagation, and ventilation. This paper discusses an approach for representing and dynamically manipulating complex underground environments, both natural and man-made. The approach uses voxelization techniques found in modern game engines, movies, and medical imaging systems. The voxelized data for soil and structures is subdivided into chunks and organized into variations of B+ trees for efficient access and storage. Smooth-mesh algorithms analyze the voxel data and generate meshes for rendering and navigation mesh generation. We describe and propose an architecture for providing underground capabilities to existing and future simulation systems in a distributed fashion. Within this architecture, we also define functional components that will be modularized in order to take advantage of cloud computing technologies.

TERRAIN DATABASE CORRELATION ASSESSMENT USING AN OPEN SOURCE TOOL

2017 IITSEC Paper No. 17004

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Configuring networked simulators for training military teams in a distributed environment requires the usage of a set of terrain databases to represent the same training area. The results of simulation exercises can be degraded if the terrain databases are poorly correlated. A number of methodologies for determining the correlation between terrain databases have been developed, by both government and industry, aiming at Verification, Validation & Accreditation of distributed simulations involving different simulators. However, there are few computational tools for this task and most of them were developed to address government needs, have limited availability, and handle specific digital formats. The goal of this paper is thus to present a novel open source tool developed as part of an academic research project. This tool analyzes a pair of terrain databases generating numeric data suitable for statistical analysis, as well as identifies specific areas where correlation may be an issue by using a configurable threshold. The analysis takes into consideration line-of-sight correlation differences between the databases. The sample size and characteristics of the line-of-sight tests, for instance elevation and azimuth, are selectable via a graphical user interface which also provides a 3D visualization of the terrain databases. Being open source, programmers may add more capabilities to the tool, such as including support to more digital formats or implementing new software methods to measure the correlation between terrain databases. Plans for extending the tool's capabilities and its possible utilizations are also included herein.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320B

S6 Non-Traditional Aspects of Military Simultion

1400
Modeling Underwater Communications in Live, Virtual and Constructive Environments (17295)

1430
A Study on the Effectiveness of Virtual and Constructive Interface Simulation (17114)

1500
A Large Scale Correlated Dynamic Weather Simulation Service (17308)

Notes

MODELING UNDERWATER COMMUNICATIONS IN LIVE, VIRTUAL AND CONSTRUCTIVE ENVIRONMENTS

2017 IITSEC Paper No. 17295

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Underwater communication networks (UCN) are enablers of current and future military and commercial applications involving undersea exploration, monitoring, and surveillance. Unmanned Underwater Vehicles (UUVs) hold promise for stealthy low-cost surveillance, particularly in areas where manned undersea platforms cannot be easily deployed, operated, and maintained. Aiming to extend the operational lifetime of UUVs, underwater hubs are being developed for charging UUVs and exfiltrating data from UUVs. As the number and heterogeneity of undersea platforms and infrastructure expected to operate in concert continuous to increase, command, control and coordination of undersea platforms, and timely and secure transfer of data become increasingly important.

UCNs face an inherently disconnected, interrupted and low-bandwidth operational environment and often require specialized protocols for supporting reliable transfer of data. Furthermore, different communication technologies being considered for undersea applications, such as acoustic, optical, and RF communications, have different, yet complementary, characteristics in terms of propagation delay, communication range, and bandwidth. Characterization of the performance of a UCN is critical to avoid unexpected operational disruptions. Yet, in-water experimentation is restrictive and costly, and often cannot be performed in an environment similar to where the UCN deployment is planned. Network modeling and simulation tools offer a low cost alternative for characterizing the performance of a UCN. Unfortunately, most commercially available network simulators designed for modeling wired and RF-based wireless networks are not well suited for modeling UCNs.

This paper describes UCN-X, a scalable UCNs simulator that can be used to investigate real-time underwater command and control, data transfer and exfiltration. UCN-X leverages parallel discrete-event model execution and system-in-the-loop interfaces from EXata, to provide a scalable, live, virtual, constructive (LVC) UCN simulator that can interface with live modems and mission operation and management software applications. UCN-X captures undersea signal propagation effects obtained based on the characteristics of the undersea propagation environment and a diverse set of protocol models at all layers of the communication stack. It additionally includes store-andforward protocol, data muling, and air/water gateway node models. To support its use within a system-of-system context, UCN-X can be federated with other simulators including force-force training environments to provide realistic undersea communication modeling. UCN-X can also be interfaced with live and unmodified UUV command-and-control (C2) software. By providing a realistic representation of the dynamic network performance under realistic operating conditions, such a federated model provides a rich and extensible training capability for both military and commercial applications.

A STUDY ON THE EFFECTIVENESS OF VIRTUAL AND CONSTRUCTIVE INTERFACE SIMULATION

2017 IITSEC Paper No. 17114

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Recently, considerable number of real world problems in ROKN(Republic Of Korea Navy) has been solved by simply relying on the scenarios and algorithms implemented in Constructive model. However, the need for new measures of analysis is in demand to accommodate the increasingly specific and heightened reliability expectations of operating forces. The ROKN is planning to acquire a LVC(Live•Virtual•Constructive) based warfighting experiment system to flagship the combat force development through complicated future defense environment. It will serve as an alternative to present problem analysis and solutions. In this study, we try to confirm the necessity and feasibility of establishing the warfighting experiment system through an interface experiment between ROKN Anti-submarine aircraft simulator(V) and Anti-submarine operational effectiveness analysis model(C). A Broker SW applied with HLA/RTI international standard was developed to conduct the interoperability. As a result, current Anti-submarine operational effectiveness analysis model(C) which is limited to engagement level analysis, was enhanced through interfacing with the weapon systems level analysis of Anti-submarine aircraft simulator(V). Furthermore, by calculating the analysis result which contains the human factor and various external factors in weapon systems level analysis, the V-C interface warfighting experiment is confirmed to increase the reliability of operations analysis. The result of this study is expected to be a foundation for a more reliable simulation analysis and be utilized as a valuable data for establishing naval warfighting experiment systems.

A LARGE SCALE CORRELATED DYNAMIC WEATHER SIMULATION SERVICE

2017 IITSEC Paper No. 17308

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Providing suitable weather conditions is important in the conduct of simulations for domains as diverse as individual and distributed training; analysis & experimentation; research, design & development; virtual test & evaluation; and mission planning & rehearsal. Despite this importance, it has typically been difficult or impossible to create realistic, dynamic, correlated large scale weather environments – simulations typically operate in a static, overly simplified environment, or use a single snapshot of real weather data.

This paper describes an innovative virtual weather service which can be used to create realistic and consistent weather environments. These environments can replicate historical or current forecast weather conditions and events, or simply provide dynamically changing conditions over a basic standard atmosphere model. The weather service is able to provide dynamic, correlated atmospheric, ground and ocean conditions with global coverage over long timeframes to many simultaneous end users via industry standard web protocols, through an application programming interface, or via a simple web service.

The paper will briefly survey the history of weather simulation, then present and discuss the requirements used to drive the development of the weather service. The paper will provide background on the architecture, components and data requirements of the service; describe the interfaces and present sample integrations with client applications; and provide performance measurements in terms of throughput, processing time and storage requirements. The paper will conclude with a review of opportunities for further work and thoughts on the standardization of weather data exchange.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320F

S6 LVC in a Distributed Environment

1400	1430	1500
Virtualization: Navy Continuous Training Environment Approach to Cloud Enabling Technologies (17289)	Performance Measurement in LVC Distributed Simulations: Lessons from OBW (17207)	NATO Initiative in Multi-national Mission Training through Distributed Simulation (17200)

Notes

VIRTUALIZATION: NAVY CONTINUOUS TRAINING ENVIRONMENT APPROACH TO CLOUD ENABLING TECHNOLOGIES

2017 IITSEC Paper No. 17289

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The Navy Continuous Training Environment (NCTE) was designated a Navy Enterprise Network on 20 OCT 2014. NCTE was growing in size and complexity (e.g., by April 2015, over 50 nodes worldwide and ~650 servers), which prompted the need for enterprise standardization and reduction in infrastructure management requirements. In 2010, the Secretary of Defense directed IT infrastructure consolidation to achieve cost savings, improve DoD mission execution and defend against cyber threats. The Core Data Center Reference Architecture (2012) categorized DoD computing and data storage facilities into four types: Core Data Centers (CDC), Installation Processing Nodes (IPN), Special Purpose Processing Nodes (SPPN), and Tactical/Mobile Processing Nodes (TPN). After declaring NCTE nodes SPPN, the Navy Enterprise Information Governance Board (NEIGB) requested a report on NCTE data center efficiency initiatives. This paper reports on 1) the NCTE SPPN efficiency analysis; 2) the challenges NCTE faced in complying with the DoD mandate to implement cloud-enabling technologies wherever practical; and 3) the team's approach toward creating an architecture that enables NCTE to support cloud services. The analysis investigated hardware/software efficiencies, operational efficiencies, and implications of adopting alternative life cycle strategies. NCTE supports over 100 distributed Fleet Synthetic Training (FST) events and other afloat and ashore events and experiments annually, thus intensifying the interest in decreasing infrastructure footprint and providing a more flexible, scalable architecture. The effort produced some interesting observations; some expected, others somewhat a surprise. First - Review of the data suggests that efficiencies were achieved across the NCTE SPPN data centers, albeit not necessarily capital expenditure- related. Second – use of Virtualized Desktop Infrastructure (VDI) appears to improve return on investment (ROI). Third - Geographically dispersed servers and C4I systems limit the virtualized server reduction ratio. Finally, new technology advances bring about new challenges in sustaining a continuing ROI.

PERFORMANCE MEASUREMENT IN LVC DISTRIBUTED SIMULATIONS: LESSONS FROM OBW

2017 IITSEC Paper No. 17207

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Operation Blended Warrior (OBW) 2016 marked the second year of a three-year effort to document lessons learned and understand barriers to implementing Live, Virtual, Constructive (LVC) distributed training. In the first year of the event, LVC focus areas included connectivity, interoperability, data standards, after-action review, and cyber security. Year two introduced additional focus areas: multi-level security, cross domain solutions, long-haul feeds, and performance measurement. This paper focuses on this latter area—defining and collecting performance measures. Performance measurement in simulation-based training faces formidable obstacles, including the identification of individual and collective performance dimensions, how these dimensions relate to training goals, and how training transfers to operational readiness. Blending of LVC elements introduces additional complexity, not only for human performance assessment but also for evaluating the effectiveness and efficiency of the technical system. In this paper, we present the measures defined and collected during OBW in four primary areas: 1) cost analysis, 2) network performance, 3) trainee performance, and 4) whether OBW met the expectations of participating organizations. We also discuss three categories of Measures of Effectiveness (MoEs) and Measures of Performance (MoPs) established by the OBW Strategic Integrated Product Team: Programmatic, Technological, and Learning. These MoEs and MoPs will facilitate annual comparisons of performance measurement at OBW and encourage use of the event as a sandbox to design and validate LVC performance measurement tools. Finally, we present the goals and measures established for Performance Measurement during OBW 2017 and recommendations for future events.

NATO INITIATIVE IN MULTI-NATIONAL MISSION TRAINING THROUGH DISTRIBUTED SIMULATION

2017 IITSEC Paper No. 17200

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NATO and nations face challenges regarding live training and exercises. Current and future operations are multinational in nature, the missions and the systems are becoming more complex and need detailed preparation. Furthermore rapid adaptation to changing circumstances is needed. At the same time opportunities for live training and mission preparation are reduced due to less available resources, more peacetime restrictions and limited time span between political decision making and deployment. Mission Training through Distributed Simulation (MTDS) presents a solution to these challenges and is therefore crucial to NATO and nations' mission readiness. Despite a number of initiatives in the past to set up a NATO MTDS capability, currently NATO does not have a standing operational MTDS capability.

In October 2013 the NATO task group MSG-128 was set up with the objective to establish essential elements for a permanent NATO MTDS capability for air operations and validate these elements through initial operational exercises and evaluation. The approach of MSG-128 is two-fold: 1. Define a concept of operations and reference architecture for a permanent MTDS infrastructure for air operations, including architectural requirements for integration of live components (connected flying platforms) in the MTDS architecture 2. Build the MTDS environment incrementally by executing a yearly MTDS exercise The MSG-128 concludes its work with a 4th exercise in March 2017. This exercise proves that realistic combined mission training for fighter pilots and controllers can be achieved in the initial NATO MTDS capability.

This paper describes the concept of operations and initial MTDS environment that provide NATO and nations already with a current capability to conduct realistic multi-national training for air operations. The paper concludes with a path for future growth towards an effective persistent LVC environment for air operations training which is defined by the reference architecture and the requirements for integrating live flying assets.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320B

S8 Threats and Scenarios

1600	1630	1700
Generative Representation of Synthetic Threat Actors for Simulation and Training (17140)	Simulation of Non-Combatant Population Movement in Battlespace (17214)	Testing and Training Convergence – Common Scenario Generation Requirements and Solutions (17129)

Notes

GENERATIVE REPRESENTATION OF SYNTHETIC THREAT ACTORS FOR SIMULATION AND TRAINING

2017 IITSEC Paper No. 17140

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In this paper we describe a generalized and generative synthetic threat actor (SynthActor) modeling capability as currently implemented in the Web Ontology Language (OWL 2). SynthActor is general in the sense that it readily supports representation and reasoning about threat actors at any level of aggregation (individuals, groups and nation states) and for any domain of aggression (kinetic, cyber, insurgency, and asymmetric warfare). SynthActor is generative in the sense that it can automatically respond to simulated or hypothesized conflict situations with behaviors that are consistent with previously specified threat actor world views and technical/aggression capabilities. Threat actor world views are represented in SynthActor as cultural sub-models reflecting the belief systems of the actor (social, political and theological). Threat actor technical/aggression capabilities are represented in SynthActor as knowledge/skill properties of the actor (chemical, nuclear, explosives, cyber and melee). SynthActor enables modeling of threat individuals and groups as active and engaged entities which respond to changing situations, prosecute an agenda, define operational goals, and execute operations to achieve those goals. Violent threat actor properties, as modeled in SynthActor, are aligned with the Multilateral Interoperability Program (MIP) and its Information Model (MIM). MIM modeling enables automated machine sharing of information about violent threat actors and activities. Cyber threat actor properties, as modeled in SynthActor, are aligned with the Department of Homeland Security's Structured Threat Information Expression (STIX) modeling language. STIX modeling enables automated machine sharing of information about cyber threat actors and activities. SynthActor, with MIM and STIX language extensions, enables automated machine derivation and sharing of detailed information about realistically unfolding threat actor campaigns in adversarial simulation environments.

SIMULATION OF NON-COMBATANT POPULATION MOVEMENT IN THE BATTLESPACE

2017 IITSEC Paper No. 17214

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The risk of adversaries instigating mass human migration, refugee flows and crowd formations in the battlespace1 requires mitigation because unexpected population movements can adversely impact the United States and partners' freedom of operations abroad. As well, Information operations and physical events initiated by operations in an area may result in population activity patterns (second and third order effects/events). Even relatively small gatherings of non-combatants, especially at urban choke points can have repercussions impacting military operations which rely on predictable traffic flow on roads and infrastructure. Simulation in the field of Pattern of Life Analytics (PoLA) is critically important to the military because it may lead to improvements in predicting patterns of movement and other behaviors that are realistic, reliable, and repeatable among non-military populations. There is insufficient modeling of the political, economic and social conditions within the operational environment (OE) and their effects on combatants and noncombatants. Meanwhile, emerging connected device tracking technologies provide rich new data sources required to assess ongoing patterns of life activity levels (traffic patterns, work, shopping, pedestrian flow, refugee movement, crowd gatherings and so on). This paper describes a technique for representing migration of a civilian population in a way that is amenable to computation (i.e., simulation). The model firmly rooted in social science principles for: a) establishing a baseline of population location data, b) calculating populace mood changes based upon Political, Military, Economic, Social, Infrastructure, Information, Physical Environment, and Time (PMESII-PT) interventions, and c) forecasting timing and size of refugee flows and direction of their movements to, d) further model their external migration in Athena. As a result, the military decision makers can understand PMESII-PT impacts of non-combatant population movement in the battlespace. Lessons learned from this work could be used to simulate and predict non-combatant movement and identify potential impacts in the OE.

TESTING AND TRAINING CONVERGENCE – COMMON SCENARIO GENERATION REQUIREMENTS AND SOLUTIONS

2017 IITSEC Paper No. 17129

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Scenario generation for simulation-enabled environments (particularly for events with integrated mission command systems and networks) is a time-intensive, complicated task involving many data sources and a variety of tools. Historically, the testing and training communities have created and maintained separate scenario generation and database population capabilities to meet their specific test requirements. The absence of collaborated solutions is commonly due to unproven assumptions that scenario requirements between the two communities are vastly dissimilar. The Army Operational Test Command (OTC) is committed to investing in and employing common testingtraining solutions to the maximum practical extent. Thus, the command conducted an analysis of scenario generation capabilities in 2016, to explore the potential for cross-community solutions. Additionally, OTC has launched a major test technology investment, the Integrated Live-Virtual-Constructive (LVC) Test Environment (ILTE) program, with a charter to establish and fund common test and training capabilities.

OTC's initial analysis focused on the testing of intelligence, surveillance, and reconnaissance (ISR) sensor platforms and information systems. OTC performed this analysis to inform a decision on replacing or updating its Intelligence Modeling and Simulation for Evaluation (IMASE) Scenario Generation Tool (ISGT). ISGT, developed and used by OTC since 2007, has become unsupportable based on cost and evolving data requirements. OTC sought a common, cross-community solution that could replace ISGT as well as address broader simulation-mission command environments. This paper describes the development of scenario generation requirements using ISGT as an initial basis, and then compares those requirements with scenario generation capabilities employed by the training community. These tools include the Exercise Design Tool (EDT), Web Military Scenario Development Environment (WebMSDE), Intelligence and Electronic Warfare Tactical Proficiency Trainer (IEWTPT), and Joint Training Data Services (JTDS). No single scenario generation tool (to include SGT) met all ISR test requirements. However, the analysis revealed that a combination of training community tools (with some tool augmentation) could support all necessary scenario generation processes for ISR testing as well as broader T&E and training applications. As a result, OTC has begun acquisition and implementation of those capabilities.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320F

S9 Applying Simulation for Readiness

1600
High-fidelity Surgical Fasciotomy Simulator for Training Special Operations Medics (17087)

1630
Modeling Combat Aircraft Training and Readiness (17149)

1700
Leverage the Training Effect in Staff Training by Automated Reporting (17133)

Notes

HIGH-FIDELITY SURGICAL FASCIOTOMY SIMULATOR FOR TRAINING SPECIAL OPERATIONS MEDICS

2017 IITSEC Paper No. 17087

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Fascia, a fibrous connective tissue, is responsible for allocating skeletal muscles and corresponding neurovasculature into function-based compartments. Pressure is capable of accumulating within these compartments, initiating the onset of a condition commonly referred to as compartment syndrome. When the pressure within the compartment compromises the arterial supply, it prevents perfusion of oxygen into the surrounding tissues, leading to tissue necrosis, or tissue death. Once diagnosed, a fasciotomy must be performed immediately to prevent severe complications. A recent study evaluated the incidence of fasciotomies performed during Operations Enduring Freedom and Iraqi Freedom and found that of 4,332 casualties to the extremities, 669 (15%) underwent a fasciotomy. According to the Joint Special Operations Medical Training Center (JSOMTC), the current training methods are insufficient for practicing the surgical technique, while other methods, such as cadaveric and live tissue training, are cost-prohibitive for the number of students that require annual training. The U.S. Army Research Laboratory Human Research and Engineering Directorate Advanced Training and Simulation Division (ARL HRED ATSD) identified the requirement to develop a next-generation lower extremity fasciotomy Part-Task Trainer (PTT) in response to JSOMTC's need for a more realistic, durable, and cost-effective training approach. The paper will describe the research conducted to satisfy these requirements, including identifying, developing, and validating the essential anatomy and physiology required to provide a realistic and effective next-generation surgical PTT. Additionally, the paper will explore how innovations in novel synthetic materials provided realism approaching traditional methods while greatly minimizing cost and maximizing training opportunities.

Key words: Fasciotomy, simulation, part-task trainer, lower extremity, compartment syndrome

MODELING COMBAT AIRCRAFT TRAINING AND READINESS

2017 IITSEC Paper No. 17149

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The simulation of combat aircraft operations has been evolving for over thirty years, with myriad applications, ranging from optimizing aircraft maintenance policies to predicting a developmental aircraft's combat reliability. The problem asks the modeler to represent multiple, independent aircraft—sometimes operating from different bases—and the required aircraft maintenance that follows each flight.

Methods vary in their complexity, but most have measured success in terms of total sorties generated or flight hours flown. In other words, all sorties are considered equally valuable. While this assumption has some applications, a combat squadron spends most of its time and resources on advanced training (or, "workup") for combat, which requires pilots to execute a defined sequence of training events. Success, in other words, requires more than simply generating a sortie; the squadron must generate a sortie, with the right pilot, flying the right event, at the right time. This presents a dilemma: some sorties have more training value than others, but they all incur the same maintenance cost. Squadron leaders manage this dilemma through policies and priorities that seek to optimize training and minimize maintenance. Complicating matters are pilot turnover and resources that are shared between multiple squadrons.

This paper examines the squadron workup process within the requirements and constraints of the Marine Corps F/A-18 Hornet community—a particularly complex case. The model makes significant additions to previous successful models by adding the event dependency that characterizes the workup process, as well as an agent-based element that incorporates the priorities made by the squadron leadership. The model is driven by and evaluated against ten years of detailed flight, failure, and maintenance statistics, and offers the ability to more accurately evaluate the effects of management priorities, resource allocations, and policy decisions—such as the rate of pilot turnover—at the squadron level and higher.

LEVERAGE THE TRAINING EFFECT IN STAFF TRAINING BY AUTOMATED REPORTING

2017 IITSEC Paper No. 17133

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This paper describes a concept and initial experiments regarding modelling and simulation as a service (MSaaS) for semi-automatic production of reports in computer assisted command post exercises (CAX).

Timely and accurate information is a critical resource in decision-making. In a wartime situation information is provided to a military staff by its subordinates. In training and mission rehearsal situations, real subordinates are often not present. The lower command is acted by a small group of personnel, whose major role, in a training situation, is to create the human to human interaction with the superior command in the staff. Adequate tools for supporting this staff is crucial, since high workload and competency requirements set constraints on the amount of information objects as well as quality of the products produced, in this case produced reports. Computerized systems play an important role to fulfill this need.

The aim has been to develop a tool for report generation as a service, independent of what simulation system used, in a way that the tool can generate reliable and believable textual reports as if they were produced by a human-manned staff, both in terms of their quality and quantity. Today several services, such as simulation systems for computer generated forces, are networked together in an information sharing federation. The prototype for the report generation service uses information from the federation and produces textual reports about the situations and activities in the simulated environment. These reports are expressed using standard formats and are to be automatically fed into the command and control system used by the trained staff.

Initial experiments at a staff exercise demonstrate validity and usefulness of the concept. The paper discusses methodological and technical requirements, such as information needed, additional federated services, and requirements on simulation systems, and points out important issues for further investigation.

THURSDAY, 30 NOVEMBER, 2017 ROOM S320B

S10 Information and Data Management

0830	0900	0930
Army Training Data Management Using a Product Line Approach (17093)	Information Management: A Core Enabler of the MSaaS Ecosystem (17061)	Operational Data to Stimulate Simulation Systems and Enhance Training (17107)

Notes

ARMY TRAINING DATA MANAGEMENT USING A PRODUCT LINE APPROACH

2017 IITSEC Paper No. 17093

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The Program Executive Office for Simulation, Training & Instrumentation (PEO STRI) Project Manager Integrated Training Environment (PM ITE) fields a wide variety of virtual, constructive, and gaming (VCG) simulations, that operate both in stand-alone and integrated modes. As with most simulations systems, these VCG simulations are largely data driven—both in data that is engineered into the capabilities when they are delivered (e.g., equipment characteristics), and data that is developed for use of these systems (e.g., terrain and scenarios). Although there is a great amount of overlap in the data these systems require and manage, each has its own data management capabilities (e.g., scenario generation). In addition to the stand-alone data management capabilities for these VCG simulations, there are separate capabilities for federations in which these VCG simulations are integrated.

PM ITE conducted an analysis of a subset of the current data management capabilities, specifically those integrated via the LVC Integrating Architecture (LVC-IA), and then developed a proposed architecture and transition strategy for how data management could be conducted in a more efficient and effective manner, with improved data quality. This paper describes the "as-is" analysis of the data management capabilities and identifies the common requirements and overlapping capabilities. It then presents the proposed "to-be" architecture. This "to-be" architecture aligns with the newly adopted ITE software product line methodology, in which shared assets are identified, managed, and incorporated into multiple products. In the case of data management, these shared assets are not only software, but encompass data exchange agreements, common requirements, common architecture design, and data interchange formats. Although the analysis described in this paper focused on a subset of the systems in the ITE, the analysis approach and many of the architectural recommendations are applicable to the full range of the ITE portfolio, and to other Army, Service, and even national capabilities for simulation data management.

INFORMATION MANAGEMENT: A CORE ENABLER OF THE MSAAS ECOSYSTEM

2017 IITSEC Paper No. 17061

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The concept of Modelling and Simulation as a Service (MSaaS) has been a topic of investigation for the global modelling and simulation community in recent years, due to the potential it offers for the delivery of flexible, modular simulations in which services and resources can be re-used to deliver many different applications. Rapid reconfiguration of existing resources to provide new capability has value to many different simulation stakeholders, and service-oriented architectures offer a novel approach to achieving this goal.

In order to deliver the MSaaS vision, a move to a new architecture is required in which individual simulation services and resources exist independently and are used to compose a wide range of simulation systems. This type of architecture delivers an ecosystem. A core enabling technology for the implementation of an MSaaS ecosystem is a comprehensive and flexible information model underpinning all participation by services, resources and human actors. This information model must support and enable many different types of components in accordance with many different standards in order achieve the required levels of interoperability and re-use.

This paper presents a high-level, implementation-independent approach to information management for MSaaS, based on a developed multi-layered information model. This model contains an information layer, defining the information and data that exist within the ecosystem, a metadata layer, and a registry layer, which defines a structure for a searchable registry in which data and metadata, and their associations, are catalogued and managed. The paper then specifies how and why this type of approach to information management is a pre-requisite for achieving all of the benefits that MSaaS has to offer.

OPERATIONAL DATA TO STIMULATE SIMULATION SYSTEMS AND ENHANCE TRAINING

2017 IITSEC Paper No. 17107

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For years, the use of simulation by smaller countries has been marked by the saying, “it is very expensive to be poor.” In contrast to the larger coalition partners or the budgets of a potential adversary, smaller countries have fractional military budgets; this makes it difficult to acquire the same assets as larger partners. When it comes to training, the utility of simulation is acknowledged, but spending, particularly in smaller countries, is often appropriately prioritized elsewhere. This leads to an approach where simulation is expected to alleviate training constraints, but must do it from a fixed amount of limited funds. Though this approach results in an inherent drawback based on the amount of resources used to setup and execute the training as well as to connect virtual / constructive simulation models to existing Command and Control (C2) systems. This requires trained technicians, and trained support personnel, all of which can exceed the number of personnel in the training audience.

This support staff-heavy model can be changed. This paper will describe techniques to utilize existing data previously generated by the training audience to enhance their training potential, while actually minimizing the amount of support personnel required for a training instance. It will additionally describe a recent use case where the Danish Army, during a military demonstration and assessment, tested the first steps in merging the C2 real world with simulation, going from live to virtual and back. Although not fully scaled, it showed how to merge live and virtual in a cost effective way. Executed successfully and at a larger scale, similar techniques will lead to a future where information flows freely between tactical C2 systems and virtual/constructive simulation models. This will create better, more affordable, solution-focused training that will benefit future soldiers in a practical and measurable way.

THURSDAY, 30 NOVEMBER, 2017 ROOM S320B

S11 Test and Analysis

1030
Discrete Event Logistics System Model: Calculating Simulator Remaining Useful Life (17154)

1100
Using Business Technologies to Cut Simulation Support Costs (17031)

1130
LVC Environment to Support System-of-System Cyber Testing (17094)

Notes

DISCRETE EVENT LOGISTICS SYSTEM MODEL: CALCULATING SIMULATOR REMAINING USEFUL LIFE

2017 IITSEC Paper No. 17154

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The US Army formally announced in 2015 that less funding will be applied to the development of new simulators and that the sustainment of the existing systems will need to be extended further. This decision made urgent the need for the development of a practical Discrete Event Logistic System (DELS) model to calculate remaining useful life for simulators and their subordinate components. As an initial approach, a two phased Remaining Useful Life (RUL) calculation using a DELS framework based upon single point failure analysis was developed. However, the premise for the two step RUL calculation is based upon having a prognostic health management (PHM) system in place to support condition based maintenance activities. This paper discusses and implements modifications to the two step RUL calculation to fit the current US Army fielded Training Aids, Devices, Simulators, and Simulations (TADSS). Multiple domain specific variables are introduced such as utilizing inherent system availability to identify the simulator's initial point of failure in place of an arbitrary selection in remaining useful life calculation (RUL1). Failures-In-Time (FIT) are identified using work orders in the maintenance management component of the Integrated Logistics System to identify achieved system availability utilized in updating the second remaining useful life calculation (RUL2). Introduction of a Rate of Occurrence of Failure (ROCOF) methodology accommodates for the lack of available system utilization data by basing simulator utilization on contracted scheduled training hours. In introducing the ROCOF methodology, a time based Non-Homogeneous Poisson Process (NHPP) is used to describe the distribution of failures. The modifications defined in this model supports the military's objective to continue delivery of world class simulation systems beyond its planned lifecycle by deploying a dynamic discrete event logistics system.

USING BUSINESS TECHNOLOGIES TO CUT SIMULATION SUPPORT COSTS

2017 IITSEC Paper No. 17031

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The use of simulation to achieve training and test and evaluation goals requires technical support staff to execute complex processes and complicated, labor-intensive activities. The need for support increases as the Army interoperates live, virtual, and constructive simulations together.

Program Executive Office for Simulation, Training, and Instrumentation (PEO STRI) developed an enterprise architecture, the Live-Synthetic, Training, and Test and Evaluation Enterprise Architecture (LSTTE EA). One of the goals of this enterprise architecture was to allow stakeholders from the training and test & evaluation communities to manage the linkages between the Technical Reference Architecture (TRA), business processes and governance structures and to facilitate discussions within the Modeling and Simulation (M&S) community. Toward that end, PEO STRI developed a Proof-of-Concept (PoC) software implementation of the LSTTE EA technical reference architecture, also known as the LSTTE Infrastructure Architecture (LSTTE IA). This paper describes our use of Infrastructure as Code (IaC) and business process modeling in the PoC implementation of the TRA, and how it reduces the need for technical support and expertise. We give an overview of the LSTTE EA and the LSTTE IA and a detailed explanation of the framework that includes the IaC and the business process modeling. Using this approach, we can capture processes and automate the execution of tasks today performed by "touch" labor and technical experts. This is not to say we eliminate all human tasks. Certain tasks require direct human decisions or input and are not fully automatable. In our experience, these decisions are generally operational in nature and do not call for great technical expertise in the underlying training simulation systems. The paper presents a comparison of the technical support and expertise needed to conduct training today and how the PoC reduces the need for this technical support and expertise, thereby also reducing cost.

LVC ENVIRONMENT TO SUPPORT SYSTEM-OF-SYSTEM CYBER TESTING

2017 IITSEC Paper No. 17094

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Much of the cyber simulation investment has been focused on the training community. The goal of the cyber training environments is to present the training audience with the effects of cyber-attacks. This is often done by white carding the effects or by using simulations to model the effects. This approach does not work well for testing cyber-attacks against systems. Testing requires actual cyber-attacks. Penetration testing is performed against individual systems and can be used to find many attack surfaces. However, another set of attack vectors can be uncovered when the systems are operated in an operationally realistic environment. Creating a cyber systems-of-systems test environment requires simulation of multiple data feeds to the systems under test. These data feeds must be consistent with each other and at the correct scale to provide a realistic load on the system. This can be done with a mixture of tactical systems and simulations. The other challenge is to establish networks and processes that allow the introduction of live cyber-attacks. A group of organizations located at Redstone Arsenal teamed together to create an environment for cyber testing systems developed by the team using a LVC distributed systems-of-systems approach. This required creating a set of processes to allow collaboration across the different organizations to document and plan the cyber test activities. The organizations had to standup a new network that allowed for the introduction of cyber-attacks. Additionally, the team integrated a set of simulations to stimulate the systems under test with the required tactical information exchanges. To prove out the concept the organizations created a verification event to test the environment. This paper will document the challenges and solutions the team encountered in the development of the test environment as well as the results from the event.

THURSDAY, 30 NOVEMBER, 2017 ROOM S320B

S12 Standards and Networks

1330	1400	1430
Quality of Service for Distributed Simulation Environments (17278)	Compressed DIS (17074)	Establishing a HLA Certification Process in NATO (17058)

Notes

QUALITY OF SERVICE FOR DISTRIBUTED SIMULATION ENVIRONMENTS

2017 IITSEC Paper No. 17278

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This paper summarizes discoveries and remedies of simulation protocol data loss across the Battle Lab Collaborative Simulation Environment (BLCSE) Wide Area Network (WAN). The use case for a network supporting large-scale constructive simulation, combined with other traffic, carries special requirements outside the typical boundaries for normal systems administration of a WAN. Understanding the challenges and solutions involved is certainly not mundane. Simulation data losses in excess of 1% can impose compounded causal effects that will easily jeopardize the analytical benefit of an experiment. The possibility of data loss must be vigilantly monitored and vigorously interdicted. One root cause of packet loss is network congestion. Congestion occurs at chokepoints, which exist in nearly all network topologies where a number of hosts on a local network aim to connect to resources at remote destinations via a shared infrastructure. Another, unanticipated cause of loss is technology integration conflict, based on original design assumptions. Finally a more surprising and insidious cause is the burstiness of simulation traffic in which High Level Architecture (HLA) packet loss occurs at utilization levels far below the bandwidth threshold (i. e. without congestion). Over time, the approach of the Cyber Enterprise Support Center (CESC) and Army Capabilities Integration Center (ARCIC)/Joint Modeling and Simulation Divisions' (JAMSD) management of the BLCSE network has evolved from reaction, to monitoring, to deliberate stimulation and most recently to the intentional, governing configuration and application of the Cisco IOS Quality of Service (QoS) technology. The hard-felt experiences of the BLCSE community, as well as the powerful off-the-shelf and custom technologies used will provide a tremendous value to the greater modeling and simulation community, and should be seriously considered for other wide-area simulation environments.

COMPRESSED DIS

2017 IITSEC Paper No. 17074

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Radio Frequency (RF) networks have a limited bandwidth compared to landlines. Therefore, when operating over RF, it is desirable to use the available bandwidth with the greatest efficiency possible. The Compressed Distributed Interactive Simulation (C-DIS) standard developed by the Air Force Research Laboratory (AFRL) is a compressedformat version of the IEEE 1278.1-2012 Distributed Interactive Simulation (DIS) standard that significantly increases transmission efficiency. It is a government owned, non-proprietary standard. C-DIS is a bit-oriented data standard that reduces the size of DIS packets by 50-to-70 percent, effectively more than doubling the bandwidth of a network. The C-DIS standard will be used on the 5G-Advanced Training Waveform (5G-ATW) RF network as part of the Secure Live Virtual Constructive Advanced Training Environment (SLATE) Advanced Technology Demonstration (ATD).

C-DIS maintains all of the currently used DIS Protocol Data Unit (PDU) fields, concepts, approaches and enumerations, making translation from DIS to C-DIS and from C-DIS back to DIS efficient and accurate. It is intended to be used as a transport-level compression that allows DIS data to be readily compressed by transmitters and decompressed by receivers. C-DIS supports current standard SISO and CAF DMO enumerations and values and allows for future enumeration growth.

In addition to standard DIS messages, C-DIS also supports compression of the CAF DMO-defined messages used for Active Electronically Steered Antenna (AESA) Radars and Advanced Jammers. These messages include the Radar Track Report, Jammer Report Record, and Jammer False Targets Record. This enables the modeling of Electronic Attack and Jamming over the limited bandwidth RF network available for Live Virtual Constructive operations.

This paper discusses C-DIS compression techniques, message formats, usage rules, and performance results.

ESTABLISHING A HLA CERTIFICATION PROCESS IN NATO

2017 IITSEC Paper No. 17058

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NATO relies on standards and agreements. Especially in distributed simulation, standards are evident e.g., AMSP01, NETN FAFD, STANAG 4603 and many more. There had been the HLA Federation Compliance Test Tool (FCTT), provided by the USA, but since 2004 there were no more updates available. The NATO Exploratory Team (ET-035) concluded in 2014 that HLA compliance testing is still important and that it needs to be extended beyond the HLA interface and data exchange testing and to address more complex federation agreements and requirements. In conjunction to the development of a new certification tool there is a need to maintain and update the NETN FAFD, as well. The NATO Modeling & Group (MSG-134) began its work in October 2015 and will deliver an Integration, Verification and Certification Tool (IVCT), a Concept of Operation and an updated NETN FAFD in October 2017. During the development of the open source tool, it will be tested in a real use-case of CWIX 2017 at JFTC, in June 2017. The expectation is the broad use of IVCT in NATO and on national level in the procurement process of simulators and by industry during the development process of simulators. Testing and certifying of systems and issuing badges (according on the requirements) will result in an increased interoperability of simulators in distributed networked simulation systems.

TUESDAY, 28 NOVEMBER, 2017 ROOM S320E

T1 Optimizing Team Performance

1400	1430	1500
Increasing Cognitive Readiness in Joint Command Battle Staffs (17048)	Assessment Instruments in Support of Marine Instructor Development (17180)	Systematic Team Assessment Readiness Training: Live, Virtual, Constructive Distributed Missions (17229)

Notes

INCREASING COGNITIVE READINESS IN JOINT COMMAND BATTLE STAFFS

2017 IITSEC Paper No. 17048

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This paper builds on the three year research and development project for Joint Continuum of eLearning (Fautua et al, 2014) and discusses the Joint Staff J-7's (Joint Training) initial effort last year to develop measures and assessments of cognitive performance among cross-functional staffs and planning teams in Joint Force Commands (Reist et al, 2016).

We will first review the initial results that indicated (but not conclusively) staffs and teams increased cognitive readiness using the joint blended learning training methodology; namely, by integrating online courses (and metrics) to achieve a declarative learning baseline; tailoring classroom discussion to address identified knowledge gaps based on the embedded course metrics; and small group scenario-based problem sets that stressed the staffs/planning teams to perform under calibrated duress. The most important aspect of this approach was the addition of a facilitated/guided after action review/reflection on the team's cognitive performance (i.e. review of the staff's ability to frame the problem and demonstrate specific aspects of higher order skills, like critical thinking, problem solving, anticipation, agility, and adaptiveness.). The challenge remains to create a valid, reliable collection tool that, while adapting existing theories and frameworks of problem-solving process and social dynamics that affect performance and group cognition, is accessible to trainers. We will discuss how to arm trainers with the theories, frameworks, and collection tools necessary to evaluate a training audience from a cognitive perspective and collecting data using the TEIR concept. TEIR stands for triggering, exploration, integration, and resolution, and the associated framework provides insights into group performance. Finally, we will discuss the process of decoding speech, analyzing data, and drawing conclusions from seven small group training events, which shows promise for helping staffs gain higher-order knowledge, skills and abilities like anticipation, problem solving, and adaptiveness.

ASSESSMENT INSTRUMENTS IN SUPPORT OF MARINE INSTRUCTOR DEVELOPMENT

2017 IITSEC Paper No. 17180

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Marine Corps instructors typically serve three-year assignments with no prior teaching experience. Although they may be subject-matter experts, the ability to pass knowledge to others is a distinct skill set and the training they receive to do so varies greatly. To maximize instructor performance, there is a need to accelerate the development of their teaching proficiency. To address this need, our team developed a mastery model for USMC instructors which describes the desired performance and provides a roadmap for development (Vogel-Walcutt, Phillips, Ross, & Knarr, I/ITSEC, 2015). The model was adopted as the basis for a new Training and Readiness Manual for instructors and as part of staff and faculty development policy. This paper reports on the next step, application of the model to develop and validate a Marine Instructor Assessment Toolkit. Assessment tools were developed to support the formal schools in accelerating instructor development with feedback-oriented instruments. They include an Observation Rubric for instructional settings, a Supervisor Rating Form for holistic instructor performance, a Self-Reflection Tool, and a Situational Judgment Test. The tablet- and web-based tools were field tested to gather user input at formal schools, and data were subjected to psychometric analysis which found the Observation Rubric and Supervisor Rating Form to be reliable and valid instruments. After field testing, the tools were finalized based on the psychometric analysis and user input. As the front end of transition to the formal schools, a baseline of instructor proficiency is currently in process to include a sample of up to 300 instructors. The baseline will serve as comparison data for future instructor performance measurements after full implementation of the instruments across the formal schools. Transition efforts following establishment of the baseline will consist of train-the-trainer workshops to familiarize the formal schools with the mastery model and the assessment tools.

LIVE, VIRTUAL, CONSTRUCTIVE DISTRIBUTED MISSIONS: RESULTS AND LESSONS LEARNED

2017 IITSEC Paper No. 17229

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A Capabilities-Based Assessment chartered by the Commanding General, Training and Education Command identified the Live, Virtual, Constructive – Training Environment (LVC-TE) capabilities required by the United States Marine Corps (USMC). These capabilities enable the LVC-TE to create a common environment for units to train across LVC domains as though located in the same battlespace and, "provide the means to conduct realistic, collaborative training and exercise of warfighting functions" (Initial Capabilities Document, USMC, 2010).

Subsequently, Training and Education Command (TECOM) required assessments be conducted for simulation training systems used in an LVC-TE intended to address recommendations identified by Marine Requirements Oversight Council Decision Memorandum and developed further by an LVC-TE Working Group. Special Operations Command followed on these recommendations and consequently requested that Headquarters, Marine Corps include the Marine Corps Special Operations Command requirement for Special Operations Terminal Attack Controller training in this effort. Thus, through collaboration with Program Manager Training Systems (PM TRASYS), TECOM, Naval Air Warfare Center Training Systems Division (NAWCTSD), Marine Corps Tactics & Operations Group, Lockheed Martin (LM), and Instructional Systems and Engineering contracted support, a team was assembled to design, develop, implement and evaluate a unique and ambitious Distributed Mission Training Environment (DMTE).

This paper first describes the three currently fielded training devices whose capabilities to support training objectives (tasks associated to Training and Readiness events) were assessed to determine suitability for inclusion in the DMTE then the methodology of the DMTE evaluation. This paper then details the Systematic Team Assessment of Readiness Training (START) process that was employed to confirm and illustrate the capability of the training devices to provide value added training in the DMTE. Results, analysis and the most salient lessons learned are then presented. Finally, the projected movement forward of this DMTE effort is briefly described.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320E

T2 Training Optimization

0830	0900	0930
Holistic Environment Generation and Multi-domain C2 Training (17165)	Optimized Pilot Training for Combat Aircraft (17199)	Using Innovative Systems Thinking to Optimize Royal Navy Training (17084)

Notes

HOLISTIC ENVIRONMENT GENERATION AND MULTI-DOMAIN C2 TRAINING

2017 IITSEC Paper No. 17165

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Advancing command-and-control capabilities is one of the United States Air Force Chief of Staff's top priorities, and has charged the U.S. Air Force with answering the question: "How do we get to a point where we are…operating at a speed of decision making and force movement that our enemies can't counter?" Answering this question and preparing U.S. and coalition forces for tomorrow's fight requires the ability to project power and create seamless effects in air, space, and cyberspace while denying the adversary the ability to do the same. In the challenging threat environment of the future, the U.S. may not enjoy the same asymmetric technological advantages it's relied on in the past. Our ability to gain and maintain multi-domain superiority will depend less on stove-piped capability advantages and more on our ability to integrate capabilities across all domains though multi-domain command and control (MDC2). Training to fight against a 5th generation-capable adversary in any domain, let alone all, is not possible solely in a live training environment, rather, it requires live, virtual, and constructive (LVC) elements woven together into a realistic, holistic training context. Currently, there are no training ranges that blend LVC across all the domains in a truly comprehensive manner; however, future warfighter readiness demands progress towards this goal. Premier combat air forces exercises have begun to address MDC2 requirements; however, they still face limiting factors such as a lack of range-to-range integration and the need for tightly choreographed white force actions that are manpower intensive and prone to human error and effects latency. The purpose of this paper is to highlight gaps in technology and policy that impede progress in meeting CSAF's intent and to provide recommendations for improving advanced readiness training that presents a holistic, integrated, realistic training environment—including LVC and MDC2—for US and coalition forces.

OPTIMIZED PILOT TRAINING FOR COMBAT AIRCRAFT

2017 IITSEC Paper No. 17199

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Training of combat aircraft pilots is a complex task, with available time being one of the main challenges. The pilots train on a set of missions according to a comprehensive training programme, with formations of various sizes. Required training currency for the different missions implies that it is challenging for the pilots to train sufficiently within available time. In addition to live training in the aircraft, simulator training will also be an important part of the future Norwegian training concept for combat aircraft pilots and is integrated in the training programme.

To support the Norwegian F-35 Program, the Norwegian Defence Research Establishment (FFI) performs analyses on the training system planned for the F-35. Here, we present the simulation tool TREFF2. The tool has been developed to analyse how realizations of possible training concepts affect training efficiency. One important factor is the qualification of the pilots, which limits the possible positions they can fill in a formation. Another important factor is the distinction between planned pilot and aircraft availability, and the actual resources in use. The training system must have enough flexibility to handle unexpected events like pilot absence and sortie cancellations. TREFF2 simulates scheduling of pilots to training missions for a given planning horizon, and also the daily training utilizing the actual available resources.

TREFF2 can be used to analyse the training system and identify possible bottlenecks, taking into consideration the qualifications of the pilots in the squadron and the available number of aircraft and simulator sorties. TREFF2 provides insight into the number of sorties needed to complete the training program and whether or not there is sufficient time available for the pilots to complete their training.

USING INNOVATIVE SYSTEMS THINKING TO OPTIMISE ROYAL NAVY TRAINING

2017 IITSEC Paper No. 17084

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While the Royal Navy (RN) has long recognised the opportunities presented by innovative training technologies and methodologies, current generations have inherited a training model that remains predicated on formal, instructor-led residential training. As the RN is looking to embrace more agile manning solutions, it is essential that the Service has mechanisms for delivering training to match.

To address these challenges, Project OPTIMUS was established to determine a more sustainable, effective and efficient system of generating People Capability through active exploitation of innovative learning theory, technology and practice. Its key argument is that new technologies, processes or ideas will only effectively root in training systems from a more collaborative approach between Service and Industry based on mutual incentives for coherent innovation.

However, discrete modernisation efforts have historically failed once local advocacy has subsided. Conversely, enduring innovation has arrived in the form of 'stove-piped' training solutions to support new equipment, or has been imposed by Defence programmes seeking localised efficiencies.

Theory of Constraints (TOC) has been used to model the complex reality of the naval training system and to gain new insights: a Current Reality Tree (CRT) was constructed and used to identify core problems and 'vicious cycles' impeding innovation. Consequently, a strategy was developed to target points of leverage and create favourable conditions for stakeholder collaboration.

This paper outlines the technique used to model the extant naval Training and Personnel systems and summarises the findings from this modelling stage. It links the findings to the subsequent strategy, shows how the resulting package of actions was developed and will be implemented, including a description of the challenges faced, and evaluates the extent to which the work has shaped the conditions for successful optimisation of RN training.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320E

T3 Measures Developed for Team Performance

1030
JTAC/JFO Team Training Effectiveness in a Simulation-based Environment (17036)

1100
Using IoT Sensors to Enhance Simulation and Training in Multiteam Systems (17064)

1130
Measuring Team Performance and Coordination in a Mixed Human-Synthetic Team Training Environment (17301)

Notes

JTAC/JFO TEAM TRAINING EFFECTIVENESS IN A SIMULATION-BASED ENVIRONMENT

2017 IITSEC Paper No. 17036

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Joint Terminal Attack Controllers (JTACs) sometimes have to rely on trained Joint Fires Observers (JFOs) during combat to provide them with timely and accurate targeting information in support of close air support operations. Simulator-based training capabilities are available to most JTACs and JFOs but they do not often train together in such environments. Therefore, a key question is the extent to which simulation-based training (SBT) can enhance the operational effectiveness of JTAC/JFO teams. Our research addresses this question by developing a first-ever JTAC/JFO integration study to examine the effectiveness of integrated training via multiple objective and subjective measures. Because this was the first study of its kind, we conducted a preliminary evaluation as an initial step to explore the possibility of effectively training JTACs and JFOs together in a simulation-based environment. Sixteen Air Force JTACs and five Army JFO personnel participated in week-long team training research trials. Training was conducted via the Joint Terminal Attack Controller Training Rehearsal System simulator (JTAC-TRS) to provide simulated scenario training experiences. Objective measures of performance were collected throughout the training week via the Performance Evaluation Tracking System. Subjective measures of mission effectiveness were collected via observation and evaluation by researchers and JTAC instructors. JTAC/JFO teams rely heavily on verbal communication and coordination to accomplish mission objectives. Therefore, this study also tested innovative methods for measuring team effectiveness reflecting these unique communication and coordination activities. As expected, results from this study found that JTAC/JFO team performance improved significantly from pre- to posttraining. More importantly, JTAC and JFO participants reported that this training was both valuable and necessary. This suggests that training in a simulation-based environment for JTAC and JFO personnel at the team level can significantly enhance training outcomes, including learning, performance, and overall mission effectiveness or transfer.

USING IOT SENSORS TO ENHANCE SIMULATION AND TRAINING IN MULTITEAM SYSTEMS

2017 IITSEC Paper No. 17064

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The vast amount of data being collected by sensors and wearable devices in healthcare simulations has yet to be harnessed to improve our understanding of teamwork and coordination between teams. For instance, a recent paper argued that several constructs serve as essential indicators of the quality of between-team activities including coordination, boundary spanning, and adaptation (Lazzara, Keebler, Shuffler, Patzer, Smith, & Misasi, 2015). This is a valuable theoretical insight, but the key to unlocking the full potential for real-world application in training and simulation is dependent on our ability to find proxies to measure those phenomena. Sensors that record proximity, position (GPS), and speech pattern data have been used as proxies for coordination, communication, and other team processes, including task management, situational awareness, and decision-making (Feese, Burscher, Jonas, & Tröster, 2014; Rosen, Dietz, Yang, Priebe, & Pronovost, 2014). Generally, data are gathered throughout an entire simulation, without a focus on which team inflection points and performance episodes are most important to capture. Moreover, emergency response scenarios are often handled by a complex system of teams varying in their betweenteam interdependencies. These systems are referred to as multiteam systems (MTSs), which are made up of two or more teams that work together interdependently toward a common goal, while separately working toward more proximal goals (Mathieu, Marks, & Zaccaro, 2001). In this paper, we review the data sources being used to describe team behaviors, discuss how to make decisions about data collected during MTS scenarios, and the importance of the data validation process. Two case studies (one Healthcare and one Fire and Rescue scenario) are reported to demonstrate the use of various sensors during simulations. Finally, directions for reporting data in after action reviews and the implications for training using an event-based approach are provided.

MEASURING TEAM PERFORMANCE AND COORDINATION IN A MIXED HUMANSYNTHETIC TEAM TRAINING ENVIRONMENT

2017 IITSEC Paper No. 17301

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The Air Support Operations Center (ASOC) is a complex sociotechnical system. It manages routine events and crises by processing a massive flow of information that originates from a variety of external agencies via numerous communication channels and procedures and across a variety of classification levels. To address the challenge of training individuals and teams to face the complexities of the ASOC environment and to learn how to effectively coordinate, the Air Force has developed the Joint Air-to-Ground Simulation System (JTAGSS). JTAGSS provides ASOC operators with the opportunity to train as a team and to encounter realistic scenarios presented in operational contexts. To achieve this training opportunity, while maintaining current support of operations, work is currently underway to apply a combination of both human and synthetic agents to fill the variety of ASOC positions (Myers, et. al., 2016). Effective training in any environment, and particularly in an environment that requires close coordination across heterogeneous entities, requires effective measurement. To realize the impact of training on the operational environment, trainers must know what to measure, how to measure it, and how to communicate the results. Currently, there are no reliable measures of performance (MOP) and measures of coordination (MOC) that trainers can utilize to ensure progress in teams within the JTAGSS. The purpose of this research was to develop and validate measures of team coordination for mixed human and synthetic teams. The researchers applied the Rational Approach to Developing Systems-based Measures (RADSM) approach (Orvis, DeCostanza, & Duchon, 2013) to develop and validate the coordination measures. The coordination measures were based on virtual communications data and validation was accomplished through a Monte Carlo simulation which utilized representative training data. This study provides evidence of the use of communications-based data in measuring performance related to team coordination.

WEDNESDAY, 29 NOVEMBER, 2017 ROOM S320E

T4 Life in the Big Sim

1600
Creating Data Driven Training Scenarios (17203)

1630
Advanced Readiness 2025: Balanced Investments Across Live, Virtual and Constructive (17241)

1700
Toward Augmenting Army Aviation Collective Training with Gamebased Environments (17282)

Notes

CREATING DATA DRIVEN TRAINING SCENARIOS

2017 IITSEC Paper No. 17203

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We live in a virtual explosion of data. The Internet generates an estimated 2.5 quintillion bytes of data every day. Though the data from instrumentation on aircraft, vehicles, ships, autonomous systems, simulators, and, increasingly, humans themselves does not reach this scale, its volume is significant and increasing. It is natural to want to use this wealth of data to build realistic training scenarios. The chief difficulty is that, whatever events were recorded, they represent only one path through the world. This makes the recording suitable for replay, but a recording cannot give students the chance to make choices in the simulated world that would take them down different paths. Recordings cannot be directly used for training scenarios unless additional steps are taken. This means that accommodations must be made, through subject-matter expertise, machine learning, or both, to synthesize the data into realistic entity behaviors in a scenario. In this paper, we discuss our experiences building several systems that take these additional steps, which generally involve machine learning and intelligent agents, and we discuss in detail an effort that focuses on creating realistic constructive maritime patterns of life from real-world data. We conclude by discussing the training value of learning patterns of life from real world data, and lessons learned that will be useful to help other training professionals create realistic data-driven training scenarios.

ADVANCED READINESS 2025: BALANCED INVESTMENTS ACROSS LIVE, VIRTUAL AND CONSTRUCTIVE

2017 IITSEC Paper No. 17241

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Since the last training paradigm shift in 1972, the Air Force introduced additional mission and new capabilities which cumulatively adds significant warfighting capability. While our training strategy has evolved to prepare warfighters to conduct current overseas contingency operations, our infrastructure has not kept pace with near-peer adversaries' technology advancements, resulting in the inability to train effectively to Anti-Access/Area Denial scenarios. The correct mix of Live (L), Virtual-Constructive (Synthetic), and Synthetic into Live (Blended) Training can be optimized across AFI 11-2-MDS Vol 1 series and Ready Aircrew Program (RAP) Tasking Messages to prepare tomorrow's Air Force to win in air, space and cyber unit's Designed Operational Capability Statements through targeted investments in these training methodologies. The Air Force needs to rebalance L, V, and C methodologies to ensure Operational Training and Test investments are prioritized appropriately. It is hypothesized that a greater percentage of integrated synthetic test/training is required to be ready for Anti-Access/Area Denial scenarios than what is currently prescribed. This paper presents the findings of warfighter surveys conducted across the United States Air Force Warfare Center subject matter experts to identify gaps between 4th and 5th generation test and training requirements and what is actually being accomplished via RAP Tasking Documents and Mission Design Series Vol 1 requirements. The survey findings show the Air Force's need to improve L, V, and C infrastructure and methodologies to maximize warfighter readiness. From these results, the paper presents a proposed strategy of test and training best done or only done in Live fly versus test and training events best done or only done in the Synthetic environment, and where Blended Live Training might provide a cost-beneficial capability.

TOWARD AUGMENTING ARMY AVIATION COLLECTIVE TRAINING WITH GAME-BASED ENVIRONMENTS

2017 IITSEC Paper No. 17282

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Maintaining the highest levels of training and readiness is an ongoing concern for today's warfighters. A rapidly evolving threat landscape, ever-present fiscal concerns, and the move toward virtualization are driving the need for more efficient training methods. The U.S. Army is addressing this need by investigating the potential of game-based systems to augment traditional simulation-based aviation collective training. Game-based training is one component of the U.S. Army Aviation Combined Arms Training Strategy (2016), which highlights the use of Training Aids, Devices, Simulations, and Simulators (TADSS) as key, low-cost tools to prepare Army aviation forces for future combat. However, the effectiveness of game-based training requires further investigation, and its use as an adjunct to aviation collective training has not been adequately evaluated. The goal for the present study was to determine the potential for the low physical fidelity Virtual Battlespace 3 (VBS3) games-for-training system to augment aviation collective training conducted in the medium physical fidelity Aviation Combined Arms Tactical Trainer (AVCATT). Evaluation efforts focused on the cognitive fidelity of these training systems. Twenty-seven expert pilots participated in a realistic collective air assault mission scenario first in either the VBS3 or AVCATT training environment and then in a high fidelity Operational Flight Trainer (OFT) serving as a real world analog environment. Each environment was evaluated in terms of presence, simulation sickness, workload, performance, and HRV. The cognitive fidelity of the OFT corresponded more closely with the AVCATT than VBS3. Objective performance was comparable between the AVCATT and VBS3 and did not lead to performance differences in the OFT. This paper concludes by discussing potential ways to augment collective aviation training with lower fidelity game-based systems and by proposing design improvements for simulated collective training environments.

THURSDAY, 30 NOVEMBER, 2017 ROOM S320E

T5 What Works in VR?

0830
Enhancing Maintenance Simulation Training Devices and Their Application Through Verification and Validation (17056)

0900
Using Virtual Reality for Training Maintenance Procedures (17108)

0930
Rapid Prototyping Innovative Virtual Worlds that Include the WOW Factor (17123)

Notes

ENHANCING MAINTENANCE SIMULATION TRAINING DEVICES AND THEIR APPLICATION THROUGH VERIFICATION AND VALIDATION

2017 IITSEC Paper No. 17056

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Over the last decade simulation training devices have made their entrance into the aviation maintenance world. Various Maintenance Training Organizations (MTOs) have acquired Maintenance Simulation Training Devices (MSTD). However, the effective usage of such devices as an integrated part of a maintenance type training program is not always evident. Such usage is further complicated by the fact that user and aviation authorities' acceptance of these devices is not well supported and lacks clear requirements. Mid 2013 a MSTD for the NH90 helicopter was delivered to the Royal Netherlands Air Force (RNLAF) Helicopter Command called the NH90 Virtual Maintenance Trainer (VMT). During the introduction in the NH90 maintenance type training in the year thereafter, the RNLAF experienced similar issues regarding the NH90 VMT training effectiveness. To gain insight in the source of these issues and enhance the effective usage of the NH90 VMT, the RNLAF requested the Netherlands Aerospace Centre NLR, to conduct a Verification and Validation (V&V) study of the NH90 VMT and its usage within the current training program. This paper will present the V&V study approach and activities. The study comprised two complementary parts. The first part focused on assessing the level of fidelity, and the functional capabilities and limitations of the NH90 VMT, and how these affected the effectiveness and efficiency of the NH90 maintenance type training. The second part directly evaluated the training effectiveness and efficiency of the NH90 VMT usage within the current and future type training program. In addition to the NH90 VMT findings and conclusions, general applicable guidelines and recommendations for the effective development and application of MSTD will be provided.

USING VIRTUAL REALITY FOR TRAINING MAINTENANCE PROCEDURES

2017 IITSEC Paper No. 17108

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In light of rapid technology advances and budget declines, the Navy is exploring innovative training solutions though initiatives such as Sailor 2025 and High Velocity Learning, which call for more hands-on, learner-centric training. Consistent with these initiatives, virtual reality (VR) offers a low-cost alternative to traditional methods of training by offering Sailors interactive and immersive 3-D simulation environments to train critical skills. Indeed, theoretical research predicts that such immersive training will result in better learning outcomes for training a procedural task than traditional computer-based training, yet there are few systematic experiments examining how and why VR may be effective for training. We conducted an experiment to: 1) test whether VR is as effective for training a military-based task as desktop-based training, and 2) compare two different input methods for interacting within the VR environment. Eighty-three participants were trained on maintenance procedures for the E-28 arresting gear, a system that hooks aircraft and rapidly decelerates them as they land. Participants were assigned randomly to one of three training conditions: Desktop-based simulation, Gesture-based VR, or Voice-based VR. A written recall test served as our measure of learning outcome. We analyzed the errors that trainees made during training and found differences between the conditions that suggest that Desktop training may be less efficient than VR training: The Desktop group committed more procedure-based errors, while the VR-Gesture group committed more gesturerelated errors (indicating they understood the procedure but had issues with using the system). This experiment addresses a critical gap in VR research by examining characteristics that may contribute to VR training optimization. Furthermore, these results demonstrate the potential of VR to provide ready, relevant training to the Fleet.

RAPID PROTOTYPING INNOVATIVE VIRTUAL WORLDS THAT INCLUDE THE WOW FACTOR

2017 IITSEC Paper No. 17123

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Submarine Learning Center (SLC) and Naval Undersea Warfare Center (NUWC) have been implementing virtual world environments to deliver US Navy courses to sailors at SLC learning sites. For these courses, minimal course design changes were made to prepare them for delivery. The courses were based on design principles that modeled traditional Navy Schoolhouse classroom delivery. The traditional training classroom design has proven to be successful in getting these courses transitioned and implemented into the virtual world environment rapidly. However, student feedback has indicated that students want future virtual environments to leverage innovative virtual world capabilities that are not possible in the traditional training classroom. Based on student feedback, SLC and NUWC reviewed the literature on virtual world design solutions, and established a creative team of sailors to design virtual environments that include designs that reward student achievement, maintain engagement, and improve instructor to student interactions. This paper will describe design solutions, the process implemented to train the sailors, and the results of working with innovative designs using rapid-prototyping during the instructional design process. This paper will make two important contributions. First, it will demonstrate how implementing rapid prototyping during the instructional design process when building virtual world environments can lead to the WOW factor by enabling flexibility during the process, leading to improved designs in less time. Second, it will provide a process that others can implement to develop designs for virtual world environments using a team-based approach.

THURSDAY, 30 NOVEMBER, 2017 ROOM S320E

T6 VR the World!

1030
Collaborative Helmet and Weapon Tracking for Augmented Reality based Training (17163)

1100
Development and Analysis of Virtual Reality Technician-Training Platform and Methods (17211)

1130
Developing an Immersive Virtual Reality Aircrew Training Capability (17319)

Notes

COLLABORATIVE HELMET AND WEAPON TRACKING FOR AUGMENTED REALITY BASED TRAINING

2017 IITSEC Paper No. 17163

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There is a need within the military to have increased levels of warfighter proficiency and readiness by providing realistic training scenarios for complex urban combat at forward and home locations. Currently, elaborate infrastructure and supporting actors are needed to create training scenarios, and record and review training sessions. Live ammunition training is limited to Force on Target training with extremely limited scenarios (no movers, same old targets); while laser-based training does allow Force on Force training, it is limited by the scheduling of exercises, range time availability and scenarios possible with live forces.

The key emerging innovative technology that addresses these shortcomings is precision mobile Augmented Reality (AR). The AR system precisely tracks actions, locations, and head and weapon pose of each trainee in detail so the system can appropriately position virtual objects in the trainee's field of view. Synthetic actors, objects and effects are rendered by a game engine on the eyewear display. Synthetic actors respond in realistic ways to actions of the trainee, e.g., taking cover, firing back, or milling as crowds. The AR-weapon can be used to fire simulated projectiles at real or synthetic entities.

This paper describes improvements made to a prototype AR system based on live testing with warfighters at a Military Operations in Urban Terrain (MOUT). We present a method for joint tracking of the helmet worn and the weapon attached sensors in a collaborative fashion in which the wearable unit on the helmet aids the weapon unit by sharing visual landmarks along with 3D location estimates in the scene. These are stored in a dynamic map on the weapon processor and continuously matched against to obtain weapon poses consistent with the head pose to provide accurate aiming capability. We also present solutions to miniaturize the system using mobile processors and smartphone sensors.

DEVELOPMENT AND ANALYSIS OF VIRTUAL REALITY TECHNICIAN-TRAINING PLATFORM AND METHODS

2017 IITSEC Paper No. 17211

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As companies continually create products and offer services of increasingly greater complexity, the need for enhanced technical communication and training is becoming more prominent in the workplace. On the factory floor, it is especially difficult, costly, and time-consuming for technicians to successfully operate on systems and assemblies when their technical understanding of a procedure is limited due to unclear information or a lack of instructions. Virtual reality (VR) training methodologies have the potential to enable technicians to transfer their skills into the real world more effectively than traditional training methods such as written, video, and live training used today. This research explores VR training techniques to increase time savings, reduce error rate, and enhance the VR user experience. A group of 30 participants were randomly assigned to either VR training instructions, or control groups without VR training using written instructions and 2D photos or video instructions. All subjects were trained to assemble a 17-part mechanical assembly. The specific target criteria measured were the amount of subjects' time spent learning from the instructions, their amount of time spent assembling the physical mechanical assembly model, the number of solved and unsolved errors committed in the physical model, the number of times the participant performed an assembly step out of indicated order, and the user preference towards the training systems. Survey results indicate that over 85% of the participants preferred the visual, 3D walk-through instructions offered with VR, especially if the assembly procedure was more complex and involved. Results show that users adapted to the VR training platform as easily as the other training methods regardless of their academic background or exposure to VR. Results suggest there was no loss in time nor accuracy for the VR trained students when assembling the physical model as compared to the non-VR trained students.

DEVELOPING AN IMMERSIVE VIRTUAL REALITY AIRCREW TRAINING CAPABILITY

2017 IITSEC Paper No. 17319

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The Combating Terrorism Technical Support Office (CTTSO) and the Air Force Special Operations Command (AFSOC) are assessing the training effectiveness of an immersive virtual reality part task trainer (vrPTT) for AC -130 cockpit familiarization. AFSOC wants to move AC-130 checklist procedures and cockpit familiarization training from low-density/high-demand weapons system simulators to a widely available, low-cost vrPTT, while simultaneously migrating the tutorial courseware and instructor-led portions of the course to a higher fidelity, more immersive environment. This blended learning vrPTT will allow pilots to receive instruction and immediately proceed to practicing scenarios in a highly realistic, immersive Virtual Reality (VR) environment. It also reduces time in the simulators by allowing pilots to learn the procedures and develop muscle memory. The vrPTT was designed and developed from an extensive front-end analysis, including task performance interviews with AC-130 pilots and instructors. The system consists of a 3D VR representation of the AC-130 cockpit viewed through an Oculus Rift head-mounted display (HMD) and underlying equipment behavior models that produce appropriate responses to pilot inputs. Pilots interact with the virtual control systems via the integration of a Leap Motion infrared sensor that tracks the position and motion of all ten fingers. Tutorial content is laid over the equipment simulation, and an integrated intelligent tutor provides adaptive feedback during a scenario and to adjust the initial instruction for future exercises. This paper describes the front-end analyses performed to create the measures for the intelligent tutor, approaches to overlay courseware in a VR HMD environment, and the overall system required to achieve acceptance by the pilot user group. It also details future phases of this program, including a training effectiveness study comparing a control group of students in the simulator who have not used the VR system to those who have used the VR system.

THURSDAY, 30 NOVEMBER, 2017 ROOM S320E

T7 Team Rediness

1330	1400	1430
Enhancing Strategic Thinking in Army Leaders through Skill-building Exercises (17167)	Military Team Training Utilizing GIFT (17286)	Point of Injury Training with Two and Three Dimensional Wounds (17270)

Notes

ENHANCING STRATEGIC THINKING IN ARMY LEADERS THROUGH SKILL-BUILDING EXERCISES

2017 IITSEC Paper No. 17167

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The complexity and volatility of today's operating environments require that Army leaders have advanced cognitive skills. It is no longer sufficient for officers to be technically and tactically proficient (Gurney & Smotherman, 2009). As tactical, operational, and strategic environments become increasingly intertwined, the Army needs leaders who can develop a holistic understanding of multi-dimensional problems, visualize ways to shape potential future states, and anticipate second-and third-order effects of decisions and actions. Recent research conducted by Sackett, Karrasch, Weyhrauch, & Goldman (2016) found that more and different strategic thinking development is required. The research found that the Army's current education and training system provides limited opportunities for developing leaders to practice the skills that underpin strategic thinking and complex problem-solving. This paper describes research to test methods for improving current and emerging Army leaders' ability to think strategically by providing them with opportunities to practice advanced cognitive skills. Specifically, the paper describes the development and formative evaluation of four practical exercises – for use in operational and/or classroom settings – designed to build and reinforce cognitive and behavioral skills that underpin the ability to think strategically. These exercises give participants the opportunity to practice and receive feedback on skills including: systems/holistic thinking, synthesis, questioning and information-gathering, reflection, thinking in time, and strategic foresight. A preliminary evaluation of the exercises was conducted with two groups: a Brigade and Division of the 1st Infantry Division at Ft. Riley and faculty members in the University of Foreign Military and Cultural Studies. The evaluation elicited feedback on 1) the value of the exercises for developing skills associated with strategic thinking, 2) ease of use of the facilitator materials, and 3) suggestions for improving the exercises. Findings are being used to revise the exercise materials.

Key Words: Strategic thinking, advanced cognitive skills, skill-building exercises, Army leaders, complexity

MILITARY TEAM TRAINING UTILIZING GIFT

2017 IITSEC Paper No. 17286

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In 2015, the U.S. Army identified intelligent tutoring as a crucial resource for effective training of soldiers. Specifically, team training is essential as military missions are usually team-based and require extensive coordination. Intelligent Tutoring Systems (ITS) review actions taken by the user and provide dynamic instructions to teach subject matter to an individual. A team ITS assesses the performance of the teams' individuals, their overall performance as a team, and the interactions of that team to provide dynamic instructions. While extensive work has been conducted regarding single person ITSs, work regarding team-based ITS is limited. A team ITS is difficult to design as the tutor must account for the actions of multiple individuals and their team interactions. The tutor must teach task skills for completing the objective, and team skills for how a team works to meet the objective.

This paper describes the implementation, development and evaluation of a Team Intelligent Tutoring System for military teams. We faced challenges such as defining the appropriate levels of cognitive load and team communication required to be successful. The goal of the work was to evaluate an ITS's effectiveness in a simple team training scenario, a two-person surveillance task in which participants signaled each other using keystrokes. The scenario was constructed using Virtual Battle Space 2.0 (VBS2), and the tutor was built using the Generalized Framework for Tutoring (GIFT). Sixteen two-person teams were run through the study in one of three feedback conditions (individual feedback, team feedback, or no feedback). Their individual and team performance within the task were assessed. We found that participants in the feedback conditions had fewer extraneous keystrokes in the task than those without feedback.

POINT OF INJURY TRAINING WITH TWO AND THREE DIMENSIONAL WOUNDS

2017 IITSEC Paper No. 17270

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A considerable amount of research and development has already occurred to increase the fidelity of simulated wounds during training, primarily at the point of injury. As materials and techniques mature and as more relevant data is collected on tissue properties, it is worth examining what fidelity is really required for medical training at the point of injury. The basic hypothesis for this effort is that at the point of injury, a two dimensional (2D) tattoo wound provides the same immersion, sense of urgency, and visual cues as a three dimensional (3D) silicone wound of the same injury.

Using a between subjects design, this effort assesses the differences in trainee treatment time and perception of the simulated wound when treating a 3D silicone wound and a 2D tattoo wound. A pilot test was completed in October 2016 ($n = 16$) and a large experiment was completed in November 2016 ($n > 150$). Participants were exposed to either a silicone or tattoo representation of a bullet wound and asked to assess and care for the wound. The time to complete treatment was also recorded. Afterwards, participants completed a survey assessing perception of depth cues, sense of urgency, and immersion.

Early user testing indicated there was a difference in how participants respond to the 2D tattoo and 3D silicone wounds. The findings from this complete research study showed that at the point of injury, there was very little difference in how 2D tattoo and 3D silicone wounds were perceived by the test subjects. A summary of the complete analysis will be presented and discussed.

PDF FILES OF THE 2017 TUTORIAL PRESENTATIONS ARE INCLUDED ON THE PROCEEDINGS CD. PLEASE SEE THE TUTORIALS SECTION OF THIS BOOK FOR SCHEDULE AND SYNOPSES DETAILS.

NOTES

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