# NAWCTSD Research Project Summaries

Fiscal Years 2014-2015

## Training, Human Performance, and Modeling & Simulation: R&D to Enable Fleet Success

*October 31, 2014*

**Naval Air Warfare Center**
**Training Systems Division**
**Orlando, Florida**
**navair.navy.mil/nawctsd**

S&T R&D Where the Mission Begins

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# A Message from Our NAWCTSD Leaders:
# R&D to Enable Fleet Success

**Captain Frank W. Naylor, USN**
**Commanding Officer**

**John Meyers**
**Technical Director**

At the Naval Air Warfare Center Training Systems Division (NAWCTSD), we are conducting research to understand and improve individual and team learning and performance and to develop education and training methodologies and technologies, to shorten training time and maximize transfer of knowledge, enabling Fleet success.

Our four research focus areas aligned to our core capabilities are: Human Performance Modeling and Assessment; Human Systems Design and Decision Support; Virtual Environments and Training Technologies; and Distributed Live, Virtual, and Constructive Synthetic Training.

Our research efforts focus on 'where the mission begins,' where the body of knowledge of human performance and training is expanded, where innovations are developed, proofs of concept are established, and prototypes are demonstrated.

We promote experimentation, creativity and encourage our people to challenge basic assumptions. We are open to reinventing ourselves based on new knowledge and understanding. This ability to adapt is our "intrinsic weapon." Ultimately, these innovations are transitioned to the Fleet and improve warfighter readiness.

Special thanks go to our principal investigators and all of our researchers for their technical excellence and innovative contributions year-round to improving the capability, quality and cost-effectiveness of the training technologies provided to the Fleet.

# Research & Technology Programs Office

NAWCTSD is a key warfare center laboratory for training systems and human performance. The primary goal of our researchers is to explore and develop advanced technologies and methodologies to ensure that the Fleet of tomorrow has the skills, training, and equipment it needs to enable success against current and future threats.

In consonance with strategic plans of the Naval Forces and the Naval Aviation Enterprise, our vision is to merge behavioral, cognitive and engineering sciences to produce effective training solutions and systems, exploiting technology to increase performance, reduce risk, and reduce cost.

Our strategy includes leveraging work at universities, industry, and other government laboratories, to provide advanced technologies that transition into operational use.

We revitalize the workforce and enable technical excellence through a focus on research and development.

*People – Researchers and Warfighters – Are Our Most Important Assets.*

**Director**
**Maureen Bergondy-Wilhelm**

**Deputy Director**
**Robert Seltzer**

**Military Deputy**
**CDR Henry L. Phillips IV**

# Science & Technology Objectives

***"We are striving to improve the way we plan and manage our S&T portfolio. Our S&T Objectives (STOs) are jointly developed by the warfighters, technologists, requirements officers and the acquisition sponsors. Roadmapping of the 33 individual STOs coupled with our newly developed, department level, bottoms up Core Capabilities play a major role in identifying gaps to guide and help develop our investment strategies. These approaches are guided by a common process supported by quantitative metrics, with a focus on transitioning the best technologies at the lowest cost as quickly as possible to the warfighter" -- Dr. James Sheehy, ST, Chief Technology Officer, Naval Aviation Enterprise***

The STOs are aligned with OSD's Joint Capability Areas, ONR's S&T focus areas, as well as the Marine Corps Aviation S&T Objectives. There are 10 capability gaps supported by 33 NAE STOs developed with OPNAV, Fleet, NSAWC/NMAWC, PEOs/PMAs, FRCs, USMC, Warfighters and Technologists input.

The STOs represent the goals of the NAE S&T program which is presented using a common road mapping process for each STO showing the ongoing projects, their TRL levels, and dollars invested. Roadmaps are defined by near, mid and far term quantitative metrics which provide the 'plan' to mature and transition needed technologies to the current and future stakeholders.

STOs are the common capability document supported by the 75 NAWC Core Capabilities (includes 4.0, 5.0 and 6.0) which define ongoing vs. needed projects, current vs. future skill sets, and the required infrastructure. The combination of the STOs and Core Capabilities as shown in the resulting road maps enables the NAE to clearly articulate to sponsors our needs, requirements and desired capabilities.

Technology development is principally performed by the elements of the Naval Research Enterprise, industry, and academia to develop and provide the critical technology and material to transition to the acquisition sponsors and ultimately the warfighter.

The responsibilities of the NAE Chief Technology Officer are to ensure alignment, leveraging and non-duplication of applicable S&T programs with the NAE's current missions and future capability needs while balancing and managing the S&T portfolio with support from our resource sponsors.

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# INTRODUCTION

*"We are unique in this integrated role ..."*

**Research & Technology Programs Director: Maureen Bergondy-Wilhelm**

The Naval Air Warfare Center Training Systems Division (NAWCTSD) is the Navy's source for a full range of innovative products and services that provide complete training solutions. This includes research and development in human performance, learning, advanced technologies through training system acquisition and life cycle support. The research mission of NAWCTSD is to plan and perform a full range of directed Research and Development (R&D) in support of naval training systems for all warfare areas and platforms, to maintain an expanding naval-critical technology base, and to transition research results to the Fleet and other customers.

The Navy Science and Technology (S&T) Strategy, developed by the Office of Naval Research (ONR), is designed to leverage advances in knowledge and technology under a Discovery and Invention (D&I) Program, and to demonstrate new technologies under a set of Future Naval Capabilities Programs. Taken together, these programs comprise the Navy's technology base and support the Sea Power 21 vision of the Chief of Naval Operations. Guidance comes from Integrated Product Teams that include representatives from the following: Requirements, Acquisition, S&T, and Fleet/Force communities. In collaboration with academic and industry partners, the Research and Technology programs at NAWCTSD respond to research gaps working with ONR through such venues as the Capable Manpower Future Naval Capability (FNC). They also address enabling capability gaps identified in the S&T Strategic Plan developed by the Naval Aviation Enterprise, of which NAVAIR is a major component.

A large portion of our research is done in support of ONR's Capable Manpower FNC, which is dedicated to improving the utilization, training, and performance of Sailors and Marines. All categories of research funding (BA1 through BA7) may contribute to developing supporting technologies for Capable Manpower. However, the primary developmental components are Applied Research (BA2), where innovations are developed, and Advanced Technology Development (BA3), where proofs-of-concept are established.


We pursue early advances in selected research areas under the D&I portion of the Navy S&T Strategy, with Basic Research (BA1) and Applied Research (BA2) as the primary components. We also are involved in Transition Research (BA4) to refine and evaluate technologies, and deliver them directly to the acquisition community or operational forces. Under the Section 219 Program, we are also able to fund critical work across the S&T budget activity levels (BA1-3) using in-house funding. This program exists to help DoD laboratories build expertise and capabilities needed to meet current and future fleet stakeholder requirements, in parallel with the DoD policy for defense contractor-funded Independent Research and Development (DFARS 231.205-18).

Another portion of our portfolio is aimed at accelerating the transition of technologies, with industry help, through such programs as the Small Business Innovation Research (SBIR) and the Small Business Technology Transfer (STTR) programs.

Additional efforts include cooperative and collaborative research with other government agencies, non-profit institutions, and commercial firms. Much of this work is done under the federally mandated Technology Transfer Program, in which capabilities developed with federal R&D funding are adapted to public and private needs. The scientists and engineers at NAWCTSD work closely together, to develop and promote transitions of promising technologies and to resolve problems in acquisition programs or with fielded trainers.

At a high level, our Research and Technology Programs have three major goals:

1. Improving learning and retention and their assessment,
2. Measuring and enhancing human performance, and
3. Improving training system technologies, components, and processes.

## NAE Science and Technology Objectives (STOs)


**Naval Warfighter Performance (NWP) Science and Technology Objective (STO)-1 Training and Education:** Increasing mission complexity, asymmetric warfare emphasis, high live/range exercise costs and growing operational demands driven by reduced timelines directed by Fleet Response Plans all require new metrics-driven processes, high-fidelity training environments and fully linked training and readiness competencies to achieve operator/maintainer qualifications and proficiency while reducing training life-cycle cost drivers. The rapid creation of combat readiness and operational proficiency, while optimizing the use of live, virtual and constructive assets is required.

- *Develop education and training technologies to cost effectively maximize transfer of knowledge from the classroom and trainer to the operational environment.*

**NWP STO-2 Human Systems Design and Decision Support:** Excessive Operator workload in a non-optimized data rich environment degrades effectiveness, resulting in extended decision timelines with potential for increased human error and injury.

- *Develop technologies to improve human systems design to reduce manned and unmanned operator workload; decision-making; model processes related to situational awareness; and mitigate stress (physiological and psychological) and injury risk; and improve our understanding of human social and cultural behavioral processes to yield improved decision making. Crewmember knowledge, skills, abilities, personality characteristics, experiential requirements, and workload targets will be quantitatively assessed. These methodologies will provide a means for more effective decisions in the context of system and platform design, manpower requirements, design tradeoffs, mission sustainability, and warfighter effectiveness.*

**Information Dominance (ID) STO-1 Command & Control:** Joint and coalition forces must have the ability to task, process, exploit, and disseminate information to/from the appropriate entity within the force with enough fidelity to be acted upon in a timely manner. With multiple sensors providing more information, operators must assimilate an increasing volume of data and information. All relevant and

available information must be filtered, organized, and coalesced to enable timely, informed decisions in order to manage, control, and manipulate the battlespace.

- *Develop technologies to enable rapid, accurate decision making to ensure efficient battle management. Desired technologies include intelligent agents or decision aids for rapid and reliable threat/intent determination, distributed and decentralized weapons/sensor coordination and control, and improved mission planning.*

## NAWCTSD Research Focus Areas

**Human Performance Modeling and Assessment:** Human Performance Modeling analyzes underlying knowledge, skills and abilities (KSAs) to predict performance across a variety of systems and contexts. Human performance assessment includes the ability to accurately measure and analyze performance at different levels, including individual, team, unit (or multi-team), and organization in multiple domains and across a variety of tasks, ranging from simple procedural skills to complex cognitive skills such as decision-making and situational awareness. Human performance assessment is an integral part of performance modeling. As technologies progress, future assessment capabilities will encompass neuro-cognitive and other physiological measures and indices. Understanding such measures in the context of training or operational tasks will serve both to expand this technical area beyond its current scope and to enhance warfighter performance and effectiveness.

Under Human Performance Modeling and Assessment there are three major sub-capabilities:

- *Human Performance Assessment*
    - Neuro-Cognitive Assessments for Performance Mastery
    - Psychometric Foundations of Performance Measurement, Prediction, and Improvement
    - Performance Assessment Support Tools
    - Measurement Authoring and Selection for Universal Re-use and Exportation
    - Configurable Database of Reusable and Exportable Performance Measurement Objects
    - Technologies for Integrating Neuro-Cognitive & Competency-Based Assessments
    - Adaptive Training Priorities and Task Loading
    - HSI Design Support Tools
    - Automated Performance Assessment for Simulators
- *Human Performance Modeling*
    - Identify and Validate Properties and Moderators of Human Performance in Biological and Social Bands of Human Activity
    - Develop and Validate Algorithms and Modeling Approaches to Capture Human Performance Regularities
    - Application of Human Performance Models (HPMs) to Simulation-Based Design, Mission Planning, and Training
    - Advance Real-time Processing and Integration of HPMs

- Library of Reusable HPMs Covering Relevant Military Tasks

- *Human Social and Cultural Behavioral Modeling*
  - Innovative Predictive Modeling for Strategic Behavioral Prototyping
  - Training Methods, Strategies and Technologies for Leaders and Small Teams.

**Human Systems Design and Decision Support:** Significant advances in Naval Capabilities, such as the increased numbers and types of sensor systems, the use of multiple autonomous vehicles, and the increased flow of intelligence information, present a significant challenge for our warfighters. The purpose of Tactical Decision Support for Command and Control research is to advance the state of the art in automation and artificial intelligence in support of decision-making and mission planning to reduce stress and information overload while increasing consistency and confidence in decisions.

- Information Fusion, Processing, and Exploitation
- Tactical Interfaces
- Control and Monitoring of System Autonomy

**Virtual Environments & Training Technologies:** Virtual Environments (VEs) can augment warfighter preparedness by providing training opportunities that might not be available due to factors such as cost, safety and resources. Three components of VE training include technology, human, and evaluation. The technology component includes the ability to provide realistic rendering and modeling, multi-sensory input/output devices, and system interconnectivity and delivery. The human component includes the ability to train at different levels of task performance from motor skills to complex cognitive skills while taking into account user interaction issues and individual differences. The evaluation component involves assessing the effectiveness of the VE training system via formalized training effectiveness evaluations, transfer of training, and training fidelity.

- Natural Language Processing for Training Devices
- Eye-Limiting Resolution Display
- Immersive, Augmented Reality, Multi-Sensory Training Environment
- Persistent Virtual Worlds (VW) for Training
- VEs for Decision Making
- Adaptive Training & Intelligent Tutoring
- Simulation Realism
- Medical Modeling & Simulation
- Game-based Training
- Personal Assistant for Learning
- Other Emerging Technologies (e.g., Mobile Training Technologies)

**Distributed Live, Virtual & Constructive Synthetic Training:** The ability to train and interact in a large-scale distributed simulation network is critical to the Department of Defense (DoD) and allied partners to allow warriors to interact, train, and learn in an operationally realistic environment.

Under Distributed Live, Virtual & Constructive Synthetic Training the three major sub-capabilities are:

- *LVC Training Architecture*
    - Simulation Fidelity
    - Multi-Level Security
    - Mission Rehearsal Enabled Databases
    - Constructive Environment Improvements
- *Distributed Training*
    - Distributed Team Competencies & Training Methodologies
    - Scenario Generation and Control for Distributed Exercises
- *Human Computer Interaction*
    - Management of Information Load
    - Collaborative Tools and Techniques

This booklet is organized into the following six sections and provides a glimpse of the research being conducted at NAWCTSD.

1. Science & Technology
2. Transition Research
3. Small Business Innovation Research (SBIR) & Small Business Technology Transition Research (STTR)
4. Technology Transfer
5. Capital Investment Program
6. Other Navy, Department of Defense and Joint Programs/Projects

We hope that you find it useful. If we can provide more information, please contact us at NAWCTSD_Research_TechnologyProgram@Navy.Mil.

# SCIENCE & TECHNOLOGY PROGRAMS

*"... supplying the pipeline of knowledge, concepts and prototypes...."*

**Program Manager: Robert Seltzer**

The Department of the Navy's (DON) Science and Technology (S&T) program, includes Basic and Applied Research (BA1 and BA2), and Advanced Technology Development (ATD) (BA3) that is funded and managed by the Office of Naval Research (ONR). ONR is the S&T provider of the DON and as such, is charged with providing the S&T products necessary for the operational concepts and visions for the Navy and Marine Corps of the future. The Naval S&T Strategic plan describes how ONR will enable the future operational concepts of the Navy and Marine Corps.

(See Naval Science & Technology Strategic Plan - Office of Naval Research )

NAWCTSD's S&T Program primarily focuses on supporting the NAE's Naval Warrior Performance Science and Technology Objectives (STOs) that are detailed in the NAE STO document dated April 2014. The NAE STOs directly align to support the Naval S&T focus area called, Naval Warfighter Performance. Other NAE STOs addressed by the S&T project portfolio include: Strike Operations, Undersea Warfare, Information Dominance, and Enterprise and Platform Enablers.

**NAWCTSD Discovery and Invention** (D&I) Program is comprised of basic and applied research. The purpose of D&I is to continuously generate new ideas. Its goals are to leverage advances in knowledge and technology, initiate investigations in areas of particular interest to the Navy, and maintain expertise in areas that are uniquely naval in nature. Thus, the focus of the work is on supporting unique requirements of the naval forces and on fields of inquiry that are unlikely to be adequately advanced by industry or other sponsors. The program area has a long timeframe, involving extensive experimentation and demonstration before it will have an impact on operational systems.

NAWCTSD has three sets of research projects funded under the D&I component of the Navy S&T program. The first is investigating intelligent tutoring under the general ONR Program. The second and third are the In-house Laboratory Independent Research (ILIR) Program and the Independent Applied Research (IAR) Programs, which are ONR-sponsored Basic Research and the early stages of Applied Research Programs executed by NAVAIR. All of these efforts have links to the Capable Manpower Future Naval Capabilities (FNC) Program, because they are either addressing research gaps that were identified by that program or pursuing studies that complement or extend that work.

**NAWCTSD's ATD Program** is made up of the U.S. Joint Forces Training Transformation Initiative, ONR projects in support of Active Sonar M&S and Fire Team Skill Acquisition Support Technologies and finally, four projects supporting the Capable Manpower FNC. The purpose of ATD is to mature technology into requirements-driven, transition oriented products that support the CNO, the Commandant of the Marine Corps, and their shared vision for the service. With respect to NAWCTSD's training, human performance and M&S research mission, the related ONR Naval Warfighter Performance objectives are:

Manpower, Personnel, Training and Education:

- Training technologies to enhance fundamental information processing abilities in young adults
- Techniques to shorten training time, reduce training costs and maximize training impact
- Tools and techniques to achieve ubiquitous, engaging, scenario-based training

Human System Design and Decision Support

- Reduce training and workload requirements through better system design
- Create design engineering tools and design standards incorporating human capacities into system performance
- Incorporate the human element into design and control of autonomous and robotic systems
- Effective, user-friendly decision support systems for kinetic and non-kinetic operations

Bio-Engineered Systems

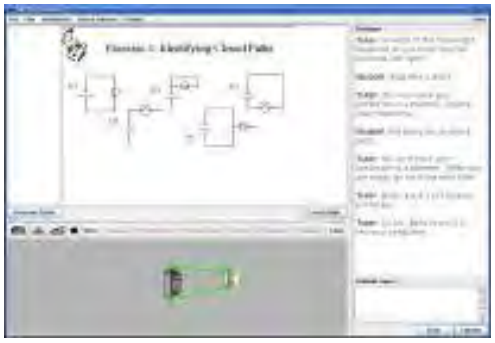
- Engineering biologically inspired intelligent sensors and autonomous systems
- Computational cognitive models for intelligent systems

The general objectives of the ATD research projects are to conduct proof-of-concept demonstrations, risk-reduction developments, and training/cost-effectiveness investigations in education and training technology. The work being done represents a continuing effort to improve fleet readiness through development, demonstration, and transition of simulation and training device technology to acquisition programs and the Fleet.

**NAWCTSD's S&T Projects** are described in the subsequent D&I, ATD and Capable Manpower FNC sub-sections that follow.

## BASIC ELECTRICITY AND ELECTRONICS TUTORIAL LEARNING ENVIRONMENT - HUMAN COMPUTERS AND SPEECH (BEETLE HCS)

**Start: Sep 05 End: Dec 15**



***Need:*** Despite tremendous advances in technological capability, intelligent tutoring systems have yet to consistently realize the instructional effectiveness typically attributed to expert human tutors. It has been suggested that one key to a human tutor's effectiveness may be the flexibility and adaptability of the tutorial dialogue that the tutor establishes and maintains with a student.

***Objective:*** (1) Gain insights from data collected with human tutors that will simultaneously improve our understanding of dialogue, instruction and learning, and (2) push the state-of-the-art in computer-based natural language processing by developing a computer-based system capable of conducting a tutorial dialogue with a student called the Basic Electricity Electronics Tutorial Learning Environment (BEETLE).

***Benefits:*** Provide the Navy with a determination of the training effectiveness of such a system, with an eye toward providing the Navy with information to support a cost-benefit analysis of this training capability.

***Status:*** In FY14, the BEETLE HCS team completed the final research study under this effort, evaluating the impact of the use of a Predict, Verify, and Evaluate (PVE) cycle that guides the instruction and requires students to face their misconceptions about the properties of electricity. Students completing the same activities in the same sequence of the original BEETLE curriculum, but not required to complete the additional steps of making and testing predictions for those activities, did not perform statistically significantly differently on a post-test from students who completed those activities embedded within a PVE cycle. We have a number of potential explanations for this finding, including the possibility that the pre- and post-tests were not sensitive enough to reflect a difference in learning and the possibility that the material covered in these few hours of curriculum is not difficult enough to benefit from this instructional technique.

While the lack of statistically significant differences between the various instructional conditions that we have run under the BEETLE program is discouraging, the positive result is that all of our conditions have yielded impressive effect sizes on the order of 1.6 to 1.8 sigma improvements relative to a no-training control condition. These results have attracted the attention of the Department of Defense Educational Activity (DODEA) and we are in conversations with them about possible ways to transition our approach to their middle school science curriculum under a different source of funding.

***Research Products:***

Dzikovska, M., Steinhauser, N., Farrow, E., Moore, J., & Campbell, G. (2014). BEETLE II: Deep natural language understanding and automatic feedback generation for intelligent tutoring in basic electricity and electronics. International Journal of Artificial Intelligence in Education, 24 (3), 284-332. doi: 10.1007/s40593-014-0017-9

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Dzikovska M.O., Isard A., Bell P., Moore J.D., Steinhauser N., Campbell G. (2011). Beetle II, an Adaptable Tutorial Dialogue System. In *Proceedings of the 12th Annual SIGdial Meeting on Discourse and Dialogue*, demo session, Portland Oregon. June 2011.

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Dzikovska, M.O., Moore, J.D., Steinhauser, N., & Campbell, G. (2010, July). The impact of interpretation problems on tutorial dialogue. In Proceedings of the 48th Annual Meeting of the Association for Computational Linguistics (ACL-2010).

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Dzikovska, M.O., Callaway, C.B., Farrow, E., Steinhauser, N.B., & Campbell, G.E. (2009, September). Dealing with interpretation errors in tutorial dialogue. In *Proceedings of SIGDIAL-09*, London, UK.

Campbell, G.E., Steinhauser, N.B., Dzikovska, M.O., Moore, J.D., Callaway, C.B., & Farrow, E. (2009, July). *Metacognitive awareness versus linguistic politeness: Expressions of confusions in tutorial dialogues*. Poster presented at the 31st Annual Conference of the Cognitive Science Society. Amsterdam, Netherlands.

Campbell, G. E., Steinhauser, N. B., Dzikovska, M., Moore, J. D., Callaway, C. B. & Farrow, E. (2009). The "DeMAND" coding scheme: A "common language" for representing and analyzing student discourse. In V. Dimitrova, R. Mizoguchi, B. du Boulay & A. Graesser (Eds.), *Artificial Intelligence in Education* (pp. 665-667). Amsterdam, Netherlands: IOS Press.

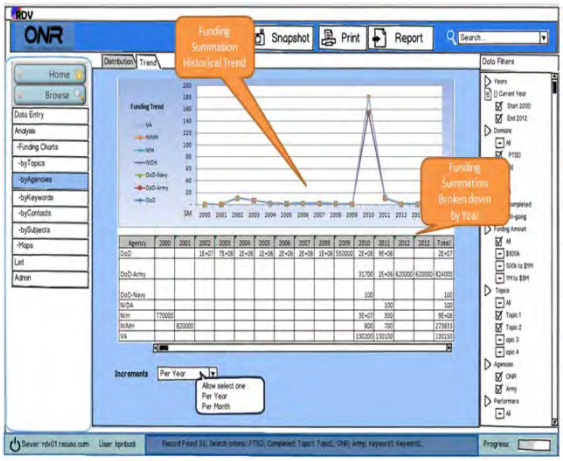
Campbell, G.E., Steinhauser, N.B., Dzikovska, M., Moore, J.D., & Callaway, C.B. (2008, July). Coding by "DeMAND": Identifying the dimensions of student dialogue that underlie theories of learning. Poster presented at the 30th Annual Conference of the Cognitive Science Society. Washington, DC.

Dzikovska, M.O., Campbell, G.E., Callaway, C.B., Steinhauser, N.B., Farrow, E., Moore, J.D., Butler, L.A., & Matheson, C. (2008, May). Diagnosing natural language answers to support adaptive tutoring. In *Proceedings of the 21st Annual Florida Artificial Intelligence Research Society Conference*, Coconut Grove, FL.

Steinhauser, N. B., Butler, L. A., & Campbell, G. E. (2007). Simulated tutors in immersive learning environments: Empirically-derived design principles. Proceedings of the 2007 Interservice/Industry Training, Simulation and Education Conference, Orlando, FL. [CD-ROM].

## POST-TRAUMATIC STRESS DISORDER/TRAUMATIC BRAIN INJURY AND TRAINING EFFECTIVE ANALYSIS

**Start: Nov 11 End: Dec 13**




***Need:*** Post Traumatic Stress Disorder (PTSD)/Traumatic Brain Injury (TBI) studies are being conducted across DoD, the private sector, hospitals, universities and in the private sector. To gain situational awareness of the numerous research investment areas and topics, metrics from the studies have been gathered using an MS Excel application. As the research data grows, the spreadsheets become unwieldy and cumbersome. This method does not lend itself to discovery of trends and relationships without considerable effort. A tool was needed to show how scientific thought evolves over time, assess portfolio investments, show use scenarios and facilitate a greater understanding of content areas for program managers and senior leaders.

***Objective:*** Develop an illustrative user interface prototype to visualize the collected research data using interactive graphical techniques. The prototype illustrates visualizing taxonomy, numerical data, and relationships between elements of the research knowledge database.

***Benefits***: The Research Database Visualization (RDV) system implements a relational database to store the research data and metrics. The system is designed so it can be easily adapted to other research domain areas (e.g., fatigue, medical, biomedical, etc.) and to initially contain comprehensive PTSD/TBI taxonomy. The system contains built-in visualization functions that are interactive and designed to glean new insight from the database. The system has a search and filter mechanism to quickly find data. The reporting system allows charts, graphs, and tabular data to be exported to a document editor or PowerPoint slides.

***Status:*** In FY14 the contractor demonstrated the functionality of the RDV in December 2013. The contractor provided interim data server and client software components for demonstration and final delivery. The contractor executed a DoD Information Assurance Certification and Accreditation Process (DIACAP) process to certify RDV application and all its dependencies including JavaFX, ThinkMap, and server components.

***Research Products:***

- Final Research Database Visualization (RDV) System Prototype Demonstration (Dec 13).
- DIACAP Certification (Dec 13)

## TUTORING EFFECTIVELY: AN ASSESSMENT OF COMMON HEURISTICS (TEACH)

**Start: Oct 12 End: Dec 16**

***Need:*** To have an effective warfighter or professional in the field, individuals need to be effectively and efficiently trained. This project aims to determine methods to train and tutor individuals effectively in Science, Technology, Engineering, and Math (STEM) domains. This additionally supports the Navy's requirement for making advances in the teaching of Science, Technology, Engineering, and Math (STEM) domains. This research will examine tutoring strategies in the application of Intelligent Tutoring Systems which could reduce instructor

demands and provide more affordable and accessible training for our forces, which aligns with the Department of the Navy (DON) Objectives for FY12 and Beyond to Maintain warfighter readiness in an era of reduced budgets- organize, train, and equip combat-ready forces.

***Objective:*** (1) Evaluate the value of feedback and scaffolding in a tutorial setting to determine if one or both are the key to tutoring effectiveness and the 2 Sigma effect. (2) Examine the benefits of proactive versus reactive scaffolding. (3) Provide empirically validated tutorial strategy recommendations for implementation into an Intelligent Tutoring System. (4) Determine useful methods for teaching the tutor to make use of effective tutoring techniques.

***Benefits:*** Give guidance for effective tutoring strategies and methods for implementing those strategies and provide empirically validated design guidance to maximize the effectiveness of future STEM tutoring systems.

***Status:*** In FY13, our team began work on the TEACH project. First, we developed the experimental design to be used for investigating our research questions. Next, we designed two versions of the curriculum to be used for experimentation (a proactive and a non-proactive scaffolding version). The curriculum teaches predator/prey modeling using differential equations and Microsoft excel. To test the effectiveness of the different conditions, we also created three knowledge tests. Once this material was created, we pilot tested both versions of the curriculum and tests with 40 participants from a local university. Edits and adjustments were made to both the curriculum and tests based on pilot performance and feedback. Final versions of both were created and are ready for experimentation. We then analyzed student errors and feedback points for tutoring. Based on this work, in FY14, our team created the feedback statements and the scaffolded responses that will be available for experimentation. Additionally, we created the experimental materials (demographics questionnaire, student reaction survey, etc.) and began the process of getting CPHS approval. A pretest and posttest were also created to test conceptual knowledge gain. Lastly, a networked computer interface was developed to allow the student and tutor to communicate and work through the lessons and record all student and tutor actions and interactions, while maintaining a controlled experimental environment. Data collection will begin in early FY15.

***Research Products:*** No publications as of yet. It is anticipated that the results from this work will be presented at the Cognitive Science Society Conference in 2016. Additionally, we plan to publish the results in a peer reviewed journal.

## IN-HOUSE LABORATORY INDEPENDENT RESEARCH PROJECTS

### MEASURING INTUITION AND ITS RELATIONSHIP TO SOMATIC MARKERS AND INDIVIDUAL DIFFERENCES

**Start: Oct 13 End: Dec 16**

***Need:*** Military interest in intuition goes back at least as far as von Clausewitz's classic treatise "On War" (first published in 1832). Although historically intuition was recognized as an important skill to the warfighter, this construct has only recently emerged within the scientific community as a legitimate topic of study. While there are, now, many different techniques for studying intuition, there is a lack of integration between these methodologies and thus an inability to properly assess whether intuition is an innate ability or if it is trainable. Additionally, it is unclear how laboratory tests of intuition relate to real-world intuitive decision making, which can be critical to survival in a war-time environment.

***Objective:*** Military theorists have long posited that intuition is important for military decision making. If so, intuitive processing ability should be an important variable to consider when selecting among candidates for military jobs. However, intuition has historically been ill-defined and therefore

unsuitable for selection use. Recent neuroimaging studies have correlated performance of laboratory intuition tasks with activity in the medial orbitofrontal cortex and limbic system suggesting that intuitive processing is related to what neuropsychologists refer to as "somatic markers." This project will examine the relationship between intuitive processing and the neuropsychological construct of somatic markers by examining the correlation between performance on neuropsychological tasks and performance on common laboratory tasks of intuition. It will then examine the potential utility of these tasks for military selection by examining the relationship between these neuropsychological and laboratory tasks and performance on a shoot-don't-shoot task.

***Benefits***: The proposed effort advances the state-of-the-art in the measurement of intuitive processing by bringing various inventories and assorted behavioral measures together into a single study to assess their reliability and convergent validity. The innovative component of this research is the incorporation of the Iowa Gambling Task and a shoot-no-shoot decision scenario into the current research on intuition. These measures allow us to not only assess intuitive ability, but also how those abilities affect the decisions that are made. This is the crux of intuition; not only does an actor need to have a gut feeling, but he or she must act on it appropriately. The knowledge we gain from this research may be leveraged to significantly increase our capability to measure and understand intuition and how it might be used for selection. If this project is successful we will have verified our measures as being reliable measures of intuition and will have recommendations for how to test and select personnel for positions that require the use of good intuition.

***Status:*** The team began this effort by analyzing the data from a previous NAWCTSD Intuition project (ILIR 3630) to determine which tasks and assessments would be included in the current study and thus finalized our experimental design. Next, the team identified a test bed for creating a shoot-no-shoot task using Virtual Battle space 2 (VBS2) and began development of the task. We also received permission to purchase the Iowa Gambling Task (IGT) from the test creator, obtained IT approval, and acquired the software. Pilot testing of the IGT is ongoing. Additionally, the team is working to obtain CPHS approval for the study.

***Research Products:*** No publications as of yet. It is anticipated that the results from this work will be presented at I/ITSEC in 2016.

## INDEPENDENT APPLIED RESEARCH PROJECTS

### TAILORING INSTRUCTION TO THE INDIVIDUAL: INVESTIGATING THE UTILITY OF TRAINEE APTITUDES FOR USE IN ADAPTIVE TRAINING

**Start: Oct 13 End: Dec 14**

***Need:*** Little research has been done to determine what makes adaptive training effective. There are many aspects of training that can be manipulated such as difficulty, content, and sequence as well as many factors that can be used as a basis for adaptation such as trainee performance, aptitude, and test scores. Further complicating this issue, training effectiveness can be mediated or moderated by many factors such as trainee motivation, perception of workload, and self-efficacy. Recently, there has been a push by the DoD to create adaptive training systems for military training. Adaptive training decisions should be made on the basis of a strong theoretical foundation, and more research is necessary to determine the optimal method for adaptation. If the research foundation to base design decisions on is deficient, adaptive training systems created to fulfill the needs of the DoD may not be effective.

***Objective:*** The objective of this research is to determine the optimal combination of factors upon which adaptive training feedback algorithms should be based. An experiment was performed to examine the relationship between trainee spatial ability, adaptive difficulty, and level of detail of feedback provided to trainees during instruction. It was hypothesized that participants who received adaptive difficulty instruction that provided feedback tailored to their level of spatial ability would perform best on a post test and transfer test, such that trainees with high spatial ability would perform better when given minimal feedback, while trainees with lower spatial ability would perform best when given more detailed feedback.

***Benefits:*** Adaptive training capability gaps have been documented in several different sources including the Naval Aviation Enterprise Science and Technology Strategic Plan, Naval Science and Technology Strategic Plan, and the Submarine Tactical Requirements Group's (STRG) prioritized focus areas for APB-13. These capability gaps span different warfare areas (i.e., aviation, surface, sub-surface, Marine Corps, joint). The fact that these capability gaps have been documented in several different forums points to the importance of research in this area. This work will serve to inform methodologies on how to adapt feedback to different individual difference levels of trainees.

***Status:*** Committee for the Protection of Human Subjects (CPHS) approval for this experiment was obtained in June 2014. Data collection began July 2014 and was completed in October 2014. The dissertation is projected to be completed by the end of December 2014.

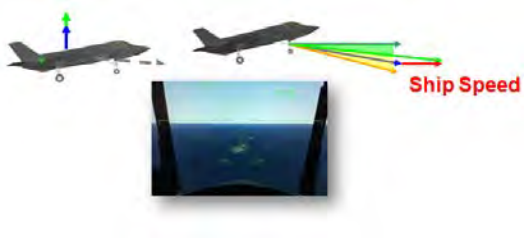
***Research Products:***

Landsberg, C. R. (In progress). *Tailoring instruction to the individual: Investigating the utility of trainee aptitudes for use in adaptive training* (Doctoral dissertation). University of Central Florida, Orlando.

## ADVANCED TECHNOLOGY DEVELOPMENT

### CARRIER QUALIFICATION TRAINING REDUCTION VIA ADVANCED PILOTING SYSTEMS (CQTRAPS) [N68335-14-C-0369]

**Start: Aug 14 End: Aug 16**




***Need:*** Landing on the deck of an aircraft carrier is one of the most difficult and dangerous tasks that Naval aviators must perform. While the current training continuum continues to be highly effective, the total ownership costs associated with live training and the need to maximize aircraft usage beckons for an improvement in aircraft capabilities to reduce initial training and currency requirements. The Maritime Augmented Guidance with Integrated Controls for Carrier Approach and Recovery Precision Enabling Technologies (MAGIC CARPET) integrates automated throttle control during final approach with onboard sensors, control capabilities, aircraft displays, and external visual landing aids to increase safety and reliability, and reduce pilot workload. While designed to improve pilot performance and safety, it is vital that this technology maintain (or potentially improve) training proficiency and readiness on the overall ability of aviators to perform landings. Therefore, the current effort Carrier Qualification Training Reduction via Advanced Piloting Systems (CQTRAPS) seeks to quantify performance benefits through training effectiveness evaluation to understand the impact this technology will have on proficiency and readiness, a vital step in ensuring training proficiency and readiness during training optimization through MAGIC CARPET.

***Objective:*** CQTRAPS will develop an empirical understanding of the MAGIC CARPET system, including its training requirements, effectiveness, and impact on skill decay, learning and workload.

An important overall objective is to estimate cost, throughput, and readiness considerations compared to conventional landing technology.

***Benefits:*** The use of quantitative measures which go beyond typical training effectiveness evaluations that focus predominantly on qualitative assessments of training (i.e., trainee reactions), will provide a more robust understanding of training effectiveness and prevent limitations associated with utilizing data from a single source (i.e., same source bias). MAGIC CARPET has huge potential to reduce costs and increase safety for a high risk task and CQTRAPS will provide empirical data to support the performance, safety, and skill acquisition associated with MAGIC CARPET use when compared to traditional landing technology.

***Status:*** Contract has been awarded and a kick off meeting conducted in FY14. Experimental plans are being finalized based on a workshop conducted under a preliminary FY14 effort. Empirical research will be conducted during FY15.

***Research Products:***


Stacey, W. & Wiggins, S. (2014). *MAGIC CARPET*. Research Report submitted to Office of Naval Research.

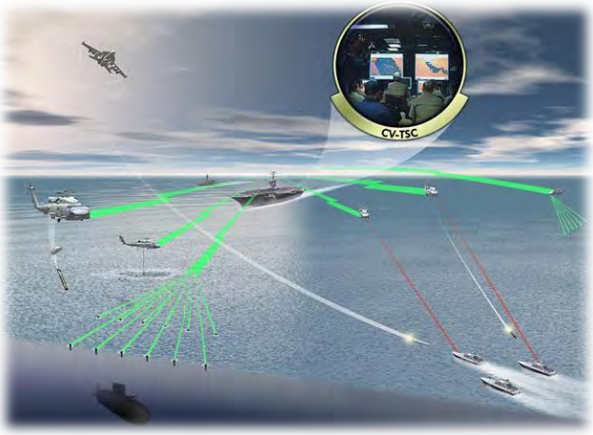
Priest Walker, H. A., Pagan, J., & Walwanis, M. (2014). *Improving the Safety of Carrier Landings: Maritime Augmented Guidance with Integrated Controls for Carrier Approach and Recovery Precision Enabling Technologies (MAGIC CARPET).* Paper presented at The 52nd Annual SAFE Symposium.

Wiggins, S., Pagan, J., Keeney, M.J., Bolton, A., Stacy, W., & Beaubien, J. M. (2014). *The Virtuous Circle and Contextualized Knowledge Elicitation: Application of a New Paradigm for Job Analysis.* Paper presented at the I/ITSEC 2014*, Orlando, FL.*


## HIGH FIDELITY ACTIVE SONAR – COMMAND (HIFAST-CMD)

**Start: Jun 10 End: Sep 14**

***Need:*** Currently, simulation-based training systems for the Sea Combat Commander (SCC) are not integrated in to the Navy Continuous Training Environment (NCTE) and are unable to participate in Fleet Synthetic Training (FST) events. The current Sea Combat Commander training is done in a "vacuum" without regard for the interactions between all of the other warfare areas that the SCC is responsible for in the Strike Group or Surface Action Group (SAG). High fidelity simulation based ASW training will preserve acoustic EMCOM while eliminating the potential impact of encroachment, environmental issues, weapons effects, distance between homeports, and cost of fuel.




***Objective:*** A SCC Zulu Module Training capability will be developed to maintain situational awareness for the ASW challenges of the SCC for training and continuous certification. The Z-Module will leverage from the Intermediate ASW Commander's (IAC 2) courseware for leave behind training between NMAWC SCC certifications. This training is intended to support three training modes: 1) Teach – provides students with guidance on ASW situational awareness and applicable processes and procedures; 2) Prompt – provide students with immediate feedback and suggested corrective actions when prescribed actions or milestones are missed; and 3) Evaluate – provide no feedback or guidance to the student, evaluation/scoring mode. The team is developing the training

requirements and synthetic scenarios to train the SCC in standalone FST-U for staff and integrated multi-unit for H-60 crews, MPRA crews, DDG Combat personnel, and SCC staff in FST-M events.

The Bravo Romeo Acoustic Stimulation System (BRASS) leverages sonobuoy acoustics capabilities from the ASW Virtual-At-Sea Training (VAST) Mission Rehearsal Tactical Team Trainer (MRT3) training device, which is a networked, PC-based trainer designed to support integrated and coordinated ASW tactical training. BRASS provides CV-TSC with the tools necessary to integrate the SH-60B and MH-60R Multi Mission Helicopters sensor data for training. The Virtual CVN is a component that provides two-way communication for LINK/Track without SSDS, Shipboard Radar, and two-way interface to the Navy's Joint Semi-Automated Forces (JSAF) simulation for tracks generated in the CV-TSC. These combined technologies will enable the SCC to have an agile training capability, enhance test and evaluation, and provide a methodology for development of dynamic training scenarios.

***Benefits:*** To use S&T to provide a training capability to the Sea Combat Commander (SCC) the Carrier Vessel Tactical Support Center (CV-TSC). The CV-TSC provides increased situational awareness to the Carrier Strike Group (CSG) SCC in support of force protection, primarily in the area of Anti-Submarine Warfare (ASW). Through the integration of off-board sensors and signal, data and display processors, the AN/SQQ-34 is utilized in detecting, classifying, and localizing threats.

***Status:*** Over this past year, the effort focused on improving the BRASS software and its capabilities and integration with various systems that when combined define HIFAST-CMD. Radar was implemented into BRASS and includes terrain data displays. BRASS provided support to the new integration with the NAVAIR Surface/Aviation Interoperability Laboratory (SAIL) HeloSim. Multiple integrations with BRASS, Camber Corporation VCP software, and NAVAIR SAIL lab HeloSim software on a single blade were performed in Pax River, MD. BRASS and other training systems were fully integrated with current CV-TSC environment and successfully demonstrated improved capabilities. This accomplishment showed greater training capabilities for the MH-60R. The increased fidelity of the passive and active functionality provides a strong foundation for full range dependent ocean model characteristics. The completion of the validation of the BRASS code using the Klocwork code analysis tool for Information Assurance (IA) was performed.

***Research Products***:

- Developed capabilities for Bravo Romeo Acoustic Stimulation System (BRASS) for Sea Combat Commander (SCC), including:
    - Increased fidelity of the passive and active functionality provides a strong foundation for full range dependent ocean model characteristics
    - Developed and implemented Radar to include terrain data displays
    - Modeled multiple helicopters in Joint Semi-Automated Forces (JSAF)
    - Created auto tune for DICASS and DIFAR sonobuoys
    - BRASS system to support eight (8) sonobuoys
    - Enables tracks configurable (MMR, VTR, Link16)
    - Command interface to control the virtual helicopter
- Provided support for the new integrations with NAVAIR SAIL Lab HeloSim
- Participated in multiple integrations with BRASS and VCP on a single blade in Keyport, WA
- Connected BRASS to Aircraft Carrier Tactical Support Center (CV-TSC) to test interoperability and connectivity with NCTE
- Demonstrated BRASS improved training capabilities for the MH-60R

## MODULAR ADVANCED TECHNOLOGIES MARKSMANSHIP PROFICIENCY

**Start: Oct 12 End: Dec 14**


***Need:*** Basic marksmanship training can consume a large number of resources (manpower, range time, ammo). Approximately 15-20% of trainees that are problem shooters can consume 50% or more of these training resources. Therefore, rapid and accurate identification of performance problems is essential to reducing the total cost of basic rifle marksmanship training. However, instructors/coaches do not have access to direct measures of student performance on key marksmanship concepts (trigger control, aim point, hold, stability, breath control, etc.) at the live-fire range to assist with assessment and diagnosis of performance. Rather they must rely on fall of shot heuristic and indirect observation, unlike in simulators where instrumentation can often provide this additional information. A need exists to provide instructors access to additional measures of basic marksmanship performance at the live-fire range.

***Objectives:*** MAT-MP is focused on developing and demonstrating transition ready (TRL 6) marksmanship instructor support technologies for use at the live-fire range. These technology tools shall (1) provide instructors with additional direct measures of marksmanship performance to assist in the assessment and diagnosis of the problem shooter performance, (2) reduce instructor workload by helping to focus attention on the root cause(s) of deficient performance, and (3) support rapid evaluation of alibi claims using actual archived shot data. The goal for these technologies is to ultimately help decrease the time to qualify and increase throughput of problem shooters by helping to reduce the total number of re-shoots and non-qualifications.

***Benefits:*** MAT-MP provides instructors at the Known Distance range a kit of tools to assist in the assessment and diagnosis of problem shooter performance. The shooter's performance can be assessed using his table of order rifle and zero. A set of sensors can be temporarily attached to the rifle platform in under five minutes that stream wireless data back to a software-based instructor assistant application hosted on a tablet computer. The data and assessment information is displayed in a graphical user interface and archived for use in delayed debrief or for alibi purposes. MAT-MP sensors provide data on basic weapon handling including trigger squeeze, trigger follow through, cant angle, buttstock pressure, and steadiness. A camera unit attached to the rear eyepiece of the combat optic provides the instructor with visual evidence of aim point and hold for each shot or series of shots. A replay feature gives instructors the option to step through the video/data frame by frame and compare different shots side-by-side. The instructor graphical interface provides for observation of up to four students at a time.

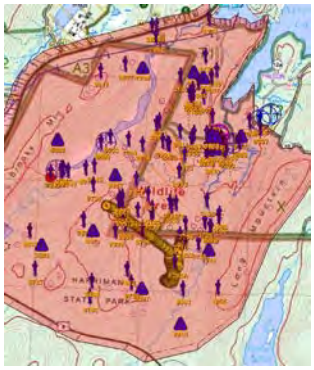
***Status:*** MAT-MP is currently funded by the Office of Naval Research Code 30 Human Performance, Training and Education portfolio. The Mk1 version of the kit was field tested in April 2014 with Marines from Weapons Training Battalion, Quantico. Results of this testing are being used to inform changes for a Mk2 version of the kit that will be completed in late 1st Quarter fiscal year 2015. A transition pathway is currently being designed that will move the MAT-MP technology into long-term field use at active training sites.

***Research Products:***

- Field test of the Mk1 version of the MAT-MP technology kit completed in April 14.
- Technical documentation package Mk2 version December 15.

## TRAINING TRANSFORMATION (T2) INITIATIVE IN SUPPORT OF UNITED STATES JOINT FORCES COMMAND

**Start: Jul 08 End: Sep 14**



***Need:*** A LVC Chemical, Biological, Radiological, Nuclear, High Explosive (CBRNE) Environment is needed that includes live range instrumentation as part of a mobile Chemical, Biological, Radiological, Nuclear, High Explosive Tactical Training System (CBRNE TTS). DoD currently has limited means of conducting realistic and repeatable Combating WMD (CbtWMD) Joint Training, Testing and Experimentation (TT&E) in a LVC CBRNE Environment – not only for passive and active defense, offensive operations, interdiction and elimination, but also for consequence management to include Homeland Defense, Homeland Security, and Civil Support.

***Objective:*** To perform research and development to develop a prototype LVC CBRNE Environment and a CBRNE TTS from emerging technologies to facilitate LVC Joint Training, and TT&E, that can then can be connected to a distributed network such as Joint Training and Experimentation Network (JTEN). The goal is for the prototype to demonstrate the capability to conduct repeatable, realistic LVC CbtWMD Joint TT&E that would help meet relevant capability gaps and deficiencies.

***Benefits:*** These capabilities in a LVC CBRNE Environment will help provide repeatable, realistic TT&E for executing CBRNE-related tactical and operational Universal Joint Task List tasks and displaying the results on Common Operational Pictures distributed to Joint Task Force, Joint Forces Commander and senior leadership at theater and strategic levels. The development of a CBRNE TTS/LVC CBRNE Environment will be a potential solution to the "realism" gap that currently exists.

***Status:*** Over this past year, the effort focused on providing support during several training operations, including USAF Weapons Systems Evaluation Program (WSEP) (Operation Swarm Defense), United States Military Academy at West Point, Air Force Agency for Modeling and Simulation (AFAMS), and Air Force Special Operations Command (AFSOC), using the Cellular Tracking System (CTS). CTS provides accurate tracking and position location information for display of LVC entities on the Common Operational Picture (COP) and facilitates communications interoperability.

Also during this past year, the effort focused on test and training interdependency initiatives to support several training operations, including Initial-Home station Instrumented Training System (I-HITS) and integration with Home Station Instrumented Training System (HITS) for Montana Army National Guard, Fort Harrison; and the 96th Test Wing (TW), Eglin Range.

***Research Products:***

- Demonstrated CBRNE TTS at various events, including Maneuver Support Center (MANSCEN) Science and Technology Conference, JCBRN Conference, and key stakeholders.
- Transferred CBRNE TTS equipment to DTRA to use for RDT&E and Training
- Executed Military Utility Assessment (MUA) with MANSCEN Battle Lab (Dec 2009)
- Demonstrated Interlaced Mobile Ad Hoc Network (IMANET) technologies to be integrated with CBRNE TTS (various facilities, e.g. U.S. Space Command; U.S. Army North (ARNORTH); and Maneuver Support Center of Excellence (MSCoE))
- Developed and Tested Prototype of Cell Tracking System (CTS) capabilities with cellular infrastructure at Whiteman AFB, MO (Apr 2011)

- Conducted various demonstrations of CTS to include: Soldier Monitoring Solutions, Fort Bragg, NC; Jackson Guard, Eglin AFB; Joint Test and Training Operations Control Center (JTTOCC) Limited Test Capabilities; National Guard Bureau, Arlington, VA; Eglin Fire Department; Fire Chief's Monthly Meeting, Niceville, FL; CAI Operations Support Division; Emerald Warrior 2012 Planning Conference, Hurlburt Field; AFSOC at Hurlburt Field and Cannon AFB, NM; Deputy PM TRASYS; and Communications Warning Coordinator for Office of Emergency Management, Orange County, FL.
- Supported DTRA Nimble Elder Exercise, Dahlgren, VA (Apr 2012)
- Supported demonstrations of CTS for Okaloosa County Economic Development Council (Jul 2012)
- Participated in Mighty Guardian and Gator Thunder Exercises with CTS (Oct 2012)
- Tested and Demonstrated Verizon/AT&T cellular capabilities at Cannon AFB, NM (Jun 2012)
- CTS used for U.S. Military Academy (USMA) SMS and Cadet Basic Training on land navigation courses at West Point, NY (Aug 12)
- Supported field testing of production ready software and configurations with 96th Test Wing (TW) Engineers (Oct 13)
- Supported Maritime Operations and SWARM/boat tests on Gulf Range Complex (Feb-Apr 14)
- Demonstrated CTS support with USAF AFSOC/A3TT and 19th SOS during Emerald Warrior 14 Exercise (May 14)
- Supported CTS Operations with 27th SOW, Cannon, NM

## CAPABLE MANPOWER FUTURE NAVAL CAPABILITY RESEARCH

### ADAPTIVE TRAINING FOR COMBAT INFORMATION CENTER (ATCIC)

**Start: Oct 10 End: Sep 14**


***Need:*** Commander Fleet Forces Command identified requirements for shore based trainers with high fidelity simulations to support the Littoral Combat Ship (LCS) Train to Quality (T2Q) and Train to Certify (T2C) strategies to satisfy individual and team-based combat systems. To accomplish this, however, training solutions must be focused on developing higher levels of proficiency than ever for both individuals (T2Q) and for teams of individuals (T2C).

***Objective:*** To conduct research, develop and transition individual and team level Adaptive Training methods and technologies to LCS in order to support efficient and effective tailored training focused on key skills necessary to support T2Q and T2C criteria.

***Benefits***: Based on the results of research on adaptive training, we expect the adaptive training system to improve team performance and reduce time to reach training criteria over non-adaptive systems, while minimizing the impact to instructor workload. As the ATCIC program is advancing the application of adaptive training to the tactical scenario based training environment and, as such, research conducted under this effort can provide guidance for adaptive training in complex team environments.

***Status:*** The ATCIC program has secured a Level A Technology Transition Agreement with the LCS Program Office (PMS505). Therefore, work currently being performed in FY14 places emphasis on the transition of the adaptive training software to scenario based training for the Littoral Combat Ship shore based tactical simulations. Initial transition of ATCIC products will occur in FY15 for LCS TAO Combat Systems Trainers for individual tactical skills training. Work has begun to support transition of team level adaptive training products to the LCS Integrated Team Trainers in the FY16 timeframe.

***Research Products:***

- Portable Adaptive Training Instructor Operator Terminal (PATRIOT): Software demonstrating proof of concept of individual and team level scenario based adaptive training capabilities.
- TAO Sandbox/DARTS: Software tool to support assessment of individual level tactical proficiency for Tactical Action Officer and Commanding Officers. This software combines a scenario based training tool (TAO Sandbox) and a Diagnostic and Rapid Testing System (DARTS)
- FY13 Blueprint Architecture Report Submitted to Office of Naval Research.

Milham, L. M., & Pharmer, J.A. , & Fok, A. (2013). Training effectiveness evaluation of real-time metacognitive feedback. Proceedings of the 2013 Interservice Industry Training Simulation and Education Conference (I/ITSEC)

Milham, L. M., & Pharmer, J.A., & Fok, A. (2013) Adaptive instructor operating systems: Design to decrease instructor workload and increase effectiveness. Proceedings of the 2013 Interservice Industry Training Simulation and Education Conference (I/ITSEC).

Munro, A. & Clark, R. E. (2013) Cognitive task analysis-based design and authoring software for simulation training. Military Medicine. 178 (10:7), 7-14.

Pharmer, J.A., & Milham, L.M. (2012). Development of an adaptive training capability for combat information centers. *The NAVAIR Journal for Scientists and Engineers.*

## ADAPTIVE TRAINING FOR SUBMARINE PILOTING AND NAVIGATION

**Start: Oct 09 End: Sep 14**


***Need:*** The Submarine Fleet Commander has identified requirements to improve the training of high-level decision-making skills for submarine commanders and crews, as well as the training and performance of submarine piloting and navigation teams (Prioritized Undersea Requirements Letter for POM-10, 10 August 2007). Further, there has been a push to incorporate adaptive training and tutoring capabilities into the classroom. For instance, in President Obama's Strategy for American Innovation, he called for a federal focus on learning technologies as an area of national priority. He recognized the need to invest in science and technology to improve learning and performance by announcing the creation of Advanced Research Projects Agency for Education (ARPA-ED). As a result, the Chief of Naval Research has also issued a Grand Challenge to develop software tutors to address DoN training needs. Likewise, the Submarine Tactical Requirements Group (STRG) has pushed this notion beyond the classroom and recently released their prioritized focus areas for Advanced Processor Build (APB)-13, which included developing "on-board adaptive training tools to support both individual operator instruction and integrated team training for sonar, combat control, imaging and electronic sensing systems." The Office of Naval Research has anticipated this need and is currently sponsoring a Capable Manpower (CM) Future Naval Capability (FNC) Enabling Capability (EC) entitled "Adaptive Training to Enhance Individual and Team Learning and Performance" to address the gaps in adaptive training and decision making.

***Objective:*** The objective of this project is to advance the capability of existing and future simulation-based training programs used by the submarine community, by incorporating sophisticated performance measurement and diagnosis as well as instructional adaptivity tailored to strengths and weaknesses of individual trainees. Specifically, the focus is on providing intelligently adaptive training for the Piloting and Navigation team during surfaced submarine operations.

***Benefits:*** We expect the adaptive training system to increase performance and reduce time to reach training criterion over non-adaptive systems. Additionally, we expect increased effectiveness and efficiency of decision-making processes (e.g., a reduction in time required for information search and communications, reduction in inappropriate and/or unnecessary actions being taken). In FY12, we collected data with 105 students from the Submarine Office Basic Course (SOBC) in order to evaluate the effectiveness of our adaptive training system as compared to a non-adaptive training system. We found that students in the adaptive training groups performed Angle on the Bow (AOB) calls significantly faster, completed training in less time, were more consistent in their improvement, and had higher learning gains than students who received non-adaptive training.

***Status:*** In FY14, the NAWCTSD team continued further development of the Periscope Operator Adaptive Trainer (POAT). More specifically, the team supported POAT Step 3 and Step 4 (At Sea) Integration for Advanced Processor Build (APB)-13. This has included further development of the adaptive training system including adding additional instructional content, increasing scenario content, fine-tuning the adaptive training algorithms, and integrating with the APB-13 Learning Management System (LMS). Toward this end, we developed 4 versions of POAT: 774 & 688 versions for tactical system installs and 774 & 688 laptop versions for Submarine On-board Training (SOBT) installs.

At the request of COMSUBLANT, we are developing POAT+ to include adaptive training tools for Surface Ship Contact Recognition and Familiarization. Toward this end, we are creating (1) a Contact Familiarization module which will allow operators to review surface ship characteristics under various

environmental conditions and review sensor capabilities, and (2) Contact Identification functionality within the POAT adaptive trainer.

Additionally, NAWCTSD completed one manuscript (accepted for publication) and is in the process of preparing 2 peer-reviewed journal manuscripts documenting the results of the 6.2 research performed under the ATSNAP program.

***Research Products:***

- A Level A TTA is currently in place with Tactical Systems Integration Section, Undersea Warfare Division, Office of the Chief of Naval Operations (N97) and Program Executive Office, Integrated Warfare Systems, Undersea Systems (PEO-IWS5).
- FY14 Periscope Operator Adaptive Trainer demonstrated
- POAT was delivered to Submarine Onboard Training (SOBT) for training on-board as well as the schoolhouse and is currently completing the SUBLAN certification process.
- POAT+ is transitioning as part of APB-15. POAT+ recently passed APB-15 Step 1 (Technology Evaluation) and will complete Step 2 (Algorithm Assessment) by the end of the ATSNAP program.
- POAT+ will also be delivered to Submarine Onboard Training (SOBT) at the completion of the program.
- 2013 Naval Air Warfare Center Aircraft Division (NAWCAD) Commander's Award
- 2013 Admiral Luis De Florez Training and Simulation Award

Van Buskirk, W.L., Steinhauser, N.B., Mercado, A.D., Landsberg, C.R. & Astwood, R.S. (2014). A Comparison of the Micro-Adaptive and Hybrid Approaches to Adaptive Training. To appear in Proceedings of the 2014 Annual Meeting of the Human Factors and Ergonomics Society.

Landsberg, C.R., Mercado, A.D., Van Buskirk, W.L., Lineberry, M. & Steinhauser, N. (2012). Evaluation of an Adaptive Training System for Submarine Periscope Operations. Proceedings of the 56th Annual Meeting of the Human Factors and Ergonomics Society [CD-ROM].

Landsberg, C. Astwood, R. S., Van Buskirk, W. L., Mercado, A., Townsend, L., & Steinhauser, N. (2012). A review of adaptive training theory and techniques. *Military Psychology, 24*(2), 96-113.

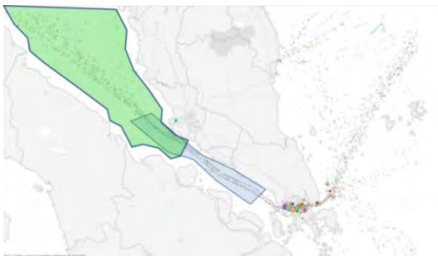
Landsberg, C. R, Van Buskirk, W. L., Astwood, R. S., Mercado, A.M., & Aakre, A. (2010). *Adaptive training considerations for use in simulation-based systems* (Special Report 2010-001). Naval Air Warfare Center Training Systems Division.

Van Buskirk, W. L., Campbell, G, E., Landsberg, C.R., Steinhauser, N.B., Astwood, R. S., Mercado, A.M., Pittard, J.& Tolley, D. (2014). *Embedded Adaptive Training Systems: Periscope Operator Adaptive Trainer.* Functional Description Document for Advanced Processor Build (APB)-13. Naval Air Warfare Center Training Systems Division.

Van Buskirk, W. L., Campbell, G, E., Landsberg, C.R., Steinhauser, N.B., Astwood, R. S., Mercado, A.M., Pittard, J.& Tolley, D. (2014). *Embedded Adaptive Training Systems: Periscope Operator Adaptive Trainer- Plus.* Functional Description Document for Advanced Processor Build (APB)-15. Naval Air Warfare Center Training Systems Division.

## DISTRIBUTED, ADAPTIVE, AND MODULAR ENTITIES FOR Unmanned Aerial Systems (DYADEM)

**Start: Mar 14 End: Mar 18**



***Need:*** The Navy is facing limited live training opportunities due to cost, time, & fidelity constraints. There is also a lack of realism of large numbers of semi-automated force (SAF) in current constructive training technologies produces a readiness gap. Operators must put forth a significant time and effort to develop and integrate SAF into constructive exercises for UAS operators. What is needed is an activity learning and recognition technology based on sensor data to generate theatre level, realistic SAFs quickly and effectively by reproducing 'Patterns of Life', which are SAF activity patterns based on raw data that are realistic and intelligent, for training UAS operators, known as the Training Pillar for Unmanned Aerial Systems Interface, Selection, and Training Technologies (UASISTT). The Dynamic Adaptive and Modular entities for UAS (DyAdeM) effort will deliver the tools, standards, and guidelines to generate large numbers of realistic semi-automated force (SAF) behaviors in a format that can be integrated into the Navy's SAF generation technology. The primary requirement of this product is to aid the integration of hundreds, if not thousands, of simulated entities into the overall training scenario that aviation requires. The DyAdeM approach will include replacing hand-coded rule sets with a capability to automatically generate new and appropriate SAF behaviors from one or more data sources including: data captured during live UAS exercises; data captured from experts operating their systems within a simulated environment; or data provided in a script-like format. Based on one or more of these initial data sets, it should then be possible to model those behaviors and extend those models to provide new behaviors that will drive SAF entities in a training environment. This approach will require integrating cognitive modeling approaches with machine learning techniques to generate tactically authentic behaviors.

***Objective:*** Conduct advanced technology demonstration research to deliver the tools, standards, and guidelines to generate large numbers of realistic SAF behaviors in a format that can be integrated into the Navy's SAF generation technology.

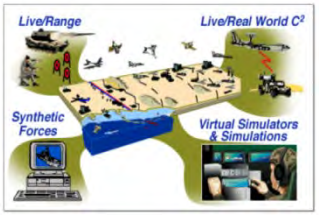
***Benefits:*** The desired products from this technical area will provide the underlying behaviors that drive SAFs that can be integrated into the Navy's SAF generation technology. The SAF behaviors driving the large numbers of entities that provide the ecological background against which the 'Patterns of Life' scenario plays out will be the focus. SAF behaviors will provide a more realistic and effective training experience, while also requiring less input from their human operators.

***Status:*** Contracts has been awarded and a kick off meeting conducted. The three components that make up DyAdeM, (1) Activity Learning, (2) Behavior Envelopes, and (3) Behavior Generation have been demonstrated for the ONR sponsor. Integration and demonstrations are planned for FY15.

***Research Products:*** DyAdeM. Demonstration for ONR sponsor (Oct 14).

## LIVE, VIRTUAL, & CONSTRUCTIVE (LVC) TRAINING

**Start: Oct 11 End: Sep 16**




***Need:*** The Naval Science and Technology Strategic Plan cites the need for optimized physical readiness and enhanced cognitive performance as well as immersive, synthetic systems for training and education. Live, virtual and constructive (LVC) training environments may offer opportunities to bridge this gap. LVC environments are growing in size and complexity and are geographically distributed. As a result, increased demands are being placed on developers, instructors and operators and

their ability to integrate, configure, and deploy these assets effectively.

***Objective:*** This effort will define the S&T questions that underpin products of the three LVC enabling capability product pillars: Virtual Constructive Representations on Live Avionics Displays (VCR LAD), Cognitive Fidelity of Synthetic Environments (CFSE), and Tactics and Speech Capable Semi-Automated Forces (TACSAF). The proposed effort involves (1) understanding the safety concerns of blending L, V and C environments and developing mitigation strategies; (2) understanding the virtual fidelity training needs for carrier-based landings; and (3) developing a generative SAF behavior capability that accounts for trainee needs.

***Benefits*:** The payoffs of this enabling capability are the ability to enhance fleet readiness, lower total ownership costs, improve safety, and reduce security risks. First, the proposed capability will enable training complex realistic scenarios with rich authoritative tactical content. This will alleviate challenges associated with inadequate range/airspace availability, scarce live adversarial assets, and availability of training personnel. Second, enabling the use of LVC assets appropriately will mitigate frame life expenditure for operational assets, assist with increasing pressures to reduce the flight hour budget and decrease the cost of steaming days/flight operations. Third, increased use of simulation is cited as a mitigating strategy for improving safety considerations associated with Blue Threats. Finally, enhancing the use of LVC will reduce security risks by moving some tactical exercises and development off of the range and out of sight.

***Status:*** **VCR LAD:** Fidelity and hazard data via surveys and interviews has been collected with participants of varying levels of experience. Also, an experimental design has been finalized and data collection has begun to assess the impact of VC displays on operators.

**CFSE:** Component technologies of a performance assessment suite (i.e., quantitative, qualitative, physiological measures) have been integrated and tested. Further, experimentation on how motion cueing and enhanced image generation system impact performance and learning has been conducted. Finally, the first half of experimental data has been analyzed and briefed to transition customer. Preparations for Experiment 2 are underway.

**TACSAF:** Experimental planning was finalized in FY14 and preliminary data collected. A demonstration of capabilities was provided to transition the customer to receive feedback that is currently under implementation. Also, test and integration of both products within the transition environment (i.e., Next Generation Threat System) was completed.

***Research Products:*** 2013 Admiral Jeremy M. Boorda Award For Outstanding Integration of Analysis and Policy-Making, Civilian Category.

- TACSAF demonstrated both component technologies to transition customer in AUG/SEP 14
- Integrated LVC Demonstrations at I/ITSEC 2012 and 2013

Chladny, B., Hebert, K., & Colbert, B. (2014). *Simulating Realistic Light Levels in Next Generation Image Generators*. Manuscript accepted to Interservice/Industry Training, Simulation & Education Conference 2014. Orlando, FL.

Cruit, J. K., Blickensderfer, B. L., Martin, T., Neville, K. J., Sherwood, S. M., & McLean, A. L. M. T. (2014). An analysis of past mishaps to consider Live-Virtual-Constructive safety [Abstract]. *Aviation, Science, and Environmental Medicine, 85* (3), 326.

Cruit, J., Blickensderfer, B. L., Martin, T., Neville, K., Sherwood, S., McLean, T., Walwanis, M., & Bolton, A.M. (2014). Live-Virtual-Constructive training: Implications of a mishap analysis. *Proceedings of the Aerospace Medicine Association's 2014 Annual Conference*, San Diego, CA.

Dykens, I., Swigert, B., & Mataafa, S. (2014). *Hypothesized strategies of metacognitive development: Debrief and active shadowing.* Research proposal submitted to the Training Technical Advisory Group of the Human Factors and Ergonomics Society.

Engler, J., Schnell, T., & Walwanis, M. (2013). *Deterministically Nonlinear Dynamical Classification of Cognitive Workload.* Paper presented at the Interservice/Industry Training, Simulation & Education Conference, Orlando, FL.

Engler, J., & Schnell, T., (2013). *Measuring and Monitoring Cognitive Workload in Training Environments.* Paper presented at the Interservice/Industry Training, Simulation & Education Conference 2013, Orlando, FL.

Martin, T., Sherwood, S., Neville, K. McLean, A.L.M.T., Walwanis, M., & Bolton, A. (2014). Integrating new technology into Navy air combat training: A training guidance gap analysis. Poster presented at the *American Society of Safety Engineers Safety 2014 Professional Development Conference,* June 8-11, Orlando, FL.

Neville, K. (2014). *Integrating Live-Virtual-Constructive technology into the complex system of Navy air combat training*. Invited presentation in the Orlando Chapter of the International Council on Systems Engineering (INCOSE), April 18, Orlando, FL.

Neville, K., Bond, A., Walwanis, M., & Bolton, A.M. (2014). Human-machine integration and the systems development process model. Manuscript submitted to *Ergonomics in Design: The Quarterly of Human Factors Applications*.

Pagan, J., Kaste, K., Reni, J. F., Atkinson, B. F. W, Sciarini, L., & Walwanis, M. (2013). *Next Generation Semi-Automated Forces (SAFs): A Guidance Model*. Paper presented at the Interservice/Industry Training, Simulation & Education Conference 2013. Orlando, FL.

Sherwood, S., Neville, K., Ashlock, B., Mooney, J., Walwanis, M., Bolton, A., & Martin, T. (2014). Envisioned world research: Guiding the design of live-virtual-constructive training technology and its integration into Navy air combat training. *Proceedings of the 2014 Annual Meeting of the Human Factors and Ergonomics Society*. Thousand Oaks, CA: Sage Publishing.

Sherwood, S., Neville, K., Blickensderfer, B., McLean, A., Walwanis, M., & Bolton, A.M. (2014). *The identification and assessment of hazards associated with the introduction of new technology into a complex air combat training system*. Manuscript under review.

Sherwood, S., Neville, K., McLean, A.L.M., Cruit, J., Kaste, K., Walwanis, M., & Bolton, A. (2014). *A multi-year study of the safety and training impacts of introducing the live, virtual, constructive training strategy into Navy air combat*. To be submitted to the 18th International Symposium on Aviation Psychology, May 4-7, 2015, Dayton, OH.

Sherwood, S., Martin, T., Neville, K., Blickensderfer, B., & Cruit, J. (2013). *Adapting Navy air combat training to take advantage of new technology*. Poster presentation to the Embry-Riddle Aeronautical University (ERAU) Board of Trustees, November 1, Daytona Beach, FL.

Stacy, W., Walwanis, M., Bolton, A., Beaubien, J., & Wiggins, S. (2014). *Using Temporal Occlusion to Assess Carrier Landing Skills.* Manuscript accepted to Interservice/Industry Training, Simulation & Education Conference, 2014. Orlando, FL.

Wiggins, S., Keeney, M., Pagan, J., Bolton, A., Stacy, W., & Beaubien, J. (2014). *New Job Analysis Paradigm: Virtuous Circle and Contextualized Knowledge Elicitation.* Manuscript under review.

Wiggins, S., Pagan, J., Keeney. M., Bolton, A., Stacy, & Beaubien, J. (2014). *The Virtuous Circle and Contextualized Knowledge Elicitation: Application of a New Paradigm for Job Analysis.* Manuscript accepted to Interservice/Industry Training, Simulation & Education Conference 2014. Orlando, FL

Wray, R. E., & Woods, A. (2013). A Cognitive Systems Approach to Tailoring Learner Practice. *In Proceedings of the Second Annual Conference on Advances in Cognitive Systems ACS (Vol. 21, p. 38).*

# NAVAL INNOVATIVE SCIENCE AND ENGINEERING PROGRAM

*" ... promote and maintain scientific vitality...."*

**Program Manager: CDR Henry L. Phillips IV, Ph.D.**

The Naval Innovative Science and Engineering (NISE) Program was created under Section 219 of the Duncan Hunter National Defense Act for Fiscal Year 2009. It is intended to promote and maintain the scientific vitality of Naval laboratories by funding innovative in-house research in support of military missions, the transition of technology development programs into operational use, and workforce development activities. There are three categories of NISE projects.

The Basic and Applied Research category consists of in-house research projects to explore the fundamental aspects of military relevant phenomena and determine ways in which those phenomena can best be used by the military. There are two principle objectives to such projects. First, the projects attempt to answer basic or applied research questions that are of direct military relevance. Second, the projects allow Naval laboratory personnel to grow and maintain expertise in technical areas that are of interest to the Navy.

The Workforce Development category of projects is intended more explicitly to build the capability of Naval labs through personnel training and laboratory capability development. There are four subcategories of workforce development projects. Training projects allow laboratory personnel to attend special training courses that will enhance their ability to perform their assigned duties. Higher Education projects assist lab personnel in obtaining advanced degrees that are relevant to their Navy mission. Strategic Rotation projects promote the sharing of information across Navy laboratories and agencies by providing funding so that lab personnel can go on rotation to other laboratories, warfare centers, and agencies. Strategic Growth projects are intended to enhance laboratory core capabilities. Examples include support of strategic positions within the workforce, development of critical skill sets, or support of unfunded capability requirements.

Finally, the Transition category provides funding for pre-Milestone A bread board or brass board demonstrations and prototyping efforts to demonstrate critical performance parameters of key technologies. As such, it provides a vehicle by which concepts that were developed under In-House Laboratory Independent Research (ILIR), Independent Applied Research (IAR), and NISE Basic and Applied Research projects can be further matured.

During FY13 and 14, NAWCTSD scientists and engineers led nine Basic and Applied Research projects, eighteen Workforce Development projects (four of which targeted Strategic Growth), and three Transition Research projects. The following pages outline Basic and Applied Research, Workforce Development: Strategic Growth, and Transition Research projects.

## BASIC AND APPLIED RESEARCH

### ASSESSMENT OF THE IMPACT ON HUMAN-SYSTEM PERFORMANCE USING AN AUGMENTED REALITY MAINTENANCE SYSTEM (ARMS)

**Start: Nov 13 End: Sep 15**

***Need:*** While there have been phenomenal advances in Augmented Reality (AR) technology, there is concern that the technical development has proceeded blindly, without regard for the technical parameters and characteristics that primarily drive the systemic goal of improved human performances. However, human performance improvements have largely been disregarded in AR development. The research that has been conducted has painted a complex picture. Early work in AR development indicated that there were performance improvements to be gained, but subsequent studies revealed conflicting results; some found no effects, while others found performance decrements, potentially due to the attention garnering effects of the AR embellishments themselves.

One domain that has received some attention is the use of AR in maintenance applications. Research in the early 1990s addressed AR training for the assembly of bundles of electrical wires for Boeing aircraft. Later work investigated mobile AR applications with access to maintainer databases, as well as the development of the Augmented Reality Maintenance and Repair (ARMAR) system and its head-mounted display focused technology. The Augmented Reality Maintenance System (ARMS), developed in 2012, presents an alternate configuration that emphasizes workbench applications. Maintenance tasks are actually a great application for this technology due to the task focus on visual identification and comparison to a body of knowledge - a mirror of the AR process overall.

***Objective:*** The purpose of this experiment is to evaluate whether the Augmented Reality Maintenance System (ARMS), as a supporting technology in recognizing printed circuit boards and identifying errors in their configuration, will significantly enhance maintainer performance, and maintenance efficiency and effectiveness. The ARMS consists of hardware and software configured to a recognized printed circuit board (PCB), to identify discrepancies from a baseline configuration of the PCB, and to display the PCB schematics and procedures for the user to view while troubleshooting the PCB under assessment. At the present time there is only one ARMS unit in existence but a second ARMS unit is planned to support the evaluation. It is hypothesized that maintainer performance will be enhanced when the standard method of PCB diagnosis is supplemented by or integrated with augmented reality (AR) compared to the standard method of PCB diagnosis without AR support.

The experiment will compare the performance of three types of volunteer participants: 1) participants who have no experience in performing aviation maintenance, 2) participants who are aviation maintainers but who do not work with PCBs, and 3) participants who are aviation maintainer who routinely work with PCBs. It is anticipated that the experimental data with be collected at NAS Patuxent River, MD, and that the ARMS will be relocated to each participating squadron to facilitate efficient data collection since the documentation for performing PCB diagnosis is located at the participating squadrons, and to minimize the impact of the experiment on the actual work of the participants.

The skill and knowledge of each participant with respect to evaluating PCBs will be assessed and demographic information will be collected by a questionnaire prior to participation in the experiment. Each participant will be asked to evaluate the condition of several PCBs configured in three different states: 1) correctly configured boards, 2) boards with incorrectly installed parts, and 3) boards with part failures using both the ARMS and the standard method. Protocol will include training on the ARMS. After completing the evaluation of the boards, each participant will be asked to complete a questionnaire on the usability of the ARMS and the standard method. The accuracy of the diagnosis

and the time to complete the evaluation of each PCB will be compared across conditions to determine whether performance in the AR supported condition surpassed performance in the control conditions. In addition, the demographics and experience information will provide covariate information for the experiment. It is anticipated that the experiment will require a minimum of ten (10) participants from each of the experience groups for a total of 30 subjects, and twelve (12) PCBs with four (4) boards in each of the three (3) maintenance conditions.

***Benefits:*** The evaluation of USN/USMC maintenance personnel performing printed circuit board analysis with AR provides an understanding of how best to move forward for various maintenance conditions and/or if investment in the technology will provide necessary improvements for a return on investment to be realized for this particular application.

The practical applications of this work are twofold. First, the work will advance state of the art Augmented Reality research in that it will allow for refinement of software used in AR systems. Second, the application of AR software and technology will be used to enhance current training systems by developing just-in-time (JIT) training scenarios with adaptive training mitigations built in that are computer generated and operator selectable.

***Status:*** This project began in FY 14. This year experimental design has been completed, and Institutional Review Board application is currently being assembled. It is anticipated that the experiment will be conducted in the 2nd and 3rd quarters of FY15.

***Research Products:*** It is anticipated that the results will be presented at I/ITSEC 2015.

## DEVELOPING WARFIGHTER TRAINING GUIDANCE FOR CUE RECOGNITION OF TRUSTWORTHINESS IN CULTURALLY-COMPLEX ENVIRONMENTS

**Start: Oct 13 End: Dec 16**

***Need:*** Current and future warfare missions require relationship-building and negotiation skills to foster trust with locals to gain strategic information and thwart enemy forces. Personnel at all levels are expected to communicate with the local populace and leaders, Non-Governmental Organizations, and foreign military in a culturally-appropriate manner, while conveying trustworthiness. However, it is difficult to predict behavior for culturally-distant individuals. The US military was not always perceived as effective with cross-cultural trust development and rebuilding (e.g., criticisms noted from actions during and after the Ehime Maru). However, with the Pentagon reporting plans to shift 60% of the Navy's warships to potentially-kinetic Asia by 2020, it has become a mission-critical factor to understand and effectively project trustworthiness cues that are valued by non-Western cultures. With movement to other countries in which we have not sustained long-term presence for conflict missions, it is not only pertinent for training region-specific knowledge, but culture-general interpersonal strategies to increase mission success. The purpose of this research is to examine the Intercultural Model of Trust, which proposes relations between culture and perceptions of trustworthiness of another when involved in risky situations. Results will provide the empirical foundation to train cue identification and an understanding of how trust can deteriorate and be rebuilt in culturally-complex environments.

***Objective:*** The purpose of this research is to test relationships predicted by the Intercultural Model of Trust, developed at NAWCTSD, which proposes relations among culture, trustworthiness, trust, and outcomes. The experiment allows for the ability to analyze which trustworthiness cues (i.e., ability, benevolence, integrity) are most valued by individuals and across cultures. This information is critical for the Warfighter's intellectual reservoir to leverage for effective and timely decision-making, especially when cultures are different. With this information and enhanced decision-making strategies, they can understand cues that are often valued by the culture in which they operate, consequently, enhancing the probability of displaying behaviors that reflect these cues and increasing

trustworthiness perceptions. Additionally, the authors are particularly interested in understanding the trust process when the outcome of the risk-taking relationship is *negative* (reducing the level of trust) and the parties have to collaborate in the future for a shared task. The results will provide the empirical foundation to train trustworthiness-cue identification and an understanding of how trust can deteriorate and be rebuilt in culturally-complex environments.

***Benefits:*** The results yielded will support the Naval research labs by expanding our current knowledge of trust development and rebuilding, decision making, and culture. Consequently, they will inform training objectives that will address the needs of the Warfighter currently operating abroad to support a global force for good. Further, understanding the trust process in cross-cultural environments can also improve cross-cultural competence, which can subsequently save lives of both the Warfighter and other nationals. With this increase in cultural situational awareness, the Warfighter can become more fluent in gaining intelligence, and preventing unnecessary confrontations and situations that could escalate into insurgency.

***Status:*** During FY14, the research design was finalized and participant pool was identified. Approval through the Committee for the Protection of Human Subjects will be attained before data collection commences in FY15.

***Research Products:*** It is anticipated that the research results will be presented at I/ITSEC 2016 and published in FY16 in a peer reviewed journal.

## IMPROVING TEAM PROBLEM-SOLVING AND DECISION-MAKING USING COMMUNICATION PROTOCOLS

**Start: Oct 13 End: Sep 15**

***Need:*** As individuals, we tend to approach our worlds by filtering information in very idiosyncratic ways. In order to solve problems in a collaborative manner, it is helpful to make our thought processes more explicit to others. The Ladder of Inference, and the related strategies of Advocacy and Inquiry, may improve decision-making and problem-solving by helping people bring their assumptions and beliefs to the surface. Carefully guided discussions, aided with communication protocols, may allow people to resolve misguided assumptions, beliefs and conclusions before they take action. This process may be especially critical in collaborative problem solving environments.

***Objective:*** Evaluate the effectiveness of a set of communication protocols for improving team discussions, problem-solving, and decision-making effectiveness. The protocols will be based on The Ladder of Inference: a simple, metaphorical visual reference that can be used to explain the mental pathway that people often follow when reacting to an event or trying to solving a problem. The bottom rung of the Ladder represents the observation of an event, while the next rung up symbolizes the act of selecting a subset of available data to pay attention to; with the next rungs representing adding meaning, making assumptions, drawing conclusions, adopting beliefs, and taking action (the top of the Ladder). People tend to “travel up” the Ladder very quickly and without much conscious thought. We intend to evaluate the use of three communication protocols using the Ladder as the framework. One protocol will have team members focus on Advocacy (making their reasoning explicit to a teammate), a second will focus on Inquiry (asking questions in order to understand their teammate’s reasoning), and a third will focus on both Advocacy and Inquiry. We will examine performance outcomes related to the task (speed and accuracy) as well as measures related to the team’s social interaction and members’ satisfaction with the decision.

***Benefits:*** These approaches may improve decision-making and problem-solving by helping people resolve misguided assumptions, beliefs and conclusions before they take action. They may also be useful in the context of military or civilian after action reviews, to help people truly understand why events unfolded the way they did and where they may have gone astray in their logic, so costly mistakes can be avoided in the future. These methods may also offer a powerful leverage point in workplace communication by helping to reduce misunderstandings and tension. They have an obvious role in helping people move beyond arguments or disagreements. If proven effective, we will

train our workforce to make these techniques a foundational habit. If Advocacy and Inquiry (using the Ladder of Inference) become widely used workplace habits, we will have an accepted tool and framework to inquire about others' reasoning, without being rude or worrying about hurt feelings. The Ladder of Inference can be used to reach better conclusions or challenge other peoples' conclusions by giving people a method to begin a conversation at the bottom of the Ladder, where they can talk more readily about observable reality instead of arguing about conclusions they have already drawn.

***Status:*** Experimental design has been completed. Experimental tasks and written scripts for training materials have been developed. The research protocol has been approved by the Committee for the Protection of Human Subjects (CPHS). The research team is producing a training video to be used in the study and will soon begin recruiting participants.

***Research Products:*** The research protocol, "TSD 213, Improving Team Problem-Solving and Decision-Making Using Communication Protocols" has been approved under the authority of Department of Defense Navy Assurance Number DoD N-40037.

## INFORMATION PRESENTATION MODALITY: A PHASED SOLUTION

**Start: Aug 11 End: Sep 15**

***Need:*** Operators of Unmanned Aerial Systems (UASs) are commonly presented with dizzying arrays of information. Under such circumstances, the most complex and difficult requirement of the job may be processing and attending to the varying displays with the proper sense of urgency. Multiple screens and interfaces demand sensation and perception in multiple modalities, often triggering the Modality Shifting Effect (MSE), a dip in performance associated with unexpected or uncertain information sources. Eliminating or mitigating MSE can improve operator reaction time and accuracy by removing this uncertainty.

***Objective:*** Develop a technique for changing from one modality to another which does not distract, confuse, or compromise the operator. This effort is intended to mitigate MSE, which is otherwise a detriment to both operator accuracy and reaction time.

***Benefits:*** An uncompromised operator may be able to monitor or operate multiple UASs simultaneously. Conversely, when freed from the deleterious effects of the MSE, an operator may be able to monitor a single UAS using fewer resources, thus enhancing performance, improving operator efficiency, and minimizing negative consequences associated with cognitive overload.

***Status:*** The PI has acquired an experimental testbed on which to conduct hypothesis testing to determine the optimal modality switching technique. This testbed has been subsequently tailored to allow the experimenter to intentionally overload the visual/auditory sensory channels of the participant, change the information presentation modality in real time, and assess participant performance all while the participant is conducting realistic UAS operator tasks. Pilot testing has been completed and data collection has begun, with results available in FY15.

***Research Products:***


Alicia, T. J. (2012). Utilizing a phased technique to mitigate the modality shifting effect: An initial examination. Proceedings of the Human Factors and Ergonomics Society 56th Annual Meeting, Boston, MA.

Alicia, T. J. (2014, May). *The bridging technique: Crossing over the modality shifting effect.* Presentation given at the 68th Department of Defense Human Factors & Engineering Technical Advisory Group, Aberdeen Proving Ground, MD.

## NEXT GENERATION OF AVIATION SELECTION: UNMANNED AERIAL SYSTEMS

**Start: Oct 11 End: Sep 15**

***Need:*** Over half of the Unmanned Aerial System (UAS) mishaps documented from 1980-2003 point to human factors/human causal factors as the predominant cause. One solution that will help mitigate and reduce these types of mishaps is the implementation of a selection tool that will select personnel that have the ability to acquire the proper skill sets needed to deal with emerging UAS systems and technologies. However, the only existing tool designed for unmanned aviation platforms is the Computer Based Performance Test (CBPT) that was developed for the legacy system, Pioneer. A great need exists to determine whether the skills assessed by existing selection tools used for manned aviation also predict success in unmanned aviation.

***Objective:*** Investigate the utility/generalizability of a manned aviation validated selection tool (i.e., Performance Based Measurement Battery (PBMB)) for Unmanned Systems.

***Benefits:*** Providing a validated selection tool designed for UAS platforms will yield a significant cost avoidance by supporting the selection of those individuals who are most likely to succeed in training, thereby improving performance, minimizing attrition, and reducing training costs overall. This effort will define the way forward for the Navy in the burgeoning area of UAS selection by providing leverage points and gaps for future selection test development efforts.

***Status:*** During year 3, tests that were identified as having high construct validity for domains also assessed by the PBMB (i.e., convergent measures) were used to begin data collection. The goal of this phase of data collection is to identify whether the PBMB measures the constructs it is purported to measure (i.e., its construct validity). Fifty percent of the construct validity data has been collected to date and other half will be collected in the coming months. The construct-valid PBMB subtests identified during this investigation will be used in Phase 3 to assess whether or not the PBMB predicts UAS task performance.(i.e., criterion/predictive validity).

***Research Products:***


Pagan, J. (2014). *Unmanned Aerial System (UAS) selection: Construct validating the Performance Based Measurement (PBM) battery*. Presentation given at the 68th Department of Defense Human Factors & Engineering Technical Advisory Group, Aberdeen, MD.

Pagan, J., Issen, H. (2014). *Next generation of aviation selection: unmanned aerial systems phase 1*. Technical report in progress.

Pagan, J. (2012). *Unmanned Aerial System (UAS) selection: Validating the Performance Based Measurement (PBM) battery*. Presentation given at the 67th Department of Defense Human Factors & Engineering Technical Advisory Group, Dayton, OH.

Pagan, J. & Vincenzi, D. (2012). *Unmanned Aerial System (UAS) selection: A path forward*. Presentation given at the 67th Department of Defense Human Factors & Engineering Technical Advisory Group, Dayton, OH.

## Optimal Learner Support for Improving Adaptive Reasoning About Complex Simulation Systems

**Start: Oct 12 End: Sep 14**

***Need:*** As simulations of complex systems such as human physiology become more realistic and comprehensive, it is unclear how best to use such simulations for exploratory learning. As in aviation and other simulation domains, high-fidelity simulation can actually overwhelm learners and inhibit their ability to discern system principles. As it currently stands, the two most prominent instructional theories largely disagree on how much support should be given to learners trying to understand an unfamiliar system. Cognitive load theory (CLT) recommends against unguided discovery learning and encourages instructional strategies that ease learner's cognitive load by guiding learners to solutions. On the other hand, the Error Management Training approach (EMT) is more favorable toward unguided discovery learning, and treats errors as valuable learning opportunities that should be intentionally pursued.

***Objective:*** The goal of this experiment is comparison of two approaches to managing learners' mental effort in complex simulations in order to determine an optimal approach.

***Benefits:*** Findings from this study may guide instructional designs, perhaps recommending one approach over the other or a combination of principles from each. Given that CLT studies typically do not assess adaptive transfer, it is possible that this study will result in a major re-evaluation of previous findings from the CLT domain.

***Status:*** In FY14, we modified our experimental materials based on results from our previous pilot study. Forty-eight biology majors from UF participated in a new study; their ages ranged from 19-40 with a mean age of 22. Nineteen of the participants were female and twenty-nine were male. Students were randomly placed into one of two training conditions. One condition was designed to be consistent with principles of CLT while the other emphasized principles of EMT learning. Analyses are underway to determine if one learning strategy was superior. The results of the research will be published in a peer-reviewed journal.

***Research Products*:**

Landsberg, C. R., Julian, D., & Lineberry, M. (in progress). Examining instructional strategies: Cognitive load theory versus error management theory. Refereed.

## Optimizing Performance of Trainees For UAS Manpower, Interface & Selection (OPTUMIS)

**Start: Oct 12 End: Sep 15**

***Need:*** Unmanned Aerial System (UAS) platforms that employ winged aviators as air vehicle operators (e.g., Predator) have shown significantly higher mishaps than those that select operators that are non-pilots (e.g., Shadow). One explanation for these findings may be negative training transfer from manned to unmanned platforms as operators are separated from the aircraft, thus depriving them of a range of sensory cues (e.g., visual information, kinesthetic/vestibular input, sound). Another explanation for the high Predator mishaps may be associated with Ground Control Station (GCS) design. Some

researchers cite interface and automation confusion and difficulty with system management as primary causes for Predator human factors related mishaps. These findings suggest that poor system design may be a large contributor to UAS mishaps. These varying explanations for differences in mishap rates across platforms indicate that manpower/personnel, training and design issues should all be considered when developing a mitigation strategy.

***Objective:*** The goal of this study is an investigation of differences in Knowledge, Skills, and Abilities (KSAs) and performance among UAS operators, Air Traffic Controllers (ATCs), and manned pilots to support identification of the right people to operate UASs who will be most likely to succeed in training and operations. Additionally, this effort will investigate methodologies that provide interface design guidance directly linked to KSAs to support GCS development optimized for operator performance; thereby improving safety and reducing mishaps.

***Benefits:*** Currently, there is no validated qualification standard for UAS operators. For example, some Naval and Air Force UAS platforms (e.g., Triton, Firescout, Predator) require their operators be winged aviators. This requires a roughly $1 million investment per pilot and years of pilot training, with UAS platform specific training still being necessary. The Shadow UAS program, on the other hand, uses junior to mid-grade enlisted personnel with no pilot experience. The training program for Shadow pilots is about 10 weeks long and about a third of the investment (about $347K) of manned aviators. Adapting a personnel model similar to that of the Shadow, if supported by analyses underway, could yield a significant cost avoidance of about $653K per operator. This effort seeks to provide baseline data for future efforts regarding selection testing, manning requirements, training, and system design.

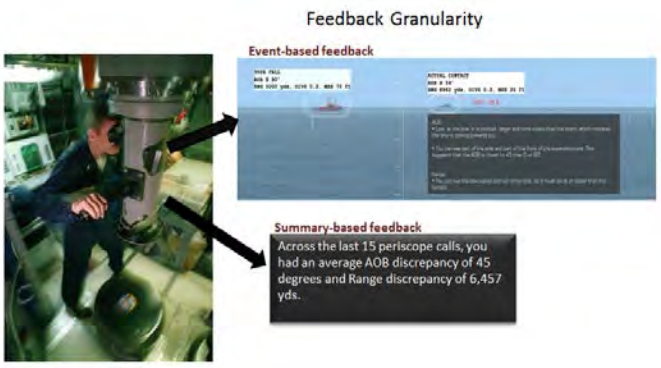
***Status:*** A qualitative analysis of existing KSAs for manned and unmanned aviators was completed. Additionally, UAS KSA to task linkage data has been collected. Data has also been collected to support the classification of KSAs into those most suitable for selection and training. Analysis of this data is currently underway. Task workload data for classifying design KSAs will be collected in FY15.

***Research Products:***

Pagan, J., Astwood, R. & Phillips, H. (2014). *Operator qualification differences between manned & Unmanned Aerial System (UAS).* Accepted for presentation at the Interservice/Industry Training, Simulation & Education Conference (I/ITSEC), Orlando, FL.

## THE EFFICACY OF FEEDBACK PARAMETERS IN ADAPTIVE TRAINING SYSTEMS

**Start: Oct 13 End: Sep 16**




***Need:*** The DoN, along with other DoD services and private industry, is exploring innovative methods and technologies to train its workforce. Recently, the Submarine Tactical Requirements Group has decided to leverage the capabilities of emerging technologies such adaptive training (AT) tools to provide on-board training to individual operators as well as teams. Despite the potential for success of AT systems, there is much that is unknown regarding the best ways to optimize AT systems. For example, when providing feedback to trainees, AT system designers can manipulate a number of different parameters of the feedback (e.g., content, timing, modality, granularity, etc.). However, the AT research literature provides little guidance as to the optimal approach for implementing and delivering feedback within the system.

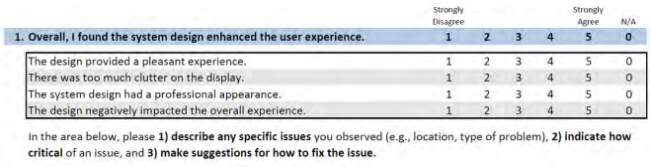
***Objective:*** The objective of this study is to examine the relationship between feedback granularity [e.g., feedback presented after each response (event-based) or feedback presented over a series of responses (summary based)], feedback timing (e.g., feedback presented immediately or after a delay), and adaptivity within an AT system. Specifically, the researchers will seek to determine the combination of feedback parameters that leads to optimal performance within an AT system. The results will help provide system designers guidance on the development of feedback in future AT systems.

***Benefits:*** Previous research results have shown that an AT system can improve performance while requiring less training time. For instance, when using a submarine periscope task, previous researchers found that an adaptive training approach lead to higher learning gains, trainees made faster periscope calls, and over 33% of trainees were able to end training earlier than were students trained using a non-adaptive training system. Further, this adaptive training approach lead to higher effect sizes as compared to traditional simulation based training techniques – *d* = .50 compared to *d* = .28 and .37 found in previous meta-analysis. Further development and refinement of adaptation techniques could be expected to lead to higher effect sizes and learning gains than those outlined above. Therefore, these outcomes can be expected to improve the Navy's ability to provide tailored, individualized instruction to operators without increasing overall training costs, time, or number of instructors. The findings of this body of research are expected to improve training effectiveness and mission performance across a broad range of tasks and missions. The automated aspect of adaptive tutoring is expected to do this in less time and at lower cost than current simulation and training practices.

***Status:*** This project began in FY14. An experimental design has been developed, and Institutional Review Board (IRB) application is in process.

## USABILITY SURVEY ENABLING RESEARCH AND ASSESSMENT FOR INTUITIVE DESIGNS (USER AID)

**Start: Apr 10 End: Mar 15**



| | Strongly Disagree | | | | Strongly Agree | N/A |
|---|---|---|---|---|---|---|
| **1. Overall, I found the system design enhanced the user experience.** | **1** | **2** | **3** | **4** | **5** | **0** |
| The design provided a pleasant experience. | 1 | 2 | 3 | 4 | 5 | 0 |
| There was too much clutter on the display. | 1 | 2 | 3 | 4 | 5 | 0 |
| The system design had a professional appearance. | 1 | 2 | 3 | 4 | 5 | 0 |
| The design negatively impacted the overall experience. | 1 | 2 | 3 | 4 | 5 | 0 |

In the area below, please **1) describe any specific issues** you observed (e.g., location, type of problem), **2) indicate how critical** of an issue, and **3) make suggestions for how to fix the issue.**

***Need:*** System design for the development of operational and training capabilities requires a balance between meeting functional requirements and system usability.

***Objective:*** Develop an empirically validated heuristic-based tool to support usability assessment and generation of design guidance.

***Benefits:*** The results of this work will impact the systems engineering communities' ability to develop systems in two key ways: accessibility and generalizability. First, a survey-based assessment tool will increase accessibility to testing; thereby supporting early and consistent identification of usability issues by providing a means of data collection that does not rely on gathering a group of usability experts. Second, a generalizable tool can be leveraged by any operational or training device providing widespread benefits.

***Status:*** A qualitative analysis of existing heuristic and usability survey approaches was conducted to expand a current heuristic approach. This analysis was followed by a card sort analysis to validate the heuristics and example design guidance groupings. These analyses have resulted in the development of UI-TEACH (User Interface - Table for Evaluating & Analyzing Composite Heuristics). A pilot reliability study was conducted to refine the survey, entitled EQUATE (Experience-based Questionnaire for Usability Assessments Targeting Elaborations). In addition to finalizing the analysis

of the psychometric testing completed in FY14, an empirical study will be conducted in early FY15 to document the benefits of prescriptive feedback and understand the ability of EQUATE to collect feedback from usability experts and novices.

***Research Products:***


Government Colloquium. Atkinson, B., (2013, August 28). USER AID: Usability Survey Enabling Research & Assessment for Intuitive Designs. NAVAIR Fellows NISE Workshop-Patuxent River, MD/DCO Chat. NAVAIR Fellows.

Atkinson, B. Tindall, M., & Ponto, S. (2014) Post-Mission Assessment for Tactical Training-Trends Analysis (PMATT-TA) Usability Report (NAWCTSD-TR-2014-0001).

Atkinson, B., Kaste, K., (2014). The Importance of Usability Analysis in Functional Design: State-of-the-Practice vs. State-of-the-Possible. *NAVAIR Journal.*

Ponto, S. J., Atkinson, B. & Tindall, J. M. (2014). Open-ended feedback to enhance survey data: Evaluating a novel heuristic-based usability assessment tool. *Naval Engineering Journal.*

Atkinson, B., Kaste, K., & Tindall, M. (In Progress). EQUATE Psychometric Development and Validation.

Atkinson, B., Kaste, K., & Tindall, M. (In progress). Unique Approach to the development of a heuristic based usability assessment. HFES Submission.

Briefing on data analysis process to staff, students, and interns who supported initial data collection efforts. (2010, November 29 - 2010, December 02). Embry Riddle Aeronautical University/University of Central Florida.

USER AID: Usability Survey Enabling Research & Assessment for Intuitive Designs. (August 2013). Presented at the NAVAIR Fellows Naval Science and Engineering Innovation Workshop, Patuxent River, MD/DCO Connect.


## WORKFORCE DEVELOPMENT: STRATEGIC GROWTH

### A BRAVE NEW "VIRTUAL" WORLD: THE USE OF VIRTUAL WORLD APPLICATIONS FOR MILITARY TRAINING

**Start: May 14 End: Sep 17**

***Need:*** The DoN has been successfully employing digital technology to enhance training for decades and continuously seeks emerging technological capabilities to keep pace with military challenges and to maintain the technological edge over those entities that may threaten us. The Naval Aviation Enterprise (NAE) Science and Technology Objectives (STO), Naval Warrior Performance (NWP) Capability Gap STO-1 (Training and Education) calls for the development of education and training technologies that cost-effectively maximize transfer of knowledge from the classroom and trainer to the operational environment.

***Objective:*** Representatives from NETC N7 contacted NAWCTSD about developing a distributable virtual environment in support of individual CENTRIXS training. One potential training solution is to utilize a VW capability to support this requirement. However, NAWCTSD currently does not have such a capability in-house. NAWCTSD has access to commercial VWs, but these commercial platforms are not approved for use on DON networks and do not offer a secure environment for research and development. Therefore the goal of this project is to:

1) Develop a secure UNCLAS in-house VW capability at NAWCTSD, utilizing the Army's Military Open Simulator Enterprise Strategy (MOSES) virtual environment,

2) Provide NETC N7 and U.S. Navy's Tactical Training Group Atlantic (TTGL) with a CENTRIXS VW training tool in support of Joint Operations FST events, as an initial use case for evaluation of the secure NAWCTSD VW instance, and
3) Evaluate the effectiveness of the CENTRIXS VW training tool compared to that of the traditional CENTRIXS training.

***Benefits:*** The critical skills and expertise that will be developed through this effort fall into two categories:

a) Supportability: Model rendering, development, utilization, and maintainability of VW assets, training content and environment, to include expertise in supportability and maintainability of the MOSES-enabled VWs to NAWCTSD System Administrators and Information Assurance Managers.
b) Research-based: Experience at development, evaluation, and validation of training scenarios and content in VW environments. The lessons learned and practical experience developed through hands-on design and execution of VW training validation research will be critically important to 4.6's ability to execute the VW elements of its S&T roadmap. Hands-on experience in understanding how to evaluate environment, avatar, and physics-based fidelity requirements as they relate to training scenario scope, design, modeling, and evaluation are critically needed.

***Status:*** Startup funds were received in May 2014. During FY14 the team submitted the DADMS application questionnaire and received permission to utilize the Firestorm OpenSim Viewer within the RDT&E lab environment. The Firestorm Viewer is necessary to connect to the MOSES Virtual World. The team also requested and received approval from NAWCTSD IA to open DREN ports to allow connectivity to the MOSES server. Lastly, a dedicated workstation for VW system development and a laptop for data collection were purchased.

***Research Products:***

Government Colloquium. Astwood, R., Slosser, S., Maxwell, D., (2014, May 20). Military Open Simulator Enterprise Strategy (MOSES) Information Exchange. University of Central Florida's Institute for Simulation and Training-Orlando, FL. Milano Hyacinthe - NAWCTSD's Human Engineering Performance Lab Information Assurance Officer.

## ADVANCED LOW-POWER WIRELESS MESH/AD HOC NETWORK DEVICE CAPABILITY DEVELOPMENT

**Start: Dec 13 End: Sep 14**

***Need:*** The NAWCTSD Rapid Prototype Design and Fabrication Lab's mission is to provide NAWCTSD rapid prototyping and electro-mechanical design and fabrication for the creation and support of advanced training system technologies, components, assemblies, and turnkey systems. The secure wireless control and flexible ad hoc integration of training devices such as simulated tactical devices, instrumented weapons and dispersed range instrumentation sensors are key technology drivers for future Live-Virtual training systems. Highly portable, low power wireless technologies are expected to play an increasingly important role in future training systems. The flexibility, ease of integration and installation and "self-repair" capability of a wireless mesh/ad hoc network makes their use very attractive in dynamic Live-Virtual training systems and environments.

Previous to this project, Laboratory personnel had no first-hand component-level design experience with emerging low-power wireless mesh and ad hoc network device technologies. Continually improving the capabilities and experience of Lab personnel is critical to meeting future rapid prototyping requirements.

***Objective:*** The objective of this project was to provide Lab personnel hands-on experience and engineering data on the abilities and limitations of the newest generation of low-power wireless mesh and ad hoc network-enabled devices in environments representative of those encountered in Live-Virtual training systems. Obtaining this experience is critical to the Lab's ability to understand and effectively integrate this technology into future devices and systems.

***Benefits:*** The Lab now possesses the knowledge necessary to judge the suitability of low-power wireless mesh/ad hoc networking technologies to specific training environments and quickly create custom circuits incorporating those technologies. The reference circuit designs and lessons learned from the effort have been documented and added to the Lab's design portfolio. The capability is self-supporting; the knowledge gained is organic to the NAWCTSD Rapid Prototype Design and Fabrication Lab and shall inform or be incorporated, as appropriate, into future proof of concept and rapid prototype devices and systems. The ability to integrate this technology will both impact laboratory custom prototypes and allow personnel to provide subject matter expertise to acquisition programs considering this technology.

***Status:*** The project is complete. Two wireless device types were integrated with laboratory-designed printed circuit boards to create generic test devices, shown above, for the testing of bi-directional communications. These devices were tested for range, transmission delay, data throughput and mesh creation/resilience in environments representative of actual usage in Live-Virtual training systems. Test results were collected and documented. The developed circuits, devices and enabling firmware exist as reference designs; starting points for further device development.

***Research Products:***

- Reference Designs – Complete electrical and mechanical data package for the Digi ZB SMT and Atmel ZigBit Test Devices.
- Reference Firmware – Source code for the test device embedded intelligence (Texas Instruments MSP430-series microcontroller).
- Test Results and Summaries – Results of performance testing.

## HUMAN PERFORMANCE MODEL VALIDATION PROCESS

**Start: Jun 13 End: Oct 15**

***Need:*** The Navy has recognized the value of human performance modeling as a means of determining optimal manpower requirements to meet mission effectiveness capability objectives for developing platforms, systems, and subsystems. More specifically, discrete event modeling of the interaction of operators and maintainers in the context of a design reference mission allows opportunities to cost effectively conduct design tradeoffs that include hardware/software/human considerations.

However, one impediment to fully capitalizing on the power of these models, once developed, is the time and resources required to verify, validate, and accredit these models and their outputs for a specific acquisition program within tight timelines. Modeling techniques used for acquisition decisions should be verified and validated by the acquisition program for use to assess the system design against capability requirements. Often, by the time these tools are fully validated within programs, their predictive capability is no longer needed because the decisions they could have supported have long since been made. Therefore, approaches that minimize the verification and validation timeline (e.g., "pre-validation" of reused/modular code,

validated test procedures for classes of model requirements, and improvement in efficiency of validation procedures and standards) are being investigated as part of this effort.

***Objective:*** The current effort has two objectives:

1) ***Develop methods/guidance/and requirements language*** for efficiently validating discrete event human performance models. These deliverables will leverage performance models developed as part of the Virtual CVN 78 (VCVN 78) program to predict sortie rates in support of design tradeoffs of various human/hardware configurations.
2) ***Disseminate the validation process requirements*** derived from this effort into Human Systems Integration (HSI) process standards currently being developed by the Navy HSI Working Group (NHSIWG). The principle investigator for this proposed effort is currently the lead of the NHSIWG whose membership consists of representatives from each of the Navy Systems Commands (SYSCOMs). The charter of the NHSIWG is to develop common HSI policy and processes across these SYSCOMs.

***Benefits:*** As a result of this effort, personnel within the NAVAIR Human Systems Department working on system acquisition programs will be able to more effectively participate in systems engineering and design tradeoff decisions using validated tools to support them.

***Status:*** Although proposed as an FY15 start, the Human Performance Model Validation Process project was initially funded and kicked off in late FY14. The focus of this effort thus far has been to support the VCVN 78 Integrated Product Team (IPT) in prioritizing system requirements and developing and refining a process for change control, risk assessment, verification, and validation.

***Research Products:*** Forthcoming products in FY15 consist of published standards and guidance for validation of human performance models.

## NAWCTSD Knowledge and Laboratory Expertise Advancement Regarding the Application of Cutting-Edge Embedded Signal Processing Designs to Military Training and Simulation

**Start: Oct 13 End: Sep 15**

***Need:*** Due to DoD's and DoN's widespread adoption of Commercial-Off-The-Shelf (COTS) PC-based hardware, the NAWCTSD Concept Development & Integration Laboratory (CDIL) and Weapons Simulation & Integration Laboratory (WSIL) have gained extensive knowledge and experience over the past two decades developing PC-based, Microsoft Windows software applications to meet digital signal processing requirements for military training and simulation. New and emerging operational requirements posed by the military training and simulation community are similar to consumer demands for mobile devices (i.e. harsh environmental conditions, strict power limitations, small footprint, and parallel processing capabilities), and such requirements are difficult to meet using COTS PC hardware. Signal processing requirements can likely be met more cost-effectively by using the latest generation of embedded processor technologies, which offer simplified design and development cycles, orders of magnitude greater performance over PC-based systems, higher efficiency, and more reliable operation.

Figure 1: Current PC-based solution which leverages COTS and custom based solution

Figure 2: Leverage state of the art embedded technology for a fully custom small scale, environmentally robust design

***Objective:*** A proof-of-principal prototype of an embedded two-channel version of a Virtual Tactical Bridge (VTB) will be designed and built using an embedded processor executing the critical portions of PC based software libraries. VTB is a live-to-virtual radio communications interface in use by the Navy, Marine Corps, Army, and Air Force for training purposes.

***Benefits:*** Enhance the expertise and capabilities of the labs while developing a technology that can be evaluated and used by the fleet. Practical knowledge and experience will be achieved through the proposed VTB design and development cycle. The prototype system will be used as a reference design for future work and as a technology demonstration for DoN and DoD sponsors with emerging requirements that emphasize reliability, form factor, power efficiency, and duty-cycle.

***Status:*** Funding was released in FY14 as well as continuation of the effort through FY15. Major tasks completed during FY14 included identifying a target embedded platform and porting the critical software to the chosen embedded software environment. The FY15 development effort will include continuing software and hardware development which will produce an available prototype for demonstration purposes.

***Research Products:***

- Hardware/Software Prototype (Sep 15).
- Technology Demonstration (Sep 15)

## TRANSITION

### HUMAN PERFORMANCE BASED SIMULATION CERTIFICATION CRITERIA TEST AND EVALUATION JOB AID – REQUIREMENTS TRACING TOOL (RETT)

**Start: April 14 End: Sep 16**

***Need:*** There is a critical need for developing new processes that supports the development and evaluation of training simulations (AIR-46 Core Capabilities and Future Directions document, 2012). To address this, this effort will develop a job aid to guide the development and tracking of required training capabilities with physical training system attributes from initial concept to test, evaluation, and certification procedures. This approach will facilitate verification and validation of whether simulations actually meet training performance requirements by insuring a tight coupling between simulation "build to" specification to training performance requirements across the acquisition lifecycle.

***Objective:*** The objective of this work is to develop a job aid to improve simulation certification (SIMCERT) processes currently in development by the USN. Current simulator validation/verification processes assess whether all required elements in the simulator specification are included in the design, and whether they meet functional requirements at the level of fidelity specified. Where these processes are deficient, however, is in the integration of these "build to" specifications with the evaluation of whether the simulator's training capabilities are achieved. This effort speaks to that shortfall by coupling design and test of human performance-based requirements and simulation "build to" specifications.

***Benefits:*** The tools and processes developed under this effort can support the SIMCERT process by resulting in acquisition of effective training devices with training capabilities as the central focus of the analysis, and thereby, better trained warfighters. This effort will improve the capability of developing, verifying, and validating whether simulations, as defined in "build to" specification also

meet training performance requirements. This capability, the Simulation Certification Criteria: Human Performance Test and Evaluation Tool, can be used to support the acquisition process of planning, implementing, testing, and certifying training devices.

***Status:*** Funding was received in mid-FY14. Job aid system requirements are currently in development.

***Research Products:*** It is anticipated that the results from this work will be presented at I/ITSEC in 2016.

## PERFORMANCE ASSESSMENT TRENDS IN TRAINING ENHANCING READINESS REPORTING FOR NAVAL SYSTEMS (PATTER$^2$NS)

**Start: Oct 13 End: Sep 16**


***Need:*** The current state-of-the-practice in assessing performance often involves instructors monitoring multiple members of an aircrew simultaneously, making it challenging to keep track of each student's performance.

***Objective:*** The objective of PATTER$^2$NS is to increase training effectiveness and efficiency with improved capabilities for automated performance measurement and trend analysis through the development of an intuitive user interface design and thoroughly tested technologies.

***Benefits:*** This technology is anticipated to provide up to a 28% improvement in training effectiveness/enhanced fleet readiness due to standardized, real-time and longitudinal diagnostic feedback. Utilizing this data will increase instructors' ability to provide readiness generating feedback for P-8 crews. The use of automated technologies and simulator data (e.g., network data from simulator subsystems, performance measures) is anticipated to result in a 70%-80% reduction in manual data entry, thereby reducing manpower requirements and costs. While P-8A is the target transition platform, the benefits of these technologies (as outlined above) have applicability to virtually any live or simulated training platform. Due to the focus on Anti-Submarine Warfare (ASW) training for P-8A, the technology will be adaptable to meet other ASW platforms (e.g., MH-60R/S, BAMS) with relatively minor enhancements. Additionally, because of the extensibility to post-mission and readiness reporting, there is applicability for meeting operational requirements.

***Status:*** An iterative round of usability assessments were conducted on the Post Mission Assessment for Tactical Training & Trend Analysis (PMATT-TA). A technical report documenting the results is in progress. Testing was conducted on the Performance Measurement (PM) Engine to verify generalizability and reliability of measures for an alternative platform. Integrated testing of PMATT-TA and PM Engine have been on-going at a contractor's facility. Planning for testing of the products within a realistic environment is underway. A study protocol is under development to baseline the debrief process for future analysis in comparison with debriefing augmented by post mission reporting and real-time performance assessment technologies. Preliminary efforts for certification and accreditation of technologies at the conclusion of the effort are underway.

***Research Products:***

- The Post Mission Assessment for Tactical Training & Trend Analysis (PMATT-TA), a web-based software application to collect and store mission data, generate post mission reporting documents and facilitate trend analysis of post mission data.
- The Performance Measurement (PM) Engine software collects simulator and instructor input data to calculate performance indicators for individual and crew measures.

- Performance Analysis & Trends in Training Enhancing Readiness Reporting for Naval Systems (PATTER2NS). Exhibit accepted for display in the US Navy booth at the 2012 Interservice/Industry Training, Simulation and Education Conference.

Government Colloquium. Atkinson, B., Grubb, L., Fiacco, R., (2014, June 05). PMA-205 Air Warfare Training Development (AWTD) IPT Meeting. NAWCTSD-Orlando, FL.

Atkinson, B. Tindall, M., & Ponto, S. (2014) Post-Mission Assessment for Tactical Training-Trends Analysis (PMATT-TA) Usability Report (NAWCTSD-TR-2014-0001).

## UNMANNED AERIAL SYSTEM COMMON CONTROL STATION PROTOTYPE-BASED TRAINING RESEARCH

**Start: Jun 13 End: Dec 16**

***Need:*** To meet the demand for cost effective training for unmanned aerial systems (UAS) operators, research and development on embedded training approaches for future UAS systems requires a CCS prototype to ensure effective transition to operational systems. This prototype must be used to design, develop, and evaluate competing embedded training approaches.

***Objective:*** Software will be developed using UAS Control Segment architecture, Systems Support sub-domain. An additional objective is to enable cross-warfare center (WD, AD, TSD, and Navy Yard) integration of efforts to support PMA-281's CCS development. The primary focus of the proposed effort is to develop and evaluate appended training approaches for the employment of the CCS. The lab currently has components (image generator for an existing UAS onboard trainer, instructor station capabilities, multiple sensors, environmental databases) that can initially serve as stand-ins for higher fidelity models as required.

***Benefits:*** Leverage multiple professional disciplines to develop training with service oriented architecture, human system interface orientation, and adaptability for different UAS platforms. NAWCTSD will expand its design, development/research capabilities into UAS control station training issues (currently primarily focused on Undersea and Special Forces training). By working with Patuxent River and China Lake on CCS issues, risk of stove piped training development will be avoided and research findings can be leveraged by all development efforts.

***Status:*** FY13 start-up funding was used to perform document review, technical discussions, and telephone meetings to evaluate work to date and current requirements for the Patuxent River CCS Prototype. Two NAWCTSD computer scientists conducted a hardware and software specification review and site visit to NAS Patuxent River to further clarify future requirements. FY 14 resulted in hardware and software specification development, hardware and software license procurement and integration to develop the CCS prototype. Additional procurements will be required in FY15 to complete the prototype, and software interface specification between the tactical CCS and the training capabilities will be initiated.

***Research Products:***

Hadden, K., Prince, M., (2015, December 16). Common Control System (CCS) Training Software Interface Requirements Specification..

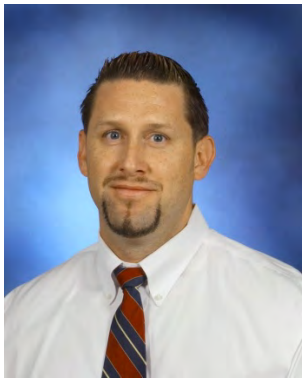
Yelverton, R., Bowens, L., Garris, R., (2016, September 15). Training Implications for Common Control System (CCS). Not archived.

Hadden, K., Prince, M., Bowens, L., (2016, September 30). Lessons Learned in Developing Training for the Common Control System (CCS). Not archived.

# TRANSITION RESEARCH PROGRAMS

*" ... reduce the level of risk associated with a newly demonstrated technology ... "*

**Program Manager: John Hodak**



Most technologies are developed and demonstrated in the usual progression from Basic Research (BA1) through Applied Research (BA2) and Advanced Development (BA3). In the Navy's S&T program, a series of demonstrations occurs that starts with simple experiments and finally leads to proofs of concept. As the technologies become mature during this progression, some need additional demonstration or refinement before they can be transitioned to the Fleet. These transition efforts are supported with Advanced Component Development and Prototype (BA4) and Operational System Development (BA7) research category funds, and occasionally by Congressional funding designated for technology transition efforts.

The purpose of transition research is to reduce the level of risk associated with a newly demonstrated technology to make it ready for direct implementation by the Fleet or transition to the acquisition community. The transition research step demonstrates final products and prepares them for procurement, bridging the gap between progressive demonstrations of technology and full-scale implementation.

The current transition research at NAWCTSD is being conducted under the Air Warfare Training Development (AWTD) Program, sponsored by Program Management Activity for Aviation Training Systems (PMA 205). The research efforts in this program focus on the following technologies: learning methodologies for large-scale simulations, integration of intelligent components into training, automated measurement, and advanced visual system and sensor technology.

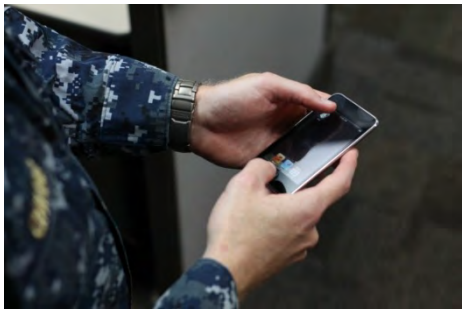
The Phase III portion of the Small Business Innovation Research Program is also considered a part of the Transition Research Portfolio.

Finally, there are two technology transition programs funded and managed by ONR. They are the Technology Insertion Program for Savings (TIPS) and the Tech Solutions Program. The TIPS program seeks to accelerate technology maturation in a very short time into DoN programs of record to meet urgent naval needs and at the same time significantly reduce operations and support costs. The Tech Solutions Program aims to provide the fleet and force with prototypes that deliver 60-80 percent solutions which address immediate needs and can be easily transitioned by the acquisition community. This past year NAWCTSD had one active TechSolutions project.

The NAWCTSD transition research projects are described on the following pages.

## INTELLIGENT TUTORING AND AUTHORING DELIVERY SYSTEM (ITADS)

**Start: Aug 13 End: Dec 15**



***Need:*** Intelligent Tutoring Systems (ITS) offer an impressive capability to the military training community, but the government cannot afford to continue to purchase single-point solutions. The government needs non-proprietary tools to author and delivery ITS capability – tools which will increase the affordability of future ITS development.

***Objective:*** This project seeks to develop a government-owned suite of Intelligent Tutoring authoring and delivery tools, complete with content that supplements existing "A" school training for the Information Technology (IT) rating with simulation-based, hands-on trouble shooting exercises.

***Benefits:*** By developing a suite of Intelligent Tutoring authoring and delivery tools, the government will be better prepared to address current and future training needs with Intelligent Tutoring technology in an affordable and effective manner.

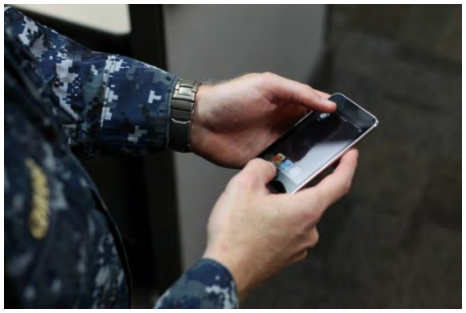
***Status:*** Significant progress has been made in FY14. System Requirements Review / System Functional Review (SRR/SFR), Preliminary Design Review (PDR), and Critical Design Review (CDR) are complete. Three requirements analysis workshops, two design analysis workshops, and one development workshop have been held to solicit feedback on user requirements, system design, and user interfaces for the tutoring system and the authoring system from typical students and instructors at the Center for Information Dominance. The shipboard virtual computer network environment has been built. Two of seventeen training scenarios based on knowledge gaps have been designed. Two interfaces for teaching the six-step troubleshooting process have been developed and, based on student input, the final system will incorporate both versions. The next major step is to integrate the tutoring environment and the virtual shipboard environment. Detailed planning for upcoming testing, including both system engineering testing and training effectiveness testing, is underway.

***Research Products:***

- ITADS Software Requirements Specification (SRS) (Aug 14).
- ITADS Software Design Specification (SDD) (Aug 14)
- ITADS Trainer Engineering Report (TER) (Aug 14)

## INTELLIGENT TUTORING FOR SIMPLE KEY LOADER

**Start: Aug 13 End: Sep 14**



***Need:*** The Navy needs to evaluate the capability of candidate Intelligent Tutoring technologies to support critical training requirements. One such technology, under development by the Army Research Laboratory – Human Research and Engineering Directorate, is the Generalized Intelligent Framework for Tutoring (GIFT).

***Objective:*** In this project we will assess and demonstrate the capability of GIFT to support the rapid and affordable development of an Intelligent Tutoring System that effectively trains a critical skill, the ability to use the Simple Key Loader (SKL) in conjunction with cryptography equipment.

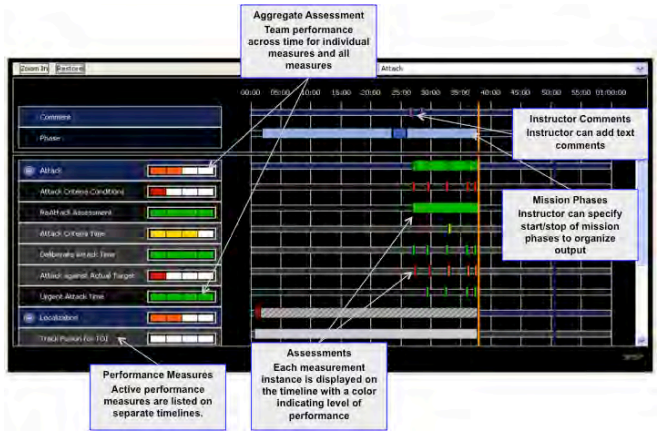
***Benefits:*** If successful, this project will contribute towards the development of a government-owned Intelligent Tutoring technology and will demonstrate the capability of that technology within the context of training a critical skill that cuts across all services.

***Status:*** This project is complete. A proof-of-concept, 3 hour intelligent training program was developed using the GIFT infrastructure and a simulated SKL. The training was tested at the Center for Information Dominance with 15 students, nine who had just finished their IT 'A' School curriculum and six who were just beginning their IT 'A' School curriculum. A handful of deficiency reports (DRs) were noted during this test. Despite these deficiencies, the training was found to be highly effective. Both groups of students showed statistically significant improvement in their ability to identify effective segments of key material on any given date, based on the start date and crypto period of the associated Short Title. A report detailing the process of developing the training and the strengths and weaknesses of the underlying training engine, GIFT, was written and delivered to the customer.

***Research Products:*** Technical report delivered in Sep 14.

## PERFORMANCE MEASUREMENT (PM) ENGINE

**Start: Oct 08 End: Sep 15**




***Need:*** A critical aspect of scenario-based training is the ability to provide students with performance feedback, resulting in a call for technologies that aid instructors in providing the right feedback.

***Objective:*** The PM Engine work focuses on developing capabilities for individual and team level performance measures that are competency-based and automated to support real time feedback and debriefings.

***Benefits:*** Development of automated performance measurements and trend analysis tools will facilitate distributed After-Action Review (AAR) and allow Navy aviation users to select and automate the collection of mission-relevant data and performance measures as part of distributed, networked simulator events. Such tools provide cost avoidance through meeting reduced manning requirements, decreasing the time required for preparation of post-mission debriefs, and increasing training focus to ensure that training objectives are met to support fleet readiness.

***Status:*** A baseline technology for collection of automated performance measures was developed, with necessary standards defined for collecting performance related data from simulator network traffic established. A set of measures were defined and implemented for Anti-Submarine Warfare (ASW), Anti-Surface Warfare (ASuW), and Intelligence, Surveillance, Reconnaissance and Targeting (ISR&T) for the P-8A. Preliminary performance testing was completed in a lab environment. A certification and accreditation for the software application is underway. Continued development will focus on configuration, real-time display, and after action review of performance measurement results.

***Research Products:***

- The Performance Measurement (PM) Engine software collects simulator and instructor input data to calculate performance indicators for individual and crew measures.
- *Performance Analysis & Trends in Training Enhancing Readiness Reporting for Naval Systems (PATTER2NS).* Exhibit accepted for display in the US Navy booth at the 2012 Interservice/Industry Training, Simulation and Education Conference.
- *Training Objectives & Performance Measures for Optimal Scenario- Based Training (TOPMOST).* Exhibit in the US Navy booth at the 2008 Interservice/Industry Training, Simulation and Education Conference.

Pagan, J., Atkinson, B. F. W., & Walwanis, M. M. (2011). Enhancing performance assessment, at what cost? Challenges & benefits of an Integrated Performance Assessment Toolset (IPAT). *Proceedings of the American Society of Naval Engineers Human Systems Integration Symposium,* Vienna, VA.

Wiese, E., Atkinson, B. F., Roberts, M., Ayers, J., & Ramoutar, D. M. (2012). Automated human performance measurement: Data availability and standards. *Proceedings of the 34th Interservice/Industry Training Simulation & Education Conference*, Orlando, FL.

Atkinson, B. F. W., Abbot, R., & Merket, D. (2013). Measuring up: Benefits and trends in performance measurement technologies. In C. Best, G. Galanis, J. Kerry, & R. Sottilare (Eds.), *Fundamental Issues in Defense Training and Simulation*. Ashgate.

## POST MISSION ASSESSMENT FOR TACTICAL TRAINING & TREND ANALYSIS (PMATT-TA)

**Start: Oct 10 End: Sep 15**


***Need:*** Shortfalls in debriefing and post mission assessment capabilities require readiness enhancing and workload reduction technologies to support assessment of tactical readiness. Additionally, the POM-15 Training System ENARG VP and HSM #3 Strategic Priority highlighted the need for post mission assessment.

***Objective:*** Increase training effectiveness & efficiency & reduce costs with enhanced performance measurement, reporting & trend analysis.

***Benefits:*** The benefits of PMATT-TA include compensating for the loss of flight hours with simulation-based training and assessing capabilities-based performance with increased standardization & longitudinal data to enhance fleet readiness.

***Status:*** A prototype web-based interface was developed to provide single point access for data entry of post mission data and qualification sheets. Input from end users from the target transition community, Command, Patrol Reconnaissance Group (CPRG) and P-3, was collected throughout the design and development to ensure product meets requirements. Capabilities of the prototype have been refined based on user input and usability testing, increasing automation and reporting capabilities where possible. The Increment 1 web-based software application is currently undergoing testing to complete necessary certification and accreditation processes for use on Navy SIPRNET. Rollout of the Increment 1 software is anticipated to begin in FY15.

Additional development of an Increment 2 software has been on-going, producing an integrated capability with the Performance Measurement (PM Engine). Additional testing to complete future certification and accreditation processes for use on Navy systems is underway, as well as planning for testing within a relevant environment.

***Research Products:***

- The Post Mission Assessment for Tactical Training & Trend Analysis (PMATT-TA), a web-based software application to collect and store mission data, generate post mission reporting documents and facilitate trend analysis of post mission data.
- *Performance Analysis & Trends in Training Enhancing Readiness Reporting for Naval Systems (PATTER2NS).* Exhibit accepted for display in the US Navy booth at the 2012 Interservice/Industry Training, Simulation and Education Conference.

Atkinson, B. Tindall, M., & Ponto, S. (2014) Post-Mission Assessment for Tactical Training-Trends Analysis (PMATT-TA) Usability Report (NAWCTSD-TR-2014-0001).

## TRAINING EFFECTIVENESS OF THE FA-18 TACTICAL OPERATIONAL FLIGHT TRAINER UPGRADED WITH A MOTION CUEING SEAT AND IMPROVED VISUAL SYSTEM

**Start: Nov 12 End: Apr 14**

***Need:*** The aircraft carrier landing environment is extremely complex. Carrier landings are among the most challenging tasks that a Naval aviator must perform. Aircraft carrier landing operations are affected by a number of variables not associated with a normal airfield. Currently, the method of preliminary carrier landing training is to practice approaches to a field site that is specially prepared to simulate features of a carrier landing deck. However, Field Carrier Landing Practice (FCLP)/Carrier Qualification (CQ) events do not permit practice on some crucial characteristics of the task. The field carrier cannot simulate deck movements found at sea, the presence of air turbulence from the carrier island, or the threshold crossing "burble" effect. These movements and environmental features, in addition to other factors such as possible light pollution affecting night training, and altitude restrictions limiting the conditions under which a pilot may train in FCLP all add to task difficulty and pose significant learning challenges to student aviators. This effort shall assess the fidelity.

***Objective:*** The objective of this work is to assess and define training and simulation fidelity requirements of the FA-18 Tactical Operational Flight Trainer upgraded with a High-Definition Visual System and a Motion Cueing Seat for the acquisition and sustainment of skills required for naval aviation, up to and including carrier landing in the FA-18 Tactical Operational Flight Trainer upgraded with High-Definition Visuals and the Motion Cueing Seat. Assessments shall focus on quantifying the training value added by the upgrades based on increased fidelity and training and readiness credit across the F/A-18 training and readiness syllabus, with priority to the mobility training tasks for FCLP/CQ simulator events.

***Benefit:*** If effectively designed, this effort can be used to better prepare pilots for Field Carrier Landing Practice (FCLP) and carrier qualifications and to achieve cost savings. The Navy is currently assessing the impact of reduced flight hours on pilot performance. They too are beginning to increase simulator use and need to be able to accurately certify simulators to train appropriate skills. This effort shall investigate the possibility of new Training & Readiness credit items due to the system upgrades.

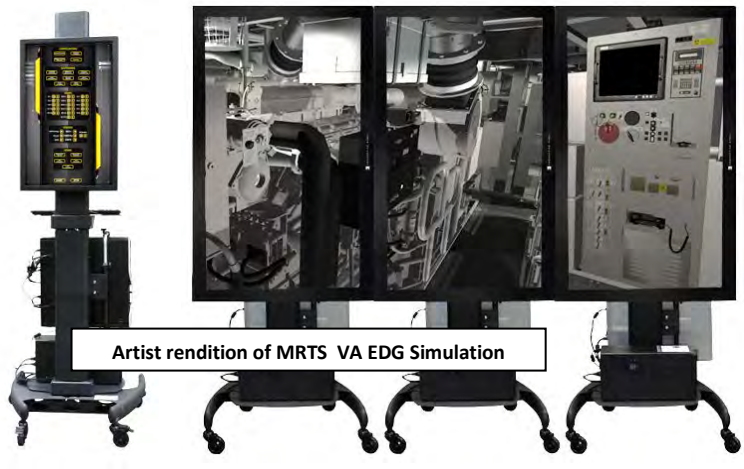
***Status:*** Contract ended in April 2014. All data was collected in a four month period. As such, the results reflect technology capabilities/limitations up to that time, but do not reflect any technological enhancements that may have been since incorporated. Additionally, all results are based on relatively low sample sizes and statistical power. Generally speaking, pilots rate the TOFT as an effective trainer for the earlier portions of the carrier landing. Data showed fidelity constraints limited the accuracy of training.

***Research Products:*** Contractor Report (April 14).

## TECHSOLUTIONS PROJECT

### MULTI-PURPOSE RECONFIGURABLE TRAINING SYSTEM 3D VIRGINIA EMERGENCY DIESEL GENERATOR SIMULATOR

**Start: Sep 13 End: Dec 14**


Artist rendition of MRTS VA EDG Simulation

***Need:*** The cost to field a tactical Virginia Class Submarine Emergency Diesel Generator (VA EDG) trainer at Submarine Learning Facilities has exceeds current funding availability. A more cost effective training solution is needed to maintain overall student proficiency in the operation of the VA EDG. Leveraging in house developed technology such as the Multi-Purpose Reconfigurable Training System (MRTS) architecture, software design engine and framework to develop a 3D physics based Virginia Class Emergency Diesel Generator simulator at a fraction of the cost of a tactical based system. The VA EDG will be displayed on large networked unlimited touch pressure sensitive displays. Sailors will be able to interact with the EDG using touch screens versus a traditional mouse and keyboard.

***Objective:*** Develop complementary, reusable, high fidelity, synergistic afloat and shore-based operator training environments that maintain and improve team and individual performance closing training gaps and reducing travel costs.

***Benefits:*** The computer-based VA EDG will provide many cost saving factors listed below:

- Close the existing VIRGINIA Class Diesel Operator training gap in Pearl Harbor
- Provide additional training advantages with greater capability than tactical trainer
- Cost avoidance of $550K

***Status:*** The project is in its final phase of development. The IOS has been designed to give the instructor control over various operating conditions and setting to challenge the students with various faults. The Instructor and student can maneuver within the 3D environment locating various components required for simulated engine startup and shutdown. Completion of the 3D Virginia Diesel is scheduled for December 2014

***Research Products:*** Anticipated delivery of a 3D Physics-based VIRGINA class Emergency diesel generator simulator (Dec 14).

## NEW MODELING AND SIMULATION TECHNOLOGY FOR NIGHT VISION GOGGLE (NVG) MISSION REHEARSAL [N04-156]

**Start: Sep 04 End: Mar 15**

***Need:*** Aircrew do not have the opportunity to train under variable weather/obscuration, cultural lighting, other aircraft, battlefield effects, do not have access to this training while deployed, and do not have the capability to train with variable terrain or operationally relevant scenarios (i.e., mission rehearsal). Even in large tactical operational flight trainers (TOFTS) there is limited physics-based NVG simulation that incorporates weather/ obscurations and battlefield effects.

***Objective:*** Provide NVG instruction and mission rehearsal in a format that is deployable to the field, modifiable (terrain, weather, mission, etc.) and cost efficient. Develop innovative modeling and simulation technology that will supplement Navy requirements for night vision goggle (NVG) instruction and provide mission rehearsal for ground and aviation operations.

***Benefits:*** Will benefit all users of night vision technologies. The imagery produced for the NVGs can also be used for other programs that need 1m resolution imagery for low level flights. Several programs have indicated interest.

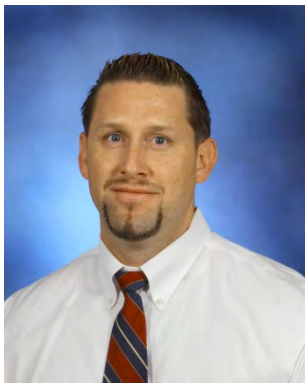
***Status:*** Phase III contract awarded to Aechelon Technologies for delivery of three Windows 7 based Night Mission Simulation System Part Task Trainers (PTTs) training systems including documentation for Contractor Operation and Maintenance of Simulator (COMS) manual for basic troubleshooting of hardware, block diagrams of the device, and cold start procedure. Additional contract awarded for nineteen Windows 7 based Night Mission Simulation System PTT deskside Image Generators (IGs) to nineteen different locations. All hardware has been delivered to sites and installation schedule has been established. During FY14, 2 PTTs and 15 IGs are scheduled for installation and remaining devices will be installed during Q1 FY15. Efforts to complete information assurance certification and accreditation are underway with an anticipated Authority to Operate in FY15.

***Research Products:*** Upgraded Night Imaging and Threat Evaluation (NITE) Labs with the latest Virtual Reality training devices through technology refresh of Image Generators (IGs) or installation of Part Task Trainers to ensure consistency across sites and removal of legacy physical board trainers at all 22 different USN & USMC locations (CONUS and OCONUS) for Night Operations Visual Flight Training, Spatial Disorientation Training and Threat Evaluation Training.

# SMALL BUSINESS INNOVATION RESEARCH (SBIR)
# SMALL BUSINESS TECHNOLOGY TRANSITION RESEARCH (STTR)

*"... vehicles through which NAWCTSD funds small companies to perform R&D."*

**Program Manager: John Hodak**



The Small Business Innovation Research (SBIR) & Small Business Technology Transition Research (STTR) programs differ only in the fact that small companies perform exploratory R&D in partnership with universities and larger nonprofit research institutions in the latter program and by themselves in the former. They share the same goals:

- Stimulate naval training technological innovations,
- Strengthen the role of small business in meeting government R&D needs,
- Foster and encourage participation by minority and disadvantaged persons in technological innovation, and
- Increase the commercial application of DoD-supported research or R&D results.

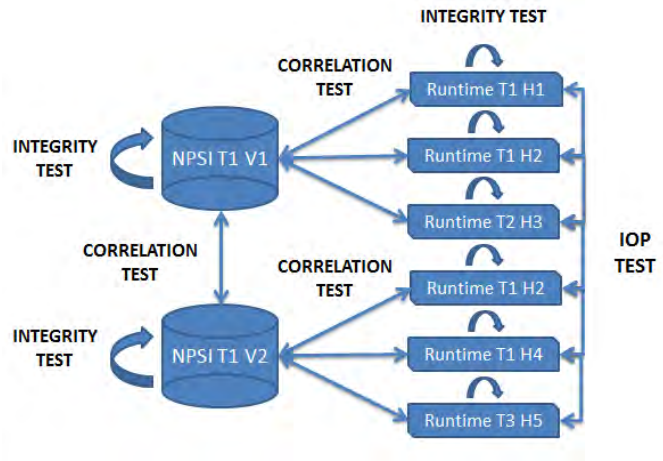
The SBIR & STTR programs are divided into three phases. Phase I is to determine the scientific or technical merit and the feasibility of new and innovative ideas. This will typically be a six-month exploratory effort. Successful completion is a prerequisite for funding in Phase II. Phase II awards are based on the results from Phase I and on the scientific and technical merit of a more comprehensive Phase II proposal. This second phase is the principal R&D effort. Companies are asked to consider the commercial possibilities of the proposed R&D, and encouraged to obtain a private commitment for follow-on funding to pursue their commercial potential. Phase II periods generally do not exceed 24 months. Phase II is expected to produce a well-defined deliverable, such as a prototype or process that the Navy is interested in acquiring. Phase III requires the use of non-SBIR/STTR capital by the small business to pursue commercial applications of the R&D and to deliver products to the Navy. This third phase is designed, in part, to provide incentives for converting DoD-funded R&D innovations to the public and private sectors. The Phase III summaries are described in the Transition Research Section.

Sources of SBIR/STTR funding include the Office of the Secretary of Defense (OSD), Office of Naval Research (ONR), the Naval Air Systems Command (NAVAIR), the Army SBIR programs, and the Joint Strike Fighter program.

Current NAWCTSD Phase I and Phase II efforts are described on the following pages.

## DISTRIBUTED SYNTHETIC ENVIRONMENT CORRELATION ARCHITECTURE AND METRICS [N141-006]

**Start: May 14 End: Nov 14**




***Need:*** Naval/Marine Corps flight simulators are often run in isolation; however, there are growing requirements for distributed networked simulation such as those included in the Aviation Distributed Virtual Training Environment (ADVTE). Correlation assessments between terrain databases and interoperability of simulation models have been investigated over the years. However, a gap still exists in the automated assessments of correlation errors between large synthetic environments as far as it relates to visual and sensor simulation for U.S. Navy / Marine Corps flight simulators.

***Objective:*** Develop an innovative and extensible distributed synthetic environment correlation assessment architecture that can verify correlation between flight simulator visual and sensor databases.

***Benefits:*** The output of Phase will result in a flexible and expandable distributed synthetic environment correlation assessment architecture for aviation platforms that will be able to perform comparisons between different formats, versions of the same databases, and the original geospatial source data. The architecture will allow for the addition of new runtime and source formats, as well as new tests and analysis plug-in modules by third party developers. The correlation assessment is expected to put emphasis on aircraft mission areas of interest such as airports, landing zones, confined area landings, low-level terrain flight areas, and ranges. Furthermore, the correlational assessment will allow for the automated correlation assessment of designated areas of interest that affect mission performance, such as avenues of approach, key landmarks, feature densities and texture densities. The display of the correlation results o will be displayed in a graphical way that allows for easy understanding of the correlation differences and the impacts on distributed training.

***Status:*** Three companies were selected to participate in Phase I; Cornerstone Software Solutions, Dignitas Technologies LLC and GameSim Inc. These companies are investigating, further defining, and determining the feasibility of an extensible distributed synthetic environment correlation assessment architecture for aviation platforms.

***Research Products:*** Prototype demonstrations (Nov 14).

## MASK-ON HYPOXIA TRAINING DEVICE

**Start: Nov 13 End: Mar 15**

***Need:*** Annual hypoxia training, required for all ejection seat equipped aircraft aviators, addresses both recognition of symptoms and recovery procedures to mitigate the risks associated with hypoxia incidents that occur each year. The training is currently accomplished either by the command's Aeromedical Safety Officer in the fleet simulators or at the local Aviation Survival Training Center.

Current technologies have several limitations including the lack of mobility (e.g., large chamber training, need for large gas bottles), high maintenance requirements (e.g., filter replacements, calibration, gas bottle replacement), obsolesce issues, and lack of training realism that can lead to negative training (e.g., risk of generating air hunger). Limitations of current training solutions, as well as increased fiscal pressures to reduce training costs, necessitate consideration of alternatives for providing hypoxia training.

A small, portable system capable of pressure-demand airflow is needed to fill this training gap. A low cost, low maintenance and fully mobile device free of gas bottle connections would significantly improve and expand the capability, efficiency and quality of training provided to the fleet.

***Objective:*** Design and develop a mobile-sized hypoxia training device capable of delivering continuous pressure-on-demand airflow to an aviator's oxygen mask with varying oxygen levels simulating sea level (ambient air) to 30,000 ft.

***Benefits:*** An enhanced hypoxia training capability that does not rely on gas bottles to supplement the simulation of altitude will increase the capabilities for survival training by support mobility of training to high fidelity simulators and provide increased opportunities for hypoxia awareness training at reduced operational lifecycle costs (e.g., maintenance, sustainment). Additionally, such a replacement lowers life-cycle costs, and decreases maintenance requirements. Naval Aviation hypoxia training has grown into an annual requirement due to the number of hypoxia incidents that occur. The current generation of individual mask-on hypoxia training devices can be greatly improved upon with new available technology. The mobility is restricted due to gas bottle connections and the realism is reduced due to the use of non-pressure demand system. The proposed capability has the potential to provide more realistic training in fast-paced training scenarios and increase the training capability to nearly any environment.

***Status:*** In early FY14, four Phase I awards were made to contractors who had unique technical approaches to reducing oxygen levels including: cyclical fluid exchange processes, electrochemical oxygen separation, and modern gas separation/filtration technologies. Each of the contractors demonstrated the results of their Phase I efforts. Based on a variety of evaluation criteria (i.e., portability of technology, estimated lifecycle costs, safety/stability of technology), two Phase II awards were offered (contracts pending award). These contractors continue to refine technologies under Phase I Option contracts. A down select will occur during FY15 utilizing the same evaluation criteria, with focus being determining the ability of these novel technologies to meet required flow rates, deliver a true on-demand system, deliver reliable training under operating conditions, and maintain low estimated lifecycle costs.

***Research Products:***

- Brief technology approaches to Fleet Customer (Dec 13).
- Demonstration of prototypes provided to technical team (Apr 14)

Scheeler, W. T., Atkinson, B. F. W., & Tindall, M. J. (Nov 14). Training naval aviators to recognize hypoxia symptoms: Advancing technologies to address a continued safety threat. *Presented at the annual SAFE Symposium.*

## COMMON UNMANNED VEHICLE CONTROL PROCEDURES TRAINER [N111-008]

**Start: Sep 13 End: Dec 14**

***Need:*** The Navy has an immediate need to develop a highly adaptive simulation platform to support existing and near future Naval UAVs. The Navy currently supports several platforms, including the Navy's Scan Eagle, Global Hawk, BAMS, RQ-7 Shadow, JTA-Fire Scout, RQ-11B Raven and several others. In development are also UCLASS carrier based options, such as the X-47B. Dedicated training platforms do not currently exist for these devices. Suppliers have provided the ability to stimulate their UAV control stations, allowing operators to train when the platform is not in use. However, this method has several disadvantages, including taking a deployable platform off line during training and requiring the use of sophisticated and costly equipment. A dedicated simulator system was never developed for these systems. Given the number of differing UAV platforms now deployed, developing a unique simulator system for each vehicle would require many large programs at significant cost. Thus, it is highly desirable to develop a highly adaptable simulation platform that incorporates the common elements of all platforms, with the ability to readily tailor the solution to virtually any vehicle simulator (air, ground, or sea).

***Objective:*** A service oriented architecture (SOA) is capable of providing several unique benefits. This architecture would allow tailoring to be done with reasonable effort, not requiring the user to become fully versed in every aspect of the simulation system. The SOA provides a set of interface points between a primary interface module (PIM), and individual simulation functions, such as engine models, flight dynamics, auto-pilots, human interface systems, sensor simulations, etc. Each discrete functional simulation element communicates to the PIM, which directs real-time data to and from those elements via socket layers. Socket layers provide a structure for data packets to and from each element module in a predefined manner, allowing such element models to be designed to match socket definitions so that element models can be easily interchanged.

This Phase 1 effort provided a starting point toward development of the SOA model. That effort took advantage of an open source flight simulator software package (FlightGear) to investigate its available functional modules and methods by which they could be separated and then reconnected via the PIM. The success of this effort provided a basis for a more sophisticated solution that will be pursued via this Phase 2 SBIR.

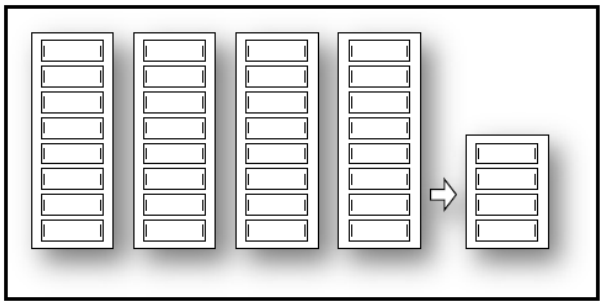
***Benefits:*** This solution will be in line with the Navy's Open Architecture goals for all new Navy systems, allowing competing interests to have access to the same core software and tools to more efficiently develop future UAV training systems. The open source nature and licensing rules of the core simulation engine will also lead to enhancements from many contributors, rather than relying on such improvements made only by each vendor for their own products. The result will be better, cheaper, more consistent training across all UAS platforms.

***Status:*** This SBIR has completed Phase I and is nearing completion of the two year Phase II component. Much interest has been received about this project from PMA 281, PMA-266, PMA-205 and related vendors resulting in cooperative partnerships to complete the project and attract future funding for continuation of the project beyond Phase II.

***Research Products:*** Demonstrated prototype Level 2 STANAG Sim Element at the Navy Opportunity Forum as part of participation in the Navy Transition Assistance Program (TAP) (Jun 14).

## DECOUPLED RENDERING CHANNELS TO REDUCE LOGISTICAL SUPPORT SPARES REQUIREMENTS OF LARGE SCALE TRAINING CENTERS [N131-018]

**Start: Jul 14 End: Feb 17**



***Need:*** Just as image generation architecture has moved from dedicated purpose computing into PCs, it is inevitable that the next step would be into some form of distributed fiber optic video distributed network. This new form of image generation will provide better logistical/maintenance support and sparing for large scale simulation training centers, and commercial training facilities that provide multiple flight simulators at one location. In order to better keep pace with continually updated and increasingly detailed imagery being made available, research is needed to determine how image generation architecture could be improved. Currently, the hours of availability provided by each stand-alone simulator are constrained by each trainer's dedicated image generation hardware functionality and the currency of the images on that hardware. Moreover licensing and maintenance of today's image generators is fragmented, duplicative, and costly. Experts predict that large scale training centers may not be viable in the long term without this type of innovation, due to the complexity and detail available for rendering.

***Objective:*** Demonstrate on a suite of flight simulators how to innovatively decouple image rendering channels from individual trainers, and instead provide imagery to multiple trainers simultaneously via a centralized pool of logistical support/spares resources, over a local fiber optic video distributed network.

***Benefits:*** The resulting centralized Image Generation System should improve availability, reduce costs, and make possible uninterrupted training to occur - while providing simultaneous imagery updates.

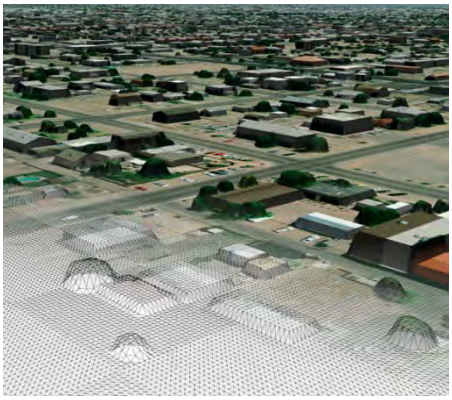
***Status:*** A Phase II was awarded FY14 to Diamond Visionics, LLC. Diamond Visionics addresses the problem through the development of virtualized rendering clusters, composed of PCs that contain multiple GPUs. Diamond Visionics is continuing research and development with OpenGL 4.4 and compute shaders to employ advanced GPU render techniques. Investigation into H264 encoding and HDMI over CAT6 continues. Diamond Visionics has consulted with Concurrent Real-Time and NVIDIA on multi-GPU system configuration options. An early prototype system has been developed and demonstrated at Boeing with their AH-64E Apache Simulator. Diamond Visionics is now utilizing NVIDIA's GRID SDK to capture frames during encoding and NVIDIA's Jetson TK1 microboards for decoding.

***Research Products:***

- "GPU-Based Visualization for Flight Simulation" – Presentation GPU Technology Conference (GTC) '14.
- Diamond Visionics and Concurrent Prototype – ITSEC 2013 / GTC '14
- Boeing AH-64E Apache Simulator Integration – '14

## GEOSPECIFIC DISPLACEMENT MAPS FOR REAL TIME, STEREOSCOPIC TRAINING SIMULATION [N102-116]

**Start: Dec 12 End: Dec 14**



***Need:*** A widely used technique for controlling modeling cost is to concentrate the level of detail on areas of interest such as airfields, landing zones, confined area landing sites, and terrain following routes. The placement and alignment of buildings and vegetation in and around these areas can be time consuming for large areas and therefore is limited in scope. This limitation in feature content can affect the visual cues needed by the pilot for the accurate perception of motion. Process and tools that reduce modeling cost while providing sufficient visual cues for training are needed.

***Objective:*** Develop an innovative automated process that unlocks the advantages of real-time displacement maps and other tessellation technologies along with geo-specific two and three dimensional source imagery for implementing high complexity terrain surface regions in virtual environments for real-time training simulators.

***Benefits:*** The outputs of this R&D effort have the potential to provide the Navy with an opportunity to significantly advance the state-of-the-art in visual realism, visual cues and overall quality of aviation simulators while reducing database production costs. State-of-the-art GPUs are increasing in performance and now incorporate displacement mapping and tessellation technology which allow for more detail on three dimensional models at no extra performance. Displacement mapping, edge detection analyses, and other new tessellation technologies have the potential to allow rapid incorporation of geo-specific regions in a virtual world for real time training simulation.

***Status:*** The Renaissance Sciences Corporation (RSC) and Arizona State University (ASU) approach includes an end-to-end framework for the generation of the displacement maps, the mapping to a generic specification (i.e. Naval Portable Source Initiative or NPSI) and a real-time rendering solution. ASU has developed a framework for the generation of displacement map data from NPSI datasets and other geospatial datasets. The DMRI prototype uses OpenSceneGraph to visualize the generated displacement map data using geometry and tessellation shaders. DMRI has also evolved to include higher resolution polygonal models at arbitrary ranges. This allows for high level of detail models at close range. Several papers have been published which documents the work performed under this SBIR (Chladny et al, 2013, 2014, Femiani 2014).

***Research Products:***

- Phase II - DMRI demo at the Navy Opportunity Forum (June 14).

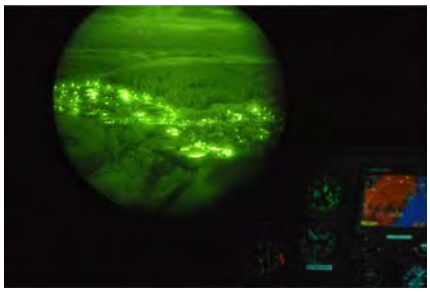
Chladny, B., Femiani, J., & Graniela, B. (2013, January). Realistic Geo-Specific Feature Densities in Real-Time Synthetic Environments. In The Interservice/Industry Training, Simulation & Education Conference (I/ITSEC) (Vol. 2013, No. 1). National Training Systems Association.

Chladny, B., Femiani, J. (2014 July), Method for Incorporating Displacement Mapping into Existing Image Generators, In the IMAGE 2014 Conference Dayton, Ohio – July 14.

Femiani, J. (2014 July), Graph Cuts to Combine Multiple Sources for Feature Extraction, In the IMAGE 2014 Conference Dayton, Ohio – July 14

## HYPER-ELEVATION MODELING OF TERRAIN, TOPOGRAPHY, & URBAN ENVIRONMENTS [N091-026]

**Start: Apr 09 End: Apr 16**



***Need:*** Current standards used for representing terrain digital elevation models do not provide for the description of topographical features such as tunnels, caves/bunkers, overhangs, multi-level highways/interchanges, and other unique aspects of strategic rural environments and urban infrastructures. Abstract methods for defining these topographical features are desired, to allow for embedding realistic targets and simulated lasing of those targets, as well as ability to accommodate temporal/diurnal changes to the topography.

***Objective:*** Develop abstract definitions for mixed topographical features on rural and urban terrain, (e.g., adjoining man-made and natural objects, having complex geometrical solutions, such as caves, highway interchanges with multiple level ramps, walkways between high-rise towers, etc.). For the purposes of training: lasing of targets, damage assessment after strikes, supporting complex interaction of simulated weapon platforms with targets of interest, and for training situational awareness, battle-state assessment, and low level navigation.

***Benefits:*** Commercial applications range from environmental studies to emergency (natural disaster and/or terrorism) planning, construction management and training. Both military and nonmilitary sectors require more sophisticated models using the wealth of data that is now being generated from commercial enterprises and by local, state, and federal governments. The depiction of dynamic terrain is particularly important in the visualization of construction operations as well as in combat because terrain is seen and manipulated at close range.

***Status:*** SBIR Phase II.5 awarded in April 2014. This effort has a 24 month period of performance. Cognitics has named the technology developed under this SBIR topic, Spawn. The primary goals are to improve the fidelity of transportation features in simulation systems and to provide terrain generation tools that work across multiple systems. Currently the primary focus is to implement enhanced hydrography. An SBIR Kick off Meeting took place on 22 Jul 2014.

***Research Products:***

- Lecture Notes in Computer Science 7042 (Nov 11).
- Orange County Public Schools Community Resources Recognition Award (Aug 14).
- Patent US8100694 B2, Infrared Aimpoint Detection System (Jan 12)
- Demonstration of prototypes provided to Fleet Customer (Nov 13)
- After Action Review Prototype Testing successfully completed at FLETC (Aug 14)
- Periscope Operator Adaptive Trainer (POAT) delivered to Submarine Onboard Training (SOBT) for training on-board as well as the schoolhouse
- POAT successfully transitioned to the Step 3 Phase (System Real-Time Implementation) of the APB process and is scheduled to be integrated with 688 and 774 watch station

Dzikovska, M., Steinhauser, N., Farrow, E., Moore, J., & Campbell, G. (2014). BEETLE II: Deep natural language understanding and automatic feedback generation for intelligent tutoring in basic electricity and electronics. International Journal of Artificial Intelligence in Education, 24 (3), 284-332. doi: 10.1007/s40593-014-0017-9

## HYPOXIA TRAINING IN NORMAL PRESSURE CHAMBERS [N08-139]

**Start: Nov 08 End: On-Going, PH III in 2016**

***Need:*** Navy trains 10,000 students for hypoxia recognition and recovery training each year. Because of risks of hypoxia training at high altitudes, mandatory inside safety observers receive hazardous duty incentive pay ($12,000.00 per month). Navy averages 4 cases of decompression sickness per year.

***Objective:*** Create normobaric (normal air pressure) simulated altitude environments up to 30,000 feet. Provide a multi-crew setting conduct training without the need for a mask and without the risk of decompression sickness (DCS). With this training device aviators can experience simulated decompression at a limited but safe altitude (10,000 feet) and higher altitudes.

***Benefits:*** Students & instructors not exposed to the risk of decompression sickness. Provides an opportunity for multi-crew teams to experience both pressure altitude decompression and high altitude hypoxia in the same chamber - without the need for a Reduced Oxygen Breathing Device. Planned Phase III transition in 2016, with an additional six units to fleet planned. Potential applications include U.S. military units, foreign military units, and U.S. and foreign aeronautical authorities involved in aviation training.

***Status:*** Located at the Flight Safety building at Naval Air Station Miramar and the Human Performance and Training Technology, NSTI Pensacola. Both have a capacity for 12+ students and two instructors at a time.

In 2014, CDR Kavanaugh, Air 1.0 PMA205 confirmed that CDR Folga of the Naval Medical Research Unit-Dayton will be validating the efficacy of the prototype normobaric hypoxia room, and that LCDR Morarend of NAWCTSD will complete a front end analysis of the fleets existing and new hypoxia training devices. The front end analysis will assure optimal use of the new normobaric devices, now slated for acquisition in 2016. Colorado Altitude Training LLC is the SBIR company.

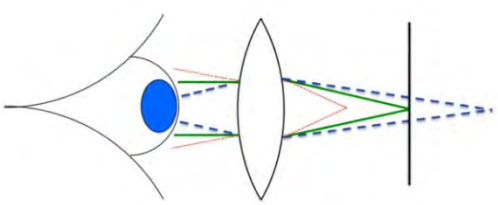
History/Problem: Dating back to Word War II, hypobaric hypoxia familiarization training while considered high-risk, has been largely successful for training multiple individuals simultaneously with a modest rate of injury. However, the maintenance and operating costs of the 9A9 hypobaric altitude chambers are high and the dwindling availability of both the aging chambers and replacement parts presents significant logistic challenges. NAWCTSD engineering point of contact for the 9A9 devices is Robert Palmblad 407-380-8486.

SBIR Innovation: Normobaric training through the use of the Multi-Person Reduced Oxygen Breathing Devices can provide a safe, reduced manpower alternative to hypobaric chambers for a fraction of the cost. Normobaric training is also considered to be much safer than hypobaric chambers because it eliminates the risk of decompression sickness and other barotraumas* among trainees and medical observers.

***Research Products:*** Two operational prototype devices were delivered in 2013 by Colorado Altitude Training.

## INNOVATIVE COLLIMATED DISPLAYS [N121-041]

**Start: Oct 13 End: Oct 14**

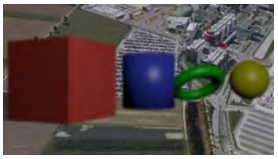
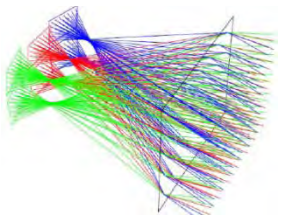


***Need:*** Rotary wing platforms require a complex set of flight regimes and close proximity visual cues during hovering, take-off and landing, search and rescue, confined area and emergency landing, and cargo loading/unloading operations. Current aircraft simulator visual displays provide monoscopic visual cues using either real image or fixed collimated displays. Each technology has its own advantages and disadvantages. However, no optimal solution exists today for low altitude operations that provide binocular disparity, and correct vengeance-and-accommodation at low altitudes.

***Objective:*** Develop innovative visual displays to provide variable collimation and improved 3D depth perception for rotary wing chin windows and cargo hatch operation.

***Benefits:*** A variable collimation display will provide accurate accommodation and vergence based on the aircraft distance to the ground. It is expected that this innovative display technology would improve the visual cues provided to pilots and therefore improve safety and training. Furthermore this display technology may also contribute to enhancements on numerous other display applications currently limited by a lack of accurate depth cues.

***Status:*** SBIR Phase II base research will end in October 2014. One of the two companies will be awarded an Option 1. The following table provides a brief description of the status on the development of the technology thus far.

| | |
|---|---|
|  <br>Holochip | The optical system is based on Holochip's patented solid-state adaptive optics architecture that utilizes an arrangement of adaptive lenses. Preliminary analysis indicates that the variable-collimation display system will be able to support requirements similar those of a full-flight simulator. Analysis shows that uniformity in luminance will be supported by providing an extremely flat field of illumination in the projection optics. Analysis of the varifocal lens control and stability takes into consideration the transport delay and high frame rate requirements. Issues such as distortion, stability, resolution, frame rate and image quality are being considered as the prototype system is been designed. The prototype 140 mm variofocal lens has been developed and it currently under test. |
|  <br>Physical Optics Corporation | The VCASH-3D system is based on a novel synthetic holographic window principle, which enables it to provide full parallax 3D images (i.e., autostereoscopic) with any desired collimation over a wide viewing direction without the apparent depth distortions normally present in standard stereoscopic and collimated display systems.<br>The fully developed VCASH-3D display will be capable of displaying full-parallax 3D imagery of far or near objects corresponding to different sets of flight regimes associated with rotary-wing simulators providing a full set of close proximity visual cues during hovering, takeoff and landing, search and rescue, and cargo loading/unloading operations. Thus far, POC has developed proof-of-concept VCASH-3D prototype that includes a functional, full-color, 60 fps, 20(H) × 7(V) FOV and ~4 in. eye box. |

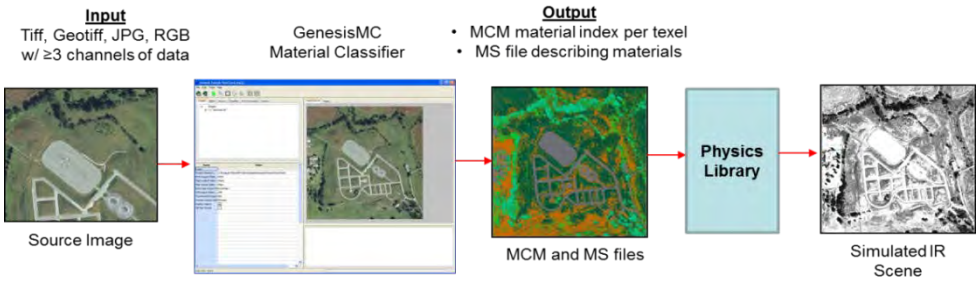
***Research Products:***

- Demonstration of prototype provided to TPOC (Feb 14).

Batchko, R., Robinson, S., Schmidt, J., & Graniela, B. (2014, March). A variable-collimation display system. In *IS&T/SPIE Electronic Imaging* (pp. 901109-901109). International Society for Optics and Photonics.

## MATERIAL CLASSIFICATION SENSOR SIMULATION WITH STEREO IMAGERY [N092-094]

**Start: Oct 13 End: Oct 14**




***Need:*** One way in which the Navy trains warfighters on the critical task of using airborne sensors such as Radar, FLIR and other Electro/Optical sensors is with methods like flight simulators and sensor simulation systems. Realistic representation and signature characterization of the terrain background is critical to target acquisition training. Sensor simulation in these types of training requires terrain databases that accurately simulate the terrain signatures experienced in the real world. The increased fidelity of more recent sensor devices requires an even higher fidelity of material encoded databases. Accurately material encoding a terrain database has traditionally been a labor intensive, slow and expensive process, especially when there is only limited data available such as RGB imagery. This is because many of the spectral signature differences among material types are at higher wavelengths.

***Objective:*** JRM technologies has performed significant technology research with the objective of developing and demonstrating an approach for improving material classification with the aid of Digital Elevation Map (DEM) and other topological data sources, often derived from stereo-pair imagery via photogrammetric processes. The technology developed will be incorporated into software classification tools to drastically improve the quality and reduce the costs of producing material encoded databases.

***Benefits:*** (1) Higher Productivity: The ability to quickly produce high fidelity, materially-classified, 3D terrain databases, even in geographic regions where a-priori topological data is not available, but stereo-pair imagery is. (2) Improved Accuracy: The ability to render such databases in arbitrary sensor bands, via validated physics modeling of all key phenomena, such as global and local irradiance, temperature prediction, angle-dependent reflection and emission, spectral atmospherics, and sensor effects. (3) Improved Training Effectiveness: A marked improvement in target acquisition and sensor deployment training, due to enhanced simulation realism, without decreasing training system performance.

***Status:*** The contract was awarded early FY13. JRM Technologies has prototyped several new metrics and techniques which utilize DEM elevation data to improve classification (e.g. shadow identification/removal, and relative elevation/slope statistics), and implemented these techniques in a new software tool (the “GenesisMC Preprocessor”), while simultaneously upgrading the main classification tool (GenesisMC) to use the additional elevation-derived metrics during classification.

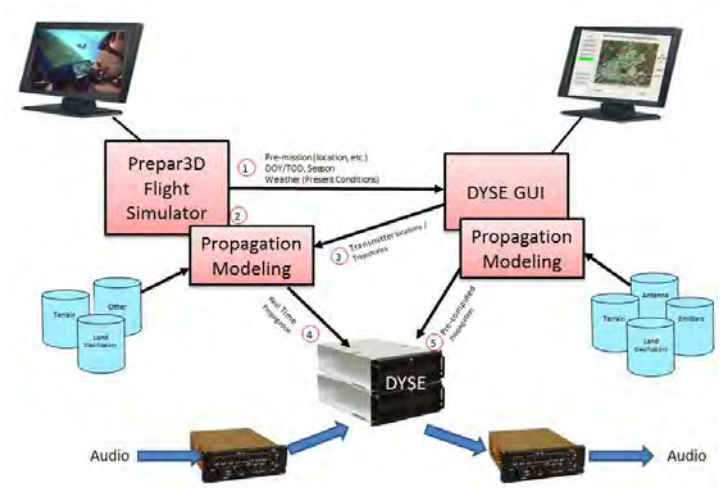
***Research Products:***

- Live Demonstration of Elevation Metric-Improved Classification and Shadow Removal Techniques at the Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC) (Dec 13).

Fink, C.E. (2014). Improving Material Classification Quality with Elevation-derived Metrics. Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC) 2014, Paper #14380.

## NEW AND IMPROVED RADIO FREQUENCY (RF) MODELING FOR CORRELATED ENVIRONMENT COMMUNICATION SYSTEM SIMULATORS WITH SENSOR SIMULATORS [N121-011]

**Start: Apr 12 End: Jul 15**




***Need:*** Military aviation simulators need to develop a set of rules and 'RF signal propagation algorithms' based upon select, critical environmental factors (i.e., weather, attenuation, backscatter, tropo-scatter, refraction, ducting, etc.) to include and incorporate essential flight parameters affecting airborne tactical communications and tactical aircrew sensor operations (e.g., antenna shielding, terrain masking, etc.).

***Objective:*** To develop accurate RF, sensor-systems, and communications systems links for military aviation flight simulators through modeling links between aircraft and a multitude of representative sea, land, airborne, and satellite-based systems, combining physical hardware with virtual training devices and emulated RF/Sensor tactical environments to create realistic mission scenarios. Echo Ridge LLC will enhance electronic jamming functionality. Improved enhancements of T-45 Aircraft scenarios, using an upgraded version of 'Prepar3D' software.

***Benefits:*** Echo Ridge's Dynamic Spectrum Environment Emulator (DYSE) Hardware system emulates realistic physical environments for communications, including key sensor process standardization, and facilitates reduced life cycle acquisition costs for new-start system acquisitions, training device procurements, and legacy visual system upgrades to trainers via operational features during simulated airborne training events

***Status:*** Completed the Dynamic Spectrum Environment Emulator (DYSE) integration to remote flight simulators. The contractor developed a prototype system that allows multiple remote flight simulators to share position and orientation information and send audio to each other using a single instance of DYSE. DYSE adds radio communication channel effects to the audio between the multiple flight simulators. Contractor will continue development during Phase II.

***Research Products:*** Prototype and Demonstration anticipated for July 15.

## RECONFIGURABLE AERIAL REFUELING TRAINER [N102-124]

**Start: Oct 10 End: Oct 14**

***Need:*** Part-task trainers eliminate the need to field additional full-task trainers, and can also reduce the expense of maintaining the existing large training systems. Only a fraction of the cockpit functionality and instrumentation is required (as compared to a traditional flight simulator) thus significantly reducing costs. Higher fidelity air refueling training will improve pilot performance especially for first timers.

***Objective:*** Cost-effective aerial refueling training technology suitable for use in different aircraft trainers or in a part-task trainer configuration. There is a need for accurate stereoscopic and parallax cuing which is

correlated with the aerodynamics and motion/haptic effects experienced by pilots in this unique flight regime. The collimation distance of displays in conventional flight simulators is fixed and incorrect for training the aerial refueling task. It often requires intervention from an instructor to perform the task, which is artificial and potentially a source of negative training.

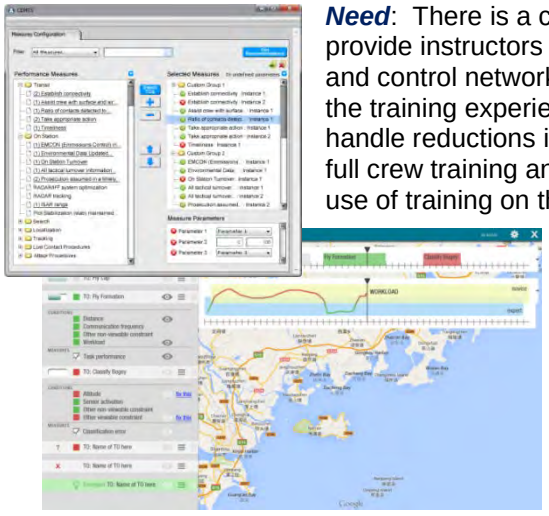
***Benefits:*** There are not enough hours available on fielded training systems to conduct all types of training required. Supplemental trainers are needed to reduce the burden of the full-function weapon system trainers. These part-task trainers can be made smaller and less-expensive, yet provide higher fidelity training for specific training objectives, than our full-mission trainers. Reconfigurable capability can further improve cost effectiveness. Advancements, however, are needed to improve the fidelity/effectiveness of simulation based training and lower the cost of individual components. Current training does not provide the stereoscopic cue critical for determining close distance and closure rate when performing air refueling.

***Status:*** A prototype was developed by AVT simulation and demonstrated to NAWCTSD. The training system effectively simulate the dynamics of the receiver aircraft and its probe connecting with the tanker hose-and-drogue, maintaining contact for fuel flow within the tanker's refueling envelope and disconnect. Provide a stereo view for the receiver pilot to provide proper perception of all the cues and optical flow patterns the pilot sees flying the up-close refueling view, including his own cockpit interior visually interacting with the exterior view of the tanker and its hose-and-drogue during closure, contact, and maintaining contact for fuel flow. Current system challenges are the tradeoffs between comfortable and high-resolution HMDs. The compact trainer design allows for low cost part task trainer.

***Research Products:*** Prototype demonstrations provided to NAWCTSD on various HMD configurations (2014).

## SEMI-AUTOMATED FORCE (SAF) TACTICAL BEHAVIOR FIDELITY (TACTICAL ENVIRONMENT ROLE-PLAYER STATION) [N07-033]

**Start: Oct 10 End: Dec 14**



***Need***: There is a critical need in aviation simulation-based training to provide instructors with a single graphical user interface (GUI) to monitor and control networked, mixed fidelity tactical environments in to enhance the training experience. Currently, the P-8A program is addressing how to handle reductions in manpower for weapons tactics, operational flight, and full crew training and how to lower total ownership cost by maximizing the use of training on the ground and reduce dependency on the aircraft. The P-8A trainer currently includes two Semi-Automated Force (SAF) applications: the Joint Semi-Automated Forces (JSAF) and the Next Generation Threat System (NGTS), which forces the instructor to decide which SAF contains the model fidelity that best matches the training need. In addition, the instructors are also responsible for role-playing semi-automated entities and monitoring basic network health functions of all pieces of software underlying the simulator. Without the use of a single GUI, the instructors' primary job of instructing will be greatly impacted.

***Objective:*** This effort aims to enable instructors to efficiently teach students through the use of a single GUI. The first phase of the Tactical Environment Role-player Station (TERS) provides a high fidelity Link 11/16 role-playing capability. The tool will also provide recommendations on SAF

behaviors and fidelity to maximize the training effectiveness of scenarios. TERS will also develop a Department of Defense Information Assurance Certification and Accreditation (DIACAP) package for the resulting tool.

***Benefits:*** Greater efficiencies and improved training content through: (1) Reduced workload for instructors; (2) Common design framework and interoperability; (3) Reduced system acquisition costs; (4) Increased use of simulators; (5) Tactical training environment that is enhanced by the use of physics-based sensor models; and (6) Link 11/16 role-playing.

***Status:*** Multiple contracts have been awarded. A single interface control capability for data link was delivered and tested by the transition customer. Ongoing efforts focus on SAF fidelity and modeling. A Scenario Advisor tool prototype was developed based on iterative feedback from P-8A end users. An initial information assurance package was completed to support future certification and accreditation for transition customers. Additional funding continues to advance technologies under a SBIR Phase II.5 to enhance the development of the SAF Behavior Fidelity model layers for scenario authoring/editing/real-time dynamic scheduling. These efforts have focused on development of a scenario use case, dynamic SAF behavior management and tool validation studies.

***Research Products:***

- Training Objectives & Performance Measures for Optimal Scenario- Based Training (TOPMOST). Exhibit in the US Navy booth at the 2008 Interservice/Industry Training, Simulation and Education Conference.
- SAF Tool Project: The Scenario Advisor. Demonstration for P-8A Subject Matter Experts (Nov 12).

## SMALL PROJECTOR ARRAY DISPLAY SYSTEM [N121-005][N07-033]

**Start: Sep 13 End: Sep 15**

***Need:*** In order to support reducing initial and life cycle costs while increasing performance, this Small Business Innovation Research (SBIR) effort takes a look at the ability to integrate several small, inexpensive projectors into a larger array in order to attempt to meet or exceed the performance of existing simulation-grade Commercial off the Shelf (COTS) projectors.

***Objective:*** Develop innovative technology leveraging small COTS Light Emitting Diode (LED) based projectors to create a cost effective, high performance, immersive, rear-projection display system with small footprint.

***Benefits:*** (1) The cost per pixel can potentially be minimized using an array of pico projectors; (2) The smaller footprint that can be achieved using short throw lenses; (3) The potential for achieving eye-limiting resolution in terms of the number of pixels required.

***Status:*** Phase II is 50% complete. RPA is looking to transition to Phase III through the TAP program.

***Research Products:*** Prototype and Demonstration anticipated for Sep 15.

## AUTOMATED HUMAN AND SYSTEM PERFORMANCE ASSESSMENT IN OPERATIONAL ENVIRONMENTS [N11A-T001]

**Start: Jul 11 End: Dec 14**

***Need:*** Mission success depends equally on the proper function of the hardware and software that make up the weapon system and on the function of the operator who uses that weapon system. During system design and test and evaluation, a highly skilled operator can compensate for adverse system design though acquired skill and natural ability. As such, the adverse traits of the system may not become apparent until the system reaches fleet users. Conversely, a good system may hide a struggling student's difficulties sufficiently to allow that student to meet minimum performance requirements without attaining the skill the training event was meant to impart. A means to record and interpret both operator and system state data is needed to adequately test system design and trainee progress.

***Objective:*** Develop a self-contained deployable system to automatically quantify combined human and system performance in real-time and for after-action-review. This technology combines inputs from Commercial Off the Shelf physiological sensors and networked data with normative models of human and system behavior to provide an objective assessment of combined operator-system performance that helps to identify the cause of performance limitations.

***Benefits:*** By looking at both components in the warrior-weapon system, this project will allow designers of weapon systems and training systems to identify shortcomings that limit overall mission performance. Future weapon systems will be better tailored to the abilities of average fleet personnel and the progress of trainees to fleet qualification will be better documented.

***Status:*** Phase II has been awarded to the Advanced Anti-Terror Technologies (A2-T2) and Old Dominion University team. During Phase II, the Fused Realities Assessments Module (FRAM) suite tested using the Small Unmanned Aircraft System (SUAS) simulated environment at Fort Benning, GA. Data collected from this testing event is currently under analysis. Additionally, they are receiving support from the Robotic Systems Joint Program Office.

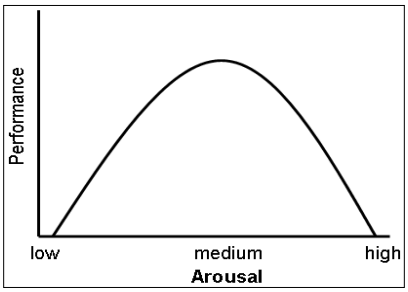
***Research Products:***

- Field test and data collection was successful completed at Fort Benning, GA.
- Successful demonstrations and press coverage of Anthropomorphic Augmented Robotic Controller (AARC) ("Wear Your Robot") spin off product.

## TAILORING TRAINING FOR DISPARATELY SKILLED PARTICIPANTS IN LARGE SCALE TRAINING EXERCISES [N09-T007]

**Start: Oct 08 End: Aug 14**

***Need:*** To rapidly create combat readiness and operational proficiency, while optimizing the use of live, virtual, and constructive (LVC) assets. One challenge associated with this need is the fact that individuals, teams, and units may have relative disparities in knowledge, skill, or expertise, either within or between teams. If the training requirements are too challenging for the less experienced participants, they are not likely to benefit. If requirements are targeted to less experienced participants, the more experienced participants will not receive maximum training benefit.




***Objective:*** Develop tools for instructors and facilitators of large-scale LVC training exercises that can be used to provide skill-appropriate training objectives and scenario items for individual, team, and unit level participants. This technology can then be used to incorporate these training objectives and scenario items into an adaptive training environment while maintaining the overall integrity and realism of the mission.

***Benefits:*** This technology will increase training effectiveness for trainees of varying skill levels without increasing instructor workload. Determining the appropriate level of difficulty to provide trainees in large scale training environments necessitates consideration of the impact on other participating trainees. Removing this workload from the instructor not only maximizes the learning participants receive, but also frees up the instructor to focus on other ongoing challenges, thus increasing the efficiency as well.

***Status:*** This effort is complete. The two companies which were awarded Phase II Option funding took unique approaches to assess performance of the trainee and adapt the training to the appropriate skill level (e.g., Multiple Item Response Theory, physiological measures). Each approach showed promise and pushed the state of the science forward in this complex field. Both companies have worked closely through the TPOC with program management and potential transition customers to ensure user needs are met and the technology will have a lasting beneficial impact for the Department of Defense.

***Research Products:***

- Demonstrations of prototypes provided to potential transition customers and program management (February, April, July 14).

Dean, C., Stacy, W., Keeney, M., Day, E., Terry, R., & Alicia, T. (2011). Item response theory facilitates adaptive training for disparately skilled trainees. *Proceedings of the Interservice/Industry Training, Simulation, & Education Conference, Orlando, FL.*

# TECHNOLOGY TRANSFER PROGRAM

*" ...increase development of partnerships with both public and private sectors "*

**Program Manager: Sunny Simmonds**

The NAWCTSD Technology Transfer Program operates under the auspices of the Federal Technology Transfer Act, related laws, executive orders, directives and guidance. The anticipated benefits of sharing the results of Navy modeling, simulation and training research and development (R&D) with public and private research organizations are: improved national, state and local training and education, new commercial products and additional national employment opportunities, access to civilian subject matter experts and resources, and feedback on R&D products that can be used to improve future government systems.

Through technology transfer, the nation's investment in federal research and development leads to products and services for the good of the public. In the past, many government patents/inventions were not licensed and, therefore, government inventions were not commercialized. To encourage licensing of government inventions, Congress has built incentives into the Federal Technology Transfer Act and related legislation. Government inventors, and the laboratories where they work, share part of the royalties generated from the commercial use of their inventions. The inventor and the labs profit through this commercialization, and our economy is enhanced through manufacturing and sale of new products.

The objective of the NAWCTSD Technology Transfer Program is to increase the development of partnerships with both the public and private sectors in order to share the cost, development, and application of technologies, and to foster development of commercial sources for NAWCTSD technologies/innovations. This is accomplished through technology transfer vehicles such as Cooperative Research and Development Agreements (CRADAs), Commercial Services Agreements, Licensing Agreements, and Education Partnership Agreements with academia and industry. Agreements such as CRADAs can provide a vehicle for NAWCTSD to receive feedback on its R&D products, which can be used to improve future systems. NAWCTSD also partners with other federal government agencies through Interagency Agreements.

There are benefits to the public from the exchange of knowledge and products within the government. Exchange includes sharing information and products with other federal agencies, as well as with state and local governments. By sharing knowledge and products on a wide basis, the public reaps the benefits from research conducted for one purpose or agency in many new ways. The return on the investment of the tax dollar is increased.

Another benefit of Federal Technology Transfer legislation has been the establishment of the Federal Laboratory Consortium (FLC). This consortium is a network of more than 700 federal laboratories and research centers. The FLC provides a nationwide laboratory forum to develop strategies and opportunities for linking federal laboratory technologies and expertise with the marketplace. NAWCTSD is a voting member of the FLC.

## SCENARIO PLANNING AND EFFECTS CONTROL SYSTEM (SPECS) AND AFTER-ACTION-REVIEW TECHNOLOGY

**Start: Oct 09 End: Sep 14**


***Need:*** A need exists for flexible and cost-affordable scenario control and After-Action-Review technologies for highly immersive, tactical training environments designed around the concept of the instructor as the operator.

***Objectives:*** (1) Develop and deploy a network-based system of Government and Commercial components designed to provide manual and automated control of scenario cueing and environmental effects within immersive training environments. (2) Demonstrate the cost effective use of a modified commercial, network-based video management system to support after-action-review of training scenarios. (3) Deploy an integrated suite of the scenario control and after-action-review technologies within operational immersive training environments.

***Benefits:*** The NAWCTSD Scenario Planning and Effects Control System enables instructor/operators to provide highly detailed and repeatable immersive training scenarios by defining combinations of cause/effect, time, and manual trigger actions between various types of sensor and environmental stimuli for increased training effectiveness, trainee immersion, and reduced instructor/operator workload. The system's audio distribution engine is capable of simultaneous streaming of sound effects to any user defined speaker location or time synchronized group of speaker locations within the training environment utilizing real-time mixing of source files. The RaidFX special effect device and training stimuli control architecture is fully extensible and capable of integrating numerous devices and training aids based on common control and communication standards. The client Graphical User Interface (GUI) is designed around the concept of the instructor as the operator, and provides for the authoring and control of scenarios within the distributed system architecture. The architecture utilizes a combination of Government and Commercial-Off-the-Shelf components providing for a high degree of flexibility and sustainability. Data integration with commercially available digital video management and debriefing systems enables event-based navigation and remediation support during after-action-review.

***Status:*** The SPECS architecture has been successfully installed and is operational within a number of immersive and mixed-reality training environments. The technology suite continues to evolve through new developments. Research and development to demonstrate compliance to the Army Live Training Transformation (LT2) architecture including integration with the Common Training Instrumentation Architecture (CTIA) was begun in FY13. The USMC SPECS baseline became a LT2 software component in FY14, and a demonstration was conducted showcasing interoperability with the USMC Range Instrumentation Control (RISCon) baseline.

***Research Products:***

- SPECS has transitioned and is in operation across multiple sites including non-Navy customers through the NAWCTSD Technology Transfer office.
- Three USMC Infantry Immersion Trainers (IIT)
- Navy's Group Two EOD Training and Evaluation Unit 2 Full Immersion Scenario Training Facility
- The Federal Law Enforcement Training Center (FLETC)
- Two Northeast Counterdrug Training Center High Risk Entry Facilities

# CAPITAL INVESTMENT PROGRAM

*" ...increase the capability of in-house laboratories..... "*

As the principal Navy center for research, development, test and evaluation, acquisition and product support activity for training systems, the laboratories at NAWCTSD provide a vital capability to ensure that we deliver the latest products and services to the fleet that are rooted in the science-of-learning. NAWCTSD's laboratory environments allow our scientists and engineers to perform the latest in research and development and accelerate the state-of-the-art for a broad spectrum of customers and warfare areas.

Since FY12, the NAWCAD Capital Investment Program (CIP) has become instrumental in ensuring that NAWCTSD laboratory capabilities will be well positioned to address future warfighting needs. As a working capital funded organization, NAWCTSD competes yearly for CIP funds to enhance our laboratory capabilities. CIP is funded by depreciation of prior acquired assets and are included in the labor rates charged to direct customers.

Currently, NAWCTSD has been approved for eight significant investment projects through FY15, with more on the horizon. This includes modernization or our Weapon Systems Integration Lab; standup of a new Software Integration & Information Assurance Lab; two projects that will significantly enhance our electrical & mechanical fabrication lab with a state-of-the-art CNC machine and 3D printing capabilities; an interoperability toolset for automating test compliance with the Navy Continuous Training Environment; a modern neurophysiological assessment system for performing the latest science-of-learning research; modernization and standardization of our communications and speech technology development capabilities; and a new Unmanned Systems lab. Together, these and future investment projects will keep NAWCTSD at the forefront of the R&D community associated with delivering the latest modeling, simulation, training and education products to the fleet.

The following pages describe the NAWCTSD labs that are currently operational.

## COMMON ARCHITECTURE TOOL SET (CATS) UPGRADE FOR THE CONCEPT DEVELOPMENT AND INTEGRATION LAB

**Start: Sep 13 End: Sep 14**

***Need:*** Rapidly develop Live, Virtual and Constructive (LVC) training devices - providing the Fleet with interoperable proof-of-principle demonstrations.

***Objective:*** Modernize and standardize our R&D environment with common developer hardware (e.g. workstations, network switches / data storage) and software development tools providing extensible, interoperable and re-usable LVC prototyping capabilities to a wide range of mission partners (e.g. US Fleet Forces Command / Naval Warfare Development Command Fleet Synthetic Training).

***Benefits:*** Cost savings attributed to modernization (development efficiency) and hardware/software commonality (e.g. reduced Information Assurance (IA) / System Administration (SA) costs).

***Status:*** IT approval received and purchasing of hardware and software accomplished in early FY14. Installation/Check Out and Initial Operating Capability (IOC) Completed May 2014.

***Research Products:***


Shizhen Huang, Shizhen (2014). SBIR User Interactive Trainer Presentation at SEAP/NREIP Outbrief, July 2014, NAWCTSD, Orlando, FL.

Gutierrez, Julio (2014). CATS Upgrade Presentation at SEAP/NREIP Outbrief, July 2014, NAWCTSD, Orlando, FL.

Gutierrez, Julio (2014). Distributed Version Control Systems in Enterprise Environments. ONR newsletter to be published Fall 2014.

## DISTRIBUTED TRAINING NETWORK GUARD (DTNG)

**Start: Sep 14 End: Sep 15**


***Need:*** Distributed training environments are in need of a Cross Domain Solution (CDS) that enables system connectivity operating at differing classification levels along with the ability to process multiple live, virtual and constructive (LVC) protocols.

***Objective:*** Develop a CDS that allows for enhancements in a cost effective, short time period. The CDS must bridge two dissimilar simulation network classification domains via filter rule sets that pass, fail or sanitize HLA, DIS or TENA protocols.

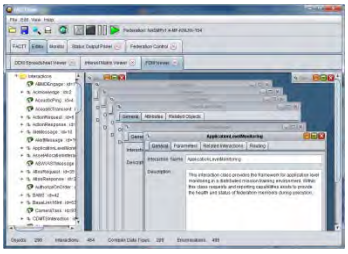
***Benefits:*** The Distributed Training Network Guard (DTNG) is a government-owned CDS which enables LVC systems operating at differing classification levels to connect in a cost effective short timeframe. DTNG is being developed in synergy with the Air Force (AFAMS, DMOC), Army (KORCOM), Joint Staff J7, Test Resource Management Center (TRMC) and the Navy (NAWCTSD), with NAWCTSD leading the development. DTNG provides an economical first step in establishing Cross Domain Information Sharing (CDIS) enterprise services. DTNG supports multiple protocols including High Level Architecture (HLA 1.3); Joint Live Virtual Constructive (JLVC) HLA 1516e; Distributed Interactive Simulation (DIS 6); and the Test and Training Enabling Architecture (TENA).

***Status:*** DTNG is currently being developed in the Interoperability, Design, Engineering & Application (IDEA) lab. The DIS phase of DTNG is currently undergoing Certification, Test & Evaluation (CT&E).

***Research Products:*** Common domain solution software algorithm (Sept 15).

## INTEROPERABILITY TOOL

**Start: Sep 13 End: Sep 14**



***Need:*** NAWCTSD does not have the capability to fully test training systems interoperability requirements during Developmental Test (DT), Operational Test (OT), and Fleet Synthetic Training (FST). Current methods are to manually analyze (> 204 hrs/event) or defer until the device is integrated into a live FST which is typically one week. This results in partial or complete loss of training for the aviation crew.

***Objective:*** Develop an automated software product to test training system interoperability interfaces. Develop critical components which include testing the most critical areas: Link 16, Emitters, and Simulation Entities (Entities = air, land, ground, surface, subsurface vehicles). Provide toolset to the training system developer and deploy to seven In-Service engineering sites to test and verify new and modified aviation training systems.

***Benefits:*** Automated testing will prevent loss of 25% training due to inability to test all requirements for a five day training event. Also shortens integration time needed for distributed training events.

***Status:*** The Emitters and Simulation Entity phase was completed. The data collection ability of the IOT Link 16 phase was tested over the NCTE network with a P-3 platform in June 14. Final testing was completed at the end of FY14.

***Research Products:*** Interoperable interface software product (Sept 14).

## NAVY AVIATION DISTRIBUTED TRAINING CENTER – PROOF OF CONCEPT

**Start: Sep 14 End: Sep 16**

***Need:*** NAWCTSD does not have an efficient method to integrate Navy Aviation trainers into Navy Aviation Simulation Master Plan (NASMP) and Fleet Synthetic Training – Aviation (FST-A) exercises. Unlike Fleet Synthetic Training – Joint (FST-J) exercises, NASMP and FST-A exercises do not have a centralized, dedicated team to run integration, scheduling, exercise execution and brief/debrief. Currently, site instructors must coordinate, plan, and execute distributed FST-A and NASMP exercises without the required external technical expertise and support. This leads to lost training opportunities, including Training and Readiness (T&R) credit and frustration within the Fleet. As more NASMP trainers come on line, the opportunity for more dynamic and complex missions, along with LVC training, will be possible.

***Objective:*** Design and implement a proof of concept for a Navy Aviation Distributed Training Center (NADTC). This proof of concept will be used as the basis for two Navy Aviation Distributed Training Centers; one on the west coast and one in the east coast. These centers will be able to coordinate, plan, schedule, integrate and execute NASMP and FST-A exercises with participating Navy Aviation trainers.

***Benefits:*** Designing and implementing a NADTC will enable Navy Aviation to conduct distributed training exercises more efficiently, provide more opportunities for Navy Aviation trainers to participate in distributed training exercises, provide more opportunity for crews to earn T&R credit and reduce the workload of the participating sites' instructors by removing technical barriers and roleplaying requirements.

***Status:*** NADTC Proof of Concept design for Orlando is nearing completion. The Interoperability, Design, Engineering and Application (IDEA) lab has been identified as the location for the proof of concept. The purchasing of equipment has begun, with Hardware/Software integration in the IDEA lab scheduled for completion in early November 2014. Testing with Strike and Maritime platforms will be conducted through June 2015. NADTC Proof of Concept demo will be conducted at the end of 3Q FY15.

***Research Product:*** Final NADTC Design is anticipated to be delivered to Oceana (East Coast) 3Q FY16 and to TTGP (West Coast) 4Q FY16.

## NEUROPHYSIOLOGICAL MEASUREMENT AND ASSESSMENT

**Start: Sep 13 End: Dec 14**

***Need:*** Advanced human performance measurement and assessment systems are needed to support ongoing and future capacity for in-house, state-of-the-art science and technology efforts requiring electroencephalogram (EEG) and physiological measuring technologies.

***Objective:*** Procure state-of-the art measurement and assessment capabilities to support current and future science and technology objectives.

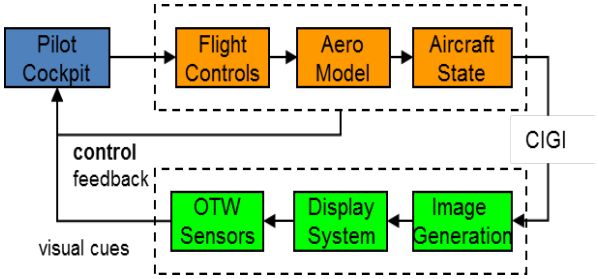
***Benefits:*** With this investment, researchers at NAWCTSD now have a list of technologies at their disposal including two Electrical Geodesics flagship 128 channel EEG systems, two Seeing Machines Face Labs eye tracking systems, two Thought Technologies physiological measurement suites, three Advanced Brain Monitoring BeAlert X-24 EEG systems, and an X-10 EEG. These added in-house capabilities will further the ability to assess the human-system relationship and substantially increase participation in the fields of Augmented Cognition and Neuroergonomics. NAWCTSD's researchers will work to expand RDT&E in areas including teamwork assessment, personnel selection, and interface design through basic and applied physiological signal monitoring and interpretation. Most importantly, while new, the neurophysiological assessment capability has been designed to be flexible and grow to meet existing, emerging, and future needs as they arise and as both the technology and the needs of the Navy mature.

***Status:*** The Neurophysiological capability will be fully stood up by the close of calendar year 2014.

***Research Products:*** New Neurophysiological measurement and assessment lab capability integration (Dec 14).

## VISUAL SYSTEMS LAB

**Start: Sep 14 End: Sep 15**




***Need:*** Capability to assess critical visual/aero training technologies to determine suitability to perform training in simulators vice aircraft. Need to reduce flight hours; increase use of "qualified" simulation; identification of critical training gaps; increase technology exploration; and reduce program risk through the development of traceable performance specifications.

***Objective:*** Develop a reconfigurable simulation environment for the integration of visual & aero modeling technologies to assess fleet training requirement needs (e.g., carrier landings) and methods to define and achieve fidelity requirements in support of

- matching essential training objectives with the appropriate perceptual cues,
- optimizing visual and aero fidelity requirements (e.g., visuals, sensors, loaders, aero models, etc.) based on training objectives and tasks, and
- ensuring technology alignment with platform modernization.

***Benefits:*** Reduce flight hours and increase use of "qualified" simulation; identify critical training gaps, and provide high risk concept verification; support visual/aero technology exploration and risk management; and mitigate acquisition strategy risk and improve performance specifications.

***Status:*** FY14 execution completed. FY15 execution on track for installation of 4 channel IG system, aero modeling workstation, aero software analysis tools, and force measurement instruments.

***Research Products:*** Successful installation of reconfigurable projector mounting structure, LED projectors, video switch, and new auto alignment system.

# SCIENCE, TECHNOLOGY, ENGINEERING AND MATH (STEM) EDUCATIONAL OUTREACH

## NAWCTSD STEM PROGRAM

**STEM COORDINATOR: Bob Seltzer** **STEM COORDINATOR: Sunny Simmonds**

NAWCTSD supports Department of Defense (DoD) and Navy Science, Technology, Engineering and Mathematics (STEM) goals and priorities. Through the National Defense Education Program (NDEP), DoD addresses the challenge to educate, train, recruit and retain personnel in STEM critical skill shortfall disciplines for National Security and Defense needs. The Navy's program, STEM2Stern, is built around five priorities:

1. **Inspire** the next generation of scientists and engineers (S&Es)
2. **Engage** students and build their STEM confidence and skills through hands-on learning activities that incorporate naval-relevant content
3. **Educate** students to be well prepared for employment in STEM careers that support the Navy and Marine Corps
4. **Employ**, retain and develop Naval STEM professionals, and
5. **Collaborate** across the Naval STEM enterprise, and with best practices organizations to maximize benefits to the Department.

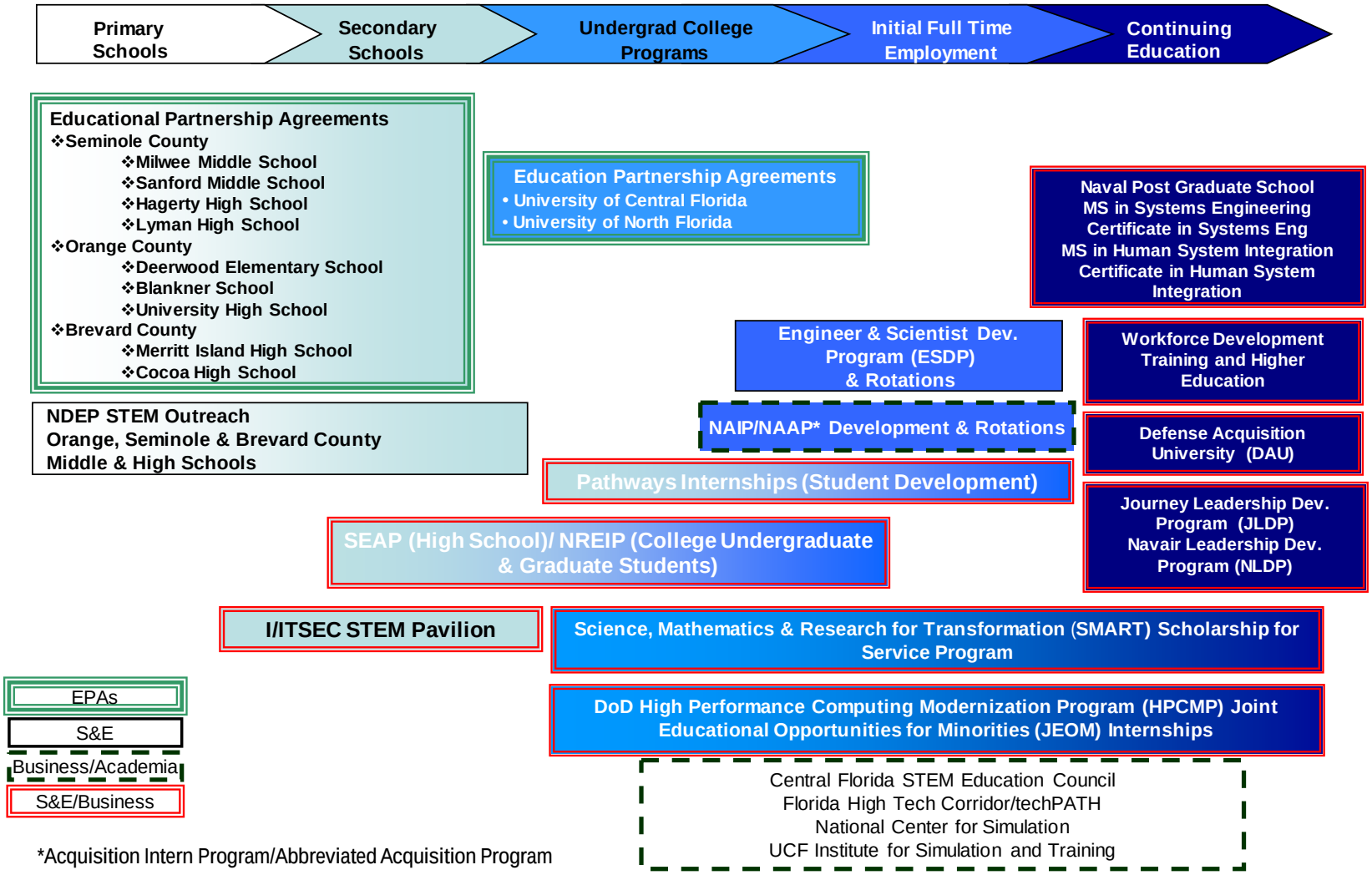
NAWCTSD'S implementation of NDEP-supported STEM initiatives commenced in late 2009, however, NAWCTSD has had a 24-year partnership with the Blankner School (K-8) in Orange County, where NAWCTSD has provided mentors, laboratory tours, job-shadow opportunities and awards/incentives for students. NAWCTSD has also had strong relationships with the University of Central Florida (UCF), providing internship opportunities for UCF students.

Today, NAWCTSD is committed to energizing STEM education in area schools by partnering scientists and engineers with teachers in classrooms to facilitate inquiry and design through project-based learning. NAWCTSD provides training opportunities for professional development of science and math teachers, provides mentors for robotics, STEM clubs, summer interns and at risk students, provides tours of NAWCTSD laboratories and demonstrations of modeling and simulation technologies for students and educators, and supports science fairs, teach-ins, science/technology field trips and summer camps. To enhance STEM education in the Central Florida area, NAWCTSD has partnered with Orange, Seminole, and Brevard County Public Schools, the University of Central Florida, the National Center for Simulation Education and Workforce Development Committee, members of the Central Florida STEM Education Council (CFSEC) and the Florida High Tech Corridor Council's techPATH.

NAWCTSD provides high school and college undergraduate and graduate level summer internship opportunities to include the following programs: Science and Engineering Apprenticeship Program (SEAP), Naval Research Enterprise Internship Program (NREIP), and Joint Educational Opportunities for Minorities (JEOM). Numerous development opportunities are provided for the NAWCTSD workforce such as Naval Post Graduate School courses for degrees/certifications, Defense Acquisition University (DAU) courses and certifications, NAVAIR leadership development programs (JLDP, NLDP) and Science, Mathematics & Research for Transformation (SMART) Scholarship for Service Program.

The following figure illustrates the NAWCTSD STEM Program Continuum.

# NAWCTSD STEM Continuum




*Acquisition Intern Program/Abbreviated Acquisition Program

## TEACHERS AND SCIENTIST & ENGINEER (S&E) PARTNERSHIPS

- ***SeaPerch***

In previous years, NAWCTSD coordinated training of NAWCTSD S&Es with teachers and trainers from Seminole and Orange County Public Schools, the Girl Scouts, Boys and Girls Clubs of Central Florida, the Orlando Science Center (OSC), and the YMCA. As a result of this training, SeaPerch clubs have been formed in Seminole County Public Schools, the OSC continues to offer SeaPerch summer camp sessions, the Army PEO STRI continues to use SeaPerch in its summer intern program, and the YMCA uses the SeaPerch activity in its after school programs.

- ***STEM Clubs***

In FY14, NAWCTSD S&Es assisted teachers with robotics programs in middle schools and high schools in Orange, Seminole and Brevard counties. S&Es also organized and ran a Math Club at Deerwood Elementary School in Orange County and tutored students in the Norfolk, Virginia area.

- ***Oak Ridge High School Aviation/Aerospace Magnet Program***

NAWCTSD has been an active partner in the development and roll-out of the new Oak Ridge High School Aviation/Aerospace Magnet Program. NAWCTSD is providing five aerospace engineer mentors, has provided lab tours and material funding. Through a Cooperative Research and Development Agreement, NAWCTSD is also partnered with TEQGame to support the evaluation of this program

## MENTORING AND INTERNSHIPS

- ***Teach-ins***

American Education Week, held in November of each year, is a national celebration of public education. NAWCTSD S&Es participated in this event by taking part in Teach-Ins at area schools. The S&Es spoke about their careers in STEM fields, NAWCTSD and the Navy in general. The response from the schools and students are overwhelmingly positive and our S&Es continue to return year after year.

- ***Blanker School Mentoring and Job Shadow Day***

Throughout the year, several NAWCTSD employees mentor at risk students of Blankner K-8 School. Mentors spend at least one hour per week assisting students at the school. In addition, at the end of the year, 8th grade students are provided with a Job Shadowing opportunity. This year, approximately 25 students shadowed NAWCTSD employees, had lunch with job shadow partners and attended 1-2 modeling and simulation demonstrations.

- ***FIRST Robotics Teams***

In the school year 2013-2014, NAWCTSD S&Es mentored FIRST Robotics Competition (FRC) teams at Merritt Island and Cocoa High Schools, FIRST Tech Challenge (FTC) teams at University and Hagerty High Schools and FIRST Lego League (FLL) teams at Sanford and Milwee Middle Schools. During the FIRST season, S&Es met with teams at least once a week and they attended competitions with teams. NAWCTSD engineers mentored 11 teams each participating in several competitions. NAWCTSD S&Es continue to support area robotics teams.

- ***Summer Interns***

Every summer, NAWCTSD scientists and engineers (S&Es) mentor high school and college undergraduate/graduate students through the Office of Naval Research (ONR) internship programs, Science and Engineering Apprenticeship Program (SEAP) and Naval Research Enterprise Internship Program (NREIP), and the DoD High Performance Computing Modernization Program's Joint Educational Opportunities for Minorities (JEOM) internship program. SEAP places academically talented high school students with interest and ability in science and mathematics as apprentices in Department of the Navy laboratories for eight weeks during the summer. NREIP is a ten-week intern program designed to provide opportunities for undergraduate and graduate students to participate in research, under the guidance of an appropriate research mentor, at a participating Navy laboratory. JEOM is a ten week program that allows interns to gain experience in key areas, such as computational science, information technology, computer science, and scientific visualization. Students from area high schools, the University of Central Florida and other universities were mentored by NAWCTSD S&Es this past summer.

## COMMUNITY/SPECIAL STEM EVENTS

- ***Engineering Futures Forum***

For the past few years, the College of Engineering and Computer Science at the University of Central Florida has partnered with industry and engineers at other practicing engineering organizations to bring students at local schools to the Engineering Futures Forum program. In 2014, NAWCTSD S&Es participated in three separate events at local schools speaking to over 1000 students about careers in engineering and specifically engineering careers with the Navy.

- ***Science Olympiads***

Science Olympiad competitions are like academic track meets, consisting of a series of 23 team events in each division (Division B is middle school; Division C is high school). Each year, a portion of the events are rotated to reflect the ever-changing nature of genetics, earth science, chemistry, anatomy, physics, geology, mechanical engineering and technology. By combining events from all disciplines, Science Olympiad encourages a wide cross-section of students to get involved. Emphasis is placed on active, hands-on group participation. Through Science Olympiad, students, teachers, parents, principals and business leaders bond together and work toward a shared goal.

The culmination of more than 280 regional and state tournaments is the Science Olympiad National Tournament, held at a different university every year. This rotating system gives kids a chance to visit new parts of the country, to tour colleges they might consider for their undergraduate studies, and provides a memorable experience to last a lifetime.

In 2014, NAWCTSD S&Es assisted with several events at the National Science Olympiad, the Florida State Science Olympiad and the Elementary Science Olympiad all held at the University of Central Florida. S&Es have also supported Science Olympiads in previous years.

- ***ZORA! STEM Conference***

The ZORA! STEM Conference, part of the ZORA! Festival 2014 was a full day of activities held at the Rosen School of Hospitality designed to jump start the interest of students in grades 6-12 in the STEM fields. The conference focused on attracting students who are historically under-represented in the STEM fields. NAWCTSD partnered with the Orlando Science Center, Valencia Community College, UCF, and techPATH in assisting the ZORA Festival organizer with bringing this conference to life. NAWCTSD S&Es conducted an Engineering Design Challenge exercise for over 100 middle school and high school students.

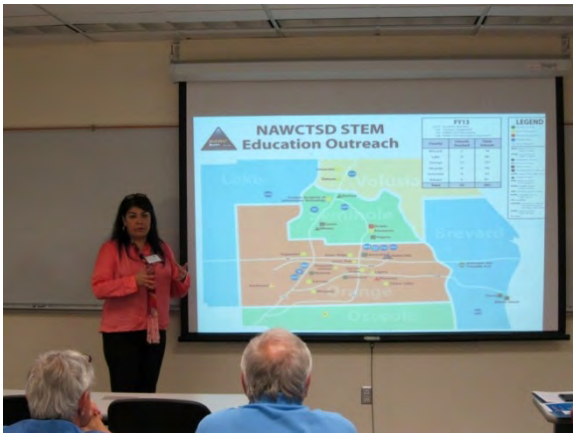
- ***Summer Camps***

In the Summer of 2014, NAWCTSD hosted several summer camp groups. The first of these groups was the ZORA! STEM middle school camp which was hosted in partnership with the National Center for Simulation and UCF's Institute for Simulation and Training. In addition, two YMCA camps and a UCF Camp Connect group toured NAWCTSD. Approximately 100 students were treated to demonstrations of simulators and discussions involving engineering, science and aviation careers.

- ***Other Special Events***

In 2014, NAWCTSD's Commanding Officer, representing the Department of Defense, was guest speaker at the 2014 Mathcounts National Competition. Teams representing 23 states were represented at the Mathcounts competition. In addition, the Commanding Officer was featured at NASA's Astronaut Scholarship Foundation STEM Scholar Technology conference. At the conference, NAWCTSD personnel demonstrated a ship handling simulator.

Additionally, a NAWCTSD engineer was guest speaker at the Teacher Enrichment Program (TEP) 2014-Bite of Science Session held at DeVry University. This event was attended by 29 teachers from the Central Florida area. The TEP is a program of the Center for Excellence in Education which was founded in 1983 by the late ADM H.G. Rickover. The TEP helps to assure a future talented and diverse U.S. workforce in STEM. TEP is available cost-free to urban and rural high school science teachers to strengthen their professional development of science in the classroom.



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# APPENDIX A
# NAWCTSD RESEARCH CAPABILITY FOCUS AREAS

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# NAWCTSD Orlando R&T Focus Area Project Crosswalk

**4 R&T Focus Areas:**

1) Human Performance Modeling & Assessment
2) Human Systems Design and Decision Support
3) Virtual Environments & Training Technologies
4) Dist., Live, Virtual & Constructive Synthetic Training

KEY: ✓✓ = Primary Focus
✓ = Secondary Focus

| TITLE | NAE STOs | | | 4.6 R&T Focus Area | | | |
|---|---|---|---|---|---|---|---|
| | NWP STO-1 Training & Education. | NWP STO-2 Human Systems. Design & Decision Support | ID STO-1 Command & Control | HP Model & Assessment | Human Systems, Design & Decision Support | Virtual Environments & Training Technologies | Dist. LVC Synthetic Training |
| **SCIENCE & TECHNOLOGY** | | | | | | | |
| **Discovery and Invention Research** | | | | | | | |
| Basic Electricity and Electronics Tutorial Learning Environment – Human Computers and Speech (BEETLE HSC) | ✓✓ | | | ✓✓ | | ✓ | |
| Post-Traumatic Stress Disorder/Traumatic Brain Injury and Training Effective Analysis | ✓✓ | ✓ | | ✓ | | ✓✓ | |
| Tutoring Effectively: An Assessment of Common Heuristics (TEACH) | ✓✓ | | | ✓✓ | | ✓ | |
| **In-House Laboratory Independent Research Projects** | | | | | | | |
| Measuring Intuition and its Relationship to Somatic Markers and Individual Differences | ✓✓ | | | ✓✓ | | | |

| TITLE | NAE STOs | | | 4.6 R&T Focus Area | | | |
|---|---|---|---|---|---|---|---|
| | NWP STO-1 Training & Education. | NWP STO-2 Human Systems. Design & Decision Support | ID STO-1 Command & Control | HP Model & Assessment | Human Systems, Design & Decision Support | Virtual Environments & Training Technologies | Dist. LVC Synthetic Training |
| **Independent Applied Research Projects** | | | | | | | |
| Tailoring Instruction to the Individual: Investigating the Utility of Trainee Aptitudes for Use in Adaptive Training | ✓✓ | | | ✓✓ | | ✓ | |
| **Advanced Technology Development** | | | | | | | |
| Carrier Qualification Training Reduction via Advanced Piloting Systems (CQTRAPS) | ✓✓ | ✓ | | ✓ | ✓✓ | ✓ | |
| High Fidelity Active Sonar – Command (HIFAST-CMD) | ✓ | ✓ | ✓✓ | ✓ | ✓ | ✓ | ✓✓ |
| Modular Advanced Technologies Marksmanship Proficiency | ✓✓ | ✓ | | ✓ | | ✓✓ | ✓ |
| Training Transformation (T2) Initiative in Support of United States Joint Forces Command | ✓✓ | | | ✓ | | ✓✓ | |
| **Capable Manpower Future Naval Capability Research** | | | | | | | |
| Adaptive Training for Combat Information Center Teams | ✓✓ | | ✓ | ✓✓ | | ✓✓ | |
| Adaptive Training for Submarine Piloting and Navigation | ✓✓ | | | ✓✓ | | ✓✓ | |
| Distributed, Adaptive, and Modular entities for Unmanned Aerial Systems (DyAdeM) | ✓ | ✓✓ | | ✓✓ | | ✓ | ✓ |
| Live, Virtual, and Constructive (LVC) Training | ✓✓ | ✓ | | ✓ | | ✓ | ✓✓ |

| TITLE | NAE STOs | | | 4.6 R&T Focus Area | | | |
|---|---|---|---|---|---|---|---|
| | NWP STO-1 Training & Education. | NWP STO-2 Human Systems. Design & Decision Support | ID STO-1 Command & Control | HP Model & Assessment | Human Systems, Design & Decision Support | Virtual Environments & Training Technologies | Dist. LVC Synthetic Training |
| **Naval Innovative Science and Engineering** | | | | | | | |
| **Basic and Applied Research** | | | | | | | |
| Assessment of the Impact on Human System Performance Using an Augmented Reality Maintenance System (ARMS) | ✓✓ | | | ✓ | | ✓✓ | ✓ |
| Developing Warfighter Training Guidance for Cue Recognition of Trustworthiness in Culturally-Complex Environments | ✓✓ | | | ✓✓ | ✓ | | |
| Improving Team Problem-Solving and Decision-Making using Communication Protocols | ✓ | ✓✓ | | ✓✓ | | ✓ | |
| Information Presentation Modality: A Phased Solution | ✓✓ | ✓ | | ✓ | ✓ | ✓✓ | |
| Next Generation of Aviation Selection: Unmanned Aerial Systems | ✓✓ | ✓ | ✓ | ✓✓ | | ✓ | |
| Optimal Learner Support for Improving Adaptive Reasoning About Complex Simulation Systems | ✓✓ | | | ✓ | | ✓✓ | |
| Optimizing Performance of Trainees for UAS Manpower, Interface & Selection (OPTUMIS) | ✓✓ | ✓ | ✓ | ✓✓ | | ✓ | |
| The Efficacy of Feedback Parameters in Adaptive Training Systems | ✓✓ | | | ✓✓ | | ✓ | |

| TITLE | NAE STOs | | | 4.6 R&T Focus Area | | | |
|---|---|---|---|---|---|---|---|
| | NWP STO-1 Training & Education. | NWP STO-2 Human Systems. Design & Decision Support | ID STO-1 Command & Control | HP Model & Assessment | Human Systems, Design & Decision Support | Virtual Environments & Training Technologies | Dist. LVC Synthetic Training |
| Usability Survey Enabling Research and Assessment for Intuitive Designs (USER AID) | | ✓✓ | | ✓✓ | | ✓ | |
| **Workforce Development: Strategic Growth** | | | | | | | |
| A Brave New "Virtual" World: The Use of Virtual World Applications for Military Training | ✓✓ | | | | | ✓✓ | ✓ |
| Advanced Low-Power Wireless Mesh/Ad Hoc Network Device Capability Development | ✓✓ | ✓ | | | ✓ | ✓ | ✓✓ |
| Human Performance Model Validation Process | ✓✓ | | | ✓ | | ✓✓ | |
| NAWCTSD Knowledge & Laboratory Expertise Advancement Regarding the Application of Cutting Edge Embedded Signal Processing Designs to Military Training and Simulation | ✓✓ | ✓ | | | | ✓ | ✓✓ |
| **Transition** | | | | | | | |
| Human Performance Based Simulation Certification Criteria Test and Evaluation Job Aid – Requirements Tracing Tool (RETT) | ✓✓ | ✓ | | | ✓ | ✓✓ | |
| Performance Assessment Trends in Training Enhancing Readiness Reporting for Naval Systems (PATTER$^2$NS) | ✓✓ | | | ✓✓ | ✓ | | |

| TITLE | NAE STOs | | | 4.6 R&T Focus Area | | | |
|---|---|---|---|---|---|---|---|
| | NWP STO-1 Training & Education. | NWP STO-2 Human Systems. Design & Decision Support | ID STO-1 Command & Control | HP Model & Assessment | Human Systems, Design & Decision Support | Virtual Environments & Training Technologies | Dist. LVC Synthetic Training |
| Unmanned Aerial System Common Control Station Prototype-based Training Research | ✓✓ | ✓ | | ✓ | ✓✓ | ✓ | |
| **TRANSITION RESEARCH** | | | | | | | |
| Intelligent Tutoring and Authoring Delivery System (ITADS) | ✓✓ | | | ✓ | | ✓✓ | |
| Intelligent Tutoring for Simple Key Loader | ✓✓ | | | ✓ | | ✓✓ | |
| **Air Warfare Training Development (AWTD) Program** | | | | | | | |
| Performance Measurement (PM) Engine | ✓✓ | | | ✓✓ | | | ✓ |
| Post Mission Assessment for Tactical Training & Trend Analysis (PMATT-TA) | ✓✓ | ✓ | | ✓✓ | | ✓ | ✓ |
| Training Effectiveness of FA-18 Tactical Operation Flight Trainer Upgraded with Motion Cueing Seat and Improved Visual System | ✓✓ | | | ✓ | | ✓✓ | |
| **TechSolutions Project** | | | | | | | |
| Multi-Purpose Reconfigurable Training System 3D Virginia Emergency Diesel Generator Simulator | ✓✓ | | | ✓ | | ✓✓ | |

| TITLE | NAE STOs | | | 4.6 R&T Focus Area | | | |
|---|---|---|---|---|---|---|---|
| | NWP STO-1 Training & Education. | NWP STO-2 Human Systems. Design & Decision Support | ID STO-1 Command & Control | HP Model & Assessment | Human Systems, Design & Decision Support | Virtual Environments & Training Technologies | Dist. LVC Synthetic Training |
| **SBIR Phase III Transition Projects** | | | | | | | |
| New Modeling and Simulation Technology for Night Vision Goggle (NVG) Mission Rehearsal | ✓✓ | | | | | ✓✓ | |
| **SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM & SMALL BUSINESS TECHNOLOGY TRANSITION RESEARCH (STTR)** | | | | | | | |
| **SBIR Phase I Projects** | | | | | | | |
| Distributed Synthetic Environment Correlation Architecture and Metrics | ✓✓ | | | | | ✓✓ | ✓ |
| Mask-on Hypoxia Training Device | ✓✓ | | | | | ✓✓ | |
| **SBIR Phase II Projects** | | | | | | | |
| Common Unmanned Vehicle Control Procedures Trainer | ✓ | ✓✓ | | ✓ | ✓ | ✓✓ | |
| Decoupled Rendering Channels to Reduce Logistical Support Spares Requirements of Large Scale Training Centers [N131-018] | ✓✓ | | | | ✓ | ✓✓ | |
| Geospecific Displacement Maps for Real Time, Stereoscopic Training Simulation (N102-116) | ✓✓ | ✓ | ✓ | | | ✓✓ | ✓ |
| Hyper-Elevation Modeling of Terrain, Topography & Urban Environments (N091-026) | ✓✓ | | | | | ✓✓ | |

| TITLE | NAE STOs | | | 4.6 R&T Focus Area | | | |
|---|---|---|---|---|---|---|---|
| | NWP STO-1 Training & Education. | NWP STO-2 Human Systems. Design & Decision Support | ID STO-1 Command & Control | HP Model & Assessment | Human Systems, Design & Decision Support | Virtual Environments & Training Technologies | Dist. LVC Synthetic Training |
| Hypoxia Training in Normal Pressure Chambers [N08-139] | ✓✓ | | | | ✓ | ✓ | |
| Innovative Collimated Displays (N121-041) | ✓✓ | ✓ | | | | ✓✓ | |
| Material Classification Sensor Simulation with Stereo Imagery [N092-094] | ✓ | ✓✓ | | | | ✓✓ | ✓ |
| New and Improved Radio Frequency (RF) Modeling for Correlated Environment Communication System Simulators with Sensor Simulators [N121-011] | ✓✓ | ✓ | ✓ | | | ✓✓ | ✓ |
| Reconfigurable Aerial Refueling Trainer [N102-124] | ✓✓ | | | | | ✓✓ | |
| SAF Tactical Behavior Fidelity (Tactical Environment Role-Player Station) [N07-033] | ✓✓ | | | ✓✓ | | ✓ | ✓ |
| Small Projector Array Display System | ✓✓ | | | | | ✓✓ | |
| **STTR Phase II Projects** | | | | | | | |
| Automated Human and System Performance Assessment in Operational Environments [N11A-T001] | ✓✓ | | | ✓✓ | | ✓ | ✓ |
| Tailoring Training For Disparately Skilled Participants in Large Scale Training Exercises [N09-T007] | ✓✓ | ✓ | ✓ | ✓ | ✓ | ✓✓ | ✓ |

| TITLE | NAE STOs | | | 4.6 R&T Focus Area | | | |
|---|---|---|---|---|---|---|---|
| | NWP STO-1 Training & Education. | NWP STO-2 Human Systems. Design & Decision Support | ID STO-1 Command & Control | HP Model & Assessment | Human Systems, Design & Decision Support | Virtual Environments & Training Technologies | Dist. LVC Synthetic Training |
| **TECHNOLOGY TRANSFER** | | | | | | | |
| Scenario Planning and Effects Control System (SPECS) and After-Action Review Technology | ✓✓ | | | ✓ | | ✓✓ | |
| **CAPITAL IMPROVEMENT PROGRAM** | | | | | | | |
| Common Architecture Tool Set (CATS) Upgrade for the Concept Development and Integration Lab (CDIL) | ✓✓ | ✓ | | | ✓ | ✓ | ✓✓ |
| Distributed Training Network Guard (DTNG) | ✓✓ | | ✓ | | | ✓ | ✓✓ |
| Interoperability Tool | ✓✓ | ✓ | ✓ | | ✓ | ✓ | ✓✓ |
| Navy Aviation Distributed Training Center – Proof of Concept | ✓✓ | | | | | ✓ | ✓✓ |
| Neurophysiological Measurement and Assessment | ✓ | ✓✓ | | ✓ | ✓ | ✓✓ | |
| Visual Systems Lab | ✓✓ | ✓ | | ✓ | ✓ | ✓✓ | |

# APPENDIX B
# NAWCSTD LABS

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## NAWCTSD LABS

| LAB | MISSION |
|---|---|
| Weapons Launch Console Team Trainer (WLCTT) Lab | Provide Life Cycle Support for the Integrated Undersea Surveillance System (IUSS) TL-29 and ICP synthetic acoustic analysis training. Develop, test and aid in the life cycle support and new development of the WLCTT fielded trainers. |
| Submarine Piloting & Navigation (SPAN) Lab | Develop Submarine Piloting & Navigation training system prototypes for NAVSEA, and provide smart buyer awareness for future submarine training system acquisition. |
| Virtual Environment for Submarine Shiphandling (VESUB) | Develop VESUB training system prototypes for NAVSEA and provide smart buyer awareness for future submarine training system acquisition. |
| Concept Development & Integration Lab (CDIL) | Research and prototype development of interoperable live, virtual and constructive training devices and technologies, and provide smart buyer awareness to training system acquisition programs. |
| Virtual Technology Development Operations Center (VTDOC) | Provide technology development and operations center for distributed simulation and training exercises. |
| Technology Integration Facility (TIF) (AKA Dome Room) | Provide Visual Systems analysis, system integration and Command demonstrations. |
| Training & Usability in Simulation-based Tools (TRUST) Lab | Conduct science & technology research & development, & acquisition activities through analysis, design, development, test, usability evaluation & transition of state-of-the-art products that enhance the training & operational capabilities of the nation's warfighters |
| Human Systems Integration S&T Lab (HSIL) | Conduct research, development and application of HSI tools, techniques, and technologies to Navy systems engineering and acquisition. |
| Anti-Submarine Warfare Center of Excellence (ACE) Lab | Develop Anti-Submarine Warfare Training Prototypes for the warfighter. |
| Trident Training System (TTS) Lab | Provide primary simulation and training support to the Trident Ballistic Missile Submarine force. Also provide simulation and training support for other UNDERSEA assets. |
| Live, Virtual & Constructive Modeling & Simulation (LVCMS) Lab | Integration Research and Development for development of ASW Training Systems. |
| Improving Multicultural Performance, Adaptability, & Competence in Teams (IMPACT) Lab | Investigation of interpersonal trust and the development of knowledge, skills, and abilities to accelerate Warfighter effectiveness when operating in multicultural environment. |

## NAWCTSD LABS (Cont'd)

| LAB | MISSION |
|---|---|
| Acoustic Training & Simulation Lab (ATaS) | Provide current sensor and acoustic data used in modeling and simulation across Navy Anti-Submarine Warfare training devices. |
| Interoperability, Engineering & Application (IDEA) Lab | Provide simulation interoperability tools and technical expertise in support of joint, live, virtual, constructive programs and related research, development, and acquisition efforts. |
| Intelligent Virtual Environments for Naval Training (InVENT) Lab | Conduct applied research into techniques for incorporating pedagogical intelligence into virtual training environments. The lab is staffed by an interdisciplinary team that includes software developers, research psychologists, instructional system designers, systems engineers and other training acquisition professionals. |
| Multipurpose Reconfigurable Training System (MRTS) | Develop and deliver trainers that simulate the operation and maintenance of the Common Submarine Radio Room (CSRR) and the Submarine Communications Support System (SCSS) for SSBN, SSGN, Virginia, SSN-688, and SEAWOLF submarines. Develop and deliver operator and maintenance trainers for other submarine systems, including AN/BLQ-10. |
| Simulation & Training Research to Improve Knowledge & Effectiveness (STRIKE) Lab | Provide cognitive and behavioral research for improving training and human performance. Investigate and advance the use of technologies for support in embedded, distributed, and distance learning applications. |
| Submarine Research Application Team (SubRAT) | Develop networked simulations and instructor scenario-scripting and control capabilities. Primary development efforts focus on navigation, piloting and contact management training, and our secondary development efforts focus on the development of shipboard virtual tours to primarily support familiarization and expedited crew qualification. |
| Visual Systems Lab | Support visual database development efforts, Visual R&D projects, NPSI development, provide smart buyer awareness for future visual system acquisitions. |
| Weapons Simulation & Integration Lab (WSIL) | Provide in-house, rapid response research and development of software and hardware technology in the areas of interactive systems, operational system integration with virtual environments, simulated equipment and control interfaces, intelligent agents, and instructor support technologies. |
| Rapid Prototype Design & Fabrication Team | Provide in-house, rapid response electronics and mechanical design, development, and rapid prototype fabrication capabilities to support NAWCTSD science and technology, acquisition and life cycle efforts. |