NAWCTSD Research Project Summaries
Fiscal Years 2016-2017

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

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

At the Naval Air Warfare Center Training Systems Division (NAWCTSD), we are conducting research to understand and improve individual and team learning and performance. We develop education and training methodologies and technologies to reduce training time and maximize transfer of knowledge, and utilize this “Science of Learning” to enable 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, concepts 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 all of our principal investigators and 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.
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 improve performance, reduce risk, and reduce cost.

Our strategy includes partnering with and 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.
“We continually strive to improve the way we plan and manage our S&T portfolio. Our S&T Objectives (STOs) are jointly developed with the warfighters, technologists, requirements officers and the acquisition sponsors. Roadmapping of the individual STOs coupled with our newly developed, department level, and bottoms up Core Capabilities play a major role in identifying gaps to guide and develop our investment strategies to clearly articulate our focus areas. These approaches are guided by a common process supported by quantitative metrics, with a goal of transitioning the best sustainable 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 the CNO’s, OSD’s, ONR’s, DCA’s Science & Technology Objectives. There are 10 capability gaps supported by 33 NAE STOs jointly developed interactively with OPNAV, Fleet, NSAWC/NMAWC, PEOs/PMAs, FRCs, USMC, Warfighters and Technologists.

The STOs are the goals of the NAE S&T program which are presented using a common road mapping process which show 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 / warfighters.

STOs are supported by the 75 NAWC Core Capabilities which define ongoing vs. needed projects, current vs. future skill sets, and the required infrastructure at the department level required to address the STOs. The combination of the two documents (top down vs. bottoms up) enables the NAE to define focus areas which clearly articulate needs, requirements and desired capabilities critical to the resource and acquisitions sponsors.

Technology development is principally performed by the elements of the Naval Research Enterprise (Warfare Centers), industry, and academia which provide the critical technology and material that transition to the acquisition sponsors and ultimately the warfighter.

The prime responsibility of the NAE Chief Technology Officer is to ensure alignment, leveraging, and non-duplication of efforts with focus on the NAE’s current missions and future capability needs while balancing and managing a fiscally responsible S&T portfolio which provide our warfighters with the technologies critical to their success.
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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 (FNC) Programs. Taken together, these programs comprise the Navy's technology base and support the 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 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.

We pursue early advances in selected research areas under the D&I portion of the Navy S&T Strategy, with Basic Research and Applied Research as the primary components. We also are involved in Transition Research 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 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.

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.

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

1. Enhance and measure human performance
2. Improve learning and retention and their assessment
3. Improve 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 (e.g., individual, team or multi-team) across domains and tasks. Future assessment capabilities will encompass neuro-cognitive and other physiological measures and indices. Understanding these 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 two sub-capabilities:

- **Human Performance Assessment**
  - 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
  - Automated Performance Assessment for Simulators

- **Human Performance Modeling**
  - Develop and Validate Algorithms and Modeling Approaches to Capture Human Performance (individuals, teams, and team-of-teams)
  - Apply Human Performance Models (HPMs) to Simulation-Based Design, Mission Planning, and Training
  - Advance Real-time Processing and Integration of HPMs
  - Innovative Predictive Modeling for Strategic Behavioral Prototyping
  - Library of Reusable HPMs Covering Relevant Military Tasks

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
- Immersive, Augmented/Virtual Reality
- Adaptive Training & Intelligent Tutoring
- Medical Modeling & Simulation
- Game-based Training
- Eye-Limiting Resolution Display
- Mobile Training Technologies
- Cyber 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

Optimized 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.

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

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

1. Science & Technology
2. Naval Innovative Science and Engineering Program
3. Transition Research
4. SBIR & STTR Projects
5. Technology Transfer
6. Capital Investment Program
7. Other Navy, Department of Defense and Joint Programs/Projects
8. Science, Technology, Engineering, and Mathematics (STEM) Educational Outreach

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

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 comprised of six ONR projects: one supports carrier qualification pilot training, and the other five projects supporting the Capable Manpower FNC. The purpose of ATDs are 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:

- Enhance fundamental information-processing abilities in naval recruits utilizing world-class innovative training technologies
- Accelerate and enhance training time and impact while reducing costs
• Develop tools and techniques to achieve ubiquitous, engaging, scenario-based training and automated performance-based readiness assessment
• Enable training tailored to the individual and team anywhere, anytime through simulation-based technologies for multi-mission, multi-platform training

Human System Design and Decision Support
• Reduce training and workload requirements through human-centric system design
• Create design engineering tools and standards incorporating human capacities into system performance
• Incorporate the human element into design and control of autonomous and robotic systems
• Develop effective, user-friendly decision support systems for kinetic and non-kinetic operations

Bio-engineered Systems
• Design computational cognitive models for intelligent systems and synthetic forces for operational experimentation, mission planning, real-time decision support and training systems
• Exploit understanding of neurocognitive processes to enhance combat system design and adaptive digital tutoring systems

Warfighter Health and Survivability
• Improve the continuum of casualty care from the point of injury, en route, and shipboard to definitive care at treatment facilities
• Enhance warfighter resilience to physical and psychological stressors

NAWCTSD’s S&T Projects are described in the subsequent D&I, ATD and Capable Manpower FNC sub-sections that follow.
**DISCOVERY AND INVENTION RESEARCH PROJECTS**

**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:** The BEETLE project has concluded. A summary of findings from our studies with human tutors and BEETLE, including the fully adaptive feedback version and a non-adaptive feedback version, were summarized. Overall, all modes of tutoring (human, adaptive computer, and non-adaptive computer) were highly effective and yielded impressive effect sizes on the order of 1.6 to 1.8 sigma improvements relative to a no-training control condition. However, there were no significant difference in learning gain between our conditions, thus we were not able to show a benefit for adaptive dialogue in our studies, but we did see that our strong curriculum was effective at teaching even with canned feedback.

Through our research on tutoring, we learned some interesting things about students, tutors, and the curriculum. More successful students spoke in longer sentences (Steinhauser, 2007; Steinhauser, 2013), used more “content” words (Litman, 2009), rarely got “stuck” during training (Campbell, 2009; Litman, 2009; Steinhauser, 2013), found an effective way to communicate with computer tutor on their own (not by copying the tutor's language) and re-used those language structures (Steinhauser, 2011; Steinhauser, 2013), and reported being more satisfied with the training (Steinhauser, 2013). We also found that negative metacognitive statements made during independent activities were accurate predictors of confusion, students rarely made negative metacognitive statements with a human tutor and, positive metacognitive statements made during dialogue with a human tutor were also predictors of confusion (Campbell, 2009).

As for tutoring techniques, we found that it is advantageous to ask open-ended questions to encourage and elicit student talk, elicit deep processing, elicit accountable talk (accurate and deep), and engage student’s interest so that some dialogue is internally motivated. When the student gives a correct response the tutor should restate, summarize, and emphasize main point(s) and appropriate use of domain terminology. When the student is incorrect the tutor should provide activities that lead student to figure out the answer (Steinhauser, 2007; Campbell, 2008; Dzikovska, 2008; Campbell, 2009).

Additionally, we found that students interact differently with different types of tutors. Students are more social and positive with a human tutor. Students are more likely to respond negatively to an adaptive computer tutor than to a human tutor. Students do not attempt to interact socially and do not make metacognitive statements to a scripted/canned tutor (Steinhauser, 2010; Dzikovska, 2010).
maturity of the Natural Language Processing technology also matters. Frequency of “uninterpretables” (times when the computer tutor didn’t understand the student) correlated with low learning gain and low user satisfaction in both the adaptive and scripted computer tutors (Dzikovska, 2011; Dzikovska, 2014).

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:**

**2014**

**2013**

**2012**
Bell, P., Dzikovska, M., and Isard, A. "Designing a spoken language interface for a tutorial dialogue system". In Proceedings of Interspeech-2012, Portland, OR, USA.


**2011**


**2010**


2009


Litman, D., Moore, J.D., Dzikovska, M.O., and Farrow, E. "Using Natural Language Processing to Analyze Tutorial Dialogue Corpora Across Domains and Modalities". In Proceedings of the 14th International Conference on Artificial Intelligence in Education (AIED-2009).

2008

2007


2006
**Tutoring Effectively: An Assessment of Common Heuristics (TEACH)**

**Start: Oct 12  End: Sep 17**

**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, thereby also supporting the Navy’s requirement for making advances in the teaching of STEM fields. 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 effect of feedback and scaffolding (in a tutorial setting) on tutoring effectiveness and the 2 Sigma effect of tutoring (Bloom, 1984). (2) Examine the benefits of scaffolding a curriculum and/or providing scaffolded statements after performance assessment. (3) Provide empirically-validated tutorial strategy recommendations for implementation into an Intelligent Tutoring System.

**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:** The team began this effort by identifying the STEM curriculum to be used as the experimental basis for determining the effectiveness of feedback and scaffolding. Differential equations, in the form of predator-prey modeling, were chosen because significant progress can be made in teaching these problems in a relatively short amount of time, without requiring much background knowledge. To make things more engaging for the student, our predator-prey model was centered around humans and zombies on a small island. To address our research questions, two curricula were developed (scaffolded and non-scaffolded) and three after-action response conditions (feedback, reactive scaffolding, or no after-action response) were created, resulting in a 2 x 3 research design (illustrated in the table below). The scaffolded curriculum deconstructed the humans vs. zombies model into three smaller models that built up complexity over time. That is, in the scaffolded version, the final model was broken down into three simpler models. As the curriculum progressed and models became more complex, the student was given increasing responsibility for completing the curriculum activities after seeing examples from the tutor. The non-scaffolded curriculum only contained the final complex model, and the student was required to complete all curriculum activities without the benefit of worked examples. After pilot-testing the curriculum, the after-action responses (feedback and scaffolding) were developed based on common errors committed by students. Feedback responses included a statement of correctness followed by the correct answer. For reactive scaffolding statements, the tutor did not provide a statement of correctness and proceeded to try to elicit the correct answer from the student. The after action responses available for the experimenter/tutor to give to the student were standardized to ensure consistency between experimenters. In the no after-action response group, the tutor simply asked the student to move on after they completed each step in the curriculum.
The dependent measures were conceptual knowledge gain (derived from a pretest and posttest) and transfer test performance (where students were required to complete three new predator-prey models without assistance from the tutor). During the experimental session, the tutor interacted individually with each of the 122 participants (about 20 per condition) via a computer chat interface. Participants were assigned to one of the six conditions which dictated the curriculum the student received and the after-action responses the tutor used. The data from our study indicate that providing some form of after-action response (e.g., feedback or scaffolding) resulted in higher transfer test scores than providing no after action response. However, feedback and scaffolding were not significantly different from each other in terms of effectiveness of after-action response. Also, there was no significant difference between the scaffolded and the non-scaffolded curricula. Interestingly, we did find an interaction effect that indicated that pairing a scaffolded curriculum with reactive scaffolding responses resulted in significantly poorer performance than reactive scaffolding responses in a non-scaffolded curriculum. Further analyses indicated that the scaffolded curriculum with scaffolding as an after-action response took significantly longer to complete than the scaffolded curriculum with feedback as the after-action response, which appears to indicate a fatigue affect for the double scaffolding condition. Additionally, we found that participants in the no after-action response conditions performed significantly better in the scaffolded versus the non-scaffolded curriculum. Unfortunately, our results did not indicate a clear curriculum design choice. Instead, they suggest that, ideally, an after-action response should be used in tutoring; however, in the absence of a tutor to provide after action responses, a curriculum should be scaffolded. Furthermore, instructional designers should take care not to overburden the student by including after action responses that may increase the time of the curriculum to the point that students begin to get fatigued.

**Research Products:** No publications to date. Final report and other publication(s) are in progress.

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**Research Products:** No publications to date. Final report and other publication(s) are in progress.
**Need:** Hypoxia is one of the most imminent threats military aviators face today. It has been cited as the cause of 15 fatalities in the last twenty years (Artino, Folga & Vacciano, 2009). And while technology continues to advance (e.g., OBOGS) to combat this threat, prevalence rates are climbing (HAZREPS, 2012). In 2012 the U.S. Air Force and Navy identified hypoxia as a common issue afflicting F-22 & F-18 pilots (Duessing, Artino & Folga, 2011). Research meant to increase the fidelity and effectiveness of hypoxia awareness and mitigation training is warranted as part of combating the threat of hypoxia.

**References:**

Deussing, Artino & Folga, In-Flight Hypoxia Events in Tactical Jet Aviation: Characteristics Compared to Normobaric Training, Aviation, Space, and Environmental Medicine, Vol. 82, No. 8, August 2011.

**Objective:** The objective of this research is to evaluate the relationship between extant physiological measures and subjective measures of hypoxia symptoms in order to better understand physiological hazard report data from aviators and improve hypoxia awareness and mitigation training. This research will be conducted in a training environment using a Reduced Oxygen Breathing Device (ROBD). In addition to collecting objective and subjective symptomology, we will also collect demographic variables that are thought to affect peoples’ susceptibility to becoming hypoxic (e.g., weight, height, gender, activity level, sleep habits).

**Benefits:** There are several benefits of this research. The first pertains to examining the differences between symptoms and their severity induced in a training environment using the ROBD with those induced during live flights. Those deltas lend us vital information on how we might improve the fidelity and effectiveness of hypoxia training in normobaric environments. In addition to the training benefits, collecting demographic information enables us to investigate whether certain individual difference variables predispose trainees to certain symptoms and symptom severity. This information could prove useful for screening aviators for training and overall selection. It may also help explain why there is huge disparity from one individual to the next in terms of the specific symptoms they experience and the severity of those symptoms.

**Status:** The initial research proposal was approved as a NAWC AD In-House Laboratory Independent Research (ILIR) project on 8/5/2016 - Project funding is expected in January 2017

**Research Products:** The initial proposal is the only product to date.
Need: There is a persistent need to improve operator performance and decrease mental workload when interacting with a complex system, such as those that require multitasking.

Objective: The objective of this research effort is to determine the impact of low-cost haptic cueing on operator performance and mental workload in a multitasking environment. For UAV operators, searching displays for critical cues is an essential responsibility. Research has shifted to investigate the effects of cueing to aid visual search, specifically haptic cueing. However, its effects on performance accuracy and cognitive workload vary. As such, there is still a need to further develop our understanding of haptic cueing on performance and cognitive workload. The goals of this research effort are to:

- Develop a low-cost, non-invasive, method of providing haptic feedback to an operator that can be easily integrated with multiple interfaces.
- Determine if this low-cost, non-invasive, method of haptic feedback can improve overall operator performance, in terms of response time and accuracy, and decrease mental workload.

Benefits: One potential payoff for developing a low-cost, non-invasive, method of providing haptic cueing to an operator is the hardware itself. Providing a cost effective way to integrate haptic cueing into multiple systems can help both the operator and system designer. Another potential payoff is to yield a clearer understanding of the performance benefits to be gained by using haptic cueing. The results of this effort can yield improved task loading capacity and performance.

Status: In FY16, the team completed data collection under this effort, evaluating performance, cognitive workload, and system usability. To aid in data analysis, the team developed a data analysis tool. More specifically, this tool filters through all of the time stamped .csv files generated by the experimental interface and extracts all the required data for analysis, saving roughly 40 man hours per participant. Results will be available at the end of the first quarter of FY17.

Research Products:
Molloy, M., & Mercado, J.E. (2016, August) CSV file data extraction tool developed.
Need: Military theorists have long posited that intuition is important for military decision making (von Clausewitz, 1832). Intuitive decisions in the military have been credited with saving lives, thus understanding this phenomenon is of great interest. 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 empirical 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, if it is trainable, or if certain individual differences or cognitive and perceptual skills are related to the decision making process. 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: The objective of this study is to investigate the relationship between intuitive decision making, individual differences, and implicit learning to determine if individual differences and/or cognitive and perceptual skills are related to measures of implicit learning and intuition that have demonstrated activation of somatic markers. In doing so, we wanted to see if we would obtain results similar to previous research or if we might determine that intuition is more than just a gut reaction and requires cognitive and perceptual skills.

Approach: The common operational definition of intuition is that it is a subconscious, preliminary perception of a pattern or meaning that biases thoughts and decisions (Volz & von Cramon, 2006). Recent neuroimaging studies have correlated performance of laboratory intuition and implicit learning 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.” These somatic markers occur when a decision is made. This reaction has been observed in the Gestalt Closure task (intuition task) and the Iowa Gambling Task (IGT) (implicit learning and intuitive decision making task).

There is also the notion that there are two distinct information-processing systems for storing and retrieving information. System one is labeled as implicit and unconscious, which leads to an intuitive pathway. This system is independent of working memory and general intelligence. The second system is labeled as explicit and is a conscious and deliberative process. In this system there is variation between individuals in terms of capacity and ability. Additionally, past investigations into intuition have showed that working memory and intelligence are not related to intuition, specifically the Iowa Gambling Task. The model below depicts the two information processing systems.

This past research provided the approach to the research questions proposed in this project. The current effort combines several bodies of research into one study to gain a better understanding of intuition and how all of these measures are related to each other.
**Benefits:** The innovative component of this research is the incorporation of an implicit learning and intuitive decision making task into one study and looking at how individual differences and cognitive and perceptual skills relate to performance on those tasks as well as how those tasks relate to each other. This allows us to assess implicit learning and intuitive decision making abilities. 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 or training in the future. The results from this effort will yield recommendations for how to test, select, and possibly even train personnel for positions that require the use of effective intuitive decision making.

**Status:** We began the current effort by selecting and developing our experimental measures. Our two main measures were the Iowa Gambling Task, which was our implicit learning and intuition task, and the Gestalt Closure Task, which was our measure of intuition. We also included measures of individual differences and cognitive and perceptual skills as indicated in the chart below.

<table>
<thead>
<tr>
<th>Individual Differences</th>
<th>Cognitive Ability &amp; Perceptual Skills</th>
<th>Intuition &amp; Implicit Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Surveys of preference for intuitive versus analytical processing</td>
<td>• Working memory span (n-back task)</td>
<td>• Gestalt Closure Task (Intuition)</td>
</tr>
<tr>
<td>• Personality (Big Five Inventory)</td>
<td>• Vigilance (letter search task)</td>
<td>• Iowa Gambling Task (Implicit Learning and Intuition task)</td>
</tr>
<tr>
<td>• Demographics</td>
<td>• Intelligence / Pattern recognition (Raven’s Progressive Matrices)</td>
<td></td>
</tr>
<tr>
<td>• Age</td>
<td>• Change detection task</td>
<td></td>
</tr>
<tr>
<td>• Gender</td>
<td>• Shoot-no-shoot task</td>
<td></td>
</tr>
<tr>
<td>• Cultural background</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Gambling experience</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Once all the measures were created, we collected data from 136 participants. This was an individual differences study where we wanted to exploratory examine the relationships between intuition and our other measures, thus our participants ran through all these measures in the same manner. All measures were administered on a laptop via PowerPoint. Next, we coded and analyzed the data to determine if any of our individual differences, cognitive, or perceptual measures were related to the intuition measures.

**Results:** Correlational analyses were conducted and found that IGT was positively correlated with intelligence ($r = .25, p < .01$) and working memory ($r = .12, p = .02$). The Gestalt Closure Task was positively correlated with working memory ($r = .20, p = .02$). Additionally, we found the IGT and the Gestalt Closure task were not correlated to each other. These results suggest that our two implicit/intuitive tasks are measuring two distinct constructs and individual differences, such as cognitive and perceptual abilities, could aid in the acquisition of implicit memory and intuitive decision making. Even, though the outcome of our study contradicts previous research, which suggests that working memory is used only for explicit processes, higher working memory capacity does seem to aid implicit/intuitive performance in some manner. Additional research needs to be conducted to look more closely at the role of working memory in implicit learning and intuitive decision making.

**Research Products:** Results were presented at the 2016 NAVAIR Advances in Research & Engineering Technical Interchange Meeting in Patuxent River, Maryland (August 24, 2016). Results were also presented at the 2016 SAFE conference in Dayton, Ohio (October 31-November 3, 2016). A formal write-up of results for publication is in progress.
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 AT 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, AT systems created to fulfill the needs of the DoD may not be effective.

Objective: The objective of this research was to determine the optimal combination of factors to create adaptive training. More specifically, 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 adapted to their level of spatial ability (i.e. trainees with high spatial ability will perform better when given minimal feedback while trainees with lower spatial ability will perform best when given more detailed feedback) would perform best on a post test and transfer test.

Benefits: Adaptive training capability gaps have been documented in several different sources such as those described in this proposal as well as 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 project will serve to inform methodologies on how to adapt feedback to different individual difference levels of trainees.

Status: Data collection was completed in October FY15. The data was analyzed in October-December. The results indicated that providing participants with feedback matched to their spatial ability was not effective, indicating that the expertise reversal effect does not apply well to cases with complex and/or novel tasks. Data suggested that video game experience was related to spatial ability scores. The results of the study were used to complete a doctoral dissertation which was accepted in May 2015.

Research Products:

Need: How carrier pilots are trained to manipulate the cockpit controls to achieve desired performance and touchdown accuracy have largely gone unchanged since the original carrier landings aboard the USS Langley. The objective of the Maritime Augmented Guidance with Integrated Controls for Carrier Approach and Recovery Precision Enabling Technologies (MAGIC CARPET) project is to provide the pilot with a control concept that is so easy to fly aboard the ship that minimizes initial training, proficiency and currency requirements. The science and technology includes control concepts that rely only on onboard sensor/control capability; decouples the flight path changes from aircraft velocity, thrust and drag variations; integrate the control on a single cockpit control inceptor; provides robust, redundant, and reliable control for degraded mode operation; and integrates the concept along with both onboard controls and displays as well as external visual landing aids. All of these capabilities are designed to reduce workload substantially, minimize the time to acquire carrier landing skill while moving novices to expert landing performance patterns, and minimizing the training pipeline to recapture costs associated with carrier landing training. This effort, referred to as Carrier Qualification Training Reduction via Advanced Piloting Systems (CQTRAPS), supports a series of inter-related subprojects aimed at developing an empirical understanding of the MAGIC CARPET system, including its training requirements, effectiveness, and safety. An important overall objective is to estimate cost, throughput, and readiness considerations compared to conventional landing technology.

Objective: The objective of the S&T effort is to conduct a skill acquisition and decay evaluation that compares MAGIC CARPET landings to traditional/manual landings. This evaluation will utilize quantitative as well as qualitative data to identify Carrier Qualification performance and reactions for both types of landing to identify training and currency recommendations ahead of the roll out of MAGIC CARPET to the Fleet (i.e., all FA-18 E/F/G aircrafts) in SEPFY16.

Benefits: MAGIC CARPET is a technology currently in the T&E phase intended to make carrier landing performance better and safer, & reduce pilot workload. Empirical data & cognitive models are needed to empirically investigate learning, effectiveness & workload considerations. Research under CQTRAPS can help the Fleet assess the extent to which MAGIC CARPET improves the ability of pilots to acquire and retain adequate carrier landing proficiency. By conducting Simulator experiments with Fleet pilots to quantify acquisition and decay rates for MAGIC CARPET versus traditional (e.g., emergency/non-MAGIC CARPET arrests) CQ, NAWCTSD is able to provide data to support consideration of modifications to CQ training and currency requirements to the LSO community and Fleet decision makers.

Status: Final reports and briefings were submitted to NAWCTSD and ONR. Briefings have been distributed to the LSO school and VX-23, as well as members of Fleet Projects Team for FA-18 who were key members of Fleet team for CQTRAPS and supported data collection and analysis. Current follow on efforts for live data collection are pending.

Research Products:
Final Briefing: CQTRAPS Highlights 8/23/2016
CROSS DOMAIN MARITIME SURVEILLANCE AND TARGETING (CDMaST)

Start: Jan 16    End: Dec 17

**Need:** The CDMaST program concept involves leveraging heterogeneous manned and unmanned system combinations across multiple domains (air, sea, sub-sea, sub-floor) to surveillance and target ships and submarines in highly contested maritime environments over very wide geographical areas. In the initial phase of the program the program, modelling and simulation will be used to explore system architectures that can achieve military goals and are feasible in terms of supporting the services (communications, energy requirements, navigation, and information management) needed to execute the mission. Due to the complexity of the heterogeneous, cross-domain system of systems, and the wide area nature of the problem space, heavy emphasis will be placed on creating an efficient test bed to address performance and interoperability. The intent is to maximize the use of virtual and constructive testing to evaluate interoperability issues with the systems and to explore concepts of operations (CONOPS) to the extent possible. The goal is to then transition to more complex mixed reality ‘system in the loop’ testing where system hardware will be exercised to further resolve engineering issues. Ultimately in water testing scenarios involving a subset of the overall architecture system key components will be done in a live, virtual, constructive (LVC) environment to demonstrate the military effectiveness and viability of the architectures and further explore tactics.

**Objective:** To integrate a cross-domain system of system LVC testing capability that will efficiently explore, reduce risk, and demonstrate the feasibility of CDMaST architecture solutions.

**Benefits:** The CDMaST LVC Testbed Framework will identify where protocols and standards are needed in order to develop, demonstrate, and evaluate potential CDMaST architecture solutions provided by industry performers.

**Status:** As of Dec 2016, CDMaST functional requirements have been defined. Additionally, a CDMaST artificial example was developed to demonstrate preliminary LVC testbed capabilities as part of Operation Blended Warrior at I/ITSEC 2016. In FY17 a plan of demonstrations (called excursions) will be developed that roll out the functionality that will comprise the final delivered LVC Testbed Framework.

**Research Products:** FY16: Initial CDMaST LVC Framework System Requirements Specification; FY17: Artificial CDMaST LVC testbed demonstration
**Need:** The Marine Corps Vision & Strategy 2025 discusses the need to “...prepare Marines for complex conditions and to counter the unexpected” and help small unit leaders “make sound decisions...in an increasingly complex environment while potentially operating in a decentralized manner”. Small unit leaders are typically Corporals or Sergeants in their first enlistment and are between the ages of 19 and 22. They need to be able to Operate from a commander’s intent with minimal supervision, perform decision-making rapidly and reliably under high stress and in complex environments, and reach effective decisions with limited information. In order for these young small unit leaders to succeed, we need infantry training standards, methodologies, and technologies to accelerate the development of decision-making skills.

**Objective:** Accelerate the development of small unit decision making (SUDM) skills in ground infantry squad leaders and units through the application of adaptive training and technology insertion. Three ADSUDM capabilities will be created and delivered as interoperable software components to enhance USMC simulation-based Small-Unit Decision Making (SUDM) training: 1) a Decision Making-Learning Management System (DM-LMS) module for the Marine Corps Training Information Management System (MCTIMS), 2) Digital Integrated Representation of Tactical Environment (DIRTE) tools for simulation terrain database generation, and 3) Simulation Tailored Training and Assessment (ST2A) that provides a situated tutor for virtual decision-making training.

**Benefits:** The ADSUDM effort will improve small unit performance and decision making skills, save the Marine Corps both time and cost to train, provide additional reps and sets for decision making training, decrease the time required to develop squad leaders, and provide an After Action Review (AAR) capabilities after training event completion.

**Status:** The ADSUDM effort just started in FY16. Contracts were awarded in July 2016 and the project kick-off meeting with stakeholders took place on October 5, 2016.

**Research Products:** Initial Technology Transition Agreements were signed in July of 2016 and will be updated in July of 2017. Planned products include DM-LMS software, ST2A software, DIRTE software, user manuals, a Small Unit Decision Making Instructional Best Practices Guide, and publications from training effectiveness evaluations.
**Dynamic Adaptive and Modular Entities for UAS (DyAdeM)**

**Need:** 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) or computer generated force (CGF) behaviors in a format that can be integrated into the Navy’s SAF generation technology, the Next Generation Threat System (NGTS). 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 includes replacing hand-coded rule sets with a capability to automatically generate new and appropriate CGF 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. On final delivery, the DyAdeM product will deliver a software based content generation capability that converts “raw” data (captured during live exercises, recorded during actual missions or generated from live range testing) into realistic CGF behaviors that will populate training scenarios.

**Objective:** Initial objectives are to develop a content generation tool that creates real entity behavior and scenario features based on one or more of the above – mentioned data sources. The primary requirement of this effort, as provided to NGTS from the user community, is to enable realistic and increasingly intelligent white force activity in tactically plausible scenarios by developing, at appropriate scales, CGF to act in them in realistic, complex, Patterns of Life. The long-term objective is that the CGF behaviors will be dynamic, allowing for tactically-realistic and contextually relevant performance that requires minimal operator guidance to develop, modify, and maintain.

**Benefits:** Ease and flexibility in creating training scenarios would be beneficial to all training systems but is specifically applicable to UAS due to their evolving capabilities and tactical mission utilization. By using generative approaches to automatically develop CGF behaviors from a range of data sources DyAdeM will be able to rapidly contribute to the development of scenarios and update them as doctrine, tactics, and environments change. In addition, it will provide a more realistic and effective training experience (because they will be based on real data); and the resultant simulated forces will require less input from instructors / training systems managers, thus reducing manning and personnel support costs (i.e., this applies to training activities, as well as, initial creation and modification).

**Status:** Delivered ten vital area scenario files with realistic routes to NGTS (Jun 16) and developed FY16-17 plan for Validation, verification, and additional functional development (route generalization; land traffic; scalability).

**Research Products:**

Scenario files for 10 key regions in NGTS

**ELECTRONIC WARFARE (EW) TACTICAL DECISION AID (TACAID)**

**Start:** Oct 15   **End:** Sep 18

**Need:** With the increasing complexity of the EW environment, there is a need to provide operators with more effective and efficient training. Adaptive training has been shown to be effective in the literature; however, studies have mostly focused on simple tasks. While some researchers have investigated more complex military environments, additional evidence would further support the use of AT for complex military tasks.

**Objective:** TACAID is a pillar under the Scalable, Integrated RF Systems for Undersea Platforms (SIRFSUP) Enabling Capability (EC). The objective of the TACAID program is to create an Adaptive Training (AT) capability for the next generation EW systems in order to improve the skills of operators with an emphasis of maintaining safety of ship. The goal is for the system to diagnose issues that the trainee is having in real-time, provide targeted feedback to correct those issues, and adjust the difficulty of the training if necessary. As part of this effort, we will conduct research to determine the optimal methods of adaptation within this dynamic and complex task. Research questions may include optimal feedback delivery time, degree of feedback specificity needed to optimize training, and when difficulty adaptations should occur (e.g., should difficulty adaptations occur within a scenario or in between scenarios). Another goal of this program is to deliver a training system architecture that will allow the instruction to integrate with the next generation tactical system on-board submarines.

**Benefits:** This program will deliver training to the fleet that is more effective than one-size-fits-all methods. The training system will reside on-board submarine tactical systems which would allow sailors to train while at sea. Therefore, they would be able to hone and practice their skills in the environment in which they will be used. In addition, as the EW task is particularly challenging and dynamic, research that emerges from this program will expand the empirical base for the adaptive training domain and open the door for its use in more complex tasks.

**Status:** As the next generation EW system has not yet been developed, we have leveraged existing systems to create several training scenarios and related course content. We have created a training system interface as well as algorithms that will drive the adaptation within the system. All content, scenarios, and algorithms have been reviewed by EW subject matter experts and have gone through initial pilot testing as part of workshops held in Orlando, FL and Pearl Harbor, HI.

**Research Products:**


- Briefed and demonstrated TACAID several times throughout the year to numerous stakeholders including: PMS 435 (CAPT Debus and Mel Gray), N97 (CAPT Neff), Dr. Mason (OUSD, Director, HPT & Biosystems Directorate), Mr. Geoff Moss (SUBPAC ONR Science Advisor), several N7 representatives including Mr. Jon Rees (Continuing Training Program Manager) and CDR Garza (Continuing Training Officer), SUBPAC Tactical Readiness Evaluation Team representatives, CAPT Byrne (Commanding Officer, NNPTC), the Ohio Replacement Team, and PMS 397.
- Developed and implemented prototype GUI for EW verbal reports.
- Developed, implemented, and began testing the performance assessment and scenario difficulty adaptation algorithms.
- Level A TTA is currently in place with N97 and PMS435.
**Need:** The need exists to prepare the Naval Fleet to employ an electronic warfare plan to ensure the ability to remain effective in operations and environments even when access and our freedom to operate have been challenged, degraded or denied. For instance, in Anti-Access/Area Denial (A2/AD) environments adversaries employ asymmetric capabilities such as cyber and electronic warfare that challenge friendly force utilization of the Electromagnetic Spectrum (EMS). Furthermore, shore-based training events often lack inclusion of Information Warfare techniques preventing adequate exposure prior to certification. A need exists to ensure CSGs receive training on all aspects of Information Warfare assessed during certification including Command and Control in Denied and Degraded Environments (C2D2E).

**Objective:** The current effort will participate in analyses, definition and development of human performance measures, standards and interfaces for use in the Navy Continuous Training Environment (NCTE), and in the development of constructive models. This S&T effort has two primary objectives:

- Develop Modeling and Simulation (M&S) techniques to train on and experiment with Real Time Spectrum Operations (RTSO) Concept of Operations (CONOPs) and Tactics, Techniques and Procedures (TTPs) relying on EMS.
- Define, develop and validate performance metrics and automated measurement techniques to provide objective assessments of readiness levels and trends for RTSO and EMS to identify A2AD training and readiness shortfalls. Specifically, these measures will address Aegis operators and Growler involvement within Anti-Ship Missile Defense missions as part of air defense overall.

Live, Virtual and Constructive (LVC) demonstrations are planned throughout the effort to display technologies and capabilities and gain subject matter expert feedback.

**Benefits:** This enabling capability will advance Fleet operational proficiency and readiness in sensing and characterizing EMS activity to enable adaptation and freedom of maneuver in the EMS as a means to effectively operate in C2D2E at the individual, unit and Composite Warfare Commanders levels.

**Status:** The program kicked off in April 2015. The team conducted the first technology demonstration in Mar 16. For this event, subjective performance measures and a technology fidelity survey were developed. Additionally, the Research Analysis team has completed more than 75% of Cognitive Task Analysis (CTA) data collections with relevant operator and warfare commander platforms and teams. Moreover, jamming models will be demonstrated to the E/A-18G community with feedback incorporated into the next iteration of the developed jamming tool. Finally, the team has started planning for the FY17 technology demonstration and experimentation.

**Research Products:**
- Conducted first program demonstration in Mar 16
  - Developed, piloted, analyzed and reported findings of survey to assess multilevel team coordination during demonstration
  - Survey Final Report delivered (Jun 16)
- Defined Electronic Warfare (EW) ship operator automated performance measures for the Joint After Action Review – Resource Library (JAAR-RL)
  - Implemented preliminary measures & reports during demonstration
  - Defined future EW JAAR-RL measures
  - Coordinating with Naval Surface Warfare Center Crane and the Naval Warfare Development Center to identify operator actions that can be captured from SLQ-32 console to support new measure development
- Began CTA data collections with Warfare Commanders, Growler and Ship Operators (May 16)
- Developed first iteration of tool to support jamming capabilities within the Next Generation Threat System
**Experience**

**Career:**
- Postdoc Research Associate, University of Southern Denmark, 2011-2013
- Research Scientist, Aalborg University, 2008-2011
- Research Assistant, University of Southern Denmark, 2006-2008

**Education:**
- PhD in Computer Science, Aalborg University, 2011
- MSc in Computer Science, Aalborg University, 2008
- BSc in Computer Science, Aalborg University, 2006

**Projects:**
- Coordinated the development of a new software framework for...
**Research Products:**

2017

2016

2015


2014


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.


2013


Sherwood, S., Martin, T., Neville, K., Blickensderfer, B., & Cruise, 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.


2012


**LIVE, VIRTUAL, CONSTRUCTIVE TRAINING FIDELITY EXTENSION: NAVAL INTEGRATED FIRE CONTROL – COUNTER AIR (NIFC-CA X) MISSION VISUALIZATION TOOL**

**Start:** Oct 14    **End:** Sep 19

**Need:** As integrated warfare capabilities like Naval Integrated Fire Control - Counter Air (NIFC-CA) become increasingly important to the dominance of the Navy’s Carrier Strike Groups, the requirement for Virtual and Constructive training environments becomes increasingly necessary in order to provide true systems-of-systems and multi-team training. Because of the current lack of Virtual and Constructive training capabilities for NIFC-CA, the integrated training commands are significantly limited in the training they can provide and the integrated training opportunities are largely limited to live training. As such, the Office of Naval Research (ONR) sought to fill a critical training gap in the NIFC-CA community by leveraging existing investments from the Live, Virtual, and Constructive Training Fidelity Enabling Capability.

**Objective:** The current effort seeks to fill a critical training gap in the NIFC-CA community by leveraging existing investments from the Live, Virtual, and Constructive Training Fidelity Enabling Capability. Specifically, ONR funded an AIR 4.6.5 led effort coordinated with 5.4 focusing on the development of a mission visualization capability that can be used to train cross-platform coordination associated with NIFC-CA employment utilizing the core LVC technologies:
• Performance Measurement Engine
• Training Executive Agent
• Next Generation Threat System

The initial proof-of-concept capability was developed in FY14 and demonstrated in Q1FY15 as a collaborative effort between NAWCAD/TSD and government contractors. The proof-of-concept, Phase 1 effort, delivered a classroom-based tool that utilizes a streamlined version of the Next Generation Threat System’s Battle Monitor (removing the need for a dedicated operator) to provide a “gods-eye view” map of a scripted NIFC-CA scenario’s blue/red forces. The capability enabled trainees to make decisions regarding how to counter a small number of threats (i.e., utilizing NIFC-CA or organic shots) using a decision making interface. These decisions are visualized on the map. Prototype performance measures were captured and presented during debrief to provide feedback on how well trainees met their training objectives. Replay capability was also available for debrief.

Benefits: This capability provides the Fleet with a mission visualization tool for classroom based training allowing for visualization during the scenario, collaborative decision making, and feedback on performance to enable readiness and cross platform coordination. Additionally, the high fidelity, physics-based models developed for NIFC-CA X are resident in the Next Generation Threat System (NGTS) and therefore can also support simulation-based training for NIFC-CA.

Status: In FY16, Phase 2 of the effort was funded by ONR. Phase 2 focused on taking the technology beyond proof-of-concept to provide a training capability that could be used by the integrated training commands. Specifically, the Tactical Training Groups Atlantic (TTGL) served as the Phase 2 use case.

Phase 2 NIFC-CA X capabilities include:
• Robust NIFC-CA scenarios leveraged from TTGL developed scenarios for Carrier Strike Group 12 training
• Enhanced fidelity of physics based models within the NGTS
• Enhanced scenario director capabilities via TXA
• Customized objective performance measures and debrief interface
• Updated student interface to support increased threat and decision options

In coordination with PMA-205, ONR, and AIR 5.4, AIR 4.6.5 delivered NIFC-CA X to TTGL in May 2016 and demonstrated to representatives from the E-2D Fleet community, Fleet Forces, Naval Surface and Mine Warfighting Development Center (SMWDC) and Naval Warfare Development Command. Tactical Training Group Atlantic plans to use the tool during their classroom-based Air Defense Syndicates.

The tool was also demonstrated to Tactical Training Group Pacific (TTGP) in June 2016 to identify the feasibility of using the existing capabilities for the next deploying Carrier Strike Group’s Air Defense Syndicate. Refinements to the existing scenarios are underway to enable training of Strike Groups on both the West and East coast. Additionally, the team is coordinating with the E-2D community to define their specific NIFC-CA X requirements.

Research Products:
• Phase 2 demonstrations conducted:
  • TTGL, Fleet Forces, and E-2D community in May 16
  • TTGP in Jun 16
• Phase 2 capability delivered to TTGL May 16
• I/ITSEC paper accepted for presentation (Nov 16)
• Additional funding for Phase 2.5 capabilities awarded and kickoff scheduled for Q1FY17
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 FY16 and 17, NAWCTSD scientists and engineers led or are leading nine Basic and Applied Research projects, three Workforce Development projects, and six Transition Research projects. The following pages outline Basic and Applied Research, Workforce Development: Strategic Growth, and Transition Research projects.
3D INTERACTIVE AIRCRAFT CARRIER OPERATIONS PLANNING TOOL Prototype

Need: This research should be performed now to aid the Fleet in how they plan their shipboard operations. The process of creating, setting up, resetting, and manually processing plans into a digital drawing to document arrangements is extremely time intensive. A typical meeting of this type can include thousands of unique items in hundreds of configurations resulting in thousands of labor hours on both the front and back end of study sessions. By using an interactive 3D software tool, these studies can be expedited yielding more efficient processes for stowage and movement of aircraft and equipment.

Objectives:

FY16: Develop a 3D Aircraft Carrier Operations Planning Tool Prototype for Planning Mode
FY17: 1) Add Operations mode and finalize prototype, 2) Conduct heuristic evaluation and comparison of the prototype to the existing Ouija board planning tool, 3) Submit a final report on the research findings.

Benefits: The proposed 3D interactive planning tool will fill a critical capability gap by providing the Handler and AB’s the necessary tools to perform their job efficiently. The 3D Prototype will provide a test bed for future research and the results from the heuristic evaluation will not only guide development of the future current tool, but provide design guidelines for using 3D representations in future platforms. This effort is an excellent example of collaboration between multiple NAVAIR commands and multiple NAVAIR teams (4.6.2.2, 4.8.1.4, and 4.6.5.1). These teams will benefit by gaining concrete knowledge on the best methods and practices for deploying 3D game engine content to the Fleet and when it is beneficial to utilize 3D data representations for training and planning exercises.

Status: The effort has completed the Planning Mode prototype and has started building the operations mode.

Research Products:
- Planned 3D Interactive Aircraft Carrier Operations Planning Tool Prototype (FY17)
- Heuristic evaluation of 3D Aircraft Carrier Operations Planning Tool Prototype (FY17)
- Evaluation of suitability of 3D graphical representations for carrier planning tasks research study
- Mentoring of two NAIP Interns
DEVELOPING WARFIGHTER TRAINING GUIDANCE FOR CUE RECOGNITION OF TRUSTWORTHINESS IN CULTURALLY-COMPLEX ENVIRONMENTS

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 intel 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 nations. 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: We were able to update our data collection method from paper- to computer-based to eliminate manual data-input efforts. We conducted training for our expanded data collection team on the experimental design and study procedure, and are poised to start data collection. Our plan is to begin the participant recruitment process, execute the experiment, and plan for publication avenues for FY16. This work supported the Principal Investigator’s acknowledgment as a Black Engineer of the Year Award – Modern Technology Leader recipient for 2015.

Research Products:
**Examining the Effects of Game Features on Learning in Scenario-Based Training**

**Start:** Oct 15  **End:** Sep 18

**Need:** In light of budget declines, there has been a strong push across the DoD for low-cost training techniques that are engaging, realistic, and can be delivered anytime, anywhere. Game-based training techniques hold promise to meet this demand as they are purported to enhance player motivation, but existing research on the effectiveness of game-based training is mixed and often nonsystematic, resulting in a failure to identify specific game features that lead to better learning and performance outcomes. Yet game-based training systems are already being delivered to the Fleet without evidence of the utility of game features, such that the training being delivered may not represent a cost-benefit over more traditional systems.

**Objective:** The objective of this research is to test the impact of two game features on performance and motivation: score/performance gauges and competition. First, providing a score and performance gauge gives the player a level of feedback on his/her progress in the game and is considered a fundamental feature of a “game.” To date, there is no previous research in this area to suggest that adding this game feature increases motivation and/or enhances performance; therefore one of the goals of this research is to directly test whether adding the score and performance gauge has the desired effect on players. Second, we will explore the role of competition on performance and motivation, which some consider an important game feature but not necessarily a defining characteristic. Competition is also theorized to increase players’ motivation to persist in a game because they find that playing is intrinsically rewarding, which again may lead to better performance. Likewise, there has been little research on the effect of competition on learner performance and motivation in game-based training.

**Benefits:** The 2014 DoN Science and Technology Warfighter Performance Focus Area, Manpower, Personnel, Training and Education Objectives calls for the development of training technologies to enhance Sailors’ information-processing abilities. Game-based training is particularly well-suited to meet this demand given the popularity of computer games with today’s young adults. This research seeks to examine the effects of incorporating game features into simulation-based training, a topic that has not been systematically investigated in the training literature. Previous studies have assessed the value of game-based training over traditional methods of instruction, but few have investigated individual game features and their impact on performance and motivation. The findings of these experiments may have a broad impact on current and future training systems by offering empirically-based guidance for designing and incorporating game features to enhance training effectiveness.
**Status:** In FY16, based on an extensive review of the educational games, presence/immersion, and motivation literatures, the research team designed a 2x2 between-participants experiment examining the impact of the presence or absence of game-like performance gauges and competition features in a scenario-based training task. In addition, the software development team made changes to the simulation test bed to accommodate the planned experiment. In FY17, the research team will submit an IRB protocol, and complete data collection, and document the results.

**Research Products:**
- Book chapter accepted for publication: Johnson, C. I., Bailey, S. K. T., & Van Buskirk, W. L. *(in press).* Designing effect feedback messages in serious games and simulations: A research review. In P. Wouters & H. van Oostendorp (Eds.), Techniques to Improve the Effectiveness of Serious Games. Switzerland: Springer International Publishing.
- Workforce Development:
  - 1 NREIP intern mentored in FY 16
  - 1 NADP intern mentored in FY 16
- Planned products include an approved IRB approval, peer-reviewed publication in a scientific journal, continued mentoring of NADP and NREIP interns.

**IDENTIFICATION AND DEFINITION OF UNMANNED AERIAL SYSTEM AIR VEHICLE OPERATOR PERFORMANCE METRICS**

**Start: Oct 14  End: Sep 17**

**Need:** Observer ratings of performance have been in use since the beginning of military aviation. They have significant benefits (e.g., ease of use, cost, measurement of complex performance) and significant drawbacks (e.g., potential subjectivity, potential for low reliability). The reality is until we are able to automate the evaluation of complex performance domains (e.g., decision making and task prioritization), it will be necessary to rely on observer ratings. Unfortunately, minimal attention is generally given to the development of these measures, leading to metrics with inadequate reliability and validity. With the current surge in acquisition and deployment of unmanned aerial systems, it is critical to develop appropriate performance measures early in the training development and acquisition process.

**Objective:** Identify, develop, validate, and transition Unmanned Aerial System (UAS) Air Vehicle Operator (AVO) performance metrics to support validation of selection and training technologies and to inform performance measurement tools currently being researched and developed.

**Benefits:**
- Allows development of in-house capability to conduct performance measurement research
- Allows development of training performance measures for transition to Triton program office with direct applicability to other programs (e.g., UCLASS, Firescout)
- Provides performance criteria for validation of DoN UAS selection tests and training programs, which directly translates into reduced training attrition and costs.

**Status:**
- Completed review of UAS Job Task Analysis data (across service and platform)
- Completed review of Triton mission documentation and conducted site visits at Naval Air Station (NAS) Patuxent River and NAS Jacksonville Fleet Introduction Team.
- Developed standardized task inclusion/exclusion rules and SME protocols that can be used to create future metrics across platforms.
- Identified measurable components of tasks and created critical incident template
- Created SME focus group protocol for standardized critical incident and objective observer performance metrics (OOPMs) review
- Prepared outline for IRB protocol for OOPM field testing

Research Products:

- This work supported the Principal Investigator’s acknowledgment as a Women of Color STEM “Technology Rising Star” recipient in 2016.

INTEGRATED WARFIGHTING CAPABILITIES (IWC) FIDELITY INVESTIGATION

Start: Oct 16   End: Sep 19

**Need:** The requirement to continuously improve force readiness in a robust and fiscally responsible manner has led to the need to better understand the fidelity requirements necessary to achieve Training and Readiness (T&R) credit through the use of Live, Virtual, and Constructive (LVC)/ Virtual, Constructive (VC) environments. This need is further exacerbated by the necessity to provide true Systems-of-Systems (SoS) and multi-team training as integrated warfare capabilities (e.g., Naval Integrated Fire Control – Counter Air) becoming increasingly important to the dominance of the Navy’s Carrier Strike Groups.

**Objective:** This effort seeks to identify the impacts of virtual and constructive training environment fidelity on proficiency. Specifically, this effort will investigate the level of physical fidelity required to train various Naval Integrated Fire Control – Counter Air (NIFC-CA) specific tasks and skills identified by the PMA-205 funded Front End Analysis (FEA) (Pagan, Tucker, Walwanis, & Zemen, 2015). Findings from this effort will provide empirical data to inform training requirements, as well as preliminary findings to understand the perishability of NIFC-CA skills in terms of skill decay.

**Benefits:** The models developed under this effort will strengthen the ability of 4.6 to conduct IWC research in the future. Additionally, the scenarios developed under this effort can be transitioned to various training communities including the F/A-18 tactical operational training systems and the Tactical Training Group Atlantic’s new mission visualization capability. Additionally, this effort will provide preliminary data for understanding the decay associated with NIFCCA skills which will support the development of training proficiency and periodicity requirements for NIFC-CA. These requirements may be able to generalize to other IWC contexts (e.g., Electronic Warfare). Finally, this effort proposes to further the partnership between MFS, NAWCAD, and NAWCTSD and promote cross competency to enable our warfighters with the most current technologies and research findings.
**Status:** This is a FY17 new start.

**Research Products:** Planned: Software with enhanced models and scenarios will be developed. The models developed under this effort may be used to support future Low Cost Trainer requirements. Moreover, these models will strengthen the ability of 4.6 to conduct IWC research in the future. Additionally, the scenarios developed under this effort can be transitioned to various training communities including the F/A-18 tactical operational training systems and the Tactical Training Group Atlantic’s new mission visualization capability. Papers and presentations at various venues such as Human Factors and Ergonomics Society, Human Factors and Engineering Technical Advisory Group, Interservice/Industry Training, Simulation and Education Conference.

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**INVESTIGATING LOW-COST UNTETHERED VIRTUAL REALITY TECHNOLOGIES AND THE ROLE OF AFFORDANCES ON TRAINING EFFECTIVENESS IN AN IMMERSIVE ENVIRONMENT**

**Need:** VR training solutions have the potential to reduce training cost, maximize training impact, and maximize transfer of knowledge from the classroom to the operational environment. The exploration and evaluation of low cost VR alternative technologies will help to inform designs and uses of VR technologies that may lead to adding VR to areas previously limited by program budgets. As VR equipment becomes more ubiquitous, this work will help the NAE remain at the front of applied S&T understanding on how best to make use of the technology. The results of this research have the potential to have broad implications for the role of affordances in VR technologies impact on learning.

**Objectives:** 1) Investigate the technology questions of feasibility and limitations pertaining to the integration of a set of the emerging low-cost VR technology devices into an operational demonstration and experimental untethered immersive test bed, 2) The technology performance parameters of accuracy and user position accuracy, latency, repeatability/precision of system, sensory fidelity, and reliability of the overall integrated system will be empirically evaluated, and subjective human factors such as simulation sickness and usability will be addressed, 3) Examine whether the affordances of an immersive VR environment enhance performance and understanding within the context of maintenance tasks. In addition, we will investigate the role of individual differences, such as spatial ability, on performance.

**Benefits:** The expanding body of research continues to demonstrate VR’s benefits. However, wide-scale practical application has been hindered by the high costs and integration complexity of technology devices capable of providing VR environments whose performance limitation did not detract from the benefit gains. Emerging COTS consumer products coming to market in the 3rd and 4th quarters of FY14 will possibly offer an opportunity to change this paradigm. This research will investigate the feasibility and limitations of the technology to provide practical and effective VR for training and performance support domains of interest to the Fleet. The research will also provide a documented low cost VR test bed design that could be generalized to other research applications of immersive environments for both training and operations. The empirical research that will be conducted will expand the literature on embodied cognition. Previous research in this area has focused on spontaneous gestures, rather than task-specific gestures and the value of gestures has not been systematically examined in virtual environments using adult populations. Additionally, this study is novel in that it could provide insight into the competing theories on the role of spatial ability in using immersive VR and PC-based training systems. Therefore, this study will fill multiple research
gaps. Results of this effort have the potential to guide the design of more effective training systems that could reduce cognitive load and result in more retention.

**Status:** The operational test bed has been developed and a technical report evaluating the Oculus Rift DK2 and Microsoft Kinect v2 technology has been completed. Gesture Affordances study was conducted FY16. A final report with the results of the study will be completed early FY17. The HTC Vive will be evaluated and included in an operational test bed in FY17. Another research study will be conducted in FY17 with a report completed in FY18.

**Research Products:**
- In preparation: Johnson, C., Marraffino, M., (2016, September 30). Journal manuscript documenting Thrust 2 results
- Operational VR test bed Oculus Rift DK2 and Microsoft Kinect v2 (Sep 15)
- Operational VR test bed HTC Vive (Sep 15)
- Mentoring of two NAIP interns

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**MAINTAINER – PROFICIENCY MODEL (MAIN-PM)**

**Start: Oct 16   End: Sep 18**

**Need:** Lack of training within the aviation maintainer pipeline has been identified as contributor to the existing Ready Basic Aircraft (RBA) gap. As part of the gap, large numbers of aircraft are being identified as Not Maintenance Ready Aircraft (NMRA), in turn impacting readiness. Current practice within the aviation maintainer pipeline is to assume that proficient performance results upon the completion of a C school course when a NEC is issued, even though it cannot be verified that sufficient practice of sufficient quality was provided or that the skills acquired do not decay before they are applied in the fleet.

**Objective:** The purpose of this proposal is to develop a model of aviation maintainer proficiency, based on learning theory, empirical data, and measures collected for this proposal, that can be used to: 1) assess proficiency, 2) determine the amount and quality of practice needed to attain proficiency, and 3) the rate of skill decay based on skill complexity and experience of the Sailor and that in turn that can be used to determine the timing of initial and refresher training.

**Benefits:** This work will result in: 1) valid metrics for assessing CH-53K O-Level Maintainer performance; and 2) a model of CH-53K O-Level Maintainer proficiency that will allow training analysts and decision makers to examine the impact of specific factors (training time, training system fidelity, instructional quality and scheduling) on skill acquisition and decay. Both of these products support a systematic approach to increasing our understanding of the drivers behind maintainer training deficits impacting the RBA gap.

**Status:** This is an FY17 new start.
Research Products: (Planned) 1) Develop and validate performance measures and establish a protocol for applying a generalizable proficiency model to a new domain, CH53K O-Level Maintainer. 2) Author/present results at the 2017 I/ITSEC and publishes research in a journal such as Military Psychology.

THE EFFICACY OF FEEDBACK PARAMETERS IN ADAPTIVE TRAINING SYSTEMS

Start: Oct 13    End: Sep 16

Feedback Granularity

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 environmental feedback (e.g., present or absent) 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:** In FY16 data collection took place and was completed. We analyzed data from 143 participants and found that those participants who received environmental feedback performed better on a post-test than participants who did not receive environmental feedback. There were no other main effects or interactions between the feedback parameters possibly due to the content of the feedback or because of interactions that occurred between the text-based feedback and the environmental feedback.

**Research Products:**
- Committee for the Protection of Human Subjects protocol developed and approved.
- Feedback capabilities incorporated into existing fielded system (Periscope Operator Adaptive Trainer (POAT)) to support experimentation.
- STEM outreach activities:
  - Demonstrated experimental test bed at Women in Science event at the Orlando Science Center May 15
  - Demonstrated experimental test bed at Take Your Sons and Daughters to Work event at NAWCTSD Apr 15
- An IITSEC paper was accepted and will be presented at the conference on November 28-December 2, 2016. *This paper was also nominated for best paper in the Training Subcommittee.
VIRTUAL ENVIRONMENT MOTION FIDELITY MODEL

Start: Oct 15    End: Sep 17

**Need:** High fidelity aircraft simulators make use of geo-specific visual and sensor terrain databases, image generation hardware and the display system (i.e. visual system) to provide the pilot with the visual representation of the virtual environment. During low altitude flight pilots make continuous adjustments in speed, height and heading guided by a mental model of where the aircraft will be in the future. The pilot transforms the perceived motion in the optical frame of reference into relative self-motion and applies feedback regulation to minimize errors between the commanded and perceived motion. Among other things the pilot extracts optical flow-field information generated by motion over the terrain and obstacles from surfaces in the field of vision. The optical flow-field defines the way in which points in the visual scene move relative to the pilot’s viewpoint motion. In other words the pilot’s low altitude flight performance is affected by the optical flow-field generated by the environment surfaces and features. Significant differences in optical flow between real world scenes and virtual environment may result in motion cues that result in the incorrect visual perception of speed, height and heading. This situation may develop a pilot’s mental models in simulated environments that do not transfer well to real world situations. A computational model with corresponding metrics that can quantify the fidelity-relevant differences between virtual environment and the real world, as captured using video footage, can be used to predict and measure the level of fidelity yielded by a given simulation.

**Objective:** The goal of this project is to develop a virtual environment motion fidelity model that can quantify low level flight motion visual cues and predict the correct combination of visual and sensor terrain database features for low altitude operations in flight simulators. The approach involves image motion metrics captured for reference and test scenes, which are then compared to generate a quality metric.

**Benefits:** The virtual environment motion fidelity model has many useful applications. It could be used in the development, testing and acceptance of visual databases: Initially during visual database development the model can be used to predict the virtual environment characteristics necessary to meet or exceed fidelity requirements. After the visual database is developed the virtual environment motion fidelity model metrics can be used as a validation tool for assessing the visual database and visual system performance. These applications have the potential to yield enhanced visual cues for low level flight and increased simulator virtual environment fidelity.

**Status:** Simulated landing approaches at the same airfield were generated using three different virtual environment complexities. Video was captured and processed using the Horn-Schunck optical flow algorithm and the histogram of oriented optical flow extracted. NPMANOVA shows that statistical differences between the three algorithms existed. Analysis using a large displacement optical flow algorithm (Brox et al 2009) is under way.

**Research Products:** Paper submitted to Computer Vision and Pattern Recognition (CVPR) 2017:

WORKFORCE DEVELOPMENT: STRATEGIC GROWTH

DEPLOYING 3D GAME ENGINE TRAINING CONTENT ON A WEB BASED LEARNING MANAGEMENT SYSTEM

Start: Oct 15   End: Sep 16

Need: The Navy has an immediate need to distribute 3D game engine based training content across a multitude of sites. Deploying content on online LMSs reduces total ownership cost to the Navy, by reducing instructor workload and trainer hardware footprints. In addition, 3D game engine based training is currently in high demand due to its cost effectiveness, interactivity, and immersive/realistic environments. Current and future acquisition programs have a direct need to procure this new type of 3D game engine based training content and have very limited knowledge and examples of how to post and utilize this content on existing LMSs. This research, final deployed course, and white paper will help provide the needed examples and knowledge in this area.

Objectives: 1) Investigate and gain experience with this new SCORM standard, 2) Modify an existing 3D game based trainer to comply with the standard, 3) Deploy the modified trainer to an existing web based LMS (NKO or CNETU), 4) Capture findings in white paper.

Benefits: This effort will help the command gain concrete knowledge on the best methods and practices for deploying 3D game engine content on web based LMSs and gain hands on experience with the newest SCORM standard. This experience will help the branch serve as technology Subject Matter Experts (SMEs) in this field and provide the AGILE team with a critical new capability with directly ties back to the Advanced Modeling and Simulation branch’s existing core capability of developing and presenting training materials. The knowledge gained will close a critical skill gap between a number of NAVAIR teams including, Engineering, Research and Development, and Instructional Systems Design. The knowledge and experience will be used to support future and on-going acquisition efforts at NAVCSTSD and support future branch customers who have a need to deploy 3D game based training content online. The branch will also have the opportunity to test and evaluate a deployed LMS course.

Status: The team successfully integrated xAPI statements into an existing 3D game based training course. The team has successfully integrated and tested on the ADL Co Lab’s Learning Record Store (LRS). The team is working with Navy E-Learning to register the course and authenticate to their LRS.

Research Products:
- NAWCSTSD Special Report (Draft Sep 16) detailing how to create/modify 3D game engine content to comply with new Experience API SCORM standard and how to deploy this content on a web based LMS.
- E-28 Maintenance Trainer deployment on Navy E-Learning (Sep 16).
- Mentoring of two NAIP Interns.
**FUSING HIGH DIMENSIONAL DATA SOURCES**

**Start: Oct 15  End: Sept 16**

**Need:** In the Live-Virtual-Constructive (LVC) integrated environment, the problem of interference between tactical frequency nets is amplified due to the escalating virtual battlespace that must be projected into the live domain for realistic representation of the communication environment.

**Objective:** Improve tactical frequency network reliability for LVC events, while running in real time. By predicting Radio Frequency (RF) interference, based on physics-based modeling, and then avoiding interference by frequency assignment, a deconflicted frequency plan with fewer blocked channels and improved reliability may be achieved. However, as the frequency plan grows, the number of possible frequency assignment combinations increase, rapidly becoming computationally complex. The challenge is finding an optimal solution for a computational hard problem, where exercising all permutations using brute force search is incomputable. Compared to past methods and practices, the desired overarching result is intended to improve reliability of tactical communications and increase utilization of the frequency spectrum for LVC events.

**Benefits:** The near-term, potential payoff is increased, reliable spectrum utilization for LVC events by deconflicting frequency plans, accurately and in real time. The algorithm, as part of the Smart Antenna project, replaces the past, laborious, and drawn-out method of performing calculations to determine a frequency assignment. The expected result is a cost savings due to automating results for tactical communication reliability during LVC events. This experience has aided the Naval Air Warfare Center Training Systems Division (NAWCTSD), Concept Development and Integration Laboratory (CDIL) to further serve as Subject Matter Experts in the field of LVC communications for Navy training and also allowed the CDIL team to gain expertise on the subject of computationally hard problems. As a final point, although intended for frequency deconfliction in the LVC environment, the algorithm is domain agnostic and may be projected on decision-making processes defined by a rule set and implemented through a series of logical steps.

**Status:** Based on trial cases and results, the effort improves utilization of the frequency spectrum in communication relay towers, used in LVC events, by performing frequency assignment calculations that avoid RF interference. The success of the effort is quantified by metrics of accuracy and speed and prospective program transition to LVC platforms.

**Metric #1: Accuracy:** A primary goal of the project was accuracy and is quantified by solutions in the top 99%. With algorithm improvements, accuracy surpassed the project goal with solutions in the top 99.975%. (Test cases used to gage success ranged between 120 to greater than 87 billion frequency assignment combinations).

**Metric #2: Real-Time Computational Implementation (Speed):** The second goal of the project was to converge to a good solution without incurring the cost of long execution times. A solution was found in 0.093 seconds or less, with an accuracy of 99.975% or better, for test cases between 120 to greater than 87 billion frequency assignment combinations. (Note: as run on a Computer with Win7, 5.9WEI, Intel Xeon CPU @ 2.10 GHz, 64bit, 16GB and 12 cores).
Program Transition (prospective): A POM19 proposal, Smart Antenna Assignment for Automated Frequency Deconfliction has been submitted, with support from the Chief Scientist and Technology Officer, AIR-4.6T. This work may have applicability to the following three platforms:

**Platform #1:** The Naval Enterprise Tactical Training Network (NETTN) - a global network infrastructure and integrated communications enterprise developed by the Navy to distribute synthetic training to Naval Platforms.

**Platform #2:** The Synthetic Radio Training Adjunct (SRTA) - a shipboard communications system designed to provide ships with the full use of its tactically available communications system in a distributed training environment.

**Platform #3:** Transmission Security (TRANSEC) configuration for maximizing the number of simultaneous, active communication nets.

**Research Products:**
- Patent Application:

- Ph.D. Independent Study, University of Central Florida (Summer Term 2014):
  - University of Central Florida Independent Study: Professor Dr. Kincaid, Graduate Student Jeff Gleacher. Naval Air Warfare Center Training Systems Division (NAWCTSD) Sponsors: Diane Richie, Dr. Long Nguyen and Dave Kotick.

- Conference Papers and Poster Sessions:
  - Richie, Diane. (December 2014). Smart Antenna Algorithm I/ITSEC Poster Session.

- Internal Naval Air Warfare Center Training Systems Division (NAWCTSD) Published Papers:
  - Zampaglione, Aaron. (January 2016). “Smart Antenna Optimization with Basin-Hopping”. NAWCTSD Concept Development & Integration Laboratory (CDIL) Internal Paper. (Code 4.6.2.3)

- Naval Air Warfare Center Training Systems Division (NAWCTSD) Presentation to the Chief Scientist and Technology Officer, AIR-4.6T:

- Project Recruitment 2016:
  - SMART Scholar, Master of Science Degree, Harvard University
RESEARCH EXPLORING MULTI OPERATOR TRAINING ENVIRONMENTS (REMOTE)

Start: May 14    End: Sep 17

Need: The Naval Aviation Enterprise (NAE) Science and Technology Objectives (STO), Naval Warrior Performance (NWP) Capability Gap STO-1 (Training, Education, and Human Performance) 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. Furthermore, warfighters are moving away from single operator and platform training paradigms towards more complex multi operator and Systems of Systems (SoS) training paradigm (e.g., training of naval integrated warfare capabilities). Game engines are just one of a variety of technology solutions that have the potential to fulfill the NWP STO-1 capability gap. However, game engines offer a multitude of options for connecting multiple users to a shared environment, passing state and user information to/from those users, and managing networked performance. Many of these solutions have varying software requirements, cost ranges, caps on numbers of users, and performance values.

Objective: The objective of this effort is to develop a secure unclassified in-house 3D Multiuser Virtual Environment (MUVE) capability at NAWCTSD in order to better understand game engine technologies and perform hands-on testing to determine which solution(s) bests fits the training model for the navy. The team intends to research and test several of these solution sets and then implement one into a game engine-based MUVE research test bed for a UAS cross training study.

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 3D MUVE assets and training content.

b) Research-based: Experience at development, evaluation, and validation of training scenarios and content in 3D MUVE environments.

The lessons learned and practical experience developed through hands-on design and execution of a MUVE training validation research will be critically important to AIR 4.6’s ability to develop and execute MUVEs in support of integrated warfighting training capabilities.

Status: In FY16 MUVE hardware was procured, the multi-user communication completed, and the Air Vehicle Operator (AVO) and Sensor Operator (SO) toolsets were completed. Additionally, tagging and storing of all user data in .csv was completed and all scenarios have been implemented within the MUVE. In support of UAS use case development a workshop with the MQ-4C Triton Lab at NAS Patuxent River was conducted. Scenario storyboards and scripts were completed for implementation into the MUVE. Performance metrics and expectations for the AVO, SO, Mission Control Operator, and Image Analyst were also completed. The engagement protocols for the MUVE users (e.g., how to identify unknown entities) as well as the AVO and SO training for all 3 levels of cross training were completed. The MUVE is in the final stages of software testing in support of pilot testing and data collection in early FY17.

Research Products:

- MUVE UAS test bed developed (Aug 16) using Unity 3D software as the game engine software platform, two networked desktop computers, and touchscreen monitors for user inputs and interactions.
- Workforce development: Mentoring. Mentee Proetsch, Matthew mentored by McNamara, Courtney. (Oct 15 – Sep 16).
- Training. 10 attendees. (Dec 15). Triton Navy Systems Integration Lab workshop. NAS Patuxent River-Patuxent River, Maryland.
**AUGMENTED TRAINING FOR EXPERIENTIAL LEARNING FOR LANDING SIGNAL OFFICERS**

**Start:** Oct 16  **End:** Sep 18

**Need:** The Navy’s objective to minimize training costs without sacrificing safety has led to the development of technology to reduce workload and complexity (e.g., MAGIC CARPET for carrier qualification {CQ}) combined with an effort to increase the level of LVC training across the FRTP, as part of the training optimization effort. For aviation in particular, this has meant an effort to reduce the number of live flight training hours focused on CQ, which has a significant costs associated with it. However, the potential for reduction in live flight hours focused on CQ facilitated by innovations like MAGIC CARPET effects more than just the pilot in the seat. For example, a majority of current training for LSOs is done at Field Carrier Landing Practice (FCLPs) and on the carrier using live pilot qualifications (supplemented by classroom and simulation-based training).

**Objective:** In an effort to mitigate the predicted impact of training optimization on the LSO training pipeline, we are working to 1) identify training challenges for LSOs in reaction to Navy training optimization, 2) identify and develop technologies to supplement live training opportunities for LSOs (e.g., heads up augmented displays for training) and 3) develop and validate methods for implementing this technology (e.g., fading, adaptive training of velocity vector overlays in augmented displays) within the LSO curriculum that can supplement LSO training issues resulting from reduced live training.

**Benefits:** Landing Signal Officers (LSOs) have a unique and important role in US Naval Aviation. Specific to ship board landings, LSOs are tasked with the "safe and expeditious recovery" of naval aircraft aboard aircraft carriers and are required to assess, coach, correct, and mentor pilots landing at the ship (LSO NATOPS Manual). While the method and technology associated with Naval Carrier landings, supported by LSOs, has proven to be quite safe in recent years leading to a substantial decrease in Class A and B mishaps since the early 2000's, carrier landings remain a highly resourced, extremely dangerous, but necessary activity in US Naval Aviation. In fact, training to land at the ship costs the Navy over one billion dollars a year in flight hours and fatigue life costs (approximately over $1B in FY12 in Flight Hour & Fatigue Life Costs; Northrop Grumman Corp, 29 Mar 2013). Because of the expense and inherent risk, there is a significant effort to introduce augmented technology in landings to increase safety and decrease live training time to reduce cost. However, the efforts to reduce flight workload and errors have not traditionally extended to training for LSOs. While the LSO School leverages simulation based training, currently undergoing upgrades at NAS Oceana, it is estimated that LSOs currently still require up to 1000 live landings to accurately calibrate their visual perception of aircraft deviations. Their ability to maintain these numbers in the face of reduced live flights for CQ in general will be a challenge. The introduction of supplemental training that can enhance this calibration could address some of these challenges and is essential in moving forward with optimized training.

**Status:** An analysis of training materials and simulation based training was performed in FY16 including a task analysis to identify specific LSO training needs, as well as software development for an augmented reality display overlay to enhance LSO training and for virtual reality training for LSO. Training objectives and metrics have been identified and are being developed for implementation in experimentation planned for FY17-18.

**Research Products:**
- NAWCTSD Contractor Final Report from Training Analysis for LSO School Simulation based training. (Pending)
**BASIC ELECTRONICS AND ELECTRICITY LEARNING ENVIRONMENT (BEETLE) II TRANSITION**

**Start: Oct 15    End: Sep 17**

**Need:** Originally, BEETLE II was developed in partnership with the University of Edinburgh to advance the state-of-the-art in Intelligent Tutoring System (ITS) capability. Research funded through the ONR D&I program was conducted to advance methods natural language processing (NLP) to support unrestricted student natural language input in ITS. Both the Navy’s Submarine Learning Center and the Department of Defense Educational Activity have expressed interest in using BETTLE II as an instructional tool if the tool could be transitioned to a more accessible web based application. Furthermore, they have expressed an interest in development of course content in additional subject areas should the transition prove successful.

**Objective:** Investigate feasibility of transitioning the Office of Naval Research (ONR) Discovery and Invention (D&I) sponsored research in BEETLE II from a closed Linux-based system to a web accessible application. BEETLE II was developed in partnership with the University of Edinburgh to advance the state-of-the-art in Intelligent Tutoring System (ITS) capability. Research funded through the ONR D&I program was conducted to advance methods in dynamic adaptive feedback generation and natural language processing (NLP) by extending symbolic NLP techniques in the context of a dynamically changing simulation environment in a moderately complex domain. This research seeks to provide an interface to the application that would permit educational institutions the ability to use this courseware as an education tool or as part of the curriculum for students.

**Benefits:** Transitioning BEETLE II from a closed Linux-based system to a web accessible application would provide an interface to the application that permits educational institutions the ability to use this courseware widely as an education tool or as part of the curriculum for students. As a web application, educational institutions would be able to use the tool without requiring specialized hardware and eases their burden with centralized maintenance of the system. Furthermore, it offers the opportunity to develop the platform from which additional courseware for other subject matter could be developed to deliver an efficient and effective learning experience for participating students. Newly developed courseware could be readily shared among educational institutions maximizing benefit to instructors and students.

**Status:** We enhanced the knowledge base ontology designed for evaluating student responses to questions using data that was gathered during development of the original Linux-based application. We have added Lexicon Model for Ontologies (LEMON) model and a formalism for semantic construction known as Dependency-based Underspecified Discourse Representation Structures (DUDES). These strategies enable a developer to provide specificity to the application for their domain of interest. The LEMON model allows us to specify the meaning of lexical entries with respect to a given domain declaratively while DUDES provide a means to represent specific relationships in the domain. These strategies arose from the need to address the fact that meanings are incomplete without contextual understanding. These strategies for NLP in a specific domain are well described in Ontology-Based Interpretation of Natural Language referenced.

The flow of our pipeline has expanded to include these formalisms. We begin processing input strings using the machine-learning based toolkit OpenNLP to parse the input into a tree. We then get syntactic and semantic information from the LEMON model and DUDES. We generate a SPARQL query to get a response from the knowledge-based ontology. This approach facilitates more robust interpretation of language as well as making the task of natural language generation easier enabling us to provide a more natural response to the student or trainee.

**Research Products:** Planned research products include collaboration with academia, hardware/software prototype, technology demonstration, paper publication and final report.
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 developed a job aid to guide the development and tracking of required training capabilities with physical training system attributes from initial concept to test, and evaluation. This approach can 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 was to develop a job aid to improve the integration of performance requirements and specifications. Current simulator requirements and evaluation processes do not address whether the simulator’s training capabilities are achieved. This effort spoke 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 both systems engineering and test and evaluation by supporting the acquisition of effective training devices with training capabilities as the central focus of the design and evaluation. This effort can improve the capability of developing, verifying, and validating whether simulations, as defined in “build to” specification also meet training performance requirements.

Status: A TRL 5 web-based prototype Job aid was developed, out briefed and demonstrated to the NAVAIR CTO and potential transition customer, PMA-205 (Sep 16).

Research Products: 1) Functional Requirements Traceability Matrix and 2) the SETT and RETT TRL 5 prototype web-based database tool, which was successfully developed and demonstrated to PMA 205 with Navy training systems test data.
**PERFORMANCE ASSESSMENT TRENDS IN TRAINING ENHANCING READINESS REPORTING FOR NAVAL SYSTEMS (PATTER2NS)**

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

**Need:** The current state-of-the-art 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 PATTER2NS 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:** Iterative, integrated testing of the Performance Measurement (PM) Engine and Post Mission Assessment for Tactical Training and Trend Analysis (PMATT-TA) and the PM Engine for automated performance measurement was conducted within the simulation-based training environment. The results of this testing included a prioritized list of performance measures with updates based on fleet testing. Following successful beta testing of PMATT-TA at MCAS Kaneohe Bay, HI (CPRW-2), introduction training was held at NAS Whidbey Island (CPRW-10) and NAS Jacksonville (CPRW-11). As a result, the system has been integrated into multiple air wings supplanting the previous post mission reporting process, and the system was successfully used during the Undersea Warfare Exercise in Jan 16. Coordination continues with deployed squadrons to develop an implementation and transition plan. The team coordinated with external stakeholders and secondary transition customers throughout the year to understand future derived requirements for the capability. Human factors evaluations completed in FY16 resulted in refined graphic user interface mockups for new functionality and a documented usability protocol for continued evaluations. A pilot study to baseline the current assessment and debrief process for comparison with debriefing augmented by post mission reporting and real-time performance assessment technologies has been completed and data collection has begun.

**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.


**Colloquiums**

**Government report**

**Panel participation**

**Paper for publication**

**Professional society presentation**

**Workforce development: Internship**
- NREIP Intern. Ponto, Shelby-Jo, (Jun 14, Aug 15).

**Workforce development: Mentoring**
- Mentee Fok, Audrey mentored by Atkinson, B. (Feb 2015 - Jul 15).

- Awards/Honors
  - Nominated for Section 219 Outstanding Project of the Year 2016 – Technology Transition
  - Nominated for 2016 NAWCAD Commander’s Award
  - Nominated for 2016 NTSA Modeling & Simulation Awards
  - Nomination submitted for 2016 American Society of Naval Engineers (ASNE) Solberg Award
Need: The Integrated Systems Evaluation, Experimentation and Test (ISEET) Department (AIR-5.1) has the responsibility to evaluate integrated systems capabilities across the Naval Aviation Enterprise (NAE). The Naval Air Warfare Center Training Systems Division (NAWCTSD) Test and Experimentation Department (AIR-5.1.1.9) is responsible for training systems T&E products. AIR 5.1.1.9 performs this function, in close partnership with AIR 4.6 Training Systems Integration, Developmental Test Squadrons, Commander of Operational Test and Evaluation Force, through the construct of an integrated test environment. To date, current test methods for training systems have been built upon legacy systems and as a result the validation of training and readiness, operational effectiveness, and operational suitability has been lacking. Current methods only address the specification compliance of training systems and fail to address the validity of training devices to meet current and future training and readiness needs established by the NAE.

Objective: The objective of SETT is an end-to-end framework that integrates human performance and training Test and Evaluation (T&E). The SETT tool will create a rigorous process to identify test requirements, test points, test plans, detailed method of tests, deficiencies and reports that will facilitate the validation of whether training devices are capable of meeting Training and Readiness (T&R) requirements. To accomplish this, this effort will leverage the Requirements Tracing Tool (RETT) effort to provide details that link the front end performance specification to test points.

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 System Evaluation for Training and Test Tool, can be used to support the acquisition process of planning, implementing, testing, and certifying training devices.

Status: The SETT project completed on 30 Sep 16 as a TRL 5 tool. Transition development and funding is currently in work. Additionally, joint Army and Air Force transition is currently in work.

Research Products: A SETT and RETT web based database tool was successfully developed and demonstrated (Sep 16) to PMA 205 with Navy training systems test data.
**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 appended training approaches for future UAS systems requires a CCS prototype to ensure effective transition to operational systems. Safety of flight issues make inclusion of embedded training approaches expensive and time consuming due to the requirement for an extensive certification process. This prototype must be used to design, develop, and evaluate appended training approaches.

**Objective:** Via cross-warfare center coordination (WD, AD, TSD, and Navy Yard), low cost CCS hardware and software will be reviewed, procured and integrated to support development and evaluation of training for PMA-281’s CCS development program. The primary focus of the proposed effort is to develop and evaluate appended training approaches for the employment by the CCS. The R&D lab currently has software and media development capabilities that will be employed to develop and evaluate augmented reality (AR) training approaches that can deliver training that will not impact the safety status of the tactical CCS. Employment of AR technologies holds the promise of providing rapid training update capabilities by avoiding the safety of flight certification requirements. This independence of the training from the tactical system will enable training capabilities to keep pace with the rapidly evolving development of the tactical CCS prototype without impacting its schedule.

**Benefits:** Leverage multiple professional disciplines to develop training with human system interface orientation, and adaptability for different UAS platforms. NAWCTSD will expand its design, development/research capabilities into UAS control station training issues. 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 hardware and software specification reviews and a site visit to NAS Patuxent River to further clarify future requirements. FY14 resulted in hardware and software specification development, hardware and software license procurement and integration to develop the CCS prototype. Additional procurements were made in FY15 to complete the prototype, and AR hardware and delivery and development licenses were selected and procured. In FY16, AR applications will be developed to address familiarization and procedural training, and usability research will be executed.

**Research Products:**

Common Control System prototype research test beds. (SubRAT and US-TES labs)
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.

The NAWCTSD transition research projects are described on the following pages.
**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. Iterative, integrated testing of the Performance Measurement (PM) Engine was conducted within the simulation-based training environment. The results of this testing included a prioritized list of performance measures with updates based on fleet testing. Information assurance documentation is underway. Development continues to refine the capability and planning is underway for future test events within the P-8A weapons tactics trainer. Future development will focus on configuration, real-time display, and after action review of performance measurement results.

**Research Products:**
- PMA-290 PM Engine software install planned (Dec 16)/delivery (Jul 16)
- Performance Measurement (PM) Engine software upgrade installation (Oct 15)
- **Colloquiums**

- **Panel participation**

- **Paper for publication**

- **Professional society presentation**
**POST MISSION ASSESSMENT FOR TACTICAL TRAINING & TREND ANALYSIS (PMATT-TA)**

**Start:** Oct 10   **End:** Sep 17

**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 post-mission assessment.

**Objective:** Increase training effectiveness & efficiency and 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 web-based application and database was developed to provide single point access for data entry of post mission data and qualification sheets. The product has undergone the necessary information assurance testing and approvals for use on Navy SIPRNET. Following iterative design and development cycles, beta testing of PMATT-TA at MCAS Kaneohe Bay, HI (CPRW-2) was conducted from JUN 2015 through DEC 2016. Introduction training was held at NAS Whidbey Island (CPRW-10) and NAS Jacksonville (CPRW-11). The PMATT-TA system was successfully used during the Undersea Warfare Exercise in JAN 2016, and a full transition to the product for state-side P-3 and P-8 air wings is underway. Coordination continues with deployed squadrons to develop an implementation and transition plan.

**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. (PMATT-TA Increment 2 software release, Sept 16)
- Colloquiums
- Government report

- Panel participation

- Paper for publication / Conference proceedings

- Professional society presentation
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.
ADAPTIVE TRAINING FOR MAINTAINING ATTENTION DURING UAS OPERATIONS
[N162-090]

**Start:** Oct 16   **End:** Sep 17

**Need:** Create a design for UAS operations training that incorporates adaptive techniques to handle different missions, unmanned systems, and operator characteristics. Develop training use cases to establish baseline and post-training performance.

**Objective:** The objective of this effort is to help individuals learn to remain attentive during long shiftwork associated with unmanned aerial systems (UAS) missions. This result will be achieved by developing adaptive training to meet the different needs of operators, UAS, and their missions.

**Benefits:** Sustained attention to a task requires orienting to important stimuli and selecting specific items among distracting items. Many sustained attention tasks place individuals in situations where target items are infrequent, where items varying importance or salience, where the surrounding context is highly complex, and where there could be some uncertainty in whether or not a stimulus represents a signal or noise. A number of Military Occupational Specialties (MOS) require sustained attention and share four main characteristics [1]:

- The individual must be attentive to potentially subtle or rare occurrences.
- There may be high stakes for missing subtle or rare but relevant items.
- The individual’s responses do not influence subsequent occurrences.
- The individual is required to stay on task for extended periods of time.

UAS operators are subject to attentional "drift" in needing to remain attentive [2,3], such as during long periods of watching video feeds. For instance, when used for Reconnaissance, Surveillance, and Target Acquisition (RSTA) missions, UAS operators are responsible for recon over a route that a unit is about to drive, looking for evidence of IED or sniper activity. Some operators may experience boredom with the task that could lead to adverse performance [4]. It is critical that these UAS operators are able to stay on task during the entire mission so as not to miss important cues.

Some research has considered if and how attention can be trained or improved. In particular, training individuals to adopt a specific decision criterion, or to require systematic attention switching, or that require periods of manual control, has demonstrated some success in warding off attention-related decrements in performance, which may have critical implications for UAS operators. Feedback during training also has demonstrated effects on attention tasks. The implication for the military is that if an individual is assigned UAS operations duty that requires sustained attention, it is crucial to be assured of that individual’s competency.

This topic seeks cost-effective, scalable training solutions that are able to adapt to the needs of different individuals, to the affordances inherent in different UAS, and to the requirements implied by different missions.

**Status:** (3) Phase I awards made in October 2016.

**Research Products:** Contractor Phase I Final Reports shall be delivered in April 2017.
**Need:** The Chief Naval Office (CNO) mandates naval survival training include parachute descent training. This training is outlined in OPNAVINST 3710.7U. Current training technology lacks the quality and sustainability needed to ensure standard, efficient and effective training. The Naval Aviation Survival Training Program Trainer Management Team (TMT) has identified the need for alternative training devices as a top 5 strategic priority.

**Objective:** Develop a novel technological training solution that is reconfigurable and provides immersive Parachute Descent Procedure (PDP), malfunction and decision-making training. Proposed solutions are expected to allow the survival training community to deliver cross-platform training without the need for multiple training systems or platform specific peripherals. The training system is intended to address three capabilities gaps: 1) training quality and effectiveness, 2) supportability, and 3) training realism.

**Benefits:** The training system should benefit the Navy by providing a reconfigurable interface that supports all Navy standard flight equipment and parachute equipment. All necessary equipment will be identified during the Phase I and Phase II execution, with hands on opportunities at the safety center facilities during kickoff or other collaboration meetings. This would include, but is not limited to, parachute harnesses and riser assemblies for all models of parachutes. Developed technology would provide the ability to demonstrate effectively both standard PDPs (e.g., inflation of the life preserver, releasing the raft when applicable) and parachute malfunction. Malfunction training should allow students to perform corrective actions and provide mechanisms to deliver feedback on performance through performance assessment and debriefing capabilities. The system should support scenarios for training that include both over land and over water options and procedures.

The requested training solution will also benefit the Navy by providing a reconfigurable connection for a variety of aircrew equipment and seat kits, which differ by platform. This is necessary to ensure the delivery of an integrated training solution without the need for multiple platform specific trainers or simulated/replica equipment only utilized within the trainer. Development of a single, reconfigurable device will significantly limit single or recurring peripheral costs if a system was designed with simulated/replicated equipment. These costs saving factors increase affordability of the requested system, while also increasing the training fidelity for delivering a critical safety-training curriculum.

**Status:** Competitive source selection was completed and 4 Phase I efforts were awarded. A competitive down select is scheduled at the end of the Phase I base, in Dec 2016.

**Research Products:**
- Professional society presentation
**METHODS FOR ACTIONABLE MEASURES OF ABSOLUTE COGNITIVE WORKLOAD**  
[N16A-006]

**Start: May 16   End: Apr 17**

**Need:** Knowing human limits in performance of complex, cognitive tasks is critical as state-of-the-art technologies and equipment are introduced to warfighters and new environments are encountered, as it helps research and developers understand and evaluate the potentially negative impacts on the safety and efficiency of operations.

**Objective:** Develop a technology for assessing absolute cognitive workload capable of identifying a validated threshold beyond which cognitive workload levels are significantly affecting performance, potentially degrading operations in a way that results in unsafe conditions for the operator(s). The resulting technology should provide an objective, measurable means to determine impacts on individual operator, crew-level, and/or multi-team system level performance when life support or aircrew systems are added or modified. The technology should account for impacts in performance when conducting complex tasks resulting from factors including but not limited to integrated systems, personal conditions of the aircrew (e.g., weight of equipment, fatigue, stress), and the operating environment (e.g., temperature, confined quarters).

**Benefits:** The resulting technology should be consistent with research and theory, assess workload and its effect on performance, and include a strategy for predicting future workload levels once experience is accumulated. In addition, the technology should highlight when workload levels reach limits that degrade human cognition and performance for consideration during design, development, test, and evaluation of operational and training systems to support upgrade activities and decision making with objective data. Such a tool has a range of applicability from PMA-202 aircrew systems through investigation of life support systems, to PMA-205 training systems development and effectiveness evaluations. New methods are needed to support systems acquisition decisions, and these methods will need to improve on existing methods, in at least three ways, as described below.

**Status:** In mid FY16, five phase I awards were made to contractors who had unique technical approaches to developing a technology for assessing absolute cognitive workload capable of identifying a validated threshold beyond which cognitive workload levels are significantly affecting performance, potentially degrading operations in a way that results in unsafe conditions for the operator(s).

**Research Products:** Contractor Phase I Reports submitted Oct 16.
CREW ROLE-PLAYER ENABLED BY AUTOMATED TECHNOLOGY ENHANCEMENTS (CREATE) [N142-090]

Start: Oct 14   End: On-going

Need: Current Navy crew training requires the assembly of an entire crew, or the use of Subject Matter Experts (SMEs), to support crew training. While training benefits from the additional costs associated with bringing a full crew together (e.g., crew coordination, team building), some individual training could benefit from the added realism provided by crew interaction. For example, when attaining skills associated with crew roles, individual trainees often conduct a series of training events in Part Task Trainers (PTTs). During these events, the emphasis is on the crew member's individual skills; however, many tasks associated with their role rely on inputs from other crewmembers. The original effort focused on the role of the Tactical Coordinator (TACCO) in a P-8A communicating and coordinating with his or her crew. However, the effort has since expanded to also include pilots training communication skills with synthetic Air Traffic Control entities while in Operational Flight Trainers. An additional future expansion interest includes virtual wingmen for platforms that fly in formation. The trainee would be able to give and receive speech commands to his or her virtual wingmen, and then have those entities respond in kind.

Objective: Develop a software application/suite that provides a synthetic crew role player to support complex crewmember interactions during dynamic training events.

Benefits: Current Navy crew training requires the assembly of an entire crew or the use of SMEs to support crew training. While training benefits from the additional costs associated with bringing a full crew together (e.g., crew coordination, team building), some individual training could benefit from the added realism provided by crew interaction. For example, when attaining skills associated with crew roles, team members often conduct a series of training events in PTTs. During these events, the emphasis is on the crew member's individual skills; however, many tasks associated with their role may rely on inputs from other crewmembers. Developing a software application/suite that provides a synthetic role-playing capability will serve to enhance the training pipeline and potentially avoid costs and provide value added without the use of training aids.

In order to successfully implement a synthetic role-player capability for Navy crew-based training, a technology solution that integrates speech capabilities (i.e., recognition, understanding, synthesis), SME level tactical domain information, reaction to multitasking and high stress situations, and relay of information via means other than speech communication (e.g., software inputs), are required. However, current technologies have not been developed to interact in this manner.

The Navy would benefit from this proposed technology by being able to supplement training for the TACCOs in the P-8A PTT. TACCOs are responsible for synthesizing information from multiple sensor operators in order to make tactical decisions about how to pursue targets of interest. Future expansions would also supplement training for pilots practicing communication skills in Operational Flight Trainers, as well as strike aircraft pilots practicing communication and coordination with a virtual wingman who could respond to verbal commands.

Status: One contractor was selected for a Phase II award (Nov 14) and has entered year 2 of the effort. Additional SBIR funding was secured for Phase II.5 to continue development for P-8A requirements, as well as supplemental Phase II expansion funding to focus on the speech recognition
aspect of the effort to include pilot communications with air traffic control and potential secondary transitions through a virtual wingman capability. The PMA-205/PMA-290 P-8A training program plans to provide FY18 funding to implement the capability within the P-8A simulation-based training environment.

Research Products:

- Reports
  - Phase I Final Report (Apr 15)
  - Phase I Option Final Report (Nov 15)
- Colloquiums
- Paper for publication / Conference proceedings
- Professional society presentation

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

Start: Jul 14    End: Feb 17

Need: Currently, the hours of availability provided by each stand-alone simulator are constrained by each trainer’s dedicated image generation (IG) 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.

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. Experts predict that large scale training centers may be not viable in the long term without this type of innovation, due to the complexity and detail available for rendering. Just as image generation architecture has moved from dedicated purpose computing into PCs, it is inevitable that the next step would be into distributed fiber optic video distributed network, thus providing better logistical/maintenance support and sparing for large scale simulation (e.g., see reference for the new P-8A aircraft) training centers, and commercial training facilities that provide multiple flight simulators at one location.

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 (IG) should improve availability, reduce costs and space requirements, and make possible uninterrupted training to occur - while conducting simultaneous imagery updates.

Status: Diamond Visionic’s approach uses a centralized IG system that renders each frame from disparate observer positions and sends those frames out as network packets, which can be routed to
different training environments. A normal IG system is composed of multiple computers in a server rack, but with Diamond Visionic's system each IG is a single computer with multiple video cards (further reducing the need for multiple spare computers in case of failure). Diamond has also innovated on how they are approaching distributed rendering by using both the latest OpenGL rendering techniques and taking advantage of the new frame encoding/decoding and hardware/software technology developed by NVIDIA.

During Phase I, a four channel prototype was developed, consisting of four Quadro K6000’s in one system. The prototype was demonstrated running a LCD display configured as a 2x2 matrix. The imagery was sent to the display over a network and ran at 60hz. The prototype was also attached to 4K projectors, driving at 1920x2160, each powered by two video cards. This resulted in an 8 to 1 reduction in the number of IG computers required in a traditional approach. Again, the system ran at 60hz in a very demanding scene.

In Phase II, Diamond has moved to an 8 channel system using the dedicated encoding technology built into the latest Quadro video cards. Their system was selected over a Rockwell-Collins IG to support AVT in a series of “whisper suite” demonstrations at the AAAA and AUSA trade shows. The system ran a combination of OTW and sensor channels, with each instance of the software driving 2 outputs, all running at 60hz.

In Phase II Option, Diamond Visionics began improving their software architecture. One large improvement was to separate the rendering and database paging models of their architecture, which allowed for construction of a database query engine called GenesisQE. This new API allows for mission functions to be offloaded to the IG system. Furthermore, by decoupling the rendering from the database paging tasks, they can now efficiently scale the architecture to more than four GPUs in a single computer. This will help to amortize the cost of the higher-end server-grade hardware needed to support multiple GPUs, bringing the cost-per-channel down into a competitive range with traditional single-GPU systems. Additionally, this opens up new possibilities for how to handle front-end rendering.

**Research Products**: Boeing became the first adopter of the consolidated IG system developed during Phase I. The requirement was to provide ten IG channels (six out-the-window, three sensors, and one UAV video feed) with 60Hz performance over areas with extremely dense cultural content (e.g., thousands of trees per square kilometer, thousands of buildings, a complex airfield environment, etc.). This was accomplished using only three IG computers.

At the 2015 I/ITSEC conference, Diamond presented the latest results of this SBIR in their booth. This included a 4-channel system which was configured to fly four independent database areas representing different locations around the world simultaneously. A separate CIGI packet stream was sent to each of the four instances of the IG software. This is a realization of one of the original goals of this Phase II as depicted in the initial prototype design.
DISTRIBUTED SYNTHETIC ENVIRONMENT CORRELATION ARCHITECTURE AND METRICS
[N141-006]

Start: Aug 15    End: Aug 17

**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 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:** This SBIR will generate 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 will be displayed in a graphical way that allows for easy understanding of the correlation differences and the impacts on distributed training.

**Status:** GameSim is developing a framework, called Validate, to detect synthetic environment correlation and integrity errors realized in military training systems. Validate automatically verifies correlation and correctness of new and networked training simulation environments to ensure a fair fight between networked participants. Validate provides a means to test correlation between any combination of source datasets, including NAVAIR Portable Source Initiative (NPSI) and run-time systems, including image generators (IG). Correlation test supports three configurations; Source-to-Source, Source-to-Runtime, and Runtime-to-Runtime comparisons. These tests require an set of areas of interest (AOI) to be specified such as ; airfields, urban areas, forests, deserts, mountains, known landing zones, and low level flight paths. Planned correlation tests include: elevation, feature, imagery, materials, illumination, field of view, level of detail, and light points. Implemented tests to date include; terrain elevation, elevation gap, slope, feature presence, feature placement, imagery resolution, and material comparison. GameSim has tested these correlation tests between NPSI data sets provided by NAWCTSD (Source-to-Source) and between Rockwell Collins and Diamond Visionics image generators (Source-to-Runtime, and Runtime-to/Runtime).

**Research Products:** Presentation and demonstration to validate tool for NAWCTSD (Aug 16).

Planned: Phase II Final Reports and Prototype Demonstration (Aug 17)
**Effective Measures of Training Display System Performance [N142-104]**

**Start: Mar 16   End: Mar 18**

**Need:** Over the past decade, the ability to measure essential display system attributes has advanced to the point where the simulation training industry has multiple suppliers who offer automated display calibration systems, capable of accurate geometry and channel-to-channel co-alignment. Several of these systems can also measure and correct edge blending, electro-optical response (gamma), color, and uniformity. Recent publications describe reasonable new metrics for mirror distortions, motion-induced blurring, uniformity, and Night Vision Goggles (NVG) stimulation capability. Despite these significant advances, the typical acceptance tests used to certify training display systems are still manual, incomplete, time consuming, and often inconsistently applied across programs.

**Objective:** Develop an objective and efficient measurement toolkit for conducting validated acceptance tests for simulation training display systems.

**Benefits:** The return on investment from the Phase II effort will be 14 metrics that are significant drivers of visual performance and the cost of training display systems. The proposed system will be capable of being rapidly set up at the real eye points within a display system, without having to significantly reconfigure the device. The measurement will be capable of dealing with the challenges associated with window bars and other obstructions that may interfere with measuring the entire field of view of the display system. The display measurement system is expected to support factory acceptance testing for major system components, such as display screens, mirrors, projectors, and image generators, prior to integration into the training device. The proposed display measurement system is expected to reduce the time it takes to perform visual system tests, and provide more consistent and objective display performance results.

**Status:** Visual Performance is working on the definitions for seven metrics: luminance, contrast, absolute geometry, relative geometry, blend geometry, collimation distance, and divergence which will conform closely to current display measurement practices. The definitions of seven additional metrics; static, dynamic, and blend resolution, sampling artifacts, channel and blend uniformity, and mirror distortion will differ from current practice. At this time Visual Performance has conducted real image display resolution and geometric accuracy measurements at NAWCTSD using the proposed metrics. The results are been compared to traditional display measurement methods for correlation. Design and development of the Display Measurement Toolkit hardware and software are under way.

**Research Products:**

- Reports and Presentations:
  - Phase I Final Report (Apr 15)
  - Phase I Option Final Report (Nov 15)
  - Presentation and demonstration of Resolution Metric at NAWCTSD (Nov 15)
  - Presentation and demonstration of Geometric Accuracy Metric at NAWCTSD (Aug 16)
  - Final Phase II Report (Mar 18)
  - Display Measurement Toolkit Prototype (S/W and H/W) (Mar 18)
**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:** The primary goals was to improve the fidelity of transportation features in simulation systems and to provide terrain generation tools that work across multiple systems. The contractor designed and prototyped and demonstrated a software tool that analyzes elevation and vector data to infer attributes on hydrology features. This tool is intended to supplement existing available GIS data and provide attribution such as width and seasonality of rivers, streams, etc.

**Research Products:** Contractor demonstrated software capabilities in April 2016.

Planned: Phase II Final Reports and Prototype Demonstration (Aug 16)
**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:** As part of the Phase II, the contractor completed two unique optical system designs for a variable collimation display (VCD). The basic principle of the VCD is based on controlling the curvature of the wavefront of light reaching the eyes of the user. When the curvature is flat, the light is 'collimated' and the image appears at a nearly infinite distance from the user; likewise, as the curvature of the wavefront increases, the image appears to move closer to the user. Both approaches employ a conventional wide-area collimated (WAC) mirror and beamsplitter to direct the light to the user's eyes. The initial approach is based on a projection lens module that incorporates an adaptive fluidic lens in order to control the wavefront curvature.

The second approach is based on moving a back projection screen (BPS) relative to the WAC beamsplitter mirror to control the wavefront curvature. Optomechanical systems, including lens mounting and actuation hardware, were designed for both approaches.

Fabrication of the large (180-mm clear aperture) fluidic lens and BPS motion system was completed during Phase II. The control system, including drive electronics and software, was also completed and tested for both approaches. This included development of a rudimentary flight simulation environment in Blender open source software, controlled using a standard XBOX console controller. The software extracts values of interest from the simulation such as Height Above Terrain (HAT) and distance of a particular object from the viewer. This data is communicated via serial port to a microcontroller which controls the hardware attached to the system. For the two approaches, this same control system can control the focal length of adaptive fluidic lens as well as the translational and rotational position of the BPS. Additionally, Holochip investigated a miniature version of the adaptive fluidic lens applied to a head mounted display (HMD) in order to provide variable collimation (i.e., variable accommodation) in virtual reality (VR) environments. Miniature adaptive fluidic lenses and a breadboard-level VR system were designed, fabricated and tested.

**Research Products:**
- Demonstration of prototype for the second time provided to TPOC (Feb 15)
- Inspection of prototype variofocal 140 mm lens demonstrated to TPOC (Feb 15)
- Phase II Final Report (planned Jan 17),
- Phase II Final prototype demonstration (planned Jan 17)
**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 supporting the 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:** Phase I base demonstrations were concluded in FY14. Down select to a single Phase I option award was completed (Nov 15). Additionally, a Phase II award was for a two year Period of Performance. Plus up funds have been approved to accelerate development, human and engineering testing to prepare the technology for production and procurement during the next technology refresh for the Reduced Oxygen Breathing Device (ROBD) training systems.
Research Products:
- Brief technology approaches to Fleet Customer (Dec 13)
- Phase I Final Report (Nov 13)
- Phase I Option Final Report (April 14)
- Demonstration of prototypes provided to technical team (Apr 14)
- Engineering testing conducted to validate pressure on demand (Jul 16)


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, training, and human performance 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 federal government subject matter experts and resources, and feedback on R&D products that can be used to improve future government systems.

Federal technology transfer has been in place since 1980 to facilitate the transfer of federally developed technologies to the private sector as well as academic institutions and state & local governments. Federal and non-federal partners have the opportunity to work together on mutually beneficial research and development using instruments called Cooperative Research and Development Agreements or CRADAs. Technology transfer legislation also promotes the licensing of inventions/patented technologies developed in the federal laboratories for commercial applications. Through technology transfer, the nation’s investment in federal research and development leads to products, services, and capabilities for the good of the public.

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 CRADAs, Commercial Services Agreements, Licensing Agreements, and Education Partnership Agreements with academia, industry, and state and local governments. Agreements such as CRADAs can provide a vehicle for NAWCTSD to receive feedback on, and to further develop, 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.

The technologies/products/services described in this Technology Transfer section offer opportunities for partnerships with NAWCTSD through CRADAs or licensing agreements. For additional partnering opportunities, refer to http://www.navair.navy.mil/nawctsd/Programs/Files/T2NAWCTSDProducts31Mar15.pdf.

For more information, please send an email to: ORLO_Orlando_Tech_Transfer@navy.mil.
MODULAR ADVANCED TECHNOLOGIES MARKSMANSHIP PROFICIENCY (MAT-MP)

**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 providing 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 was successfully developed and demonstrated as an advanced prototype (TRL 7) under sponsorship by the Office of Naval Research Code 30 Human Performance, Training and Education portfolio. The Mk1 version of the kit was field tested in Apr 14 with Marines from Weapons Training Battalion, Quantico. Mk2 version of the kit was demonstrated in Dec 14. An expanded capability Mk3 version of the kit was transitioned in Oct 15 to the Federal Law Enforcement Training Center under support by the DoD Domestic Preparedness Support Initiative. The Marine Corps Program Manager Training Systems (PMTRASYS) has funded the creation of five complete MAT-MP Mk3+ prototype kits to be deployed to Recruit Depot Parris Island for extended field evaluation beginning in Jan 17. The technology is patent pending.

**Research Products:**
- Field test of the Mk1 version of the MAT-MP technology kit completed in Apr 14.
- Mk2 version prototype demonstration completed Dec 14.
- Technology assigned Patent Pending status Sep 15.
- Custom Mk3 Kit transferred to Federal Law Enforcement Oct 15.
- Five (5) complete Mk3+ prototype kits to be deployed to Recruit Depot Parris Island for extended field evaluation in Jan 17.
**Scenario Planning and Effects Control System (SPECS) and After-Action-Review Technology**

**Start:** Oct 09   **End:** Sep 16

**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 accomplished in FY14 and FY15. 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) v1.1 baseline. Compatibility with industrial automation control systems utilizing the Building Automation and Control Networks (BACnet) data communication protocol was added to SPECS in FY16.

**Research Products:**
- SPECS has transitioned and is in operation across multiple sites including non-Navy customers through the NAWCTSD Technology Transfer office.
  - 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)
  - Northeast Counterdrug Training Center High Risk Entry Facilities
  - Component of USMC Range Instrumentation Control (RISCon) and Live Training Transformation
OTHER NAVY, DOD AND JOINT PROJECTS/PROGRAMS

DISTRIBUTED TRAINING NETWORK GUARD (DTNG)

Start: Oct 15    End: Feb 17

**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, with the first phase supporting DIS 6.0 protocol. DTNG is able to maintain interoperability with the HLA 1.3 and 1516 protocol by using the Joint Simulation Bus (JBUS) gateway. SPAWAR is currently evaluating the DTNG baseline for use with the F-18 C/D training system. HLA 1516 and TENA protocols will be completed in a future development phase.

**Research Product:**
- DTNG 3.1.x baseline completed/approved to support F-18 C/D training system. (November/December 2016)
- DTNG 3.1.x baseline will be utilized within the Navy Aviation Distributed Training Center (NADTC), which is being delivered to NAS Oceana in October 2016.
- Ruleset Development for F-18 C/D (February 2017)
HOIST ELECTRICAL DISCHARGE SOLUTION
Start: Oct 15   End: Sep 16

Need: During rescue operations, the rescue swimmers consistently receive electric shock while on the rescue hoist cable. The steel cable delivers this electric shock to personnel as they make contact with the ground or water. The Electrostatic Discharge (ESD) built up by the rotor blades represents a significant safety hazard to Aircrew and Survivors. A solution of non-conducting ropes eliminates the ESD hazard the rescue crewmen face currently.

Objective: The objective of this project is to research, find, and develop an alternative non-conducting material for helicopter hoist operations to reduce/eliminate the electric shock when crewmen are being lowered from the helicopter to the ground or into the water. The possible alternatives will be tested in a controlled lab environment and then in a real world environment to determine the viability as a replacement for the current steel cable.

Benefits: The development of a synthetic rope for use in the hoist system of naval rescue helicopters will provide significant advantages over the steel wire ropes that are currently being used. The most important advantage of the new synthetic rope will be the elimination of the electrostatic discharge that shocks the rescue divers and swimmers as they make contact with the water or the ground. The synthetic rope solution will not require modifications to the hoist hardware. The synthetic rope solution will reduce aircraft weight, eliminate injuries caused by broken steel strands and the amount of maintenance required to maintain the cable.

Status: Over the past year, the focus was on working closely with several rope manufacturers as well as experts from Cornell University to develop and test some new rope designs. There have been visits to several Navy bases to observe the hoist system in use and to consult with naval rescue personnel about their experiences with the current steel cable and requirements for suitable replacements. Once new synthetic rope alternatives have been developed and tested in a controlled test environment, the synthetic rope will be tested under real world conditions at the Navy Search and Rescue Facility.

Research Products: Final Technical Report (PMA-299) and Prototype rope (10) transitioned to AIR 4.3.5.4 – Cargo and Squad Operations Lab
**MEDICAL TRAINING VALIDATION 2 (MTV2)**

Start: Oct 16  End: Sep 17

**Need:** It is essential that combat medics receive proper training before they enter the battlefield. While existing training has traditionally utilized live tissue, and previous research has shown live tissue training to be an effective surgical training approach, an increased focus from advocacy groups may apply public pressure to substitute live tissue with medical simulation technology. Furthermore, recent medical simulation devices have dramatically increased in fidelity and capabilities, yet few studies have empirically compared simulation-based training to live tissue training. Those studies which have assessed performance differences between training technologies have occasionally exhibited bias toward minimizing live animal model training, and often produce differing results. While some authors have shown no difference between trainees performing on a simulator or a live model others showed simulation as more effective than a live animal model or human cadaver training. Still others showed human cadaver training to be better than live animal models. Despite this, combat medic instructors often insist that live tissue training is essential and simulation cannot adequately recreate the necessary cues which a combat medic would rely upon in the field (or worse, provide inaccurate cues which lead to negative transfer of training). This conflicting evidence potentially clouds the future of combat medic training techniques by not being able to provide a specific answer to important questions such as “which tasks are most likely to benefit from simulation-based training?” and “how specifically do we need to advance simulation technology to ensure it is most effective?”

**Objective:** To develop a validated set of tasks and cues for reuse by multiple stakeholders (e.g., as requirements for designing new training simulations), and to develop validated performance metrics for two combat medic skills: amputation management and needle chest decompression.

**Benefits:** Validated measures of performance will provide a foundation of comparison of performance when utilizing live tissue and simulation based training alternatives. Validated tasks and cues provide standardization of training requirements for future modeling and simulation efforts.

**Status:** This is an FY17 new start.

**Research Products:** The final research products will include: 1) validated performance measurement instruments for amputation management and needle chest decompression; 2) validated set of tasks and cues and other relevant training requirements for amputation management and needle chest decompression.
**NETWORK EFFECTS EMULATION SYSTEM (NE2S)**

**Start: Oct 14  End: Sep 17**

**Need:** The Test and Evaluation (T&E)/Science and Technology (S&T) Net-Centric Systems Test (NST) program exploits new technologies and processes to meet important T&E requirements; expedites the transition of new technologies from the laboratory environment to the T&E community; and leverages commercial equipment, modeling and simulation, and networking innovations to support T&E. One of the T&E technology gaps is the inability to simulate and analyze network effects within joint context to create, instrument, and analyze the impact effects on shared situational awareness in a net-centric environment.

**Objective:** The objective of this project is to research and develop a cost effective, enterprise tool for the T&E/Net-Centric Systems Test (NST) and Training and Experimentation (T&E) communities capable of simulating a wide range of network and host based effects that can be centrally managed and controlled.

**Benefits:** The Network Effects Emulation System (NE2S) provides realistic emulation of network and host-based cyberspace attacks. NE2S integrates traditional test and training environments with cyber-attack scenarios. The Master Control Station (MCS) affords centralized control of real time, instructor-initiated effects, or scripted scheduled scenarios. NE2S employs a network-centric architecture and currently supports Linux and Windows operating systems. The system uses encrypted communications over standard network protocols (e.g. SSL, HTTPS, SSH). Authentication
credentials are encrypted at rest. The NE2S effects are initiated, managed, and terminated using a Master Control Station (MCS) communication to Effects Generator(s) (EG). Effects occur on user workstations without affecting network traffic and can be synchronized with Master Scenario Event Lists (MSEL). NE2S does not affect real-world networks and only emulates desired effects through the Effects Generation Software Application (EGSA) middleware application downloaded on specific exercise systems. The NE2S software provides support to various distributed sites and terminal/systems. By simulating network and host based effects, NE2S enables the Testing, Training and Experimentation communities to create a wide range of conditions under which applications and systems can be tested (i.e., Cyber for Cyber) improving event reality. NE2S provides realistic training capability during events or exercises whether local or distributed.

NE2S is accredited to operate on Non-Classified Internet Protocol Router (NIPR) Networks and Secret Internet Protocol Router (SIPR) Networks.

**Status:** Over the past year, the focus was on working on software upgrades. Specifically, the NE2S system was upgraded to Windows 10 for all host and client machines. Other enhancements include enhanced After Action Reporting Capability; more targeted network effects; interoperability (web API, simulation protocols); and effects editor. NE2S 2.0 includes a web-based server for the Master Control Station (MCS) and automatic workstation reporting. NE2S is used in daily operations for the TRADOC Training Brain Repository as well as the South Carolina National Guard and Army EPG. NE2S will be utilized in several military exercises in the upcoming future. More software upgrades and improvements are planned for FY17.

**Research Products:** A NE2S Prototype Windows 10 Software Upgrade (Sep 16).
**Personal Assistant for Life Long Learning**

**Start:** May 16  **End:** Sep 17

**Need:** Navy sailors are experiencing long time delays between training and deployment which can lead to skill decay and sailors arriving onboard unprepared. This program is a first step to provide sailors with an automated training tool to maintain their knowledge and skills after initial schoolhouse training is complete.

This research is a critical component in the Office of Naval Research’s “Sailor 2025” initiative aimed at transforming sailors’ on-the-job performance across their careers to be more efficient and cost-effective. Specifically, the Ready Relevant Learning (RRL) pillar of Sailor 2025 seeks to move away from the traditional Navy training paradigm of brick-and-mortar schoolhouses to more modern multi-platform instructional delivery solutions that leverage advances in S&T to enable more effective and engaging training anytime, anywhere.

**Objective:** The objective of the Personal Assistant for Lifelong Learning (PAL3) effort is to develop personalized instruction for individual students in Apprentice Technician Training (ATT) electronics courses on a mobile device. PAL3 includes an embodied pedagogical agent that helps students navigate through a library of curated learning resources (including intelligent tutoring systems, circuit building simulations, tutorial videos, and webpages) by providing recommendations based on the student’s learning record. The goal of this effort is to demonstrate that recent A-school graduates who use PAL3 experience less skill decay and are more prepared for C-school compared to students without PAL3, as students with PAL3 are able to practice the skills and knowledge they gained during A-school during the typical 3-6 month gap before entering C-school.

**Benefits:** Extensive use of such a system will provide an individualized proficiency and readiness tracking capability. Small micro assessments (e.g., 5 minutes every day) would be a more accurate gauge of a sailor’s readiness, and remediation provided by PAL3 would maintain a sailor’s proficiency at the highest levels and provide guidance on when refresher training is actually required based on objective evidence of skill decay. The current transition path is with NETC and their ATT School, specifically targeting sailors who have the large delays between A School and C School (~6 months) and showing skill decay between that time.

**Status:** In FY17, NAWCTSD is collaborating with partners from the University of Memphis-Institute for Intelligent Systems and the University of Southern California- Institute for Creative Technologies to integrate more instructional resources within PAL3, enhance the level of interaction between the user and PAL3, and prepare for and execute a large-scale training effectiveness evaluation of the system.

**Research Products:**

- System demonstration at Pentagon (Jun 2016)
- Usability evaluations at NAVSTA Great Lakes with A-school graduates (Spiral 1: Sep 2016 and Spiral 2: planned Feb 2017)
- Training effectiveness evaluation at NAVSTA Great Lakes with A-school graduates (planned Mar 17)
**Need:** Tactical Combat Casualty Care (TC3) is, by definition, team decision making under stress. It requires interdependent squad members, performing their role-based critical tasks, to make decisions that achieve a set of common goals under extreme stress.

**Objective:** The objective of SOvM-TC3 is to develop and transition an organic capability affording Army 68W Combat Medics, Navy Corpsmen, Army/Navy/Marine Corps Combat Life Savers, and TC3 first-responders the opportunity to practice simulation-based Care Under Fire and Tactical Field Care skills in a squad-based, integrated curriculum incorporating formal instruction as well as practice in virtual and live environments.

**Benefits:** SOvM-TC3 is teaching integrated combat skills. More than building knowledge, this effort is about developing skills through application to increase mission capability. Squads get a chance to put all these skills to use in tactical scenarios, to give them hands-on experience at where, when, and how to apply the targeted skills to make themselves more tactically effective units.

The Collective TC3 training course developed within this project spans three days and includes Classroom, Virtual and Live training. TC3 providers and squad leadership receive instruction on and have opportunities to practice and apply teaming skills, medical and tactical decision making skills, and stress response skills in a series of increasingly complex and challenging virtual and live environment mission scenarios following a contiguous storyline.

**Status:** A joint research team including the Naval Air Warfare Center Training Systems Division (NAWCTSD), Army Research Laboratory (ARL), Walter Reed Army Institute of Research (WRAIR), the Fort Benning Maneuver Center of Excellence (MCoE), and Marine Corps Systems Command Program Manager for Training Systems (PM TRASYS), in an effort helmed by the Army Program
Office for Simulation, Training and Instrumentation (PEO-STRI), is conducting this study evaluating an integrated curriculum and technology enhancements in gaming and live environments to improve TC3 effectiveness for Army and Marine Corps Infantry squads through integrated training. This effort is funded by the Office of the Secretary of Defense’s Defense Health Office Joint Program Committee – 1.

Each day of the 3 to 4 day curriculum includes the integration of various training media to support individual and collective TC3 response: Classroom including presentation and video-driven interactive discussion, scenario diagnostic exercises, and hands on part task medical simulators; Virtual involving tactical and medical scenarios – Virtual Battlespace 3 (VBS3) has been augmented with TC3Sim, a game based TC3 trainer; and Live environments incorporating a wide variety of training media ranging from simulated artillery and IED blasts to interactive wall avatars interacting as opposing forces capable of inflicting and receiving casualties, as role-players, key leaders, and tactical questioning targets, and as casualties capable of incorporation into triage and TC3 scenario management. Warfighters and role-players in the live environment are also equipped with Multiple Integrated Laser Engagement System (MILES) gear augmented with electronic casualty display devices enabling TC3 responders to identify, prioritize and succeed or fail to provide appropriate treatment according to realistic timelines and prognoses. Role players were equipped with moulage and simulated injuries to increase realism. Data collection was conducted at Fort Benning at the McKenna MOUT and Clarke Simulation Centre in November 2015 and October 2016 for curriculum validation and training effectiveness evaluations, respectively.

Follow-on work in FY17 will involve a train-the-trainer transition event scheduled for December 2016 for Army Central Command at Camp Buehring, Kuwait, and targeted transition events for USMC units at Camp Lejeune in Q3 FY17.

**Research Products:**


**SYSTEMATIC TEAM ASSESSMENT OF READINESS TRAINING (START) APPLIED TO MEDICINE: MEDIC/CORPSMAN PROFICIENCY MODEL (MED-PM)**

**Start:** Oct 16  **End:** Sep 17

**Need:** The modern battlefield and advancements in technology have changed the performance of combat casualty care. Training programs/initiatives such as Tactical Combat Casualty Care (TCCC) have made a tremendous difference in preparing medics/corpsmen and combat lifesavers to save lives on the battlefield. However, conflict exists regarding the use of animal simulation in training combat medicine. Increasing pressure from advocacy groups to eliminate live tissue training practices gives rise to the need for modeling and analysis methods to examine the impact of alternative training approaches on medical skills development and to allow acquisition and training stakeholders to predict the impact of changes to a training media, course or curriculum on proficiency acquisition and maintenance over time.

**Objective:** Develop a model of proficiency attainment within the combat medic and corpsmen domains that supports decision making regarding media selection as well as provides additional decision support regarding the scheduling of training to minimize skill decay and maximize proficiency. The Med-PM model will consider not only the impact of the media on skill development, but also elements of the larger training system trade space including practice time, instructional quality and the readiness of trainees to learn from the given exposure. The following research questions will be explored: the following questions: 1) How should media selections be made given an analysis of a training continuum versus a single course within the training continuum; and 2) How do media selections depend on the proficiency of the trainee?

**Benefits:** The Med-PM will provide decision makers with a tool to support training media evaluation and selection, as well as evaluation of strategies for optimizing the training continuum. Optimization “what ifs”, for example, could include:

- When and/or where in the training continuum can media and instructional interventions have the greatest impact on developing, enhancing and maintaining proficiency?
- At what point in the training continuum would a high value training asset be most advantageous to insert?
- At what point in the training continuum is skill decay an issue and what interventions could mitigate the impact of skill decay?

**Status:** This is an FY17 new start.

**Research Products:** The planned research products are: 1) Conceptual Medic/Corpsman proficiency framework vetted by SMEs, 2) Prototype Med-PM model and 3) Case study report with lessons learned and recommendations for model refinement.
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.

NAWCTSD was approved for two investment projects that ended in FY16, with more on the horizon. The two projects were (1) an interoperability toolset for automating test compliance with the Navy Continuous Training Environment and (2) an Unmanned Systems – Training Experimentation & Simulation (US-TES) Laboratory. 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.
INTEROPERABILITY TOOL SUITE

Start: Oct 13    End: Sep 16

**Need:** NAWCTSD requires the capability to fully test training systems interoperability requirements during Developmental Test (DT), Operational Test (OT), and Fleet Synthetic Training (FST).

**Objective:** Develop an automated software product to test training system interoperability interfaces. Combine existing individual tools into a single application that uses a plug-in based architecture. Provide toolset to the training system developer and deploy to nine In-Service engineering sites to test and verify new and modified aviation training systems.

**Benefits:** Automated testing will prevent loss of training due to inability to test all interoperability requirements. This shortens the testing and integration time needed for distributed training events. Federation Object Model (FOM) agnostic application allows migration between different FOM versions without the need to rewrite High Level Architecture (HLA) interfaces.

**Status:** Federation Agreements Compliance Test Tool (FACTT) Suite version 1.0 was released in 1Q FY-16 and version 1.1.0 will be released at the end of 4Q FY-16. FACTT Suite 2.0 is schedule for release in FY-17.

**Research Products:** Interoperable interface software product (Oct 16)

UNMANNED SYSTEMS – TRAINING EXPERIMENTATION & SIMULATION (US-TES) LABORATORY

Start: Oct 15    End: Sep 17

**Need:** NAWCTSD lacks the common UAS architecture to support current and future UxS/UAS Training Systems RDT&E. Currently personnel have to schedule time, travel and perform tasks on contractor and/or operational equipment to perform RDT&E for training. Due to travel costs, criticality of equipment in use, and an overall lack of familiarity with products many trips are sometimes required and in many cases the RDT&E tasks cannot be completed.

**Objective:** Provide a RDT&E lab for Human Systems and Training System Solutions in support of UxS/UAS environments. Support NAWCTSD users by providing the needed UxS/UAS hardware and software in a re-usable lab environment to help reduce cost, scheduling and technical risk.

**Benefits:** Cost, Scheduling and Technical risk associated with training emerging UxS/UAS technology can be reduced by having in-house equipment for NAWCTSD personnel to perform RDT&E on. NAWCTSD users can perform tasks that previously required travel in house reducing travel costs, increasing fidelity and providing a safe place for experimentation in place of operational equipment usage.

**Status:** The US-TES lab has procured all the necessary hardware and software to run four re-configurable UAS control stations. Currently the control stations are setup to duplicate the existing MQ-25 System Test Integration Lab (STIL) located in PAX River and has working integrated versions of the PMA-281 Common Control Station (CCS) software and PMA-281 Joint Mission Planning System (JMPS). Near term plans include upgrading the physical space to accommodate more HVAC, incorporating operational versions of the TI-16 for MQ-25 Mission Systems Trainer interlock research, performing test and evaluation on MQ-25 models and creating a secure US-TES lab space for secure research.

**Research Product:** MQ-25 Training Systems and variant CCS Product line.
NAWCTSD supports Department of Defense (DoD) and Navy Science, Technology, Engineering and Mathematics (STEM) goals and priorities. Through Command and ONR funding support, the Program 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 STEM Program, 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 the National Defense Education Program/ONR-supported STEM initiatives commenced in late 2009, however, NAWCTSD has had a 25-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, the Central Florida STEM Education Council (CFSEC) and its members the Florida High Tech Corridor Council’s techPATH, the Orlando Science Center, and the U.S. Naval Academy.

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

Educational Partnership Agreements (EPAs)
- Seminole County
  - Milwee Middle School
  - Sanford Middle School
  - Hagerty High School
  - Lyman High School
- Orange County
  - Deerwood Elementary School
  - Blankner School
  - University High School
- Brevard County
  - Merritt Island High School
  - Cocoa High School

Primary Schools
Secondary Schools
Undergrad College Programs
Initial Full Time Employment
Continuing Education

Naval Post Graduate School
MS in Systems Engineering Certificate in Systems Eng
MS in Human System Integration Certificate in Human System Integration

Engineer & Scientist Dev. Program (ESDP) & Rotations

Pathways Internships (Student Development)

Scientific, Mathematics & Research for Transformation (SMART) Scholarship for Service Program

DoD High Performance Computing Modernization Program (HPCMP) Joint Educational Opportunities for Minorities (JEOM) Internships

Central Florida STEM Education Council
Florida High Tech Corridor/techPATH
National Center for Simulation
UCF Institute for Simulation and Training

STEM Outreach Activities
Orange, Seminole & Brevard County
Middle & High Schools

*SEAP (High School)/ NREIP (College Undergraduate & Graduate Students)

*Navy Acquisition Intern Program/Navy Abbreviated Acquisition Program
*Student Experiential Apprentice Program/Navy Research Enterprise Internship Program
TEACHERS AND SCIENTIST & ENGINEER (S&E) PARTNERSHIPS

➢ **SeaPerch**
NAWCTSD has 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 FY16, 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 has provided five aerospace engineer mentors and provides lab tours and material funding.

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.

➢ **Blankner 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 20 students shadowed NAWCTSD employees, had lunch with job shadow partners and attended 2 modeling and simulation demonstrations.
FIRST Robotics Teams

In the school year 2015-2016, NAWCTSD S&Es continued to mentor 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. Additionally, a NAWCTSD engineer mentors the University of Central Florida (UCF) Robotics Club. 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. Students from the local area high schools, the University of Central Florida and other universities were mentored by NAWCTSD S&Es this past summer.
COMMUNITY/SPECIAL STEM EVENTS

➢ **Science Olympiads**

Science Olympiad competitions are like academic track meets. 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 2016, NAWCTSD S&Es assisted with several events at the Florida State Science Olympiad and the Elementary Science Olympiads in previous years.

➢ **Summer Camps**

In the Summer of 2016, NAWCTSD hosted several summer camp groups. One 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, one FRC team – 12 Volt Bolt and a UCF Camp Connect group toured NAWCTSD. Approximately 82 students were treated to demonstrations of simulators and discussions involving engineering, science and aviation careers.

➢ **Scientist For A Day**

For the 2016 Bring Your Kid(s) To Work Day, NAWCTSD hosted a Scientist For A Day event. Kids and parents alike experienced various lab stations where they learned science hands on. Stations included lessons like the science and mechanics behind robotics where the kids learned the function of ligaments and muscles, how robots are used in military medical training, and how opposites repel each other while making a colorful keepsake of their experiment. Another station taught them about surface tension by making a paper clip float. A favorite station by all in attendance was the one where you had to make a potato float using various materials made available. The future scientists/engineers were delightfully able to launch their marshmallows farther than some of our engineers’.
## 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

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<tr>
<th>TITLE</th>
<th>NAE STOs</th>
<th>4.6 R&amp;T Focus Area</th>
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<td>NWP STO-1</td>
<td>Training &amp; Education.</td>
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### SCIENCE & TECHNOLOGY

#### Discovery and Invention Research

| Basic Electricity and Electronics Tutorial Learning Environment – Human Computers and Speech (BEETLE HSC) | ✔️ ✔️ |   | ✔️ | ✔️ |

#### In-House Laboratory Independent Research Projects

<p>| Construct Correspondence of Physiological and Subjective Measures of Hypoxia | ✔️ ✔️ |   | ✔️ |   |
| Impact of Low-Cost Haptic Feedback on User Performance and Workload | ✔️ ✔️ |   |   | ✔️ |
| Measuring Intuition and its Relationship to Somatic Markers and Individual Differences | ✔️ ✔️ |   | ✔️ |   |</p>
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**Naval Innovative Science and Engineering**

**Basic and Applied Research**

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<td>Investigating Low-cost Untethered Virtual Reality Technologies And The Role of Affordances On Training Effectiveness In An Immersive Environment</td>
<td>✓ ✓</td>
<td>✓</td>
<td></td>
<td>✓ ✓</td>
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<tr>
<td>Maintainer – Proficiency Model (Main-PM)</td>
<td>✓ ✓</td>
<td></td>
<td></td>
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<tr>
<td>The Efficacy of Feedback Parameters in Adaptive Training Systems</td>
<td>✓ ✓</td>
<td></td>
<td></td>
<td>✓ ✓</td>
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<tr>
<td>Virtual Environment Motion Fidelity Model</td>
<td>✓ ✓</td>
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## TITLE

### NAE STOs

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<tr>
<th>NWP STO-1: Training &amp; Education.</th>
<th>NWP STO-2: Human Systems, Design &amp; Decision Support</th>
<th>ID STO-1: Command &amp; Control</th>
<th>4.6 R&amp;T Focus Area</th>
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<tbody>
<tr>
<td>HP Model &amp; Assessment</td>
<td>Human Systems, Design &amp; Decision Support</td>
<td>Virtual Environments &amp; Training Technologies</td>
<td>Dist. LVC Synthetic Training</td>
</tr>
</tbody>
</table>

#### Workforce Development: Strategic Growth

- **Deploying 3D Game Engine Training Content on a Web Based Learning Management System**
  - ✔️ ✔️
  - ✔️
  - ✔️ ✔️ ✔️

- **Fusing High Dimensional Data Sources (FHDDS)**
  - ✔️ ✔️

- **Research Exploring Multi Operator Training Environments (REMOTE)**
  - ✔️ ✔️

#### Transition

- **Augmented Training for Experiential Learning For Landing Signal Officers**
  - ✔️ ✔️ ✔️

- **Basic Electronics and Electricity Learning Environment (Beetle) II 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 (PATTER2NS)**
  - ✔️ ✔️

- **System Evaluation for Training and Test Tool (SETT)**
  - ✔️ ✔️

- **Unmanned Aerial System Common Control Station Prototype-based Training Research**
  - ✔️ ✔️
<table>
<thead>
<tr>
<th>TITLE</th>
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<th>4.6 R&amp;T Focus Area</th>
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**TRANSITION RESEARCH**

**Air Warfare Training Development (AWTD) Program**

<table>
<thead>
<tr>
<th>Performance Measurement (PM) Engine</th>
<th>✓ ✓</th>
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<td>Post Mission Assessment for Tactical Training &amp; Trend Analysis (PMATT-TA)</td>
<td>✓ ✓</td>
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**SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM & SMALL BUSINESS TECHNOLOGY TRANSITION RESEARCH (STTR)**

**SBIR Phase I Projects**

<table>
<thead>
<tr>
<th>Title</th>
<th>NWP STO-1</th>
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<tbody>
<tr>
<td>Adaptive Training For Maintaining Attention During UAS Operations [N162-090]</td>
<td>✓ ✓</td>
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<tr>
<td>Immersive Parachute Descent Procedure, Malfunction and Decision-Making Training System [N161-007]</td>
<td>✓ ✓</td>
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<td>Methods for Actionable Measures of Absolute Cognitive Workload [N16A-T002]</td>
<td>✓ ✓</td>
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**SBIR Phase II Projects**

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<tr>
<td>Crew Role-player Enabled by Automated Technology Enhancements (CREATE) [N142-090]</td>
<td>✓ ✓</td>
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<td>Decoupled Rendering Channels to Reduce Logistical Support Spares Requirements of Large Scale Training Centers [N131-018]</td>
<td>✓ ✓</td>
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<tr>
<td>Distributed Synthetic Environment</td>
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<tr>
<td>correlation assessment [N141-006]</td>
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<td>Effective Measures of training display system performance [N142-104]</td>
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<tr>
<td>Hyper-Elevation Modeling of Terrain, Topography &amp; Urban Environments</td>
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<tr>
<td>[N091-026]</td>
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<td>Innovative Collimated Displays (N121-041)</td>
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<td>Mask-on Hypoxia Training Device [132-093]</td>
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<td>TECHNOLOGY TRANSFER</td>
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<td>Modular Advanced Technologies Marksmanship Proficiency</td>
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<tr>
<td>Scenario Planning and Effects Control System (SPECS) and After-Action</td>
<td>✓ ✓</td>
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<tr>
<td>Review Technology</td>
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<tr>
<td>OTHER NAVY, DOD AND JOINT PROJECTS/PROGRAMS</td>
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<tr>
<td>Distributed Training Network Guard (DTNG)</td>
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<td>Hoist Electrical Discharge Solution</td>
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<td>Medical Training Validation 2 (MTV2)</td>
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<td>NWP STO-1 Training &amp; Education.</td>
<td>ID STO-1 Command &amp; Control</td>
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<tr>
<td>Network Effects Emulation System (NE2S)</td>
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<tr>
<td>Personal Assistant for Life Long Learning</td>
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<tr>
<td>Squad Overmatch – Tactical Combat Casualty Care</td>
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<tr>
<td>Systematic Team Assessment of Readiness Training (START) Applied to Medicine: Medic/Corpsman Proficiency Model (MED-PM)</td>
<td>✓ ✓</td>
<td>✓ ✓</td>
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<tr>
<td><strong>CAPITAL IMPROVEMENT PROGRAM</strong></td>
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<tr>
<td>Interoperability Tool</td>
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<tr>
<td>Unmanned Systems – Training Experimentation &amp; Simulation (US-TES) Laboratory</td>
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<td>✓ ✓</td>
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<tr>
<td>LAB</td>
<td>MISSION</td>
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</tr>
<tr>
<td>Anti-Submarine Warfare Center of Excellence (ACE) Lab</td>
<td>Develop Anti-Submarine Warfare Training Prototypes for the warfighter.</td>
<td></td>
</tr>
<tr>
<td>Acoustic Training &amp; Simulation Lab (ATaS)</td>
<td>Provide current sensor and acoustic data used in modeling and simulation across Navy Anti-Submarine Warfare training devices.</td>
<td></td>
</tr>
<tr>
<td>Concept Development &amp; Integration Lab (CDIL)</td>
<td>Research and prototype development of interoperable live, virtual and constructive training devices and technologies, and provide smart buyer awareness to training system acquisition programs.</td>
<td></td>
</tr>
<tr>
<td>Human Engineering Performance (HEP) Lab</td>
<td><strong>Simulation &amp; Training Research to Improve Knowledge &amp; Effectiveness (STRIKE) Lab:</strong> 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.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Multi-Integrated Systems and Teams (MIST):</strong> Conduct science &amp; technology research &amp; development, &amp; acquisition activities through analysis, design, development, test, usability evaluation &amp; transition of state-of-the-art products that enhance the training &amp; operational capabilities of the nation’s warfighters</td>
<td></td>
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<tr>
<td></td>
<td><strong>Basic &amp; Applied Training &amp; Technologies for Learning &amp; Evaluation (BATTLE):</strong> Conduct cognitive science, behavioral research, &amp; training evaluations to improve training &amp; human performance in a variety of learning environments. Capabilities include: Instructional Strategies research, Advanced Training/Instructional Technology R&amp;D</td>
<td></td>
</tr>
<tr>
<td>Interoperability, Engineering &amp; Application (IDEA) Lab</td>
<td>Provide simulation interoperability tools and technical expertise in support of joint, live, virtual, constructive programs and related research, development, and acquisition efforts.</td>
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<tr>
<td></td>
<td><strong>Technology Integration Facility (TIF) (AKA Dome Room):</strong> Provide Visual Systems analysis, system integration and Command demonstrations.</td>
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<tr>
<td>LAB</td>
<td>MISSION</td>
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</tr>
<tr>
<td>Multipurpose Reconfigurable Training System 3D®</td>
<td>Design, integration, and lifecycle support of the MRTS 3D® classroom and MRTS 3D laboratory and their associated software applications; including: maintaining software baseline repositories and testing MRTS 3D products. Fielded MRTS 3D products include simulations for VIRGINIA Torpedo Room, VIRGINIA Emergency Diesel Generator, and Mobile Electric Power Plant (MEPP). Numerous additional products are in development. The lab also provides lifecycle support for the Integrated Undersea Surveillance System (IUSS) TL-29 and ICP synthetic acoustic analysis trainers, as well as legacy MRTS products such as the Submarine Communications Support System (SCSS) Trainer, Common Submarine Radio Room (CSRR) Trainer, Weapons Launch Council Team Trainer (WLCTT), and AN/BLQ-10 Maintenance Trainer.</td>
<td></td>
</tr>
<tr>
<td>Navigation Lab (NavLab)</td>
<td>Provide software development, integration, test and post deployment support of Submarine Piloting and Navigation training systems including training devices Submarine Piloting &amp; Navigation (21B71), Reconfigurable Submarine Piloting &amp; Navigation (21B71A) and Virtual Environment for Submarine Shiphandling (21H35).</td>
<td></td>
</tr>
<tr>
<td>The Rapid Design, Development, and Fabrication Lab (RD2F)</td>
<td>Provide rapid response ‘Speed to Fleet’ and research and development capabilities for advanced concept demonstration and prototyping, customization, and low rate production of advanced training technologies. Utilizes cutting edge technologies including 3D immersive and game engines, virtual and mixed reality, speech recognition, adaptive training, automated machining, and additive manufacturing to create innovative training products, reduce acquisition program risk, extend legacy system life-cycles, and further the science of learning.</td>
<td></td>
</tr>
<tr>
<td>Submarine Research Application Team (SubRAT)</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Trident Training System (TTS) Lab</td>
<td>Provide primary simulation and training support to the Trident Ballistic Missile Submarine force. Also provide simulation and training support for other UNDERSEA assets.</td>
<td></td>
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<tr>
<td>Virtual Technology Development Operations Center (VTDOC)</td>
<td>Provide technology development and operations center for distributed simulation and training exercises.</td>
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</table>