

NAVAL AIR WARFARE CENTER TRAINING SYSTEMS DIVISION



2021

RESEARCH

COMPENDIUM

Training • Human Performance • Modeling & Simulation



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NAWCTSD

Research Mission

- Plan and perform a full range of **research and development**, in support of **Naval training systems** for **all warfare areas** and **platforms**
- Continue to expand the **Naval technology base**
- **Transition results** to the **Fleet** and other customers

RESEARCH COMPENDIUM

2021 EDITION

NAVAL AIR WARFARE CENTER TRAINING SYSTEMS DIVISION



The Naval Air Warfare Center Training Systems Division (Photo Credit: Doug Schaub)

Training • Human Performance • Modeling & Simulation

Research & Development to Enable Fleet Success



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A Message from Our NAWCTSD Leaders: Science & Technology to Enable Fleet Success



Captain Tim Hill USN
Commanding Officer



John Meyers
Executive Director

At NAWCTSD, we conduct research to understand and **improve individual, team, and multi-team learning** and performance. We develop education, training methods, and tools to **reduce training time and maximize transfer of knowledge**, utilizing emerging findings in the **Science of Learning** to enable Fleet success.

OUR MISSION

To be the principal Navy center for research, development, test and evaluation, acquisition and product support of training systems, to provide Inter-service coordination and training systems support for the Army, Marine Corps and Air Force, and to perform such other functions and tasks as directed by higher authority.

Near-term Fleet Science & Technology focus areas includes: distributed, Live, Virtual and Constructive (LVC) training; adaptive training; human performance modeling; measurement & assessment; virtual reality and augmented reality training technologies; cyberwarfare and electronic maneuver warfare training; and, rapid prototyping of training technologies.

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 and creativity, and we encourage our people to challenge basic assumptions. We are open to reinventing ourselves based on new knowledge and understanding. To do this, we work to consistently seek Fleet input and feedback on our projects.

Our ultimate goal is that our training solution innovations are transitioned to the Fleet as quickly as possible to improve warfighter readiness. As part of this process, we lean forward to deliver Fleet prototypes for selected projects that show the greatest promise for transition and Fleet impact.

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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.

OUR VISION:

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:

Partnering with and leveraging work at universities, industry, and other government laboratories, to provide advanced technologies that transition into operational use

Our research focus areas align to our CORE CAPABILITIES:

1. Human Systems Engineering, Integration, and Acquisition
2. Optimized Human Performance and Decision Support
3. Advanced Training Systems Technology
4. Human Systems Analysis, Design, and Evaluation

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.

NAWCTSD's research mission 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.



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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). 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 (STO) 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.

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

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.

The Workforce Development category of projects is intended more explicitly to build the capability of Naval labs through personnel training and laboratory capability development.

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.



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Small Business Research Program Manager

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.

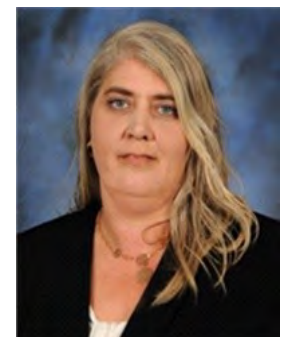
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The Small Business Innovation Research (SBIR) & Small Business Technology Transition Research (STTR) programs differ only in the fact that small companies perform exploratory R&D in partnership with universities and larger nonprofit research institutions 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.

Technology Transfer Program Manager

The **NAWCTSD Technology Transfer Program** operates under the Federal Technology Transfer Act, related laws, executive orders, directives and guidance. The anticipated benefits of sharing the results of Navy 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.



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Human Research Protection Program Chair

The **Human Research Protection Program (HRPP)** implements NAWCTSD's policies and procedures to protect human subjects involved in research conducted by, for, or through NAWCTSD. Our Institutional Review Board (IRB) was established in 2000 and has the responsibility to protect the rights and welfare of human subjects at potential risk in research projects. NAWCTSD maintains a DoD-Navy Assurance to conduct research.

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An aerial photograph of a research team of eleven people standing in a circle on a dark, wet, metallic surface, likely the deck of a ship. The team members are wearing various colored protective suits: yellow, white, blue, green, red, and black. Each person is wearing a helmet and some have their hands near their faces, possibly adjusting equipment or taking a break. The text "RESEARCH PROJECT SUMMARIES" is overlaid in the center of the image in a large, white, sans-serif font. The surface has several circular drains visible.

RESEARCH PROJECT SUMMARIES

CORE CAPABILITY 1: HUMAN SYSTEMS ENGINEERING, INTEGRATION, AND ACQUISITION



The successful acquisition of training and crew system solutions is highly dependent upon the tailored application of Human Factors, Systems Engineering, and Human Systems Integration (HSI) strategies and processes throughout the acquisition life-cycle. The Department of Defense's (DoD) acquisition policy goal is to optimize total system performance while minimizing the cost of ownership through the development and acquisition management by applying HSI elements to acquisition systems.

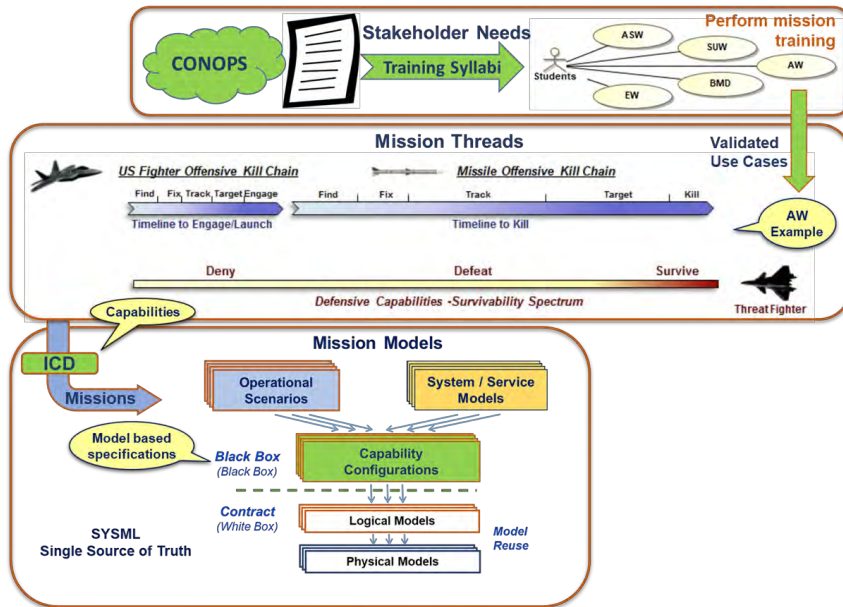
HSI establishes the technical framework for delivering crew and training system capabilities to the warfighter. It ensures the effective development and delivery of capabilities through the implementation of a balanced approach with respect to cost, schedule, performance, and risk using integrated, disciplined, and consistent systems engineering activities and processes throughout the acquisition life-cycle to guide knowledge-based product development that demonstrates high levels of performance, protection, and sustainment before significant commitments are made.

The following Technology area comprises this Core Capability: Research, Design and Development of Integrated Human System products.

MISSION MODEL ARCHITECTURE FOR AIR WARFARE (WFDSG-21-027)

OBJECTIVE

To explore repeatable practices for modeling missions using SysML and a systems-of-systems architecture.



PROJECT DURATION
OCT 2020 - SEPT 2022

SPONSOR
Naval Air Warfare Center Aircraft
Division (NAWCAD) | NISE: WFD-SG

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DESCRIPTION

Using an established SysML methodology, the DoD Architecture Framework (DoDAF), and sample missions, this strategic growth effort will develop a repeatable set of practices for applying Model Based Systems Engineering (MBSE) to model missions. The effort will go through the steps necessary for modeling an example mission -- capabilities based assessment, data models, black box operations, white box functions, and finishing with an analysis that results in a logical architecture. The relevant viewpoints will be created, to include the CV, OV, SV, SvcV viewpoints, and the range of data model views - DIV's 1, 2, & 3.

NEED

NAVAIR is going through a transformation from using documents that describe systems, to models that document

systems. Having a generic set of practices for developing a hierarchical architecture for modeling missions would accelerate NAVAIR's modeling maturity at a time when it is needed most.

BENEFITS

With NAVAIR's emphasis on Model Based Systems Engineering (MBSE) for acquisition, having a mission model template based on the Department of Defense Architecture Framework would simplify integration and reuse not only across NAVAIR, but across SYSCOMS and possibly the other services.

STATUS

This is an FY21 new start. Enterprise frameworks and industry model methodologies were researched to outline repeatable practices for mission modeling.

MILESTONES

- ◆ FY21: A hierarchical systems-of-systems structural model created with uses cases. Generic mission operations demonstrated.
- ◆ FY22: Generic Strike and Maritime mission behavioral models developed. Mission model template established.

MULTI-INTEGRATED DOMAIN ADMINISTRATIVE SUPPORT SOLUTION (N182-104)

OBJECTIVE

Design and develop a cross-domain solution (CDS) technology that allows a centrally located system administrator to disseminate network configuration information to multiple associated networks.



The Department of Defense effort to enhance and combine its computer networks to improve capability and reliability

PROJECT DURATION

SEP 2018 - JAN 2021

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)

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DESCRIPTION

One of the core security features of distinct information networks is that they are separate from other computer networks. This is primarily implemented to ensure that if one is compromised, the other remains unaffected as access to the network is limited and restricted by an administrator. This effort focuses on designing, developing, and demonstrating the feasibility of a proof-of-concept cross-domain administrative solution and network communication between trusted and untrusted networks.

NEED

Although the cyber security benefits of individual networks are clear, there is a desire for a secure CDS to allow a central system administrator to manage multiple networks. Cross-domain solutions provide the ability to transfer information between two domains with different security levels that are isolated from each other. Currently, each network administrator must set up separate instances for their own respective domains, which poses software-related concurrency challenges. The desired solution is envisioned as a standalone solution, or a technology that can be added to an

existing cross-domain solution for network communication between trusted and untrusted networks. Key factors of an envisioned solution include the scalability of architecture and the supportability of the device.

BENEFITS

Having the ability to manage all domains with a single cyber security solution (through a specialized guard) would significantly lessen both the initial acquisition and sustainment costs of any procurement that had the requirement for multiple classification levels, or design solution tradeoffs of comparative technologies.

STATUS

NAWCTSD personnel conducted an evaluation of the Phase 1 effort at the end of November in 2018. The cross-code project team determined that the contractor should be awarded the Phase 1 option period, and be invited to submit a full Phase 2 proposal for additional work. The Phase 2 effort is underway in which the contractor and Navy are working close together to modify and implement CDS solutions deemed feasible from Phase 1 work.

MILESTONES

- ◆ **Phase I:**
 - ◇ A single contractor was selected for Phase 1 award
 - ◇ Cross-code project team comprising research psychologists and interoperability engineers monitoring was completed via bi-monthly progress reports and periodic status updates
 - ◇ A closeout meeting was held in late November of 2018 at NAWCTSD in Orlando and a Phase I option was awarded
- ◆ **Phase II:**
 - ◇ The contractor is currently working on the Phase 2 effort
 - ◇ Implemented prototype CDS solutions expected by the end of the Phase II (Jan 21)

NEXT GENERATION TRAINING SYSTEMS DEVELOPMENT FOR MANNED & UNMANNED CONCEPTS (WFD-SG-18-049)

OBJECTIVE

Develop workforce skills in individual & team level training concepts that apply to future concepts for manned-unmanned team training environments including implementation of artificial intelligence, development of trust in automation in training & applications for data science for performance assessment/effectiveness analyses.

PROJECT DURATION
AUG 2018 - SEP 2020

SPONSORS

Naval Air Warfare Center
Aircraft Division
(NAWCAD) | NISE: WFD

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The JMR-TD is demonstrating platform and mission systems technologies to help the Army make decisions about FVL capabilities, which could look like this hypothetical rendering. The demonstrator effort is managed jointly by a team led by the U.S. Army Aviation and Missile Research, Development and Engineering Center (AMRDEC). (U.S. Army graphic by AMRDEC VizLab)



DESCRIPTION

This effort seeks to develop workforce skills in individual & team level training concepts that apply to future concepts for manned-unmanned team training environments including implementation of artificial intelligence, development of trust in automation in training, & applications for data science for performance assessment/effectiveness analyses. Additionally, the team is refining a methodology to identify the transitional Knowledge, Skills & Abilities (KSAs) that will impact the selection of training technologies for future training solutions.

NEED

As the Navy adopts novel aviation platforms such as Future Vertical Lift, which strives to maximize automation and manned-unmanned teaming solutions, there is a need to address training strategies and technologies required for training. Specifically, expanding on existing instructional strategies, modalities, and training technologies to advance individual and team training will be necessary to address the emerging needs of future concepts for manned-unmanned team training environments.

BENEFITS

Through the early involvement of instructional system designers and research psychologists, this effort seeks to identify capability and

technology gaps that can be pursued via science and technology development efforts ahead of platform fielding. Further, the team is defining a methodology for early identification (pre-milestone A) of training requirements for human machine performance issues introduced by increase automation and advanced technologies.

STATUS

Quarterly joint working group meetings supported discussions with stakeholders including Army and Air Force, focusing on technology development and general capabilities under consideration for Manned-Unmanned Teaming solutions within the Future Vertical Lift (FVL) program. Preliminary research and development roadmap inputs including highlights for Joint service science and technology efforts that align with expected platform development and training solutions was developed.

Development of the Training Requirements for Rapidly Acquired and Complex Systems (TRRACS) methodology was conducted and leveraged for Army FVL analyses focused on the CH-53K and V-22. Army funding in FY21 will continue early training solution planning through media and fidelity analyses.

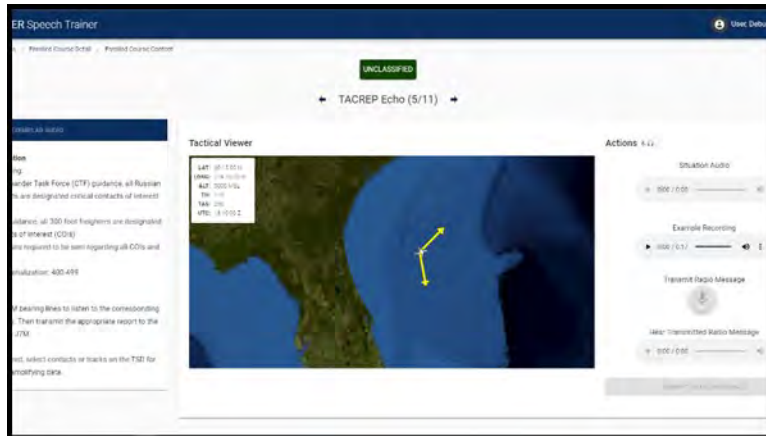
MILESTONES

- ◆ Conducted four (4) conference presentations on implications of trust, early training analyses methods and findings, and relevant training technologies
- ◆ Supported quarterly joint working group discussions and coordinated training working integrated product team meetings
- ◆ Developed multiple government and technical reports on training system analysis methods and findings from CH-53K and V-22 for pilot, aircrew, and maintainers
- ◆ Workforce development included mentoring of junior teammates on future Navy platforms, training systems needs analysis, advanced science and technology solutions for training, and method development for initial front end analysis when pre-Milestone A; early level employee rotation supported under effort, as well as training course attendance on rotary wing airframes
- ◆ Planned Transitions (FY21): Product transitions to Naval Air Warfare Center / Fleet Readiness Center Strategic S&T roadmap; Initial individual & team training concepts as input to program office training planning & capability development documents (CDD)

RADIO OPERATIONS GUIDANCE AND EDUCATION RESOURCE (ROGER) TEST & EVALUATION (219RPC-21-009)

OBJECTIVE

Facilitate ROGER development and transition efforts by conducting fleet experimentation and demonstrations to include: human factors analysis, usability analyses, and training effectiveness evaluations. Results from formal analyses will inform future acquisition on the benefits of the technology to quantify return on investment for transition.



ROGER Prototype User Interface, Showcasing Intermediate Course Concept

PROJECT DURATION
OCT 2020 - SEPT 2022

SPONSOR

Naval Air Warfare Center Aircraft Division
(NAWCAD) | NISE: RPC

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DESCRIPTION

ROGER is a web-based radio communications trainer for the Maritime Community. Throughout this effort a series of fleet demonstration and experimentation events will be conducted on the ROGER prototype to evaluate the training capability. The initial prototype exists on stand-alone laptops for demonstration and experimentation with the Maritime Patrol and Reconnaissance Aircraft (MPRA) community. Fleet users will have the opportunity for hands-on demonstration, and a time to provide feedback to the team for further iterations of the system. The results of experimentation will provide human factors and training effectiveness data to inform the system design and identify capability improvement areas. Further, the team will work with the end user community to develop concept of operations and pre-training needs for define how to successfully implement with the program of records course of instruction.

NEED

The Maritime Patrol and Reconnaissance Aircraft (MPRA) community has no existing curriculum or dedicated training capabilities for training radio communications, and as such as

cited a need for radio communications training. The primary fleet impact of this effort is to provide quantitative data to the acquisition program of record on the benefits of the technology to closing skill gaps associated with multi-domain and joint communication via a designated radio communication-based training system.

BENEFITS

Testing will focus on reliability of component technologies, as well as the effectiveness of the ROGER training solution to provide an instructor-in-the-loop and/or instructorless training system that students can interact with to learn how, when, and why to perform certain tactical radio calls. Through quantitative analysis of the effectiveness of the technology, arguments can be formulated to execute an accelerated acquisition to deliver this emerging technology to the fleet.

STATUS

This is an FY21 new start effort. Institutional Review Board (IRB) package initiated OCT 2020

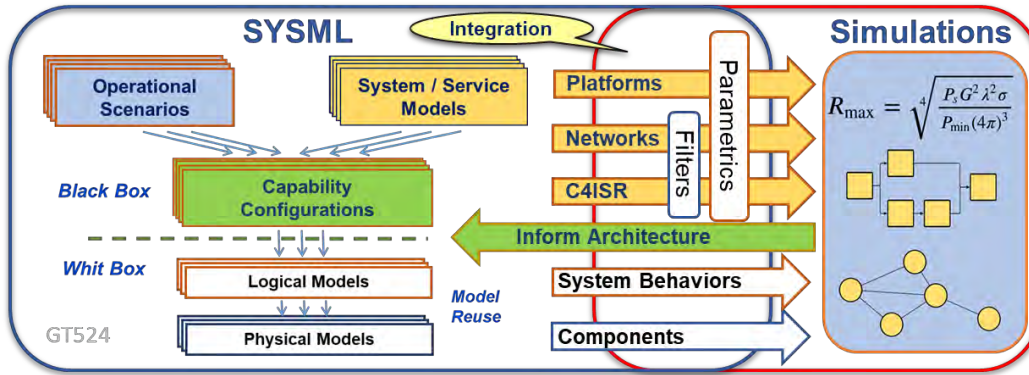
MILESTONES

- ◆ Year 1: IRB approval, Human Factors analysis of system
- ◆ Year 2: Usability and effectiveness study results and documentation and Concept of Operations documentation

SIMULATION WITHIN SYSML FOR TRAINING SYSTEMS (TR-21-027)

OBJECTIVE

To develop design patterns and document practices for integrating simulation within SysML (TR-21-027).



PROJECT DURATION
OCT 2020 - SEPT 2021

SPONSOR

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: WFD-TRG

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DESCRIPTION

There are several sources for learning SysML available to NAWCTSD employees, each having its own focus area. This effort unifies learned concepts and focuses them in areas that would expand NAWCTSD's capability to apply SysML in a consistent and reusable manner for simulating systems. The training for this effort complements what has already been taught and comes directly from the suppliers of the tools NAVAIR is already using. The intention is to channel several disparate model-based training efforts into focused model-based practices for the purpose of accelerating the transition to SysML. The training consists of focused training classes which will be used as a basis to develop an approach for integrating simulation within SysML.

NEED

There is a growing demand across several programs for capable modelers that can integrate simulation. This effort will accelerate the development of skilled employees to meet the demand.

BENEFITS

Supplements NAVAIR SET SysML courses with a focus on developing modeling practices specific for training systems.

STATUS

Three courses identified to meet requirements:

SysML by NoMagic: The SysML Frameworks, Architectures, Methodologies, & Practices course offered onsite will teach SysML in the SE lifecycle order using MagicGrid within a 3 day lecture. It includes a hands-on practical exercise after each module.

Simulation by NoMagic: The Simulation of System Behavior 3-day course offered onsite teaches the fundamentals of using the Simulation Toolkit to execute Parametric Diagrams, behavior diagrams and system models using SysML and Executable UML. It includes lectures, hands-on practical exercises and best practices using Cameo Simulation Toolkit.

Simulink by MathWorks: The Simulink for System and Algorithm Modeling 2-day course offered online demonstrates how to apply basic modeling techniques and tools to develop Simulink block diagrams. Topics include: Creating and modifying Simulink models and simulating system dynamics; Modeling continuous-time, discrete-time, and hybrid systems; Modifying solver settings for simulation accuracy and speed; Building hierarchy into a Simulink model; Creating reusable model components using subsystems, libraries, and model references.

MILESTONES

- ◆ 1QFY21 - Schedule courses
- ◆ 2-3QFY21 - Arrange and complete the NoMagic and Simulink Courses
- ◆ 4QFY21 - Document lessons learned

SURVEY RESEARCH TO SUPPORT THE USE OF SYNTHETIC CREWMEMBERS IN MARITIME AVIATION TRAINING

OBJECTIVE

Conduct survey research with the end user community to focus on (1) understanding trainee expectations of interacting with synthetic crewmembers, (2) understanding shifting trainee feedback needs and (3) providing recommendations for transitioning students from the current training environment to an environment that utilizes automated technologies.



P-8A student during a part-task training exercise

PROJECT DURATION

JAN 2020 - JAN 2021

SPONSOR

Naval Aviation Training Systems and Ranges Program Office, PMA-205, Air Warfare Training Development

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DESCRIPTION

Synthetic agents seek to solve a long-standing initial training challenge - how to train a single trainee in a task that requires a crew or group to complete it. Typical solutions include rotating trainees, or using contractor or instructors as role players. However, these solutions can be inefficient and/or costly to implement. With recent technological advances in speech recognition, the feasibility of incorporating synthetic role-playing into a dynamic initial training has increased.

NEED

The development and inclusion of technologies within training happens before the ramifications of augmenting technology is fully understood. There is a need to further assess the human component in a human-machine team. A long-standing challenge of utilization of new technologies is user acceptance and user training. When changing the training paradigm to include synthetic crew members, it is important to appropriately train and transition students (and instructors) from the current technologies to the newly developed ones.

BENEFITS

Intelligent, speech-activated role player agents include autonomous, interactive crewmembers that are capable of supporting and providing information to, and interacting with the Tactical Coordinator or TACCO, to support TACCO initial training within the P-8A Part Task Trainer (PTT). The results of this effort will inform best practices for utilizing synthetic agents in a training program, and student perceptions of these changing training technologies.

STATUS

In FY20, surveys were developed to distribute to both P-8A Poseidon instructors, as well as students (NFOs, AWOs, and EWOs). Data collection was completed and data analysis has begun. Preliminary results indicate some hesitation and some excitement on behalf of students and instructors regarding the use of synthetic agents. Best practices and recommendations for transitioning students to a synthetic agent training environment are being generated.

MILESTONES

- ◆ IRB approval obtained through modification of existing protocol
- ◆ Survey creation completed APR 2020
- ◆ Data collection completed SEP 2020
- ◆ Final Technical Report JAN 2021

CORE CAPABILITY 2: OPTIMIZED HUMAN PERFORMANCE AND DECISION SUPPORT



Current and future Naval systems are not only dependent on the qualities of the systems and the performance of their operators, but are also highly dependent upon the interaction between the human and the system. Failure to effectively integrate the human and the system invites mission failure. It is routinely reported that 70-80% of all aviation and other mishaps trace back to human error in some fashion.

The overwhelming majority of these errors are related to inaccurate decisions, judgments, and perceptions, attributable to inadequacies in the systems design or decision-support capabilities. The extent to which those same design and/or decision support inadequacies contribute to operational inefficiencies or outright decrements is not as clearly quantified, but is expected to be profound.

Human Performance refers to the range of perceptions, decisions, and actions that an individual or team carries out in the context of performing a task. The underlying detail in each of these actions traces back to the design of systems and the training of operators. Human Performance Assessment (HPA) focuses on the ability to accurately measure and analyze task performance at different levels which include individuals, teams, multi-teams, and organizations. HPA can be conducted across multiple domains and tasks, ranging from simple procedural skills to complex cognitive skills, such as tactical decision-making, and is an integral part of Human Performance Modeling (HPM). Measurement technologies encompass neurocognitive, as well as other physiological measures or indices. Better understanding of such measures in the context of training or operational tasks will serve both to expand this technical area and to enhance warfighter performance and effectiveness.

(Continued on next page)

CORE CAPABILITY 2: OPTIMIZED HUMAN PERFORMANCE AND DECISION SUPPORT

(Continued from previous page)

While there is already a clear adverse impact resulting from the lack of/flawed human systems design and decision support, there is also a significant concern that this will be rapidly exacerbated due to the overwhelming amount of data being collected and available in a timely fashion. For human decision-makers to be effective in these information-rich environments, “they must be able to access the data necessary to make a decision when, where and in a manner that addresses the need. The data must be integrated and organized so that they become useful information to the user” (Morrison et al., 1998, p. 375). The challenge of integrating the human and system can be parsed into four separate pieces: 1) human factors engineering—which is required for the system to be used effectively by the human operator, 2) HMIs specifically developed to supplement the human’s ability to process, infer, and decide in real time actions based on system-provided information, 3) developing the requisite training materials of modes of presentation to optimally use the information to make and implement better, faster decisions, and 4) automation to perform functions without direct human intercession.

The following Technology areas comprise this Core Capability:

- Human-Machine Interfaces
- Human Performance Measurement and Assessment
- Training Methodologies for Distributed Team Competencies
- Advanced Instructional Techniques
- Applied Human Behavior Modeling

ADAPTIVE TRAINING SYSTEM FOR MAINTAINING ATTENTION DURING UNMANNED AERIAL SYSTEMS (UAS) OPERATIONS (N162-090)

OBJECTIVE

The purpose of this effort was to develop an innovative and adaptive training system for Unmanned Aerial Systems (UAS) operators to maintain attentiveness during the long shiftwork associated with extended UAS missions. The initial call (for proposals) was made for cost-effective, computer-based, simulation training solutions that are able to adapt to the 1) learning characteristics of different individuals, 2) affordances inherent in UAS, and 3) specific details involved with different missions.



Image courtesy of TiER1 Performance Solutions, Copyright 2018. Includes U.S Navy Photo 140918-N-UZ648-008



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PROJECT DURATION

OCT 2016 - SEP 2021

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)

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DESCRIPTION

The work shifts for UAS operators can sometimes approach 12 hours in length. Such shiftwork is associated with higher fatigue levels, degraded task performance, and higher error rates. As UAS are used with increasing frequency, it becomes even more critical for UAS operators to maintain their attention for longer periods during lengthy missions. However, there are currently no training systems that focus on attention. This research aims to develop tailored adaptive training techniques to minimize the issue of channelized attention.

NEED

Channelized attention occurs when all of an individual's cognitive resources are focused on one aspect of the environment, causing other equally important cues to be missed. Investigations of UAS mishaps have implicated channelized attention as a likely contributor to mishaps with larger UAS. Thus, it is critical to provide training for UAS operators on how to maintain attention over extended periods of time.

BENEFITS

Research on attentional training has indicated that it is possible to train attention *and* create effects that transfer to tasks after training. Moreover, attentional training may be more effective if it is adaptive. Adaptive training (AT) is broadly defined as any instruction that is

tailored to an individual trainee's strengths and weaknesses, varying the training experience from one individual to another, based on task performance, aptitudes, or test scores. The goal of AT solutions is to provide the effectiveness of one-on-one tutoring through computer-based training that does not require an instructor in the loop. Thus, such training can possibly reduce the likelihood of UAS mishaps via a cost-effective method.

STATUS

The selection team approved two companies (i.e., Adaptive Immersion Technologies [AIT] and TiER1 Performance Solutions [TiER1]) to proceed to the Phase II Option period for their systems. The AIT-developed Sustained Attention Training in Unmanned & Remote Navigation (SATURN) system targets the attentional training of air vehicle operators. In contrast, Tier1's Attentional Trainer To Improve Control of Unmanned Systems (ATTICUS) focuses on sensor operators. During this period, both companies continued to make refinements to their systems. Although COVID-19 stymied much of the anticipated progress during FY20, AIT continued to make considerable progress on prototype development, including scenario definitions and implementation. Likewise, despite the pandemic, TiER1's data collection efforts are underway, to assess the validity of ATTICUS in improving the attentional skills of UAS operators.

MILESTONES

- ◆ Selected 4 companies (from >25 proposals) for the Phase I Base period.
- ◆ Selected (using gated approach) two companies to proceed with the Phase I Option, Phase II Base (abbreviated), and Phase II Option periods.
- ◆ Both companies successfully completed the SBIR Transition Program in April 2019.
- ◆ Sebok, A., Walsh, M., Wickens, C., Andre, T., Kreisler, N., Pei, L., Bowens, L., & Landsberg, C. (2019). Development of attentional skills training for operators of unmanned aerial systems. Proceedings of the Human Factors and Ergonomics Society 2019 Annual Meeting, pp. 2161 - 2165.
- ◆ Recently, Tier1 began data collection for the ATTICUS training effectiveness study, and the AIT team made significant progress in developing the mission platforms for SATURN.
- ◆ The important next step for Tier1 is to complete the study (e.g., data collection, analysis) to validate the use of ATTICUS in improving attentional skills. For SATURN, important next steps are to begin software development and commercialization efforts.

ADJUSTABLE CREWMEMBERS - ACCELERATING INSTRUCTOR MASTERY (AIM) N152-108

OBJECTIVE

This effort will design, develop, and demonstrate a suite of synthetic crew members, who operate in support of Tactical Coordinator (TACCO) training in the Anti-Submarine Warfare (ASW) domain, capable of dynamically adjusting their performance to better fit the needs of the trainee during part-task training activity.



A member of VP 5 plans radar search tactics onboard a P-8A Poseidon aircraft during a sea search and rescue operation off the coast of Argentina. (U.S. Navy photo by Mass Communications Specialist 2nd Class Sean R. Morton/Released)

PROJECT DURATION

MAR 2018 - APR 2020

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)

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DESCRIPTION

The Adjustable Crew Members effort is focused on further augmenting the baseline Crew Role-Players Enabled by Automated Technology Enhancements (CREATE) technology suite that brings advanced speech recognition and intelligent agent behavioral modeling in to the P-8A part-task training. It will enable synthetic crew members to dynamically adjust their performance to better fit the needs of the trainee and instructor during TACCO-centered part-task training activity.

NEED

The successful transition of autonomous crewmembers technology seeks to solve a long-standing training challenge - how to train a single trainee in a task that requires a crew or group to execute it. Through a software solution for autonomous crewmembers that builds on recent technological advances in speech recognition, this technology capability has the potential to reduce operator workload and facilitate more robust and realistic training of skills such as crew coordination earlier in the training pipeline. The Adjustable Crew Member effort allows instructors to better tailor the intelligent agent's domain awareness and expertise to the individual TACCO trainee.

BENEFITS

Adjustable and customizable intelligent and autonomous crew member agents will allow for more realistic and robust early TACCO training. As much of the TACCO role focuses on being the nexus of information, building communication and coordination skills early during individual training is a key motivator. By leveraging realistic crew member agents, the instructors can focus on driving the scenario and providing timely and appropriate feedback to the trainee, rather than having to role-play the various sensor roles.

STATUS

This effort was selected for Phase 2 award as an FY18 new start. FY18 effort focused on modifying three crewmember models (acoustic operator, electronic operator, co-TACCO) so that they can adjust their performance and proficiency in response to internal or external stimuli. FY19 tasking included modifying the agents to support automatic (or cued) performance degradation, as well as designing the instructor interface for these actions to be instantiated. A testbed environment was developed for experimental testing and data collection concluded in FY20. Future work is pending transition sponsor funding.

MILESTONES

◆ Phase II:

- ◆ NAVAIR awarded a Phase II contract to a single vendor based on progress made during an Office of Naval Research SBIR and maritime patrol program interest.
- ◆ Phase 2 kickoff meeting involved discussions with stakeholders including the P-8A Fleet Projects personnel, Fleet Training personnel, and members of the P-8A Innovation Council.
- ◆ FY20 tasking included modifying the agents to support automatic (or cued) performance degradation, as well as designing the instructor interface for these actions to be instantiated.
- ◆ Transition of technology is pending as initial transition path is reprioritizing immediate training systems needs based on evolving fleet needs and limited resources.

AVIATION RECONFIGURABLE COCKPIT FOR HYPOXIA & HAZARD EXPOSURE & RECOGNITION (ARCH2ER) AF090-027

OBJECTIVE

To research, develop, and testing of a reconfigurable and modular cockpits and controls for aviation pilot training that are low-cost but moderate fidelity to support immersive training devices.



Aviation survival training seeks to advance mishap awareness training through interactive, immersive visualization techniques such as moderate fidelity training systems.

PROJECT DURATION
OCT 2018 - SEP 2021

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)
Naval Undergraduate Flight Training Systems, PMA-273
Naval Air Warfare Center Aircraft Division
(NAWCAD) | NISE: WFD-SG

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DESCRIPTION

This effort seeks to evaluate the feasibility of a reconfigurable training system to provide higher fidelity emergency procedure training in aviation survival training centers, fleet synthetic or Live Virtual Constructive (LVC) training centers (configure to needed platforms for next training exercise), and deployed training sites with limited space and multiple T/M/S in the area.

NEED

As the Navy seeks to identify ways to provide low-cost, high fidelity training options with a family of training systems, novel solutions such as augmented reality are under investigation. One potential way to capitalize on the benefits of this flexible training medium for aviation training is the use of replica cockpits and controls to provide high physical fidelity during training. However, to maximize the benefit, low-cost equipment that is reconfigurable to different type/model/series (T/M/S) platforms would allow for flexibility for training multiple types of aircrews.

BENEFITS

Development of a reconfigurable cockpit training solution provides an opportunity to increase training fidelity at locations where aircrew from multiple platforms are trained while minimizing costs and footprint requirements when compared to platform specific training solutions. Additionally, by advancing the fidelity of hardware cockpits and controls, while seeking to minimize costs, this effort provides initial research into solutions that may increase the feasibility of augmented reality training.

STATUS

A Phase III contract was awarded to focus on the design and development of an initial reconfigurable cockpit, development of an intuitive instructor operator station, and the test and demonstration of resulting prototypes (SEP 2018). Early developmental prototype demonstrated (DEC 2018) with prototype systems delivered to Aviation Survival Training Centers in Pensacola, FL (JUN 2019) and Miramar, CA (JUL 2020) for evaluation and testing. Continued development continued in FY20 and FY21, to include integration of research capabilities (e.g., eye tracking, speech analysis).

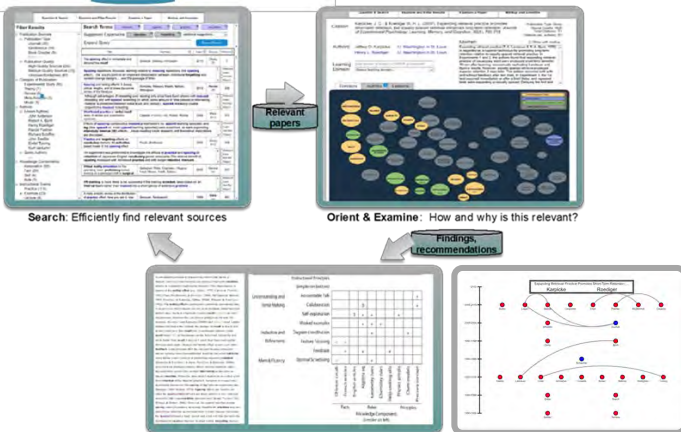
MILESTONES

- ◆ **Workforce Development:** Mentored junior teammates on program management and contract package development
- ◆ **Presentations:** Demonstration exhibit at IITSEC (DEC 2018); presentation focused on advanced training capability at the annual SAFE Symposium (OCT 2019)
- ◆ **Transitions:**
 - ◇ Three prototypes have been delivered to the Pensacola, FL, Aviation Survival Training Center (ASTC) in 2019, which includes hardware for F-18, T-6 and F-35 configurations, with software support for F-18, T-45, T-38, F-35, and T-6
 - ◇ One prototype has been delivered to the Miramar, CA, ASTC in 2020 with hardware for F-18 and F-35 and software support for additional platforms
 - ◇ Two research units were developed and delivered in SEP 2020. Units delivered support hardware for F-18, F-35, T-6, and F-16 with software variations for additional platforms including T-45 and T-38. To support research initiatives, the systems support integrated eye tracking and speech analysis capabilities to support future research and development of advanced after action review capabilities
 - ◇ The development team continues to explore alternative configurations to decrease procurement cost, increase system capabilities based on end user feedback, and explore transition path via PMA-205 General Training

COMPLEX-KNOWLEDGE VISUALIZATION TOOL (N17A-T004)

OBJECTIVE

The objective of this project is to develop a tool that synthesizes learning and cognitive science literature and provides compelling, data-based information and visualizations to support training system acquisition decisions. For example, the tool would support analysts trying to answer questions such as: "What is the return on investment if a debriefing system is included with the training system?" and "What training system fidelity is needed to facilitate learning and transfer?"



Search results and visualizations facilitating synthesis and understanding of complex learning science literature

PROJECT DURATION

SEP 2018 - SEP 2020

SPONSORS

Naval Aviation Training Systems Program Office, PMA-205
Naval Air Systems Command (NAVAIR) Small Business
Innovative Tech Transition Research (STTR)

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DESCRIPTION

This Phase 2 STTR effort will result in a cloud based tool leveraging a learning science ontology to support intelligent literature search, analysis, synthesis and reporting of complex information. The tool provides users with:

- guided query formation and expansion supported by learning sciences ontology based visualizations.
- literature results review through intelligent paper markup and annotation.
- synthesis, characterization and visualization of data and relationships across multiple papers.
- acquisition oriented decision support visualizations.

NEED

The work performed for this effort supports the Advanced Instructional Techniques Technology Area.

BENEFITS

The tool will improve training system quality by assisting users in extracting, synthesizing and providing learning and cognitive science based evidence for acquisition related recommendations.

Users - analysts and decision makers - will gain a more comprehensive understanding of issues related to a query - not only theoretical and empirical evidence synthesized to support an 'answer' to the query, but also an understanding of, e.g., gaps in the research, who is performing related research and within which organizations, what trends are exhibited in research over time. Information of this type is especially relevant when dealing with cutting edge technologies.

STATUS

Two performers were selected to complete option tasks and continue to Phase 2. Performers are in year 1 of Phase 2.

MILESTONES

- ◆ Functional product demonstration (Minimal Viable Product; MVP) October 2019
- ◆ iCloud based user testing, 1st quarter FY20
- ◆ Tool delivery end of FY20

OPERATIONAL PARTNER TO INTERACTIVELY MANAGE UNINHABITED SYSTEM PROCEDURES & RESPONSES IN MULTI-EMERGENCIES (OPTIMUS PRIME; No7-To31)

OBJECTIVE

Develop a software technology that leverages machine-learning to assist operators by prioritizing & reasoning over malfunction errors & troubleshooting.



Conceptualization of Concept of Operation and User Interface

PROJECT DURATION

DEC 2019 - DEC 2022

SPONSOR

Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)

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DESCRIPTION

As the complexity of Tactics, Techniques, and Procedures (TTPs) increase, testing in part via computational simulation and optimization is necessary. Such analyses systematically vary tactical applications of the warfare capability to a variety of threat scenarios, simulate and score each encounter, and generate a ranked list of the most successful tactics per threat, resulting in a wealth of data. OPTIMUS PRIME machine-learns from NATOPS data and procedures AND human, expert AVOs how they generate, select, and execute malfunction Emergency Procedures to provide corrective actions, and assists operators by assessing malfunction errors to support fault resolution.

NEED

The possibility exists for over twenty cascading fault codes in less than five seconds. In order to prevent aviation disaster, there is a need for technology that (1) machine-learns from human unmanned aerial vehicle (UAV) operators how they generate, select, and execute malfunction Emergency Procedures (EP) to provide corrective actions, and (2) assists

operators by prioritizing and reasoning over malfunction errors and troubleshooting steps to increase the probability of successful fault diagnosis and fault resolution in flight.

BENEFITS

The inclusion of a machine-learning system that assists with fault resolution will significantly diminish the risk of platform loss, by better training operators to understand and react to fault codes. Such a system can also be instrumental in operational flights. Air Vehicle Operators will manage emergency procedures more effectively and efficiently, due to both training and in-flight support.

STATUS

In early FY20, a kickoff meeting was held with stakeholders to discuss the design and development plans for the OPTIMUS PRIME technology. Documentation has provided a baseline knowledge base, as well as subject matter expertise, for the design of the system architecture and automation. Focus is on fault detection and likely root cause analysis based on cascading malfunction codes.

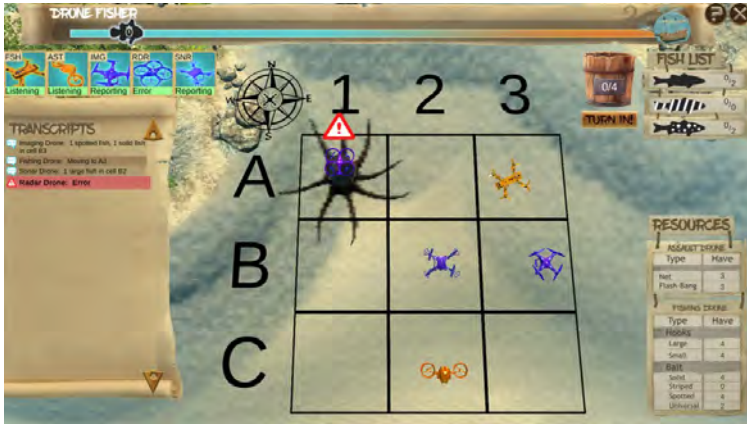
MILESTONES

- ◆ Kickoff meeting for Phase II effort held in Patuxent River, MD (FEB 2020) with stakeholders from NAWCTSD and PMA-262
- ◆ Development team has coordinated a system concept and developed derived requirements based on available documentation and subject matter experts, and developed a framework and infrastructure for technology development
- ◆ Development of learning models anchored in data structure and meaning, as well as human expertise and behaviors, including integration of machine learning models and logic programming
- ◆ Baseline user interface is under development based on operational interface concepts

UNDERSTANDING THE EFFECTS OF AUTOMATION TRANSPARENCY (BAR-21-023)

OBJECTIVE

Investigate training and designs strategies for complex human-autonomy interaction and their relationships to situational awareness, operator cognitive workload, and trust factors associated with and operation of highly automated and autonomous systems.



DroneFisher Game to Support Levels of Transparency Research

PROJECT DURATION
OCT 2020 - SEPT 2022

SPONSOR

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: BAR

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DESCRIPTION

Development of an integrated design (automation transparency) and training solution incorporating workload, trust, situation awareness will result in improved performance on human-autonomy interaction tasks. The results of this effort will provide integrated training development and system design guidance and standards for the most effective ways to introduce complex/autonomous systems to the Fleet for best human system performance .

NEED

As automation becomes more prevalent in training and operational systems, there is an increased need to understand best how to design human-automation interfaces. Though the potential benefits of automation are well-understood, much is still unknown regarding the safe and appropriate use and design of automation to facilitate human-automation teaming. As automated and autonomous systems become

“teammates,” there is a greater need to understand how design and development of these systems will influence human performance, as well as the performance of the overall team, including manned and autonomous components.

BENEFITS

This aim of this project is to better understand the effects of different automation design characteristics on important human outcomes (e.g., workload, performance, situational awareness, trust). Though individual systems and interfaces will likely have different needs, the results of this study can provide general lessons learned for the future design of systems and interfaces for optimal human-automation interaction .

STATUS

This is an FY21 new start effort.

MILESTONES

◆ FY21:

- ◆ Report on the assessment of possible effects of design (automation transparency) and training factors (competencies, training methodologies, metrics) on SA, Workload, and Trust
- ◆ Qualitative Task Analysis Report utilizing background research and literature and interviews with subject matter experts
- ◆ Documented human performance data collection plan.

◆ FY22:

- ◆ Report/conference submission on the results of human in the loop experimentation based on knowledge gaps identified
- ◆ Documented design recommendations to include mockups and examples; Improved game-based training tool and testbed for autonomy interface design (DroneFisher)

VARIABLE ACCOMODATION HEAD MOUNTED DISPLAY (HMD) (N121-041)

OBJECTIVE

The primary objective of this program is to overcome the vergence-accommodation conflict and fatigue in head worn displays.



Screenshot of the proposed virtual test environment.

PROJECT DURATION
DEC 2017- FEB 2020

SPONSOR

Naval Air Systems Command (NAVAIR) Small Business Innovation Research (SBIR) Phase II.5

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DESCRIPTION

The proposed technology incorporates variable accommodation into the HMD to eliminate the conflicting cues and decrease fusion time of binocular imagery and accuracy. The project will leverage the Variable Collimation Display (VCD) technology developed under the current NAVAIR SBIR topic N121-041 Phase II program. Specifically, the VCD's Variable Adaptive Lens (VAL) technology, control electronics and software will be adapted to fit in head worn display similar in size, shape and field-of-view to current commercial HMDs. The VAL will be integrated in a head worn display (i.e. VAHMD) in order to stimulate accommodation-vergence response in the user, thus improving an enhanced immersive experience.

NEED

Accommodation depth cues (i.e., focus) are currently not replicated in current head worn displays. Instead, the eye is forced to focus on a fixed image plane regardless of the object location, resulting in a vergence-accommodation conflict. This limitation hinders the user's ability to accurately judge distances, reduces the user's sense of

immersion and can cause or exacerbate virtual reality sickness (eye strain, dizziness, etc.).

BENEFITS

The anticipated benefits and potential commercial applications of the VAL when incorporated into high-resolution and wide-field-of-view head worn displays include: (i) improvement in users' immersion; (ii) reduction in Virtual Reality (VR) sickness (eye strain, dizziness, etc.); and (iii) improve spatial awareness and more accurate judgement of depth and image distance.

STATUS

The two two-year program was partitioned into four 6-month phases, or "Spirals". Design Interactive (DI) evaluated the VAHMD and found that VAHMD can perform well at multiple depth planes while conventional HMDs degrade in performance when objects are placed outside their fixed depth plane. Holochip has had healthy commercial sales of VAL Development Kits to leading tech companies and HMD developers for evaluation of the technology.

MILESTONES

- ◆ Manuscripts/Publications: Batchko, R., Robinson, S., Schmidt, J., & Graniela, B. (2014, March). A variable-collimation display system. In Proc. SPIE (Vol. 9011, p. 901109).
- ◆ Presentations: Spiral 2 (Month 6) Design Review 8/21/18
 - ◇ Spiral 1 HMD delivered and presented at NAWCTSD, April 10, 2018
 - ◇ Spiral 2 HMD delivered and presented at NAWCTSD, March 7, 2019
 - ◇ Spiral 3 HMD delivered and presented at NAWCTSD, February 13, 2020

VIRTUAL REALITY FOR TRAINING: EXAMINING THE BENEFITS OF HAPTIC FEEDBACK AND NATURAL GESTURES ON LEARNING (BAR-19-022)

OBJECTIVE

To evaluate virtual reality (VR) technology by systematically examining the effects of providing haptic feedback and supporting natural gestures on learning outcomes and other factors such as feelings of presence, usability, and cognitive load while training in VR.



Example student completing a training exercise in VR.

PROJECT DURATION

OCT 2019 - SEP 2022

SPONSORS

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: BAR

POINTS OF CONTACT

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DESCRIPTION

There has been a recent flurry of interest by Fleet customers and stakeholders to provide virtual reality (VR)-based training across a variety of platforms and tasks. VR offers the potential to train tasks that may not be feasible to practice in the real world, but care must be taken to consider when and how to incorporate VR technologies within the training pipeline to ensure it is the right solution to achieve training goals. Therefore, the goal of this effort is to conduct research to explore different tasks and different methods of interaction between the trainee and the environment in a VR-based training environment to determine how these variables affect learning and other factors such as feelings of presence, usability, and cognitive load. Specifically, we aim to explore the impacts of more high-fidelity interactions within the environment, such as natural gestures and haptic feedback across different task types.

NEED

VR training solutions have the potential to reduce training cost, increase training impact, and maximize transfer of knowledge from the classroom to the operational environment. Knowing the capabilities and limitations of the technology and when to apply it

as a training solution will allow the Navy to build more effective and efficient training. Furthermore, this research will enable the NAE to remain at the front of applied S&T understanding on how best to make use of these technologies to support Fleet readiness.

BENEFITS

This research is critical to provide timely evidence-based recommendations to Fleet customers on the benefits and risks of using VR for training and will culminate in a research testbed with integrated haptic gloves, several published conference proceedings papers, and journal articles to address significant gaps in the science of learning literature.

STATUS

In FY20, the research team developed a research testbed and designed Experiment 1, which focuses on exploring the impacts of natural interactions in VR on learning outcomes in a spatial task. In this task, trainees learn to find critical safety equipment onboard a virtual submarine under different training conditions. In FY21, researchers will conduct Experiment 1 and design and conduct Experiment 2, in which the goal is to examine the impact of performing natural gestures in a procedural VR-training task. Data analysis and publications are planned for FY22.

MILESTONES

FY20:

- ◆ Designed Experiment 1 and submitted IRB. Received endorsement to conduct experiment at Submarine Learning Center.
- ◆ Completed research testbed development, incorporating natural interactions to explore their effects on learners' spatial understanding of the virtual environment.

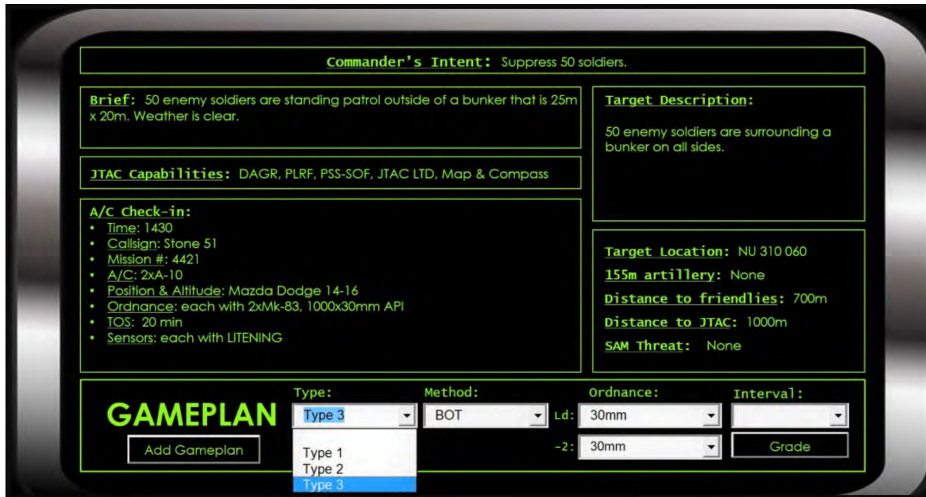
FY21-22:

- ◆ Conduct Experiment 1 and write up results for publication.
- ◆ Develop testbed to support Experiment 2, incorporating haptic feedback and natural gestures for a procedural task.
- ◆ Design Experiment 2 and submit IRB.
- ◆ Conduct Experiment 2 and write up results for publication.

ADAPTIVE TRAINING FOR USMC CLOSE AIR SUPPORT TACTICS AND DECISION-MAKING

OBJECTIVE

The goal of this effort is to perform systematic research on the efficacy of adaptive training (AT) for a complex decision-making task centered on the Joint Terminal Attack Controller (JTAC). Specifically, the AT testbed focuses on game plan development, a critical planning task that sets the stage for the execution of a Close Air Support mission and a challenging topic for JTAC trainees to master.



PROJECT DURATION
DEC 2016 - DEC 2019

SPONSORS
Office of Naval Research (ONR)

POINTS OF CONTACT
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DESCRIPTION

Adaptive training (AT) is training that is tailored to an individual's strengths and weaknesses, and it has led to higher learning gains and decreased training time when compared to traditional training approaches in certain domains. However, more systematic research is needed to determine which AT techniques to employ, when to employ them, for what content to inform best practices, and when to invest in AT technologies. This research examined the benefits of AT techniques in a scenario-based Close Air Support (CAS) decision-making task (i.e., game plan development) for Joint Terminal Attack Controllers (JTACs). Specifically, the AT prototype adjusted the type of feedback and the difficulty of subsequent scenarios based on trainee performance during training in accordance with science of learning principles.

NEED

The Commandant's Planning Guidance and ONR's Science & Technology (S&T) Strategy for Warfighter Performance both highlight the need for tailored training that focuses on the individual learner. Adaptive training is well-suited to meet this demand.

BENEFITS

This research has the potential to optimize classroom training time by allowing students the opportunity to practice key CAS skills on an individual basis, freeing up instructor time to focus on more challenging topics with the class. Additionally, this research will inform the military training community on AT best practices.

STATUS

In FY19-20, in collaboration with the Expeditionary Warfare Training Group (EWTG) Pacific, the research team performed an experiment comparing learning outcomes of three training conditions: Adaptive ATTAC, non-adaptive ATTAC, and a traditional training condition. Results showed that Adaptive ATTAC led to significantly higher learning gains than the other two conditions, providing further evidence for the benefits of AT to support military training. In addition, the team conducted an evaluation of ATTAC at 10th Marines and found that all students improved their performance on a decision-making post-test after training with ATTAC.

The ATTAC prototype is currently in use at EWTG Pacific, EWTG Atlantic, and 10th Marines to augment their JTAC training courses.

MILESTONES

- ◆ Developed *Adaptive Training for Terminal Attack Controllers* (ATTAC) prototype. ATTAC:
 - ◇ Displays scenarios and assesses performance
 - ◇ Contains a scenario difficulty algorithm that adjusts based on performance during training
 - ◇ Contains a feedback algorithm that provides feedback tailored to an individual trainee's response
- ◆ Created over 90 unique scenarios (including error-specific feedback) with input from subject matter experts
- ◆ Conducted experiment with 60+ students in a USMC course to evaluate the efficacy of AT to train complex decision-making task
- ◆ Conducted evaluation of ATTAC during Tactical Air Control Party Primer course at 10th Marine Regiment Artillery Training School
- ◆ Conference presentations covering testbed development and experiment results at HCII 2019, HFES 2019, and I/ITSEC 2019 (Best Paper in Training award)

AN INVESTIGATION OF EYE MOVEMENT INDICATORS FOR PHYSIOLOGICAL EVENTS (ILIR-20-007)

OBJECTIVE

Demonstrate the ability of eye tracking technology to identify physiological events (PEs) in-flight or in training. In addition, this project will result in an early prototype debriefing software capability for use in PE training environments that provides video replay with eye tracking analysis overlays so trainees fully understand the gravity of PEs in operational situations .



Normobaric Hypoxia Trainer Pilot Training Station with Notional Eye Tracking Range

PROJECT DURATION
OCT 2019 - SEPT 2022

SPONSOR
Naval Air Warfare Center Aircraft
Division (NAWCAD) In-House Laboratory
Independent Research (ILIR)

POINTS OF CONTACT

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DESCRIPTION

The research seeks to investigate whether abnormal deviations of eye movement and oculometric from baseline will correlate significantly with trainees' subjective reports of hypoxia symptomology. Additionally, this research will also attempt to determine whether deviations of eye movement from baseline will correlate significantly with other physiological indications of a PEs. Eye-tracking technology offers a potential method to detect and monitor significant changes in vision and eye movement associated with hypoxia experienced by naval aviators. Research will be conducted in mask-on and/or mask-off normobaric hypoxia training and research environments, and data collection will include demographics, eye-tracking, physiological data, and subjective data.

NEED

Hypoxia presents an immediate life-threatening situation for any pilot. Hypoxia, or lack of oxygen, impairs psychomotor capabilities and deteriorates an aviator's mental and physical health. This situation leads to grounding of crew, which stalls naval operations, but can also lead to more grave outcomes

such as death. Therefore, finding ways to preemptively detect symptoms of hypoxia and advance associated safety training is of the utmost importance for fleet readiness .

BENEFITS

This research will determine the potential for modern eye-tracking hardware and software to preemptively identify the onset of a PE for hypoxia, and potentially minimize the possibility of type 1 and type 2 errors when alerting Navy aviators for this condition. Additionally, this effort will also result in an enhanced debriefing capability that will show trainees specifically how they are impacted by hypoxia even when they are not consciously aware .

STATUS

IRB protocol was developed in Q2 FY20. Authorization for conducting the study at the ASTCs is being sought from the leadership at the Naval Survival Training Institute. Initial pilot testing is planned for in Q1FY21 with the internal research team. Additional pilot testing will take place in Q2FY21 at the NAS Jacksonville ASTC.

MILESTONES

- ◆ **Planned milestones FY21:**
 - ◆ Pilot testing scheduled for Q1 & Q2 FY21
 - ◆ Present preliminary results of our research at Aerospace Medical Association (AsMA) annual conference (FY21).
 - ◆ Present additional findings at the SAFE annual symposium (FY21).
- ◆ **Planned milestones FY22 year-end:**
 - ◆ Submit final results as technical report to the Defense Technical Information Center (DTIC)
 - ◆ Provide initial prototype of a debriefing tool in hypoxia awareness and mitigation training that includes feedback pertaining to eye-tracking, performance and physiological data.

DART: DATA-DRIVEN AFTER-ACTION REVIEW TOOL FOR STUDENT PILOT PERFORMANCE ASSESSMENT USING FLIGHT DATA (TT-20-001)

OBJECTIVE

Develop a data-driven after-action review tool for T-45 instructor pilots with capabilities to visualize flight trajectories, identify maneuvers, and automatically and objectively evaluate pilot performance



Two T-45C training jets prepare to perform flyover maneuvers. (U.S. Navy photo by 1st Lt. Andrew Straessle, via Navy.mil Images)

PROJECT DURATION
OCT 2019 - SEP 2021

SPONSORS

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: Tech. Transition

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DESCRIPTION

The Data-Driven After-Action Review Tool (DART) is an interactive web-based application for use in After Action Reviews of training flights on the T-45 platform. Our goal is to enhance communication between the instructor and student, while providing quantitative measures of human performance to aid instructors in standardizing their evaluations. The solution combines interactive 3D and 2D visualization of flight data, automatic maneuver identification, and performance evaluation in a web application interface.

NEED

After-Action Review for T-45 instruction currently consists primarily of verbal communication between instructor pilots and student pilots. Student miscomprehension of error and resistance to correction have been reported by instructor pilots for CNATRA, and multiple re-flies of training flights are costly. Improvement in

student comprehension leads naturally to improvement in student performance.

BENEFITS

With interactive visualization, instructors will be able to convey feedback more accurately to students. The quantitative assessment of maneuver performance made by DART will produce a numerical indicator of performance for each maneuver. This numerical indicator will aid instructors in standardizing their evaluation of student pilots. Additionally, a government-owned software solution provides flexibility and agility for future support and expansion to new platforms.

STATUS

A prototype DART app has been developed and hosted. The app interface will continue to be improved with new visualization capabilities and a more user-friendly experience. Identification and evaluation of additional maneuver classes are in work.

MILESTONES

- ♦ JAN 2021: Deliver prototype DART software to instructor pilots for evaluation period
- ♦ JUL 2021: Incorporate advanced segmentation component and human performance evaluation component
- ♦ SEP 2021: Deliver final software package based on feedback from evaluation periods

DATA SCIENCE DRIVEN AIRCREW PERFORMANCE MEASUREMENT AND PROFICIENCY SYSTEM (N181-026)

OBJECTIVE

Develop a software technology to pre-process, fuse, and store data from multiple sources for human performance assessment and proficiency tracking during training, with the capability to parse and synchronize disparate data from live, virtual, and constructive aviation training system sources to output automated performance metrics.



150903-N-SS390-266 FALLON, Nev. (Sept. 3, 2015) F-35C Lightning IIs, attached to the Grim Reapers of Strike Fighter Squadron (VFA) 101, and an F/A-18E/F Super Hornets attached to the Naval Aviation Warfighter Development Center (NAWDC) fly over Naval Air Station Fallon's (NASF) Range Training Complex. VFA 101, based out of Eglin Air Force Base, is conducting an F-35C cross-country visit to NASF. The purpose is to begin integration of F-35C with the Fallon Range Training Complex and work with NAWDC to refine tactics, techniques and procedures (TTP) of F-35C as it integrates into the carrier air wing. (U.S. Navy photo by Lt. Cmdr. Darin Russell/Released)

PROJECT DURATION
JUN 2018 - MAY 2021

SPONSORS
Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)

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DESCRIPTION

This effort seeks to design and develop an architecture and process for linking available data sources to tactical aircrew performance in warfighting capabilities based on fleet tactical recommendations and mission essential tasks references, that is flexible to incorporate future tactics and scalable to address individual to multi-team performance. The team will work to determine the feasibility of implementing a software-based solution to process, parse and fuse disparate data sources and types for a single platform, as well as design advanced data science approaches intelligence for automated and human-in-the-loop data output for performance assessment, facilitating feedback, and support longitudinal trend analysis computations.

NEED

The current state-of-the-practice for performance assessment relies heavily on subjective rating, which is hampered by a manually intensive and time-consuming process. A software tool that provides an automated mechanism to pre-process and fuse multiple data sources for human performance assessment and proficiency tracking in warfighting capabilities would alleviate this burden. Specifically, to develop computational methods that can

assist with timely and continuous calculation of aircrew performance, proficiency and identify associated trends.

BENEFITS

Better feedback to aircrew will improve performance by identifying training gaps. Increased quantities of data on aircrew performance will enhance future mission capabilities by informing decisions on training resource requirements. This effort seeks to close debrief and reporting gap identified by recent analyses of existing large force exercises. This gap will be present in and increasingly relevant to the effectiveness of forthcoming distributed simulation and LVC training events.

STATUS

This SBIR has undergone competitive source selection resulting in multiple Phase I awards and Phase II selections. Government stakeholders support periodic status updates and demonstrations with various potential transition sponsors to support transition planning and provide technical guidance. Multiple vendors are participating in the Navy's SBIR/STTR Transition Program (STP) in FY21.

MILESTONES

◆ Phase I:

- ◇ Kickoff meetings were held with each of the four Phase I contractors
- ◇ Phase I status was monitored via bi-monthly progress reports, periodic status updates, and close out briefs
- ◇ Phase I Option efforts end July 2019

◆ Phase II:

- ◇ Phase II awards were made in July 2019 to three contractors based on Phase I effort and transition interest by PMA-281, PMA-264, PMA-290, PMA-205, and the Next Generation Threat System.
- ◇ Periodic status updates are supported by government technical points of contact with vendors to provide transition planning and technical oversight.
- ◇ As technologies have matured, virtual or in person demonstrations are coordinated with appropriate stakeholders for feedback.
- ◇ Vendors and technical points of contact have participated in preparation activities for the Navy STP in FY21

LANDING SIGNAL OFFICER DATA ANALYSIS TOOLKIT (LSO-DAT) (N112-111)

OBJECTIVE

Use modern technology to identify deeper trends for assessing pilots, aggregate data to identify safety issues, and make LSOs more efficient.



Landing Signal Officers (LSOs)

PROJECT DURATION

DEC 2018 –AUG 2020

SPONSORS

NAVAIR Small Business Innovation Research (SBIR)
Naval Aviation Training Systems and Ranges Program
Office, PMA-205

POINTS OF CONTACT

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DESCRIPTION

There are four major initiatives in LSO-DAT:

- 1.LSO Data Analysis Tool (LSO-DAT)-Software that interacts with APARTS data to provide in-depth reporting on individual pilots, virtual greenie boards, up-to-date CAG LSO reporting and more. Also provides LSO School and researchers tools for analyzing large numbers of pilots (squadron vs squadron comparisons, for example).
- 2.Data Analytics-We have been mining APARTS data to answer questions regarding skill acquisition and skill decay in light of PLM adoption and FCLP reduction.
- 3.Advanced Analysis of Flight Data (SIM-DAT)-We are producing flight-based visuals to incorporate with SIM-DAT (e.g., stick movement vs position in glideslope). We are also using machine learning to identify hidden commonalities in passes and their relationship to issues observed by LSOs.
- 4.Handwriting Recognition (LSO SCRIBE)-Neural-network-powered software that can read handwritten LSO cut sheets and automatically export them to APARTS. Minimal typing required.

NEED

The Landing Signal Officer (LSO) community is responsible for “the safe and expeditious recovery of non-V/STOL fixed-wing aircraft” (1)

landing aboard the U.S. Navy’s aircraft carriers. Duties in service of this charge range from teaching and training of Student Naval Aviators (SNAs) to ongoing support and management of embarked Naval Aviators. Landing fixed-wing aircraft in a limited landing area is a uniquely challenging aspect of Naval Aviation; LSOs are deeply concerned in minimizing risk for the pilots in their charge. LSO community facing several questions due to rapid introduction of Precision Landing Mod (PLM).

BENEFITS

These capabilities will enhance the LSO assessment of pilots and allow data driven answers to questions of Pilot proficiency. Capabilities include: Provided tools for deeper level analytics and automated performance measurement in assisting in the assessment of the extent to which PLM improves the ability of pilots to acquire and retain adequate carrier landing proficiency. Provide data tools to support consideration of modifications to CQ training and currency requirements. Provide tools for automated data entry.

STATUS

This discretionary SBIR Phase II project ended in Aug 2020 and coordinated transition with the SHARP program.

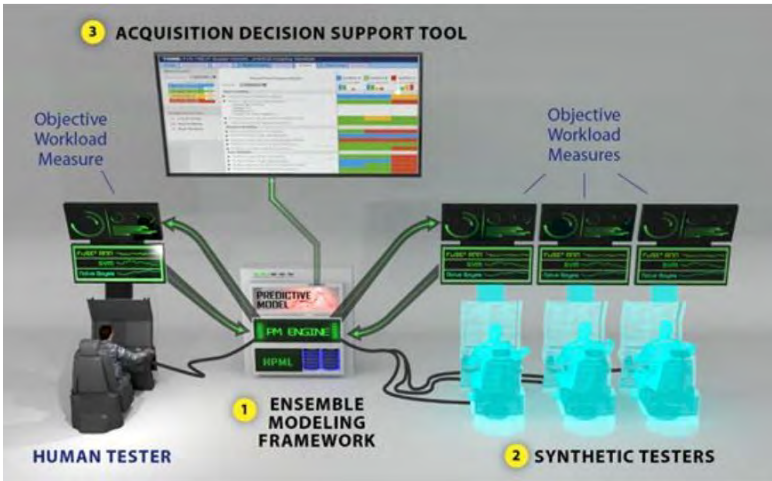
MILESTONES

- ◆ FEB 20: Presented results to LSO School and PMA 205
- ◆ JUL 20: Demonstrated capabilities to PMA-205 and SHARP Program Management
- ◆ AUG 20: Transitioned analyses and results to Sierra Hotel Aviation Readiness Program (SHARP)

MEASURES OF ABSOLUTE COGNITIVE WORKLOAD (N16A-T002)

OBJECTIVE

To develop an innovative and cost-effective capability that will provide an objective and measurable means of workload and other physiological states for determining impacts on individual operator, crew-level, and/or multi-team system level performance when life support or aircrew systems are added or modified.



Aptima's Tools for Objective Measurement and Evaluation applied to a notional T&E environment.

PROJECT DURATION

OCT 2014 - JULY 2020

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Technology Transition (STTR)
Naval Aviation Training Systems and Ranges
Program Office, PMA-205

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DESCRIPTION

In the Naval community, improving affordability is one of the main focus areas. Specifically, standardized workload management systems have been deemed one essential component to gain increased affordability. It is critical to know human performance limitations when introducing complex/cognitive tasks, state-of-the-art technologies/equipment, and new environments to warfighters. Knowledge of these limitations can help researchers and developers understand and evaluate the potentially negative impacts on safety and the efficiency of operations. This effort develops a hybrid approach to objectively assess aircrew workload. This effort develops a hybrid approach to objectively assess aircrew's physiological states such as workload.

NEED

Current state-of-the-practice is to assess physiological states such as workload either physical or cognitive in nature, through a variety of assessment methods. The most commonly implemented are subjective measurement techniques; however, there is an increased desire for more objective data on which to base acquisition decisions. Although, variety of objective measurement techniques exist for cognitive workload including performance measures, new, cost-reducing methods are needed to support system acquisition

decisions. These methods need not only be comprehensive in its approach, but also leverage existing methods.

BENEFITS

This effort seeks to investigate a hybrid approach that would allow for real-time measurement of physiological state, specifically physical and cognitive workload using results and modeling capabilities to understand how variations in the associated factors might affect operator safety and performance.

STATUS

In FY19, one of two vendors was awarded an additional 15 months (Option Period) to mature their prototype. During this time, multiple subjective and objective measures evaluating workload (e.g., NASA TLX, sensors, features, user interface) were upgraded. In FY20, the contractor collected data through the suite of tools using cloud capabilities in a repeated measure design to validate the prototype's ability to provide and predict accurate measures of workload. The contractor also used results from the validation to provide a use case for future physiological measures that could influence operator safety and performance, expanding the prototypes initial capabilities. Currently, we are exploring an expansion of this effort to address other aviation acquisition challenges associated with simulator sickness.

MILESTONES

- ◆ **Phase I:** Kickoff meetings were held with each of the Phase I contractors and project status was monitored via bi-monthly progress reports and periodic status updates. Closeout briefs were held with each of the contractors to discuss Phase I progress and Phase II plans. Phase I Options were awarded for two vendors and progress on product concepts were reviewed.
- ◆ **Phase II:** Phase II gated efforts were awarded for two vendors. Kickoff meetings and periodic reviews were held for the prototype toolkits being developed. Status was monitored via quarterly progress reports and monthly status call updates. Contractors submitted for Institutional Review Board (IRB) approval for data collection.
- ◆ **Phase II Option I:** Down selected to one vendor with potential for an additional option period. A kickoff meeting was held to provide plans for validation study. Monthly progress reviews were also held to go over prototype upgrades. Attended in-person pilot study to explain experimental design, discuss data collection approach, and finalized both subjective and objective measure selections. Results from the pilot study were provided in a report along with the upgraded toolkit to support a future validation study with the aviation population. Currently seeking to expand this effort to also address other physiological concerns (i.e., simulator sickness) influencing system acquisition decisions in the aviation community.

FLEET ADAPTIVE MULTILEVEL MEASUREMENT FOR OPERATIONS AND UNIT SYSTEMS (FAM2OUS)

(EAM2OUS)

OBJECTIVE

Provide integrated collection, fusion, analysis, archive capability for LVC training and operational events across platforms to increase proficiency, readiness, and overall mission performance through improved accuracy of assessment and quality of instruction

PROJECT DURATION
OCT 2019 - SEP 2022

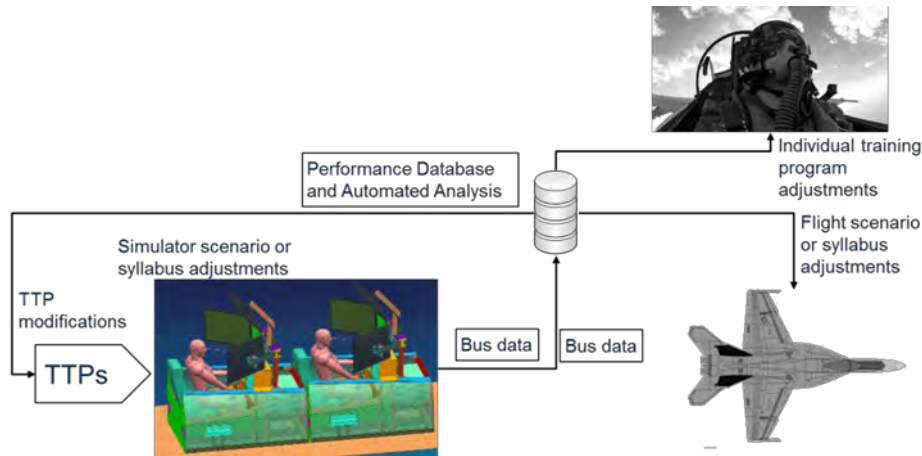
SPONSOR

Office of Naval Research (ONR);
Naval Aviation Training Systems Program
Office (Program Management Activity
[PMA] 205)

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Data Framework Developed by NAWDC

DESCRIPTION

The science and technology of this Future Naval Capability (FNC) focus on developing assessment capabilities that automatically and adaptively collect, fuse, display, analyze, and archive training data (Live, Virtual, Constructive) from disparate systems. Competency-based, automated objective performance measures will be developed at the individual, unit, and carrier strike group level. These measures will be used for debrief and trend analysis to support decision making (currency, proficiency, acquisitions). Additionally, these measures will be enable comparison between live, virtual, and constructive (compare differential impact of simulation and live training opportunities). These data will be stored in a centralized system that will enable rapid development of post-mission and readiness reports.

NEED

Performance assessment of Carrier Airwings (CVWs) during integrated training relies solely on qualitative instructor assessments presenting resource challenges with manpower, training time for instructors, standardization of metrics and feedback, and overall accuracy of recorded data. This practice requires instructors to pull data from multiple, disparate, often stove

-piped systems and manually synthesize these data to conduct debrief and provide assessments which is time intensive.

BENEFITS

This capability will provide instructors with relevant data that is automatically fused to allow for increased for a reduction in manpower and time requirements for instructors. This will also reduce instructor workload focused on assessment and allow for increased quality of instruction and ultimately greater warfighter proficiency and readiness. Finally, this tool will allow for comparison between simulator and flight performance, assess the effect of simulator rehearsal on live flight proficiency, and enable development Concept of Operations and refinement of Tactics, Techniques, and Procedures (TTPs).

STATUS

This three year FNC kicked off in FY20 and is the continuation of the FAM2OUS 6.2 Technology Candidate (TCAN) effort. In February of FY20, core TCAN capabilities were demonstrated as standalone functionality in an operationally representative laboratory. Additionally, data mining activities were conducted. FY21 will focus on the integration of component technologies.

MILESTONES

- ◆ Feb 20: Concluded 6.2 TCAN activities in Feb 2020
- ◆ Feb 20: Kicked off FNC activities in Feb 2020 with demonstration of TCAN functionality and testing/data mining
- ◆ Nov 20: Demonstrate current real-time assessment, debriefing, and trend analysis capabilities to NAWDC
- ◆ Mar 21: Conduct integrated system test in Open Architecture Systems Integration Site (OASIS) laboratory at Patuxent River, MD.
- ◆ Sep 22: Transition final Software to the Integrated Training Facility via the Next Generation Threat System

TECHNIQUES TO ADJUST COMPUTATIONAL TRENDS INVOLVING CHANGING DATA (TACTIC-D) (N17B-T032)

OBJECTIVE

Develop technology based on statistical or computational methods to assist in the continued tracking of training performance and proficiency trends as underlying tactical data changes.



Racks containing Naval Integrated Tactical-Cloud Reference for Operational Superiority (NITROS) capabilities.

PROJECT DURATION

MAR 2019 - FEB 2021

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Technology Transition (STTR)

POINTS OF CONTACT

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DESCRIPTION

The continued push for integrated warfare will likely result in cross-platform, mission-based trends; however, there may be differences in constructs across platforms (e.g., one platform may rely on timeliness and another on accuracy) that if not accounted for in the analysis or development of common construct definitions would skew analysis results. This effort seeks to identify statistical or computational methods that can assist with these adjustments to statistical trends, and implement them in an automated tool that will allow for the timely and continued calculation of trends related to fleet performance and proficiency.

NEED

The DoD and USN seek to leverage the benefits of qualitative data analytics for tactical proficiency assessment to support decision making. Military domains for big data is unique in that the tactics, techniques and procedures used by the fleet shift over time due to changes in capabilities or the need to adapt, creating a unique challenge for the typical statistical processing to ensure that comparisons remain meaningful.

BENEFITS

Navy leadership has called for technologies that support analytics of big data sets such as avionics and human performance; however, as new systems or technologies are introduced and/or new tactics emerge to maintain superiority, underlying data sources may change. At this time, systems are built to support basic trends and statistical outputs, without accounting for this shift. Given the implications of decision makers relying on outputs to adapt training, modify resources or refine tactical approaches, a solution for understanding the implications or adjusting results based on these types of shifts is required. Advance statistical or novel modeling techniques are sought to address this unique challenge.

STATUS

Three vendors completed Phase I efforts, resulting in a down select to a single vendor in Phase II. The contractor is completing the Phase II base period, which will result in a decision on award of Phase II Option. Discussions and demonstrations with stakeholders have occurred periodically during the Phase II development.

MILESTONES

- ◆ Manuscripts/Publications: Fegley, Carlin, Cheng, Tindall, Killilea, & Atkinson. (2019). Avoiding *Data Overload in an Adaptive Training Use Case*. Modsim.
- ◆ Phase I:
 - ◇ Kickoff meetings were held with each of the three Phase I contractors
 - ◇ Contractors status was monitored via bi-monthly progress reports and periodic status updates
 - ◇ Closeout briefs were held with each of the contractors to discuss Phase I progress and Phase II plans
 - ◇ Phase I Option was awarded for single vendor
- ◆ Phase II:
 - ◇ Progress brief in JUN 2020 to determine the path/focus for the remaining period of performance
 - ◇ Development has focused on effects analysis, anomaly detection, and advanced visualizations for integration in the software prototype
 - ◇ The project has been registered with the Navy's SBIR/STTR Transition Program (STP) for FY21 participation
 - ◇ Prototype Software delivery and Phase II Option Decision expected by FEB 2020

TRANSITION OF CREW ROLE-PLAYER ENABLED BY AUTOMATED TECHNOLOGIES TO MARITIME PATROL TRAINING (219TT-18-003)

OBJECTIVE

This effort will conduct the research and development necessary to refine the Crew Role-player Enabled by Automated Technology Enhancements (CREATE) technology to facilitate transition to PMA-205 and PMA-290, focusing on conducting human factors analyses, feasibility of automated performance measures for communication, and performance testing.



Aircrewmembers assigned to Patrol Squadron (VP) 8 perform pre-flight procedures aboard a Boeing P-8A Poseidon maritime aircraft in preparation to support search and rescue efforts for the missing Republic of Korea cargo ship crew in the FOURTH Fleet Area of Operations

PROJECT DURATION
OCT 2017 - SEP 2020

SPONSORS

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: TT

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DESCRIPTION

The CREATE technology development has progressed significantly over the last two years, resulting in increased interest in harnessing the technology by platforms. However, work to date has focused on the challenges associated with the integration of speech and behavior modeling technologies. As platforms move forward with implementation of this technology, greater attention is necessary to refine the instructional interface to ensure an appropriate amount of data is provided to facilitate human-machine trust without placing additional unnecessary workload on operators.

NEED

The successful transition of autonomous crewmembers technology seeks to solve a long-standing training challenge - how to train a single trainee in a task that requires a crew or group to execute it. Through a software solution for autonomous crewmembers that builds on recent technological advances in speech recognition, this technology transition effort has the potential to reduce operator workload and facilitate more robust and realistic training of skills such as crew coordination earlier in the training pipeline.

BENEFITS

SBIR work has focused on the challenges associated with the integration of speech and behavior modeling technologies. As platforms move forward with activities to implement this technology, greater attention is necessary to refine the instructional interface with the appropriate amount of data to facilitate training without placing unnecessary workload on operators. The lack of attention to these factors now, ahead of transitions, will result in schedule and financial impacts to programs to address usability issues identified after fielding. Additionally, increased usability at the on-set will increase fleet buy-in and increase the likelihood of successful fielding.

STATUS

Efforts in FY20 researched opportunities for advanced performance assessment through communication capabilities and fleet testing of the component capabilities and integrated system performance. The team documented interface mockups and opportunities for automated communication performance measurement, and reviewed with end users. A collaborative study was conducted on operator interface transparency to inform future studies and human machine interface designs. A final report to document communication performance measures to enhance diagnostic feedback to individual and aircrew training is under refinement.

MILESTONES

◆ Manuscripts/Publications:

- ◆ Anania, E. C., Killilea, J., & Atkinson, B. F. W. (2018). *The application of automation systems for training - Implications of trust*. Proceedings of the Interservice/Industry Training Simulation & Education Conference, Orlando, FL.
- ◆ In preparation: J. Killilea, B. Atkinson, (2020, April 01). Techniques for Improving Automatic Speech Recognition in Unique Domains. IEEE venue TBD. Refereed.

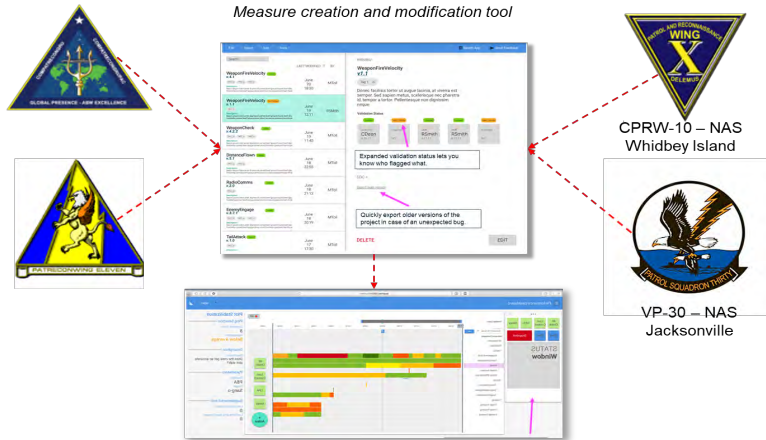
◆ Information Exchanges:

- ◆ CREATE demo and status briefing with Fleet representatives from VP-30 and Phase 3 performers (Soartech, ASEC, NAWCTSD). J. Killilea, (2019, February).
- ◆ P-8 Technical Interchange Meeting at TACTIP in NAS Jacksonville with the MPRA community. J. Killilea, (2019, March).
- ◆ Integration meetings with Boeing and the NAWCTSD IPT begin in August of 2019
- ◆ Final report submitted NOV 2020

TRANSITION OF END USER AUTOMATED PERFORMANCE MEASUREMENT TOOL (TT-19-018)

OBJECTIVE

Provide Fleet customers with an in-house capability for developing, modifying and implementing automated and observer-based performance measures within a broader performance measurement system.



Measure creation and modification tool.

PROJECT DURATION
APR 2019 - DEC 2021

SPONSORS
Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: TT

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DESCRIPTION

Current solutions for developing and integrating automated performance measures into training systems require a lengthy contractual process to hard code modifications to existing measures or add new measures. An opportunity exists to empower the warfighter, in conjunction with leadership, to rapidly respond to changes in the environment by modifying existing measures or creating new ones to ensure TTPs and performance standards are current. This effort seeks to place the power of software system modification and development in the hands of the end-user.

NEED

In military contexts, where change is inevitable and rapid, it is crucial to ensure we are training to stay ahead of our adversaries, constantly challenge the status quo, and saving costs. The current effort seeks to address this fact, creating software which will allow end-users (e.g., Commanding Organizations, Wing and Squadron Instructors, Deployed Units) to easily create and implement automated and observer-based performance measures into training immediately, without the need for alternative contracts each time new performance measures are needed.

BENEFITS

Navy leadership has called for technologies that support analytics of big data sets such as avionic or human performance. This effort seeks to provide a way for end-users to develop, modify, and implement automated and observer-based performance measures within a broader performance measurement system.

STATUS

This effort was first proposed in Q2 FY18. The effort was awarded in Q2 FY19 IRB protocol was submitted and accepted May 28 FY19. Data collection is set to begin July FY19.

MILESTONES

- ◆ Effort awarded to Q2 FY19
- ◆ Request for approval and full IRB protocol submitted Q3FY19
- ◆ IRB protocol approved Q3FY19

AFTER ACTION AND REPORTING TOOL FOR DISTRIBUTED LIVE, VIRTUAL, CONSTRUCTIVE (LVC) TRAINING (TT-21-009)

OBJECTIVE:

Conduct research to understand distributed LVC after action and reporting requirements, how those compare to single site virtual-constructive (VC) requirements, and develop a method for presenting data in a more standardized fashion. Specifically, this effort aims to create a uniform interface to allow for seamless utilization across multiple media and of training (L, V, C) and delivery method (single site, distributed) by conducting an analysis of requirements and gaps across user communities and provide optimal debriefing.



Screenshot from NGTS ART

PROJECT DURATION
OCT 2020 - SEPT 2021

SPONSOR
Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: Tech Transition

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DESCRIPTION

This effort will leverage the data source investigation conducted under the Office of Naval Research funding Fleet Adaptive Multilevel Measurement for Operation and Unit Systems (FAM2OUS) program to support identification and implementation of requirements that go beyond single site Virtual/Constructive (VC) training to support distributed Live/Virtual/Constructive (LVC) events. These capabilities will allow Next Generation Threat System Analysis and Reporting Tool (NGTS ART) to better meet the needs for both the Naval Air Warfare Development Center and the Naval Aviation Distributed Training Center (NADTC) by providing a standardized and more comprehensive picture of human performance across the training pipeline. While the initial use case is planned for NGTS ART as it aligns to the NAWDC and NATDC requirements, the analysis of requirements will focus on overall debrief and a cross walk can be done for NGTS ART and any other system of interest.

NEED

Multiple communities throughout the NAE utilize NGTS including F/A-18, F-35, NADTC. However, requirements are pushed to Final Operational Capability development with the mindset often being "we'll use what's there". This presents a challenge as the ART requirements have been heavily driven by Fighter, single site communities. As we move to integrated, distributed, multi media

(LVC) events, NGTS ART will fall short to provide learning points required to foster integration assets. This effort is necessary to identify the shortfalls of NGTS ART and develop capabilities that span user communities to meet those needs.

BENEFITS

Conducting standardized, formal debrief is something Naval Aviation communities pride themselves on for the teaching and learning of the warfighter. However, standardizing across platforms has been challenging; as we move to distributed LVC events the challenges will widen and the ability to conduct a standardized debrief across sites and platforms will increase resulting in lost learning opportunities and reduced training effectiveness. This effort aims to mitigate these risks by conducting analyses and development activities to ensure standardized debriefing across media and sites. Through standardization and sound methods, this effort will support optimized debriefing for improved training and readiness.

STATUS

In FY 21 analysis will be conducted with NGTS users (operators, instructors, analysts) to determine common requirements across user communities, how to streamline data presentations, and what needs to be consistent across interface (standardization) as well as identifying the gaps given a distributed LVC environment.

MILESTONES

- ◆ FY21 New Start
- ◆ Determine common NGTS requirements across the various user communities
- ◆ Author/publish report documenting results (SEP 2020)

INVESTIGATING CROSS-DOMAIN ADAPTIVE TRAINING

OBJECTIVE

The goal of this effort is to perform research on the generalizability of adaptive training (AT) techniques for self-paced, rapid knowledge acquisition tasks across different domains. Specifically, we are planning to conduct a series of experiments using a flashcard-like interface to determine if AT algorithms that are effective in one domain extend to other domains.



Example of feedback after a learning trial in the experimental testbed.

PROJECT DURATION

DEC 2018 - DEC 2021

SPONSORS

Office of Naval Research, ONR-31

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DESCRIPTION

Adaptive training (AT) is training that is tailored to an individual's strengths and weaknesses, and it has led to higher learning gains and decreased training time when compared to traditional training approaches in certain domains. However, developing effective AT systems can be time-intensive and costly, and they are typically developed as one-off systems to address a specific training need.

The goal of this research effort is to determine the most effective and efficient instructional strategies for rote learning tasks and explore the generalizability of a common set of AT algorithms across different training domains.

NEED

The U.S. Navy and Marine Corps are focused on modernizing training for the information age by providing learner-centered training available at the point of need. In addition, they seek to reduce bottlenecks in schoolhouse training and find training opportunities for students awaiting training. AT is well-suited to meet this demand.

BENEFITS

This research has the potential to optimize classroom training time by allowing students the opportunity to practice skills on an individual basis, freeing up instructor time to focus on more challenging topics with the class. Additionally, this research will inform the military training community with evidence-based research on the effectiveness of domain-general AT techniques across different domains.

STATUS

In FY19, the research team designed a series of experiments to explore adaptive spacing and card dropping criteria and developed a flexible testbed that allows the research team to quickly implement new features, algorithms, and training content to enable experimentation. In FY20, the research team conducted AT experiments in collaboration with the Marine Corps Intelligence School and the Marine Corps Combat Service Support School. Additional experimentation is underway in FY21 to demonstrate the efficacy of generalizable adaptive algorithms to support rote learning in across multiple domains.

MILESTONES

- ◆ Developed *Flexible Adaptive Sequencing for Training (FAST)* testbed. FAST is a flashcard-based testbed in which researchers can manipulate AT algorithms to identify the most effective and efficient techniques to produce learning gains across multiple domains.
- ◆ Conducted evaluation of FAST as part of Automotive Maintenance Technician Basic Course at the Marine Corps Combat Service Support School. FAST included flashcards that covered 4 out of 9 automotive systems and over 160 learning objectives from the course. Students studied using FAST on their course-issued laptops during the whole 52-day course, and instructors will provide students' course outcome and FAST usage data to the research team for analysis.
- ◆ Conducted Experiment 1 in collaboration with the Marine Corps Intelligence School that explored different sequencing and flashcard dropping techniques on learning armored vehicle identification.
- ◆ Experiment 2 is currently underway to follow up and extend the results of Experiment 1.
- ◆ Published Experiment 1 preliminary results in HCII2020 conference proceedings.

INVESTIGATION OF TRAINING FIDELITY FOR CARRIER QUALIFICATION AND PRECISION LANDING MODES (BAR-18-042)

OBJECTIVE

This effort will research the level of flight simulation fidelity required for the carrier landing training using Precision Landing Mode (PLM) flight control laws. Deliverables include 1) data analytics reports that identify training gaps and performance issues for both pilots and LSOs, 2) simulated and live data that will be leveraged for the LSO virtual reality (VR) trainer and computational pilot models, and 3) empirical reports documenting solutions for training gaps and performance issues.



Landing Signal Officers (LSOs)

PROJECT DURATION
OCT 2017 - SEP 2020

SPONSORS
Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: BAR

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DESCRIPTION

Precision Landing Mode (PLM) refers to a set of control laws that adds additional landing modes designed to improve pilot landing and recovery capabilities. These control laws decrease workload for pilots and improve aspects of recovery and landing performance (e.g., centralized landing patterns). However, the reaction of the aircraft to inputs from the pilot is different and the techniques of Landing Signal Officers (LSOs) waving pilots land at the ship may need to change. This will necessitate adjustments to pilot skills sets, disrupting long automated muscle memory and decision making for expert pilots and introduce more complex learning for novice pilots due to additional modes.

NEED

Originally planned for initial roll out early in FY18, integration started over a year early (Q4FY16) and is estimated to be fully integrated by the end of FY17. This early delivery of the PLM upgrade technology may result in pilots being undertrained as they struggle with either learning techniques for multiple modes or unlearning long held habits and muscle memory reactions under quick timelines and dangerous conditions (experts). This can

present its own set of challenges such as negative impacts on muscle memory maintenance and mode confusion.

BENEFITS

First, the relationship between simulation fidelity and transfer/learning area is generating significant attention in the Navy as we shift toward less live flight training and more simulation-based training, to save cost and increase safety. Thus, a need exists within the Navy to empirically evaluate theories of training transfer and fidelity in the environment when new technology is introduced and Fleet requirements change. Furthermore, this effort will provide a significant contribution to the scientific community in that it will provide an understanding of the relationship between fidelity and learning in highly complex, dynamic military environments.

STATUS

Conducted two Experiments at Manned Flight Simulator (MFS) to create Pilot Profile Data and Compare Maintenance Card Data/Pilot. Performing analyses focused on E2D and E2C aircrafts at start of FY21.

MILESTONES

- ◆ Conducted Experiments at MFS to create Pilot Profile Data
- ◆ Conducted Experiment to Compare Maintenance Card Data/Pilot Inputs to APARTS Data
- ◆ Analyzed samples from A/C Removable Media Module for Audio Management Unit (RM AMU) data
- ◆ Collecting subjective data (APARTS) for all platforms
- ◆ Meeting with SHARP contractors in San Diego 1-2 MAY 2019; Conducted Virtual TIM in JUNE 2020
- ◆ Obtained E2D and E2C data for additional Analytics for LSO analysis at Carrier Air Group and Force Levels
- ◆ Transitioned analyses and results to SHARP and LSO School

LIVE, VIRTUAL, CONSTRUCTIVE (LVC): AN INVESTIGATION OF THE LEGEND OF AVAILABLE DATA

OBJECTIVE: Examine application of data fusion, machine learning, and assessment techniques for both debrief and real-time decision aids for mission planning and replanning. Investigate data required and available to conduct real-time battle management assessment to support rapid synthesis of multiple courses of actions in the battlespace and feed human performance assessment and debrief for LVC.



Google Image of E-2D Live Aircraft

PROJECT DURATION
FEB 2020 - OCT 2022

SPONSOR
Office of Naval Research, ONR-34

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DESCRIPTION

The present effort seeks to build from a current Office of Naval Research Future Naval Capability: Fleet Adaptive Multilevel Measurement for Operational and Unit Systems (FAM2OUS). The proposed effort will expand the FAM2OUS applicability beyond Virtual-Constructive environments to Live, Virtual, Constructive (LVC), and eventually operational environments, by examining the application of data fusion, machine learning, and assessment techniques to support real time decision aids for mission planning and re-planning. Specifically, the Science and Technology (S&T) of this effort will focus on investigating the data required and available to conduct real-time battle management assessment in the LVC training environment to support rapid synthesis of multiple courses of actions in the battlespace and feed human performance assessment and debrief for LVC. Data and algorithms will be investigated to define both the pieces of data required for each measure and the means for synthesizing these data into meaningful output for instructor debrief and longterm trend analysis. These methods will be examined and expanded on to investigate their application to Battle Management Aids (BMAs) for E-2D operators during real-time operations using the same data sources and synchronization of data in LVC for real-time decision making across platforms.

NEED

The high levels of coordination the E-2D is required to orchestrate for current and evolving tactics makes real time decision making complicated and dependent on large amounts of disparate data and inputs. However, despite the integrated role decision-makers play, the tools to dynamically assess, manage and plan the battlespace are lacking, highlighting a gap in existing BMAs and planning tools. Thus, the need exists for tools that can be fed by the same disparate data sources and can populate real time feedback and debriefs in LVC environments.

BENEFITS

Real-time BMA provides operators with improved situational awareness and a more critical analysis of options resulting in improved warfighting performance. Additional data sources fused for debriefing provides a more comprehensive diagnostic picture of performance, improving the quality of instruction, increasing proficiency and readiness. This will also enable trend analysis and comparison from live and VC training.

STATUS

In FY21, development of fusion algorithms for synthesizing data is planned, interface and display for BMA and debrief capabilities based on available data and user needs is planned. These developments will be demonstrated later in FY21.

MILESTONES

- ◆ Preliminary data collection with E-2D SMEs: Tactical Training Group Pacific Q1 FY20, VAW120 10FEB 2020
- ◆ Identification of warfare center partner in May 2020
- ◆ Kickoff held Q3 FY20
- ◆ Investigation of Resource Allocation Algorithm's applicability to the Air Defense domain underway

TEAM OVERMATCH: ENHANCED RESILIENCE/COMBAT OPERATIONAL STRESS REACTIONS (COSR) TRAINING (ERT) FOR TEAMS

OBJECTIVES

1) Accelerate the development of high performing teams by integrating TOvM Enhanced Resilience/COSR individual and team strategies (including iCOVER) with tactical training, 2) Develop readiness, psychological resilience, and casualty care decisions through integrated and structured After Action Reviews (AAR).

Building on Existing
Warrior Skills Training



TOvM:

Training to help squad members maintain tactical effectiveness through increasing situation awareness, developing and improving teamwork behaviors, communication, and improving decision making under battlefield stressors.

PROJECT DURATION
DEC 2018 - MAR 2020

SPONSORS

Defense Health Agency (DHA)

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DESCRIPTION

Our Soldiers face unimaginable stress on the battlefield - sleep deprivation, physical exhaustion, lack of food, and the ever-present threat of the enemy. TOvM developed team resilience strategies that focus on the recognition of self/buddy cues that illustrate Combat Operational Stress Reactions (COSR) and teach 'tactical resilience care' behaviors to provide on-the-spot stress injury care, to include iCOVER. This was integrated into the TOvM Training Support Package (TSP) that provides comprehensive planning and execution support for conducting a Platoon-level exercise with integrated cognitive strategies, practice scenarios, and curriculum.

NEED

There is a need to contextualize individual and team resilience training within tactical training for self and buddy care. Further, there is a need to contextualize decision making under stress training within tactical training.

BENEFITS

TOvM is the first U.S. demonstration of the iCOVER training program, designed to address COSRs during high-risk operations. This training may mitigate the risk associated with having a team member functionally impaired during combat operations by applying first aid strategies for stress injuries that can be conducted during a tactical mission.

TOvM is a guided methodology to enable new users in critical response, life threatening, high stress occupations/environments to self-adapt the curriculum to support their unique missions.

STATUS

U.S. Army Central Command (USARCENT); 3rd/1st Armor Brigade Combat Team, Camp Buehring, Kuwait (December 2017)
U.S. Army Pacific Command (USARPAC); 25th Infantry Division, Camp Casey, Korea (June 2018)

II Marine Expeditionary Force (IIMEF); 2nd Marine Division (2MARDIV), Camp Lejeune, NC (April 2017)

MILESTONES

- ◆ Deployed TOvM: USARCENT: 3rd/1st Armor Brigade Combat Team, Camp Buehring, Kuwait (Dec 17), 2) USARPAC: 25th Infantry Division, Camp Casey, Korea (Jun 18), 3) IIMEF: 2MARDIV, Camp Lejeune, NC (Apr 17), 4) USARPAC: 25th Infantry Division, Schofield Barracks, HI (Aug 18).
- ◆ Developed individual and team resilience instructional strategies and tools that ensure resilience skills will be applied in real life via iCOVER – training products (curriculum, learning objectives, performance assessment, and integrated AARs) designed to teach service members how to recognize and respond to ASRs using a simple, 6-step procedure. (May 2018; June 2019)
- ◆ Developed a TC3 manikin operation class (December 2018)
- ◆ Developed a Team Resilience Virtual Application Practice that provides immersive scenarios that allow interactive training on recognition of ASR, procedural knowledge, and execution practice (April 2018)

TEAM OVERMATCH: INTEGRATED TRAINING SUPPORT PACKAGE DESIGN WIZARD

OBJECTIVES

The goal of TOvM is to integrate human dimension (HD) and team performance training into Army training events. This is accomplished via the Wizard, a collaborative computer-based job aid backed by a relational database that links HD competencies to key individual and collective tactical tasks/ battle drills, and guides leaders through the eight-step Army training model. application opportunities.

Building on Existing
Warrior Skills Training



TOvM:

Training to help squad members maintain tactical effectiveness through increasing situation awareness, developing and improving teamwork behaviors, communication, and improving decision making under battlefield stressors.

PROJECT DURATION
OCT 2019 - DEC 2020

SPONSORS

Defense Health Agency (DHA)

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DESCRIPTION

TOvM provides the capability to build leaders through an online Wizard that guides scenario development from the perspective of the 8-step Training Model to plan, design, and execute integrated Combat Operational Stress Reactions (COSR) training. The Wizard provides train-the-trainer courses in Human Dimension (HD) skills, including Advanced Situation Awareness (ASA), Team Dimensional Training (TDT), Enhanced Resilience/COSR Training (ERT), iCOVER Training, and Tactical Combat Casualty Care (TC3). The Wizard is based on Army training doctrine and certification standards, but seamlessly guides Platoon leadership through integrating key HD skills in live, high fidelity, scenario-based training. The process outputs an integrated CONOPS, schedule, tactical mission / map, key events for HD skills, and performance measures tied to individual and collective tasks, and HD performance. The Wizard is designed to be used on mobile devices, and observer/controllers can use phones or tablets during training for reference and to score performance. An integrated After Action Review (iAAR) is generated after training performance, providing leaders with guided questions for soldiers that lead to performance improvement and goal setting for the next training event.

NEED

Currently, HD skills are trained in a silo, and are not well integrated into training exercises. Further, Army leaders have few tools to support the planning and design of effective training events. The TOvM Wizard can be used for field training, integrating specific individual and collective skills for a mission set, while ensuring that Soldiers are integrating the cognitive skills to build team

performance and resilience. COSR can prevent Warfighters from performing their duties, negatively affecting troops' readiness. The more Warfighters know about normal reactions to extremely abnormal experiences, the more resilient they will be at dealing with the stress of combat and other military operations. Training Warfighters on how to recognize the magnitude of a potentially traumatic event (PTE) as it affects exposed individuals, how to recognize the symptoms of a negative stress reaction in self and others, and how to perform self and buddy care strategies are key to the success of COSR reduction.

All of the TOvM domains are part of the TDT framework, which was developed to reduce breakdowns in team performance for large, distributed teams. TDT has been researched with Warfighters for over 20 years, and that effort coined the catchphrase "turn a team of experts into an expert team" (Salas, Cannon-Bowers, & Johnston, 1997).

BENEFITS

This training provides Army leaders with easy-to-use interfaces to develop high quality training. Training in HD skills increases tactical performance and decision making. It may mitigate the risk associated with having a team member functionally impaired during combat operations by applying first aid strategies for stress injuries that can be conducted during a tactical mission.

STATUS

Online capability planned December 2020 for initial testing.

MILESTONES

- ◆ NOV 2019: System architecture
- ◆ JAN 2020: Database design done
- ◆ MAR 2020: Basic User Interface
- ◆ AUG 2020: Data collected from sources
- ◆ SEP 2020: Data populated in database
- ◆ OCT 2020: Online office document editor
- ◆ DEC 2020: Wizard UI integrated with database

VIRTUAL OBSERVER CONTROLLERS FOR ADAPTIVE TRAINING (VOCAT) (OSD11-CR1)

OBJECTIVE

Automated adaptive assessment and instruction to trainees within a denied and degraded collective, LVC training environment. Specifically, contractor (Discovery Machine Interactive or DMI) will deliver a software application and mentor dashboard called ZARATAN: Zulu Adaptive Reasoning Advisor and Training Agent for the Navy.



ZARATAN Mentor Dashboard Screen Capture

PROJECT DURATION
OCT 2019 –AUG 2020

SPONSORS

Office of Secretary of Defense
Small Business Innovation Research (SBIR)
PMA-205

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DESCRIPTION

For VOCAT, the SBIR performers developed intelligent agents having situation awareness and decision processes mapped in software via knowledge representations. In addition, the VOCAT has a supplemental ontology representing the training objectives and cues.

NEED

Individualized instruction is vital in complex decision making environments such as Anti-Submarine Warfare (ASW) and Anti-Access/Area Denial (A2/AD) domains where trainees need to be prepared for situations that are highly varied and where needed assets or communications are unavailable. Today instructors must fabricate realistic situations in simulations in which to immerse the trainee. These highly dynamic environments often require numerous actors or “pucksters” who take on the roles of the opposing forces. So the instructor’s job becomes one of orchestration rather than instruction.

BENEFITS

The adaptive training solutions developed under this effort will extend the science of real-time adaptive training for the Navy by creating a unique virtual observer/controller (VO/C) approach to guide and evaluate trainee performance. The innovative VO/C was developed with expert training knowledge of optimal task performance that can simultaneously track and evaluate multiple potential task sequences at varying threshold levels for a given individual. This allows not only for complex tasks where optimal performance may be represented by two or more tasks, but also allows for evaluation based on experience level, where novices may be allowed larger tolerances early in the learning to afford experiential learning.

STATUS

The ZARATAN application and dashboard was completed and delivered Aug 2020 to Naval Simulation Center Pacific NSCPAC (San Diego).

MILESTONES

- ◆ Research on speech recognition engines and natural language processing technologies was documented in the Phase II final report and could be used with Fleet chat applications. Additional transitions are being sought via the Navy supported Joint After Action Review (JAAR) application and Naval Surface Warfare Dahlgren Division Dam Neck Annex (NSWDDC DNA).
- ◆ FY19Q3: Developed VOCAT Dashboard Framework - which allows for customizable user interfaces driven by intelligent agents
- ◆ FY20Q2: Expanded JAAR integration allowing automatic generation of High Interest Events (HIE) and visualization in VOCAT Dashboard
- ◆ FY19-20: Developed ZARATAN User Interface for Zulu mentor dashboard that will support mentor assessment and monitoring of LVC events.
- ◆ FY20Q1 and FY20Q2: Participated in two V&V events that resulted in refinement and testing for ZARATAN capabilities.
- ◆ Aug 20: Phase II Final Report

ARTIFICIAL INTELLIGENCE (AI) FOR ANTI-SUBMARINE WARFARE TRAINING (N202-091)

OBJECTIVE

Implement a tactical and evolving Anti-Submarine Warfare (ASW) application with AI technology, specifically the application of AI technology to passive ASW analysis. AI augmentation should be aggressively pursued to increase the manning and training aspects of the AO (operational availability) equation across the Navy.



P-8A Poseidon, an Anti-Submarine Warfare aircraft

PROJECT DURATION
OCT 2020 - OCT 2021

SPONSOR
NAVAIR Small Business Innovation
Research Program (SBIR)

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DESCRIPTION

This SBIR project seeks a phased approach to implementing a tactical and evolving Anti-Submarine Warfare (ASW) application with AI technology, specifically the application of AI technology to passive ASW analysis. The early system will demonstrate a form of explainability and confidence values in outputs provided. Future iterations of the system will include self-tuning algorithm parameters. Performers will be developing a proof-of-concept system that will demonstrate the feasibility of the proposed training capability within an undersea (or relevant) domain with publicly available training data

NEED

Acoustic operators go through approximately two years of initial training including hands-on training and years of additional submarine contact time in order to build proficiency. With additional capabilities of the Maritime Patrol community coming online, the demands on a given acoustic operator have only increased. With these increased demands, we must recognize the limitations of human acoustic operators when analyzing acoustic data, especially before initially locating a subsurface

target, when unsure of when and where contact will appear. As human beings, they can only apply their cognitive process to information from a single sonobuoy at a time. Experience and training may allow the operator to process the information faster and more accurately, but their capacity is still limited.

BENEFITS

Trained AI can assist AWOs in the training and operational context. Confidence values with those explanations would further involve the human trainee in the situation. Flag officers have recently requested that information that AI systems output should come with a confidence factor as standard practice. Although the trainee would have the final say in all matters, the AI can help scaffold the training so that the trainee has useful information about multiple different variables, and the reasoning why confidence values are what they are.

STATUS

This is an FY21 SBIR Phase I new start.

MILESTONES

- ◆ (3) Phase I Contracts awarded OCT 2020
- ◆ Kickoffs planned for OCT/NOV 2020

DESIGNING NON-PLAYER CHARACTERS FOR INDIVIDUALIZED INSTRUCTION IN ELECTRONIC WARFARE TRAINING SYSTEM (BAR-21-022)

OBJECTIVE

This effort seeks to empirically validate the use of non-player characters (NPCs) for providing instructional interventions to trainees in adaptive training systems. As an instructional feature, NPCs often resemble tutors that facilitate knowledge acquisition by providing feedback and interaction with trainees during their training experience. Expanding on our previous work with NPC designs in EW adaptive training, this effort seeks to understand in what contexts NPCs are most effective in adaptive training, while simultaneously developing diagnostic algorithms to support the effectiveness of NPC-delivered feedback.



Notional feedback algorithm output, showing detailed feedback to trainee (with NPC narrations)

DESCRIPTION

Non-Player Characters (NPCs) are computer-controlled characters that often take the form of an instructor in a training system. Previous research suggests that NPCs facilitate immersion, engagement, and motivation, which subsequently aids learning. This effort adopts a scientific approach to examine the potential short- and long-term learning benefits of training an applied task (Electronic Warfare - EW) with an NPC to provide feedback. Part of this effort will analyze previous data collections with our EW training system to identify task components that would be suitable for feedback. This analysis will support the development of an automated, tailored feedback algorithm, which will drive the NPC's feedback delivery to the trainee. After accomplishing these development goals, we will test the effectiveness of feedback algorithms and NPCs with a research experiment, assessing learning in the short-term and long-term. Additionally, we will examine related factors (such as immersion, engagement, and motivation) to better understand how NPCs can benefit learning. Looking forward, a goal of this effort is to ensure that any improvements we develop (e.g., feedback algorithms, NPC best practices) transition upward into our existing Fleet EW training systems.

NEED

The Navy has emphasized improving the warfighter's ability to monitor the electromagnetic spectrum. The EW Wholeness Campaign has stated that training is needed which can "rapidly improve experience levels of current EW operators." In order to address these concerns, improved training is one of the campaign's primary pillars. Therefore, training is needed which can rapidly improve the experience level and proficiency of current EW operators. The outcome of this effort would directly support

the training pillar of the EW Wholeness campaign by providing evidence for the inclusion of advanced instructional techniques in EW training systems.

BENEFITS

his research will help to understand not only an NPC's role in knowledge acquisition, but also the longer-term effects on retention. If the NPC serves to make training more engaging and immersive while also improving learning outcomes, and helps trainees retain their knowledge after time away from training, then this would be an effective instructional strategy to implement. Understanding how best to implement NPCs in training systems will help the Navy build more effective and efficient training 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. For instance, while this research is using a UAV-inspired research task, its findings will be applicable to air, surface, and undersea platforms. In particular, the algorithms developed in this proposal could immediately transfer to our currently deployed systems under the Electronic Warfare Micro-adaptive Trainer (EW-MAT) program.

STATUS

In FY21, the research team will develop the conceptual framework for NPC instructional interventions, identifying ways in which an NPC intervention could be useful within existing EW training simulations. This includes identifying the types of content an NPC intervention could be useful for teaching, as well as the units of data that would inform the algorithm for providing an NPC intervention. This groundwork will culminate in an experimental plan to be conducted in FY22 to scientifically evaluate the efficacy of NPC instructional interventions.

PROJECT DURATION

OCT 2020 - SEPT 2021

SPONSOR

Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: BAR

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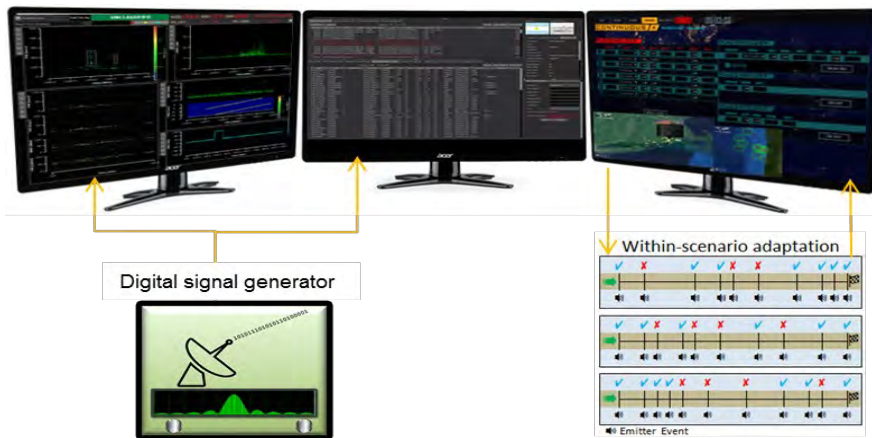
MILESTONES

- ◆ In FY21:
 - ◇ Develop conceptual framework for NPC instructional interventions
 - ◇ Analyze prior data to design and finalize instructional algorithms
 - ◇ Prepare detailed experimental plan
- ◆ In FY22:
 - ◇ Collect experimental data
 - ◇ Develop transition plan with customer to transition instructional algorithms to on-board training
 - ◇ Prepare results for publication and conference presentation
 - ◇ Sep 21: Prepare complete technical documentation package for the system at initial operational capability

ELECTRONIC WARFARE—MICRO ADAPTIVE TRAINING (EW-MAT)

OBJECTIVE

The main objectives of this Future Naval Capability (FNC) are to (1) create validated micro-adaptive training algorithms to diagnose the strengths and weakness of operators in real time as they perform actions using the on-board tactical system, (2) develop a digital signal generator that will inject realistic signals in an on-board trainer, (3) evolve the state-of-the-art in EW hardware and software to create a common EW framework for air, sea, and undersea platforms.



PROJECT DURATION

SEP 2017 - DEC 2021

SPONSORS

Office of Naval Research, ONR-31

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DESCRIPTION

The research team will develop a training architecture within ONR's Rough Squid EW Sandbox that allows operators to perform actions using the on-board tactical system hardware/software. The architecture will support a digital signal simulator to inject realistic and robust signals representative of advanced EW sensors along with micro-adaptive training algorithms to diagnose the strengths and weaknesses of operators in real time during training.

NEED

Submarine EW operators provide critical, time-sensitive information for maintaining ship safety and avoiding counter-detection. Yet there is no current capability for embedded, on-board adaptive training for Electronic Warfare (EW) operators. As described by the Submarine Force Electronic Warfare Wholeness Campaign, training is needed which can "rapidly improve experience level of current EW operators." Furthermore, the Submarine Tactical Requirements Group (STRG) recently has recommended Adaptive Training (AT) to fulfill critical training gaps (requirement STRG-TRG -0(1)).

BENEFITS

Research has demonstrated that AT systems lead to improved performance while requiring less training time. These outcomes provide the potential to enhance training for submariners by improving the Navy's ability to provide tailored, individualized instruction to operators, and therefore enhancing readiness, without increasing the Submarine Force's overall training costs, time, or number of instructors. Additionally, investing in a cross-platform training solutions (e.g., the digital signal generator), will lead to more highly trained operators in the Fleet capable of managing increasingly complex RF environments. Thus allowing the Navy to maintain its maritime superiority and decisive edge.

STATUS

The first major development thrust involves expanding upon the adaptive training service modules, scenarios, network interfaces, and user interfaces that were developed in the Submarine EW Adaptive Trainer (SEW-AT) effort and incorporating them natively into Ghost Rider Analyst Spectrum Publisher (GRASP). Additionally, we are tackling several S&T challenges including the appropriate design of adaptive training (in terms of instructional content and adaptive scheduling) and its performance impact/training value.

MILESTONES

- ◆ Demonstrated SEW-AT to PEO Submarines and PEO IWS5 on 13DEC19
- ◆ Invited to participate in the Submarine EW Tactical Advancements for the Next Generation (Sub EW TANG) Training Community Day on 18FEB20. The team presented program status and provided a SEW-AT demo to PMS-435, UWDC, SLC, etc.
- ◆ Completed implementation of experimentation testbed and began data collection on first experiment (of two) to address S&T challenges associated with adaptive scheduling and goal-setting feedback.
- ◆ Designed the EW Report Human Machine Interface that will be integrated into the AN/BLQ-10 tactical system.

Marraffino, M. D., Schroeder, B. L., Fraulini, N. W., Van Buskirk, W. L., Johnson, C. I. (2020, accepted). Adapting Training in Real Time: An Empirical Test of Adaptive Difficulty Schedules. To appear in *Military Psychology*.

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ENHANCING AVIATION ANTI-SUBMARINE WARFARE TACTICAL READINESS ANALYSIS (TT-21-008)

OBJECTIVE

The objective is to provide the Maritime Patrol Reconnaissance Force (MPRF) with comprehensive, high-fidelity, filterable, and tagged real-world submarine prosecution data within the existing SIPR post-mission database system, PMATT-TA (Post Mission Assessment for Tactical Training and Trend Analysis).



Improving anti-submarine warfare training requires collecting higher quality data

PROJECT DURATION

OCT 2020 - SEPT 2022

SPONSOR

Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: Tech Transition

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DESCRIPTION

Advanced analytic technologies leveraging the cloud, artificial intelligence, and data science are only as effective as the quality of the data they synchronize, integrate and analyze. A challenge with implementing these technologies is the reliability, validity, quality and gaps in the underlying data. This effort will conduct a technical analysis of the current fidelity of high-impact prosecution data, identify missing critical data sources, and pursue opportunities to increase data quality and availability to the MPRF. The goal will be to demonstrate critical performance parameters of data analytic software for post-mission reporting that is currently complicated by each Fleet having different reporting requirements and repositories, and spanning multiple areas of Operation that make standardization and tracking difficult.

NEED

With the prevalence of big data analytics and artificial intelligence throughout the Department of Defense, there's a

scientific urgency to ensure these efforts are setup for success early.

BENEFITS

Success of this effort will enable the MPRF community, and associated organizations, access to full PMATT-TA timelines and data sets of their most relevant and critical Anti-Submarine Warfare events. Enabling full trend and tactical analysis transparency will inform decision makers with highly relevant real-world data and can allow them to further develop training to ensure limitations are being addressed and fulfilled. Members of the MPRF community are already taking stock of what data sources they have access to, in order to try and answer tactical and training questions. Although data exists, it resides in multiple data repositories, with varying levels of fidelity and quality; organizing and ensuring high fidelity data is critical.

STATUS

This is an FY21 approved new start.

MILESTONES

- ◆ FY21:
 - ◆ Identification of one recent high-priority prosecution timeline
 - ◆ Fleet discussion to determine pre-implementation analysis and reporting
 - ◆ Conduct initial gap analysis based on availability and location of required data
- ◆ FY22:
 - ◆ Expansion of year-one work to additional full prosecution timelines
 - ◆ Conduct post-implementation comparative results analysis to show the benefit of high-fidelity input data
 - ◆ Final Report: Provide MPRF stakeholders with comparative results, as well as recommendations and lessons learned.

FUTURE INTEGRATED TRAINING ENVIRONMENT (FITE)

OBJECTIVE

The purpose of the FITE effort is to meet the needs and demands of the United States Marine Corps (USMC) by addressing the technical challenges associated with linking air and ground simulations for providing integrated training capabilities. The FITE effort enables existing and future disparate simulation components to communicate efficiently and operate together in an integrated manner to enhance warfighter capability with a specific focus on Close Air Support. This effort also develops virtual reality integrated training solutions for Joint Terminal Attack Controllers (JTAC).



FITE Integrated Virtual Reality Training solutions for Close Air Support: JTAC Virtual Trainer (left), Viper Virtual Trainer (right)

PROJECT DURATION
JAN 2017 - MAR 2021

SPONSORS

Office of Naval Research
ONR-34

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DESCRIPTION

The FITE effort supports the Marine Corps Live, Virtual, and Constructive-Training Environment (LVC-TE) program by addressing the technical challenges associated with linking air and ground simulations. FITE is comprised of two main components: the Synthetic Battlespace Service (SBS) and the Synthetic Environment Service (SES). FITE SBS provides an extensible service that allows dissimilar simulation components to effectively interact with one another in real-time, based on what each simulation requires for the training event. FITE SES synthesizes and fuses terrain generation capabilities across dissimilar simulation systems to facilitate an integrated and interoperable training environment. The FITE effort has also developed the JTAC Virtual Trainer (JVT) that provides portable training for JTACs in a virtual environment that can utilize SBS to provide integrated training capabilities.

NEED

USMC Leadership, via a Deliberate Universal Needs Statement (DUNS), expressed a requirement for a distributed mission operations (DMO)-capable training simulator capability for Joint Terminal Attack Controllers (JTAC), Joint Forward Observers, pilots and aircrews to train effectively in a common, simulated operating environment. This requirement is also reinforced by the Marine Air Ground Task Force (MAGTF) Fires Operational Advisory Group (OAG) Tactical Air Control Party (TACP) Simulation recommendation to have "full TACP simulation

interoperability and interoperable distributed mission training with Aviation Combat Element (ACE) and Joint Systems."

BENEFITS

The FITE effort will enable existing and future disparate simulation components to communicate efficiently and operate together in an integrated manner, thus meeting the training needs and demands of the USMC fires community and leadership.

STATUS

The current FITE system includes the integration/interoperability of the USMC Deployable Virtual Training Environment - Combined Arms Network (DVTE-CAN) and Virtual Battlespaces (VBS), The JTAC Virtual Trainer, and the ONR Warfighter Augmented Reality (WAR) system. Throughout FY20, significant progress was also made on FITEware Adaptors (for bridging, filtering, and enumeration conversions), the JTAC Virtual Trainer (JVT), terrain generation, maintaining the Set-Repo terrain repository, and dynamic environment services. Many demonstrations and interactions have occurred with USMC stakeholders and users communities.

The remainder of the effort will focus on exit criteria testing and incorporating FITEware SBS and SES technologies into the USMC Live Virtual Constructive Training Environment (LVC-TE) Program of Record for transition. The team will also conduct an evaluation event for JVT at MAWTS-1 in Jan 2021.

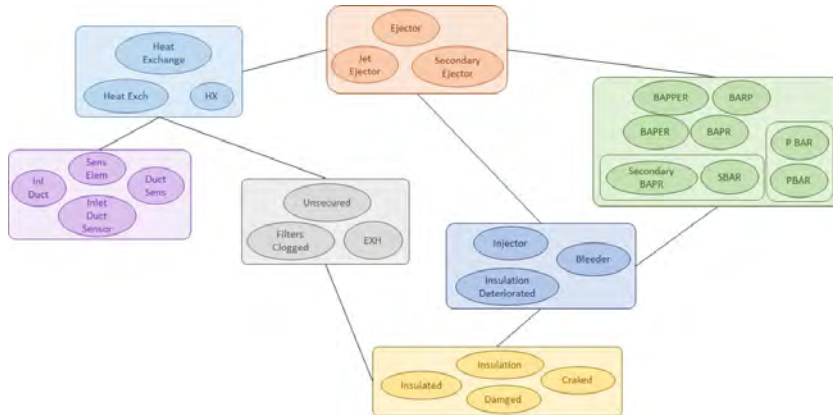
MILESTONES

- ◆ Demonstrations, training and interactions at: 10th Marines, 11th Marines, 29 Palms Battle Sim Center, MAWTS-1, 1st Anglico, School of Infantry West, School of Infantry East, IITSEC, EWTGPAC, EWTGLANT, LVC-TE, and OASIS
- ◆ 20+ JTAC Virtual Trainer prototypes and/or FITEware software deliveries deployed to various USMC organizations
- ◆ Launched set-repo.org for sharing high fidelity virtual terrains
- ◆ Delivered FITEware to the LVC-TE team to begin Exit Criteria testing

LEXICAL NORMALIZATION TO FACILITATE INFORMATION EXTRACTION OF NAVY TEXT (BAR-20-025)

OBJECTIVE

Develop and evaluate Navy-specific unsupervised Natural Language Processing (NLP) models to improve the handling of domain specific terms, abbreviations, and anomalies that are present across Navy enterprise free text responses, such as maintainer logs. The second objective is to evaluate the ability of the resulting trained models to generalize to other Navy text domains.



Representation of lexical relationships of some Navy-specific language.

PROJECT DURATION
OCT 2019 - SEP 2021

SPONSORS

Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: BAR

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DESCRIPTION

Proven unsupervised natural language processing models for Navy text facilitates faster information extraction from maintenance logs. First though, the text must be cleaned (e.g. identify acronyms, fix typing errors) then semantic meaning must be extracted. These will enable identification of the documented reason for the maintainer action, what action they took, and what aircraft part(s) were involved in that action. These tasks can be embedded within a larger system for more robust identification of patterns within other corpora. Increasing robustness and thoroughness in the analysis of aircraft health and maintenance actions is necessary to transition towards prescriptive maintenance.

NEED

The Navy produces significant amounts of unstructured, human-generated text which contain issues (e.g. typos in maintenance reports and repetition in training) that are roadblocks to making use of automated techniques for search and understanding.

Supervised training methods can be costly, especially if repeated across domains. Unsupervised models that can generalize across Navy domain spaces can reduce cost and provide greater use case opportunities. The resulting unsupervised NLP algorithms generated and proven by this effort will improve and broaden the use of advanced machine learning applications on Navy text data

BENEFITS

These models will improve the extraction of information for effective search and understanding of the data, and enable the effective use of the data within machine learning applications

STATUS

This is an ongoing effort from FY20.

MILESTONES

- ◆ **FY20:**
 - ◇ Implement unsupervised algorithms for lexical normalization
 - ◇ Evaluate lexical normalization models on tagged text
 - ◇ Present results at Navy Applications of Machine Learning workshop
 - ◇ Build Natural Language Processing library code for others to use
- ◆ **FY21:**
 - ◇ Evaluate tokenization algorithms on tagged Navy text
 - ◇ Evaluate document embedding algorithms
 - ◇ Customize text feature extraction code for Navy text
 - ◇ Update library code with best results
 - ◇ Author technical report

MARITIME PATROL RECONNAISSANCE AIRCREW COMMS TRAINER: RADIO OPERATIONS GUIDANCE AND EDUCATION RESOURCE (ROGER)

OBJECTIVE

Develop a prototype web-based application to facilitate instructorless radio communication training. Develop a basic-to-advanced training technology that provides access from early Category 1 students to post-Fleet Replacement Squadron (FRS) training to complement existing training solutions.



ROGER Prototype Testing and Demonstration Event at Jacksonville, FL

PROJECT DURATION
JUN 2019 - DEC 2020

SPONSOR
Office of Naval Research (ONR)
ONR Global: TechSolutions

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DESCRIPTION

The Maritime Patrol Reconnaissance Aircraft (MPRA) community identified a skill gap in proper and efficient radio communication. Despite heavy reliance on chat communications within U.S. only operations, voice remains predominant in cross-domain & multi-national operation. This effort seeks to design and develop a web-based application with a simple user interface that provides a capability to listen to good examples of communications of specific report types. The technology focuses on communication completeness and brevity, with a focus to assess automatically language disfluency.

NEED

There is a lack of radio communications-based training for the MPRA community. Though Crew Resource Management and inter-aircrew communication are a focus of current individual and team training environments, there are limited opportunities to engage in training communication skills with other airborne, command and control, or tasking agencies in the current curriculum.

BENEFITS

The development and continued iterative testing of ROGER will provide VP-30 early Category 1 Co-Tactical Coordinator (COTAC) students to post-Fleet Replacement Squadron (FRS) Aircrew a program to practice and gain experience delivering brief and clear radio communication, without the need for an instructor. The prototype system allows students to practice in an increasingly more robust tactical environment, which can be expanded in the future to include realistic interfaces and voice-interactive role-players.

STATUS

FY19-20 efforts focused on the design and development of the web-based ROGER prototype, including the capability to analyze and store structured automatic speech recognition (ASR) results. Three courses developed demonstrate the range of content capabilities. FY21 delivery and testing of the ROGER prototype are underway. Future work includes expansion of speech analysis capabilities, performance assessment and learning management, and end-user scenario authoring.

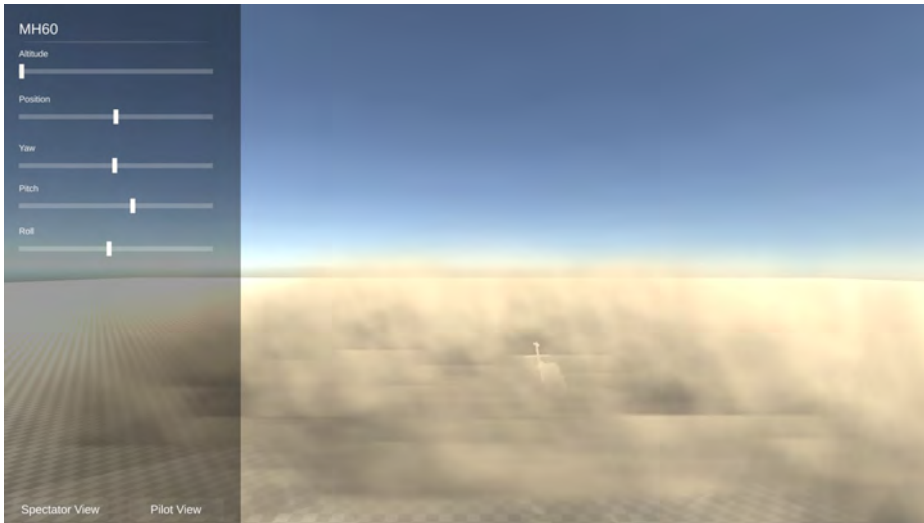
MILESTONES

- ◆ Project meetings to evolve design including a Preliminary Design Review (SEP 2019) and Critical Design Review (DEC 2019)
- ◆ Awarded an Indefinite Delivery Indefinite Quantity (IDIQ) contract for cybersecurity support (AUG 2019)
- ◆ A Technology Transition Agreement (TTA) was signed by NAWCTSD, the Small Business Innovative Research (SBIR) office, and PMA-290 to support a cluster of three (3) parallel Phase II efforts to research and develop modular technologies for ROGER
- ◆ Iterative system testing and development was conducted throughout the project to refine the system, including an initial system demonstration and review (FEB 2020) and a virtual fleet demonstration (JUN 2020)
- ◆ Initial informal usability testing conducted to refine system user interface (AUG-SEP 2020)

MISHAP AWARENESS SCENARIOS AND TRAINING FOR OPERATIONAL READINESS RESPONSES (N172-117): WING MISHAP AWARENESS NARRATIVES (WINGMAN)

OBJECTIVE

Develop a customizable software program that provides outputs to result in a suite of training tools and technologies that support recreation of aviation mishap events to convey lessons learned and improve safety training through classroom based videos and interactive, immersive visualization techniques.



User interface Demonstrating Development of Brownout / Whiteout Scenario.

PROJECT DURATION
SEP 2017 - FEB 2022

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)

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DESCRIPTION

Advances in virtual reality and computer graphics make it possible to create a software program that allows the user to set a scenario based off of mishap data to recreate mishap events for training leveraging a range of media. The Navy seeks a single scenario development technology that provides inputs to develop a range of training opportunities that are consistent and require minimal investment by the program to continue to expand mishap training scenarios. This system should allow for the development of new scenarios, as well as provide an ability to modify previously created scenarios within the tool through a simplified user interface.

NEED

Spatial disorientation (SD) and situational awareness (SA) are significant contributing factors to the majority of aviation mishap events. The aviation survival training community has requirements to provide sensory physiology/situation awareness training; however, the current training is predominantly classroom based instruction that leverages videos which are not easily updated as new platforms or situations occur.

BENEFITS

Providing a more immersive range of training opportunities will allow for more trainee experience and engagement and likely improve the fidelity and appropriateness of the training. Operator performance will also increase through the ability to better recognize and/or implement emergency procedures when experiencing SD/SA situations, creating safer and more effective warfighter operations.

STATUS

This SBIR has undergone competitive source selection resulting in a single Phase II effort - WingMAN. The development team has continued to refine the scenario authoring tool based on end user feedback to increase usability and increase efficiency. System capabilities have been expanded with support for 360 video export. Continued development of baseline scenarios continue and include lead aircraft roll illusion, black hole illusion, and reduced / absent visual cues scenario.

MILESTONES

- ◆ During Phase I efforts, kickoff meetings were held with four (4) vendors, closeout briefs including technology demonstrations; as a result of performance, a gated Phase II approach was selected resulting in award of three (3) Phase I Options
- ◆ Phase II base efforts included kickoff meetings and Phase II base out brief meetings with three (3) vendors to include demonstrations of prototype capabilities with aviation survival training end users (AUG 2019) to evaluate progress for selection of option funding
- ◆ Technology demonstration was provided to Rear Admiral Luchtman (FEB 2020)
- ◆ Phase II option funding was provided to a single vendor, who continued development efforts in FY20 and conducted a virtual demonstration and status update to stakeholders in NOV 2020

MOBILE AVIATION SURVIVAL TRAINING CENTER APPLICATION AND SMARTBOARD SCENARIO-BASED TRAINING TOOLBOX (219TT-RPC-007)

OBJECTIVE

Provide a mobile technology architecture for students and instructors to modernize and augment current survival training by allowing users to access domain relevant content on topics to reinforce classroom and laboratory training solutions. Instructor capabilities will include authoring new modules, and easy assessment of student needs and feedback.



Students Receiving Instruction on Basic Parachute Landing Techniques

PROJECT DURATION
OCT 2020 - SEPT 2022

SPONSOR
Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: RPC

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DESCRIPTION

The aim is to design a web-based application to include course content including specific scenario-based training to students, highlighting real-life occurrence bailouts to hold discussion-based lessons. The proposed baseline technology provides a lightweight, web-deployable training system that is capable of supporting adaptations based on trainee performance. This aspect of the system provides flexibility to support both instructor led as well as instructor-less training capabilities that can adjust based on implementation needs. Additionally, this training tool will include an authoring mechanism for instructors to create supplemental lessons to enhance classroom learning.

NEED

The aviation survival training community currently has no means for reinforcing the survival training that occurs once every four years, nor do they have a means for developing training content that is current and collecting feedback from trainees on the effectiveness of the training. The mobile

application is intended to directly address these three areas of need.

BENEFITS

The mobile application has the potential to advance aviation survival training by providing a means to reinforce the training that happens infrequently. Thus, the application has the potential to save lives by ensuring aviators are well-equipped to deal with emergency scenarios. Additionally, the application offers a means for the continual advancement of survival training at the Aviation Survival Training Centers (ASTCs) by offering training effectiveness assessments and content generation capabilities.

STATUS

This is an FY21 new start effort. Internal development team kickoff meeting planned for NOV 2020 in collaboration with industry partners to understand technology baseline and refine concepts for requirements and development efforts. Stakeholder kickoff and requirement meeting anticipated in DEC 20.

MILESTONES

- ◆ Year 1: Develop system architecture and provide report of relevant course material to be integrated into the system
- ◆ Year 2: 1) Conduct usability study on the mobile application and scenario-based training toolbox to finalize the system architecture and provide a prototype demonstration to the ASTC in Pensacola, 2) document results of fleet experimentation on system effectiveness, lessons learned, and recommendations and 3) Concept of operations (CONOPS) documentation

MULTI-DOMAIN DATA FUSION INSTRUCTIONAL STRATEGIES AND METHODS (N202-112)

OBJECTIVE

Research and develop training objectives for the multi-domain environment and instructional strategies for manned-unmanned data fusion tactical decision making. Research and develop instructional tools that support defined strategies and methods to increase operator training effectiveness and mission readiness.



Next Generation F-35 Fighters

PROJECT DURATION
OCT 2020 - OCT 2021

SPONSOR
NAVAIR Small Business Innovation
Research Program

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DESCRIPTION

Operator reliance on sensor fusion is becoming more prominent as platforms increase reliance on automated technology in next generation platforms. Further, as programs look to extend platform capabilities through off-board, unmanned sensor technology and capabilities, requirements for operator synthesis of data and decision-making based on manned-unmanned collaboration will become an essential part of operations. As these technologies advance, training systems must identify appropriate instructional strategies and training methods to ensure that operators understand the implications of automated technologies .

NEED

As the Navy increases the use of data fusion technology on manned and unmanned platforms, the operator must have appropriate training and sound human factors interfaces to increase safety and operator performance. Further, the multi-domain nature of the future battlespace requires technology fuse data from multiple heterogeneous sensors with

overlapping coverage areas, which increases the complexity of interpretation of data outputs for operators. These emerging capabilities create new training challenges that must be addressed early in the training cycle.

BENEFITS

Increased efficiency of training via targeted instructional strategies and sound human factors interfaces would increase transparency of automated systems in a way that will minimize workload impacts, resulting in increased operator performance. Additionally, advanced instructional strategies and training methods will ensure that operator understand the implications of advancing automated technologies .

STATUS

This is an FY21 SBIR Phase I new start.

MILESTONES

- ◆ Phase I SBIR contracts awarded OCT 2020 to (3) companies.
- ◆ Kickoffs conducted with stakeholders in OCT 2020

NAVAL AIR TECHNICAL TRAINING CENTER (NATTC) AIR TRAFFIC CONTROL FUNDAMENTALS LAB

OBJECTIVE

Build, test, and deliver a new Air Traffic Control Fundamentals Lab Trainer, which will be utilized for Air Traffic Control "A" school (ACA1) located at NATTC, Pensacola, FL.



PROJECT DURATION

APR 2019 - SEP 2021

SPONSORS

Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: BAR

Naval Aviation Training Systems Program
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DESCRIPTION

The new training system will allow the airfield, aircraft, and ground vehicles to be visualized in a virtual environment. The system will allow highlighting of aircraft, airfield features, and vehicles to help target class discussion and focus on the specific aspects of the training. An Instructor Operator Station (IOS) will be created to allow instructors to dynamically create/load scenarios. The system will be able to play, pause, and resume scenarios, allowing them complete control of the scenario to add discussion points during training.

The system will allow multiple roles to be played simultaneously. Allowing more than three students to participate in training at a time. This will actively engage more of the class and allow the students to greatly increase their hands-on time with the system. The system will include speech recognition for student phraseology. This will allow trainees to practice their voice commands without increasing instructor workload. This tool could also be broken off as a standalone system for afterhours practice. The system will include the communications and VIDS systems, so students can learn what they'd expect to see when they transition to the tower simulator.

NEED

The current Air Traffic Control Static Lab requires instructors and students physically move models of aircraft and vehicles around a

table top depiction of an airfield. The trainer does not have role player automation, the ability to train phraseology, and trainer capacity is limited to 3 students (out of 14) at a time. These deficits have led to delays in student skill acquisition (e.g. inability to complete the advanced tower simulator) and increased training attrition rates (currently at 37%).

BENEFITS

With an average of 650 students trained per year, the high attrition rates are not sustainable. This updated trainer will increase trainer efficiency, reduce instructor workload, and give students five times more hands on practice time during Phase 1 of training. This coupled with earlier introduction to ATC Tower tools like the radar, VIDS, and EVTS systems will increase student performance in Phase 2 of ATC Training and reduce the attrition rates for the overall course.

STATUS

A prototype of the trainer was developed and demonstrated in the lab in FY19. The team installed the trainer at the schoolhouse in FY20 and will be targeting IOC after the first quarter of FY21 and FOC by the end of FY21.

MILESTONES

- ◆ Prototype for NATTC Review 4th Quarter FY19
- ◆ Initial Operational Capability FY20
- ◆ Final Operational Capability FY21

ON DEMAND TRAINING SOLUTIONS FOR MAINTENANCE TECHNICIANS (N193-Do1)

OBJECTIVE

Develop an adaptive training environment with integrated capabilities to assess performance of skills that is scalable to operational maintenance department training needs and flexible to instructor-in-the-loop to instructor-less practice.



Aviation Machinist performs maintenance on an MH-60S Sea Hawk assigned to the "Sea Knights" of Helicopter Sea Combat Squadron (HSC) 22 aboard USS Detroit (LCS 7)

PROJECT DURATION
AUG 2020 - AUG 2022

SPONSOR
NAVAIR Small Business Innovation
Research Program (SBIR)

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DESCRIPTION

Sailors will commonly go through "A" school and "C" school, to receive advanced training and earn a Navy Enlisted Classification (NEC), only to spend years away from the system they were taught to maintain. This is often the case when Sailors go to shore duty, and then return to the operational unit where the skills they had have become eroded. While the Navy is working toward extending first shore tours to provide more experience to maintainers early in their careers, providing on demand capabilities throughout the training pipeline to include operational tours is critical for minimizing skill decay, and ensuring proficiency at the time skills are required.

NEED

Rear Adm. Roy Kelley, stated Class C mishaps have doubled in the Navy since 2012 and involve upwards of \$50,000-\$500,000 in damages or nonfatal injuries. Ensuring maintainers have the tools required to react to maintenance issues is a crucial part of addressing the cause-or-effect relationship maintenance has in mishap incidence. Previous

efforts by the Navy to invest in readiness-builders, including increased inventory of spares, maintenance, and logistics, have shown positive gains. However, investment in ready relevant training solutions and capabilities for assessing performance of skills are necessary.

BENEFITS

An on demand training solution will provide maintenance technicians refresher training capabilities on topic-based and standardized recurring training at the squadron level. This would also save training dollars and improve readiness. Introduction of training at this level fills a gap associated with infrequent maintenance tasks, complex maintenance repairs, and emerging recurring maintenance trends .

STATUS

This effort is currently in a Phase II, with two (2) vendors developing alternative technologies. During Phase II, vendors will design and develop a prototype of the integrated training system for demonstration to stakeholders.

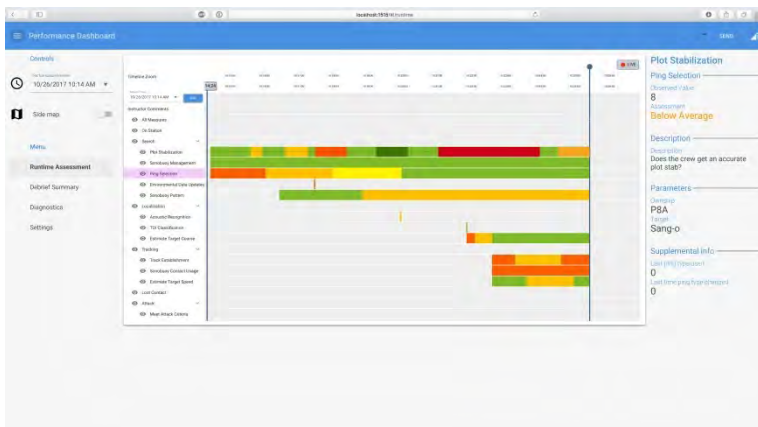
MILESTONES

- ◆ Kickoff meeting was held with stakeholders including Naval Air Warfare Center Training Systems Division and PMA-205
- ◆ Coordination is underway with multiple user groups to refine design and development of prototypes

POST-MISSION ASSESSMENT FOR TACTICAL TRAINING & TREND ANALYSIS (PMATT-TA): SIMULATION-BASED TRAINING TOOLS

OBJECTIVE

PMATT-TA implements instructional tools for simulation-based training to increase training effectiveness and efficiency automated performance measurement and assessment capabilities that support post event reporting and trend analysis, facilitating a better understanding of aircrew performance and proficiency.



The PMATT-TA Increment 2 instructor interface provides a timeline display with quick access to automated, system-based performance measurement results

PROJECT DURATION
OCT 2010 - APR 2021

SPONSORS

PMA-290; PMA-205;
Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: TT
Office of Naval Research (ONR); NAVAIR
Small Business Technology Transition (STTR)

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DESCRIPTION

PMATT-TA efforts for simulation-based training tools targets research, development and implementation of a automated system-based performance measures, increased automation for post mission reporting, and technology to support community sustainment and development of performance measures as tactics, techniques, procedures, and mission tasking evolves.

NEED

A Statement of Urgent Need (CPRG, JUN 2010) highlighted the lack of existing Navy products to support force-wide Anti-Submarine Warfare training assessment. The call cited the lack of centralized performance data as the key limiting factor that needed to be address with objective, outcome-based performance data to understand aircrew performance based on measures that provide force-wide tactical proficiency and support targeted remediation via training solutions.

BENEFITS

PMATT-TA's simulation-based training tools increases the reliability and standardization in performance feedback provided to aircrew. PMATT-TA will also assist stakeholders in accurately gauging fleet readiness and competencies in a streamlined and easy-to-use way based on the results of observer and system-based performance measures. The final product seeks to provide a novel technology to view trends in training and performance, ultimately allowing for more informed decision making and proficiency tracking.

STATUS

The effort received FY20-21 funding from PMA-205 and PMA-290 to facilitate a software build that is compatible with a new software architecture (NIS 1516), implements new performance measures, and delivers a Performance Measure Workbench software capability. The funding also supports iterative usability analyses and research to inform the Concept of Operations (CONOPS) and performance measures pertaining to new combat systems capabilities.

MILESTONES

- ◆ **Manuscripts/Publications:**
 - ◇ Atkinson, Tindall, Killilea, Anania. (2018). Advancing performance assessment for aviation training. Proceedings of AHFE.
 - ◇ Atkinson, Tindall, Killilea, Tolland, & Dean. (2017). Standardizing human performance measurement for ease of data analytics. Proceedings of the IITSEC.
 - ◇ Tindall & Atkinson. (2019). Standardizing performance measurement while ensuring psychometric validity . Proceedings of the IITSEC.
- ◆ **Presentations:** Demonstration exhibit at IITSEC 2017.
- ◆ **Workforce Development:** Mentored junior teammates on program management, interaction for transition, usability analyses, and coordination with fleet customers.
- ◆ **Transitions:** Transition of PMATT-TA Performance Dashboard to PMA-290 with APN funding in FY18-FY21.

REMARKABLE DATA SOURCES IMPROVED DEBRIEF AND TREND ANALYSIS ACROSS THE TRAINING PIPELINE

OBJECTIVE

Create a suite of usable, flexible tools that can import, tag, and format data to enable fusion, interpretation, and analysis of needed data for training to include F/A-18 aircraft mission/maintenance data and audio communication.



Google Images of F/A-18 Aircraft, Radio, and Mission Card

PROJECT DURATION

JUN 2020–SEP 2021

SPONSOR

Office of Naval Research Global
TechSolutions

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DESCRIPTION

Development under this effort will include machine learning algorithms to train models to recognize patterns in the data and interpret communications to enable the association of raw, live data (e.g., RM AMU data, SHARP data, NALCOMIS) with other objective data currently being used (e.g., timelines and events) in debrief to better assess training outcomes. Ultimately, we will provide a suite of tools, within Next Generation Threat System Analysis and Reporting Tool (NGTS ART), that will allow the Naval Air Warfare Development Center (NAWDC) and other Fleet users to ingest, tag, interpret and fuse data with contextual information from exercises in a common database for analysis of training to include F/A-18 aircraft mission/maintenance data and audio communication of relevant platform.

NEED

The Integrated Training Facility (ITF) Tactical Air Simulator Requirements document (24 May 2016) specifically calls for instrumentation to allow rigorous comparison of simulator performance to performance data from live flight (e.g., F/A-18 data bus recorder) to track performance, refine Tactics, Techniques and Procedures, refine training syllabi and scenarios, and determine the optimum mix of simulator and live events for training. Moreover, the ITF Tactical Air Simulator Requirements document specifically calls for interoperability with the Air Wing Training Facility

(AWTF). Therefore, both ITF and AWTF have a need to incorporate live data into the NGTS ART to enhance their debriefing capabilities and this effort seeks to provide a baseline capability through inclusion of aircraft data and audio data.

BENEFITS

NAWDC is developing the capability to collect and analyze detailed data on training evolutions. While the data will be collected, much of it will need new tools to be put in useful form. Thus, this effort seeks to fill this gap by adding voice recognition and the capability to read and format F/A-18 mission data collected through telemetry to an existing toolset. This enhanced capability will increase proficiency, readiness, and overall mission by enabling automatic capture and analysis of competency-based, objective performance indices of readiness to improve accuracy of assessment and quality of instruction.

STATUS

All performers received funding at the end of JUN 2020. The program kicked off at this time with stakeholders from NAWDC and PMA-205. Currently, the team is conducting domain analysis activities to refine software design plans. Additionally, the team is working with various stakeholders to gain access to relevant sample data and documentation to support software development.

MILESTONES

- ◆ Kickoff held JUN 2020
- ◆ Domain analysis and software design underway
- ◆ Coordinating receipt of voice, mission/maintenance card data

RESPOND: MH-60R COMMUNICATIONS TRAINER

OBJECTIVE

Provide a game-based software solution that enables aircrewmembers to practice communication procedures in an immersive and relevant environment that can communicate back to the student, as well as provide debrief information .



Scorpions of Helicopter Maritime Strike Squadron (HSM) 49, identifies and tracks surface contacts at a sensor operator console aboard an MH-60R (JUL 2017)

PROJECT DURATION

MAY 2020 - MAY 2022

SPONSOR

Office of the Secretary of Defense (OSD)
U.S. Department of Defense (DoD) Rapid
Innovation Fund (RIF)

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DESCRIPTION

Respond is a training system designed to allow aircrewmembers to converse with speech-enabled agents and the ability to manipulate relevant displays within the aircraft during mission execution. This system will have multiple impacts on the H-60R community: 1) increase the proficiency and confidence of aircrewmembers when speaking on the radios; 2) provide a visual environment for part task training, and 3) leverage external simulation engines to properly model the fidelity of training scenarios as appropriate .

NEED

Aircrewmembers are seldom afforded sufficient real world opportunities to communicate during training, reducing their impact to crew performance and increasing the time it takes to reach full proficiency. Pilot training drives nearly all scheduling decisions, and aircrewmembers are paired with pilots based on training needs. There are few opportunities to have dedicated flights based on communication-based proficiency, and aircrewmembers have limited tools at their disposal to conduct self-training. Generally, two students will practice together, resulting in a low level of

standardization, and no quality checks. Content and scenarios largely rely on student imagination current knowledge. There is a need for greater standardization and a more formalized way for aircrewmembers to practice communications, as well as receive feedback regarding their performance on communication metrics.

BENEFITS

Respond will provide a standardized and structured way for aircrewmembers to practice various communications, and receive feedback without the need for an instructor. This allows for value-added training without overburdening instructors or requiring classroom-specific time for the addition of communications-based training in the MH-60R aircrewmembers course of instruction .

STATUS

In FY20, a contract award was made to initiate design and development. Rapid integration of modular baseline capabilities was conducted to facilitate an early prototype demonstration during the program kickoff.

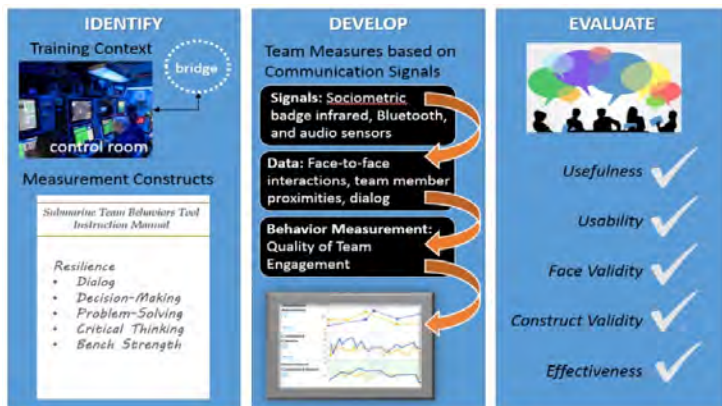
MILESTONES

- ◆ Contract award was made to the small business for design and development.
- ◆ A kickoff meeting was held with stakeholders at PMA-205, PMA-299, fleet squadron/wing personnel, and NAWCTSD in JUL 2020; demonstration of rapid prototype that integrated modular capabilities from Small Business Innovation Research efforts was provided with positive feedback from fleet stakeholders
- ◆ Coordination is underway to collect relevant publications and gain access to subject matter experts for interviews to inform iterative development of underlying speech capability and user interfaces
- ◆ Add high level FY21 Milestone of what will be achieved
- ◆ May 2022: Provide HSM Community with prototype game-based S/W solution to enables aircrewmembers to practice communication

TEAM-BASED ADVANCED RESILIENCE ACCELERATOR (TARA) OSD10-CR3

OBJECTIVE

Develop a prototype system called Team-based Advanced Resilience Accelerator (TARA) for unobtrusively and objectively measuring teamwork and team resilience behaviors. In addition to measuring performance, TARA will also provide descriptive and prescriptive feedback to training instructors to aid them in providing feedback, developing an After Action Review, and providing recommendations for training scenario adaptation to target areas of weakness within the team.



TARA system concept

PROJECT DURATION

SEP 2017 - SEP 2020

SPONSORS

Naval Aviation Training Systems Program Office, PMA-205

Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)

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DESCRIPTION

This research and development effort will expand on existing solutions to develop TARA, a team behavior measurement and feedback system that will support coaching, mentoring, training, and self-assessment of team skills. Ultimately, TARA will support performance assessments over time to allow instructors and teams to discover the deep connections that exist between their actions, the task conditions, and outcomes, which will provide them with the foundation they need to act and make intuitive decisions as a resilient team. The TARA system is comprised of Submarine SPOTLITE, for online assessments and immediate performance feedback, and Learning Locker, for storing and tracking team performance over time. Together, these provide benefits for instructor and trainee in terms of understanding a team's strengths and weaknesses, and by using this knowledge to select the optimal training path for the team.

NEED

NAE Science & Technology Objective Alignment: 10. Naval Warfighter Performance (NWP) Capability Gap (10.1 NWP STO-1: Training and Education) Submarine Learning Center expressed an interest in streamlining and enhancing team assessment and team training within scenario simulation trainers and provided a letter of support for this effort. TARA will result in the accelerated development of resilient team skills that are needed for the team to perform effectively and efficiently when on duty. Performance assessment and targeted/ adaptive training is needed to accelerate these skills, but instructors are already overworked in these environments. Providing tools to assist the instructor are needed; TARA meets this need.

BENEFITS

The proposed work will benefit the Submarine Force by providing advanced resilience training to tactical teams at all five levels of training practices: Formal Schools, Formal Qualification, Continuing Training, Inspection and Certifications, and Self-Assessment. These teams will be better equipped to recognize danger and seize opportunity in times of uncertainty, as well as being able to adapt to changing situations. This effort aims to improve the effectiveness and efficiency of training by improving assessment quality and feedback, tailoring training experiences based on past performance, and potentially reducing training time by excluding learned activities.

STATUS

The Contract for this effort was awarded Sept 2017. The first annual technical review of this effort took place Sept 2018. The FY19 effort involved the software development and integration of the tools to include live performance tagging, team member self-assessment, and AAR capabilities. FY20 culminated in the final delivery of the TARA Prototype system to the Integrated Submarine Piloting and Navigation Trainer/Submarine Bridge Trainer (ISPAN/SBT) at the Submarine Base New London, including final demonstrations to instructors and course leads and technology demonstrations at the Interservice/Industry Training, Simulation, and Education Conference 2019.

MILESTONES

◆ FY19 Deliverables:

◇ Final Report

◆ FY20 Deliverables:

◇ SEP 20: Final Demonstration of TARA to Submarine Learning Center (SLC)

◇ SEP 20: TARA Software and Hardware prototype to SLC

◇ SEP 20: Final Technical Report

TECHNOLOGY TRANSITION OF THE ADAPTIVE TRAINER FOR TERMINAL ATTACK CONTROLLERS (ATTAC) (TT-21-005)

OBJECTIVE

The goal of this effort is to transition ATTAC, a successful proof-of-concept adaptive training (AT) system, to a fieldable training product. ATTAC is a scenario-based adaptive trainer that focuses on game plan development, a critical decision-making task in Close Air Support (CAS) carried out by Joint Terminal Attack Controllers (JTACs)



Screenshot of an ATTAC scenario from the research testbed version of ATTAC

PROJECT DURATION
OCT 2020 - SEPT 2022

SPONSOR
Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: Tech Transition

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DESCRIPTION

Initially developed for an ONR research initiative, ATTAC is a proof-of-concept adaptive training system for training game plan development, a key decision-making task in CAS that sets the stage for the rest of the mission. ATTAC provides the Fleet reps and sets by utilizing self-paced scenario vignettes, assessing the decisions of the trainee, providing tailored feedback, and adapting the difficulty of scenarios based on performance. In an initial evaluation of the system, ATTAC improved students' game plan decision-making performance by over 20% after only 35 minutes of training. Based on significant interest from stakeholders to incorporate ATTAC into their curricula, this project will transition ATTAC from a research testbed to mature, fieldable training product.

NEED

This effort addresses the USN and USMC's needs for flexible, learner-centric training to improve assessment of CAS decision-making skills, enhance performance, and increase mission readiness as outlined in the 2018 S&T Strategic Plan Training and Education STOs 1: Learning and performance assessment), 2: Experiential learning technologies and

methodologies, and 3: Warrior decision-making. Additionally, The skillset held by JTACs has been flagged as integral by the Marine Corps' future force designs, as outlined in the Marine Corps Aviation Plan.

BENEFITS

ATTAC offers the ability to provide training for basic CAS skills that is tailored to the needs of individual students. Therefore, when students are in the classroom, valuable time is not spent with instructors going over the basics, but rather more time is spent discussing the more nuanced parts of the task that are harder to capture with computer-based training approaches.

STATUS

In FY21, the focus will be on developing the core functionality of ATTAC in a new system architecture. In addition, new features of ATTAC requested from stakeholders will be designed and implemented, such as performance dashboards for tracking trainee performance and developing new scenarios. Once key features are in place, an initial evaluation will be conducted to validate new scenario difficulty and ensure new features meet Fleet requirements and are usable.

MILESTONES

- ◆ FY21:
 - ◆ Initial discussions with potential transition partners / Finalize requirements with stakeholders
 - ◆ Create new scenarios and design performance dashboards
 - ◆ Begin porting ATTAC to new software architecture
 - ◆ Study 1: Design and implement initial ATTAC evaluation
- ◆ FY22:
 - ◆ Finalize competency-based adaptation algorithm and development of ATTAC
 - ◆ Conduct Study 2—Capstone efficacy evaluation and document results in final report

TRAINING DESIGN FOR INTUITIVE EXTENDED REALITY INTERACTIONS (BAR-21-027)

OBJECTIVE

Taking a user-centered approach, this effort explores methods to redesign user interactions in XR to enhance the user's experience by: 1) establishing the most intuitive methods of interactions for commonly performed tasks and 2) testing different methods of presenting information in an XR-based training system, with the goals to reduce users' cognitive load and improve human performance.



CDR Douglas Kramer training in VISIT™ VR. Photo Credit: Roy Holt, TechRAT

PROJECT DURATION
OCT 2020 - SEPT 2022

SPONSOR
Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: BAR

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DESCRIPTION

Many of the problems with today's extended reality (XR) experiences, which include augmented reality (AR), virtual reality (VR), and mixed reality (MR), arise from a poor understanding of how people most intuitively interact with virtual interfaces. Rather than innovating, these misguided designs have relied on forcing artifacts of 2D interaction into XR, leading to unintuitive controls, user frustration, higher cognitive load, and reduced performance/learning outcomes. This effort will explore novel types of XR interaction with the goal of improving the user experience.

The effort includes two human performance research experiments. In the first experiment, we will explore commonly performed tasks in an XR training environment to determine which forms of input (e.g., gesture-based input, gaze tracking, laser pointer) are most effective for said tasks. In the second experiment, we will examine different methods of presenting information in and their impacts on learning outcomes.

NEED

The Navy is investing heavily in XR, and development teams have an immediate need for evidence-based guidelines for XR input and output design. The time to do this research is now, before program offices deploy XR applications on a large scale. This work is timely because it has the potential to prevent costly redesign of difficult interfaces and to prevent the Navy from investing in ineffective training products.

BENEFITS

The results of these experiments will lead to evidence-based guidelines for building more immersive XR training experiences that will benefit the Navy training community broadly. When we build more intuitive, XR-based trainers, users will spend less time learning how to interact with the simulation and more time in training.

STATUS

This is an FY20 new start. Testbed development for experiment 1 is underway with data collection planned for Q3FY20.

MILESTONES

- ◆ Develop experimental plan for Experiment 1, focused on effective inputs to an XR system
- ◆ Submit IRB protocol
- ◆ Develop testbed with different input methods to perform common tasks in XR training environments
- ◆ Conduct Experiment 1
- ◆ Analyze and write up results for conference publication

TRAINING SIMULATION INTELLIGENT SCENARIO GENERATION TOOLS (No2-184)

OBJECTIVE

Develop an anytime-anywhere training tool designed to rapidly create, script, and grade training events and scenarios. Automated performance measurement and after-action review reduces Instructor workload, capable of being used in a stand-alone or distributed team training mode.



Training System Demonstration and Testing with End Users

PROJECT DURATION
MAR 2020 - MAR 2022

SPONSOR
NAVAIR Small Business Innovation
Research Program

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DESCRIPTION

The technology under development provides a training environment that allows instructors to create, execute, grade, and provide after action reporting and debrief. Highlights include the ability to create training roles and teams, scripted and custom scenario inject content, training event playback, tagging inject elements with course and training objectives, and instructor in the loop student grading. The training jacket capability allows for performance assessment and grade-based reach back at the student and class levels. Training content information is structured to accommodate future development activities that will enable automated training adaptations for improved and tailored grading and training content analysis, resulting in an adaptive training capability - at the student, class, and instructor levels.

NEED

With an increased reliance on Naval Intelligence Surveillance and Reconnaissance (ISR) assets for mission support and Intel dissemination, ISR training has become critical to mission

Success. To support training needs, the Maritime ISR (MISR) requires an agile web-based adaptive training that could rapidly adapt to changing weapon school requirements and teaching situations.

BENEFITS

Development of a distributed and standalone training solutions provides flexibility to meeting a variety of training needs and environments. Scenario scripting provides the ability to maintain system utility as tactics and procedures evolve over time.

STATUS

Current training prototype is at a TRL 5. As most Navy weapon schools were forced to cancel or postpone due to the pandemic, prototype technology was used in a distributed manner for MISR's final exercise and practical, allowing the weapons school to remain open to graduate their class as scheduled. Efforts are underway to level set class participants prior to the start of a weapons school class as participants typically come from a variety of Mission Design Series (MDS). Iterative stress tests continue with end users to refine technology.

MILESTONES

- ◆ Kickoff meeting was held with stakeholders including Naval Aviation Warfare Development Command including members of the Maritime ISR Weapons School Community, Naval Air Warfare Center Training Systems Division, and PMA-205
- ◆ Technology design and development has resulted in a TRL-5 prototype, and due to challenges associated with COVID-19 and in-person training, the end user community elected to leverage the prototype in their final exercise Resolute Hunter to ensure remote training could continue to ensure the fleet met required proficiency
- ◆ FY21: Continue iterative stress testing that includes end user evaluations of modifications and new system capabilities to inform agile development toward final prototype (Sep 21)
- ◆ FY22: Complete final TRL level 6 training tool prototype to rapidly create, script, and grade training events and scenarios in stand-alone or distributed team training Mode (Mar 22)
- ◆ Transition focus based on use case development is targeted toward the MQ-4C Triton via PMA-290/PMA-205

TRAINING OPERATIONAL PERFORMANCE VIA MEASURE AUTOMATION AND SCENARIO GENERATION TECHNOLOGY (N18A-TO03)

OBJECTIVE

Design and develop a software technology that leverages data science and advanced computational analyses of tactical data sources to improve training scenarios and assessments and make training more adaptive, efficient, and effective.

PROJECT DURATION
SEP 2018 - SEP 2021

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Technology Transition (STTR)

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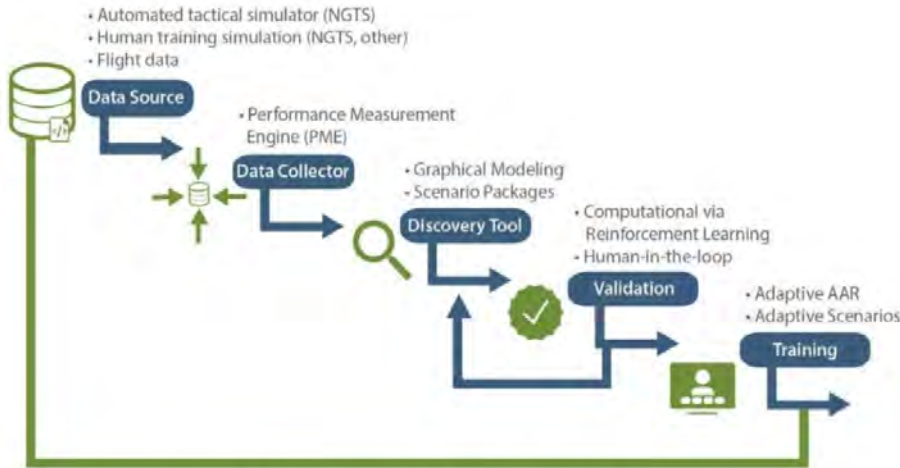


Figure 1. System data flow diagram of TOPMAST.

DESCRIPTION

As the complexity of Tactics, Techniques, and Procedures (TTP) increase, testing in part via computational simulation and optimization is necessary. Such analyses systematically vary tactical applications of the warfare capability to a variety of threat scenarios, simulate and score each encounter, and generate a ranked list of the most successful tactics per threat. The scenarios, measures, and knowledge generated in this type of work are rich and voluminous, providing opportunities to leverage data science. This effort seeks to deliver a software technology solution capable of re-using analytic data outputs for populating training content.

NEED

Emerging warfare capabilities offer a great many new tactical options to commanders. However, this also increases the demands on decision-makers during operations. The dynamic and complex nature of integrated warfare results in training challenges to prepare for those engagements. To address this need, this effort seeks: 1) the capability to generate scenario libraries, and 2) the ability to improve integrated assessments of human tactical and decision-making skills to make training more efficient and effective.

BENEFITS

Navy leadership has called for technologies that support analytics of big data sets such as avionics and human performance; however, as new systems or technologies are introduced and/or new tactics emerge to maintain superiority, existing training scenarios can quickly become obsolete. Advance statistical or novel modeling techniques are sought to address the unique challenge of ensuring training scenarios are current.

STATUS

The STTR has completed the Phase II base period. The decision of the government was to award a single Phase II option to the team developing the TOPMAST tool. This tool is intended to repurpose data from MQ-4C TRITON operational missions (including malfunction and fault data) to develop training scenarios that are current.

MILESTONES

- ◆ **Phase I:**
 - ◇ Kickoff meetings were held with each of the three Phase I contractors
 - ◇ Contractors status was monitored via bi-monthly progress reports and periodic status updates
 - ◇ Closeout briefs were held with each of the contractors to discuss Phase I progress and Phase II plans
- ◆ **Phase II:**
 - ◇ Kickoffs held in Q1 FY20
 - ◇ Phase II base period evaluations performed JUL 2020
 - ◇ Phase II option awarded to a single contractor SEP 2020

CORE CAPABILITY 3: ADVANCED TRAINING SYSTEMS TECHNOLOGY

Training systems, such as LVC simulations, provide an appropriate mix of environments where learners can interact in real time with each other using networked devices. Technology can augment warfighter preparedness by providing training opportunities that might not be available due to factors such as cost, safety, and resource availability. Training technology includes the ability to provide realistic rendering and modeling, multisensory input/output devices (e.g., visual/audio/haptic displays, speech recognition, and flight control sticks), and system interconnectivity, such as Web servers, networking bandwidth, and processing speed.

The following Technology areas comprise this Core Capability:

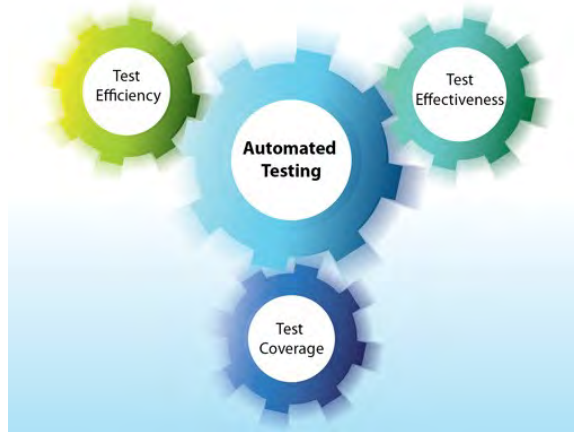
- High-Fidelity Training Environments
- Simulation Interoperability and Distributed LVC Technology



AUTOMATED SOFTWARE TESTING CAPABILITY (WFD-SG-20-022)

OBJECTIVE

Analyze, design and implement an automated and extensible software testing capability for the IDEA Lab, and then deploy it in the development and maintenance of the Federation Agreements Compliance Test Tool (FACTT) Suite software as a use case.



Automated Testing Benefits

PROJECT DURATION

OCT 2019 - SEP 2020

SPONSORS

Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: WFD: SG

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DESCRIPTION

The proposed effort will analyze, design and implement an automated and extensible software testing capability for the IDEA Lab, and then deploy it in the development and maintenance of the Federation Agreements Compliance Test Tool (FACTT) Suite software as a use case. The choice of FACTT Suite is fitting because it is a critical and contractually required software product for assessing NASMP/NIS standards' compliance for the Fleet Synthetic Training - Aviation (FST-A) simulations and it has become an increasingly complex software system which has hampered its development and testing efforts and causing delays in delivering critical capability to the users.

NEED

This capability is urgently needed to address the current inefficiencies in software development and testing processes in the NAWCTSD-IDEA Lab which has contributed to delays in software product deliveries and at a higher cost.

Particularly, FACTT Suite will immediately benefit from it as an early technology adopter.

BENEFITS

The proposed capability will enable software developers to uncover implementation issues sooner while requiring less manual labor. This capability will enhance the IDEA Lab software development process by shortening the software development and testing cycles and yielding more robust software products in a timely manner.

STATUS

Completed implementation of automated software build and testing infrastructure and delivered to the NAWCTSD IDEA Lab for use by the resident software development teams.

MILESTONES

- ◆ Research on automated testing technology and strategies complete (Oct 19)
- ◆ System requirement for automated build and testing infrastructure complete (Nov 19)
- ◆ System design for automated build and testing infrastructure complete (May 19)
- ◆ Prototype of automated build and testing infrastructure complete (Jul 19)
- ◆ Stand up the automated build and testing infrastructure in the IDEA Lab complete (Sep 21)

DESKTOP TACTICS TRAINER FOR MARITIME PATROL AIRCRAFT (N202-111)

OBJECTIVE

Develop a desktop tactics trainer with a low-cost, computer-based, simulated environment where trainees can practice tactics learned in advance of simulator events, and flight events.



A P-8A Poseidon multi-mission maritime patrol and reconnaissance aircraft assigned to Patrol Squadron (VP) 4 (MAR 2020)

PROJECT DURATION
OCT 2020 - OCT 2021

SPONSOR
NAVAIR Small Business Innovation
Research Program

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DESCRIPTION

Fleet Naval Flight Officers (NFOs) in the Maritime Patrol community are trained to: 1) conduct anti-submarine warfare first, 2) conduct intelligence, surveillance, and reconnaissance always, and 3) conduct anti-surface warfare, if needed. They use the multi-mission aircraft platform, the P-8A, to accomplish these missions. The aircrew consist of multiple personnel (both enlisted and officers) operating a multitude of sensors. Through combining their training with the advanced and complex capabilities of the aircraft, they are tasked primarily with finding and tracking submarines and ships in the world's oceans. Trainees need a practical way to apply classroom training between scheduled part-task trainers (PTT) or weapon tactics trainer (WTT) simulator events.

NEED

Currently, fleet students (upgraders) do not have a tool that allows them to try-out and practice learned tactics in a simulated environment without scheduling highly limited and valuable time in a multimillion dollar simulator. The job is difficult, and the crew need to be proficient in their roles making the most use of the

maritime platform. Real ships and submarines are typically not available to train maritime aircrews. Additionally, when given real surface and subsurface platforms to train with, they are U.S. or allied friendly forces. Training against real-world adversaries provides a higher fidelity of training.

BENEFITS

A computer-based tactics trainer is a cost-efficient way to provide hands-on tactics training on demand to NFOs. By providing a "learn on your own" simulator tool, students can increase their knowledgebase before an event, and decrease the likelihood of event failure, maximizing the value of expensive crew simulator events, both in effectiveness and efficiency. The ultimate result is enabling trainees to be more qualified at the end of training, while increasing their readiness and ability to perform the tasks in the operational environment.

STATUS

This is an SBIR Phase I new start.

MILESTONES

- ◆ Contracts awarded to (4) companies - OCT 2020
- ◆ Kickoffs planned for OCT/NOV 2020

EXTENDED REALITY (XR) FLIGHT TRAINING RESEARCH SYSTEM INTEGRATION LABORATORY CAPABILITY (RR-21-006)

OBJECTIVE

Establish a dedicated and sustainable System Integration Lab (SIL) capability at NAWCTSD focused on Extended Reality (XR) technologies in support of student aviator training.



T-45 Aircraft Cockpit

PROJECT DURATION OCT 2020 - SEPT 2021

SPONSOR

Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: R&R

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DESCRIPTION

This effort will establish a dedicated Extended Reality (XR) flight training System Integration Laboratory (SIL) at NAWCTSD. The effort will design and fabricate a reconfigurable single-seat cockpit surround with flight controls and procure a mixed reality (MR) head mounted display system and simulation environment in order to create a flexible XR integration and experimentation capability. The end result of this project will be a government-designed and owned flight trainer targeting the T-45 platform. The overarching objective of the XRSIL is to be a flexible and reconfigurable testbed in order to support other training platform configurations and future experiments, tests or development efforts.

NEED

The Chief of Naval Air Training (CNATRA) has established the Naval Aviation Training Next (NATN) initiative to produce better prepared aviators via the creative use of new and emerging technologies. NATN has a particular focus on the promise of XR approaches. CNATRA has determined that in

order to execute an effective undergraduate pilot syllabus that equips students with Fleet Replacement Squadron entry-level skills will require further improvements and expansion of current virtual reality capabilities, including continuously evaluating and implementing rapidly evolving XR technologies. Timely and cost-effective technology investigations require the establishment of a dedicated SIL and experimentation capability focused on rapidly assessing and demonstrating the utility of emerging XR technologies.

BENEFITS

Disruptive emerging technologies, such as XR, can provide pilots more frequent training opportunities at a lower cost than traditional Operational Flight Trainers. The organic hands-on test and development capability provided by the XRSIL will speed the adoption of these training technologies and lower developmental cost and risk.

STATUS

XRSIL development began in October 2020.

MILESTONES

- ◆ Jan 21: Prepare preliminary design for econfigurable operational flight trainer incorporating XR hardware for the T-45 aircraft
- ◆ Mar 21: Procure required parts, equipment and commercial components
- ◆ Jun 21: Fabricate required custom components and electronic interfaces
- ◆ Jul 21: Create any required firmware/software interfaces (e.g. simulated instrument panel controller firmware)
- ◆ Aug 21: Integrate components, configure and test for initial operational capability - August 2021

EVALUATION OF EXTENDED REALITY (XR) HEAD MOUNTED DISPLAY (HMD) TECHNOLOGY AS A REPLACEMENT FOR OPERATION FLIGHT TRAINING (OFT) DISPLAYS

OBJECTIVE

1. Develop a T-45 Mixed Reality (MR) flight trainer that leverages a fabricated cockpit and a MR HMD that will provide the ability to interact with the cockpit to provide 360 degree visuals.
2. Evaluate the benefits and training impact of the MR flight training on student pilots.



NAS Kingsville T-45C OFT + Mixed Reality Visual System

PROJECT DURATION

OCT 2020- OCT 2022

SPONSOR

Office of Secretary of Defense (OSD)
Foreign Comparative Testing (FCT)

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DESCRIPTION

With the advancement of Extended Reality (XR) Head Mounted Displays (HMDs) the Chief of Naval Air Training (CNATRA) has asked Naval Air Warfare Center Training Systems Division (NAWCTSD) to investigate the feasibility of developing a Mixed Reality (MR) flight trainer. The current FCT T-45 MR flight trainer development and evaluation focuses on using promising MR HMD COTS within a characteristic operational setting (i.e. OFT & CNATRA) to identify limitations, further refine MR requirements and provide feedback to industry.

NEED

The CNATRA program is currently exploring the potential for the use of XR Part-Task Trainers (PTTs) to supplement the existing curriculum. The lower cost of XR technology can make more training devices available to pilots, therefore improving the quality and speed at which they are trained.

BENEFITS

Currently, the Navy, Army, and a majority of the USAF utilizes a combination of classroom lecture, static training, Operation Flight Trainers (OFTs), and live aircraft flight to train aviators. The urgency to augment the aviation training pipeline as identified in the Navy's "Naval Aviation Training Next", the USAF "Pilot Training Next", and the Army's "Aviation Training Next" has highlighted that XR technology has the potential to increase student access to training and reduce instructor workload, at a fraction of the cost compared to larger-scale OFTs or live aircraft.

STATUS

Planned program kickoff will be Nov 2020, with T-45 MR flight trainer delivered to CNATRA Q4FY21, Training Effectiveness Evaluation will be perform in 2022 with planned completion in Q3FY22 and final technical report in Sep 2022.

MILESTONES

- ◆ Program kickoff Q4 2020
- ◆ SME requirements Q1 2021
- ◆ T-45 MR flight trainer development Q4 2020- Q4 2021
- ◆ CNATRA Training Evaluation Q4 2021 - Q3 2022
- ◆ Training Effectiveness Technical Report Q4 2020

FLIGHT DECK CREW REFRESHER TRAINING EXPANSION PACKS (TEP)

OBJECTIVE

The objective of this effort is to create an expandable framework of game-engine-based, immersive 3D Flight Deck Crew Refresher Training Expansion Packs (TEP) for use by trainees in Fleet Concentration Areas (FCA). The TEPs shall allow for individual, team, or multi-team training events, and shall utilize appropriate combinations of state of the industry immersive technologies, including virtual reality.



Screenshot of actual 3D flight deck and aircraft models used for the effort.

DESCRIPTION

NAWCTSD has created an expandable system baseline architecture and built three flight deck teams: 1) Primary Flight Control (Pri-Fly) TEP, 2) Landing Signal Officer (TEP), and 3) Catapult Launch TEP. The development process has included over 55 fleet SMEs from 5 carrier hulls and 2 schoolhouses. Work is continuing by adding faults, scenarios, and passes to the existing teams, expanding teams, and delivering to Norfolk in the C-ARTS system via a Cooperative Research and Development Agreement (CRADA) with Cape-Henry Associates and PMS-378,

NEED

Flight Deck Crew readiness, refresher, and certification training opportunities are limited. The training pipeline and available technology for flight deck crew initial training is often limited or outdated. Flight deck crew members are often sent to other underway carriers for refresher training and readiness sustainment. This is costly to the ship and logistically challenging. This practice results in crew members not training with their actual team members. New Ford Class carrier crew members are not training on the correct Aircraft Launch and Recovery Equipment (ALRE) gear.

BENEFITS

- Increase readiness, refresher, and certification training opportunities for aircraft carrier flight deck personnel by providing training at FCAs for individual, teams, and multi-team coordination.
- Allow for single trainee, single team, and multi-team training opportunities for flight deck crews.
- Prevent stovepipe training solutions for flight deck crews.
- Target crew specific ALRE and flight deck parameters (e.g., Legacy Steam Catapults vs Electromagnetic Aircraft Launch System (EMALS)).
- Include technologies that allow trainees to use realistic communications and equipment and provide an immersive environment for the trainee with the appropriate fidelity.

STATUS

The Primary Flight Control (Pri-Fly) and Landing Signal Officer (LSO) Editions were delivered to the LSO School in NAS Oceana in FY18. The Catapult Launch Team was delivered to CNATT in FY18. Pri-Fly and Catapult Launch were delivered to Norfolk Naval Station in FY20 as part of the C-ARTS system. The Pri-Fly team will receive updates and additional functionality in FY21.

YOUTUBE LINK:

<https://www.youtube.com/watch?v=OSQLBX2WUqI>

MILESTONES

- ◆ **Final system:**
 - ◇ Pri-Fly Training Expansion Packs with connectivity to LSO and Catapult Crew
 - ◇ Software Baseline Architecture for connectivity of all future Training Expansion Packs
 - ◇ Ending technology readiness level (TRL): TRL Level 6
- ◆ **Documentation:**
 - ◇ User Manual
 - ◇ Technical Manual

HEADSET EQUIVALENT OF ADVANCED DISPLAY (N192-087)

OBJECTIVE

To develop through the SBIR program a novel Virtual Reality (VR), Augmented Reality (AR), and/or Mixed Reality (MR) headset that performs equivalent to or better than current flight simulator display systems. The headset will allow the pilot to see all cockpit instruments plus minimizes and/or eliminates any impacts to human factor qualities.



Mflight trainer

PROJECT DURATION

AUG 2019- AUG 2023

SPONSOR

NAVAIR Small Business Innovation Research (SBIR)
PMA-205, PMA-209

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DESCRIPTION

Two companies (Holochip Corporation, Pison Technology Inc.) are independently working on this topic to develop an AR/VR/MR headset customized for Navy flight simulators. Both headsets will provide out the window visuals which are equivalent to or better than current flight simulator display systems, and allow the pilot/user to see the actual cockpit displays along with their real hands. Holochip is developing a custom AR headset from scratch while Pison is customizing a COTS VR headset.

NEED

Current display systems for aircraft flight simulators are extremely expensive and very large, require a lot of equipment, and are difficult to transport between different facilities. AR/VR/MR technologies are approaching the same level of performance as modern flight simulator display systems, and can eliminate the challenges of current display systems.

BENEFITS

Integrating an AR/VR/MR headset with a flight simulator will greatly reduce the cost and footprint of flight simulators, and could lead to mobile flight simulators that can be mass produced and deployed aboard ships or to bases around the world. The final products could extend beyond aircraft and military applications, into areas such as gaming, entertainment, and private sector training.

STATUS

Both companies are starting their phase II base. Both headsets are expected to meet the topic requirements for flight simulators, but the Holochip headset also has potential applications for in flight operations since it's an augmented reality headset. Both companies are on track for initial prototype demonstration FY21.

MILESTONES

- ◆ Pison — Customized a COTS high resolution VR headset with a version 1 MR camera module Q2 2020
- ◆ Pison — Integrating chroma key into MR module v2 software Q4 2020
- ◆ Pison — MR module v3 development beginning in Q2 2021
- ◆ Holochip — Finalizing a custom 6DOF tracker algorithm Q4 2020
- ◆ Holochip — Started fabricating a prototype AR display prototype Q4 2020
- ◆ Holochip — Initial headset with AR display prototype and 6DOF tracking Q2 2021

IMMERSIVE PARACHUTE DESCENT PROCEDURE, MALFUNCTION AND DECISION-MAKING TRAINING SYSTEM, SKYFALL (N161-007)

OBJECTIVE

Develop a novel reconfigurable device training system that provides immersive Parachute Descent Procedure (PDP), malfunction and decision-making training to allow the survival training community to deliver cross-platform training without the need for multiple training systems or platform specific peripherals.

Left: Aviation Survival Training Center instructors test prototype parachute procedure trainer during feedback session for design refinement.

Right: Game-based variant of parachute trainer installed at local game arcade for user testing.



PROJECT DURATION
JUN 2016 - SEP 2021

SPONSORS

Naval Air Systems Command (NAVAIR) |
Small Business Innovation Research (SBIR)

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DESCRIPTION

This project is a Small Business Innovation Research (SBIR) project targeted at researching, designing, and developing a novel, immersive training system that provides the ability to train aviators by addressing three capabilities gaps: 1) training quality and effectiveness, 2) supportability, and 3) training realism. The training system should provide a reconfigurable interface that supports all Navy standard flight equipment and parachute equipment. Developed technology would provide the ability to demonstrate effectively both standard procedures (e.g., inflation of the life preserver, releasing the raft when applicable) and parachute malfunctions.

NEED

Current parachute procedure safety training is based on technology that has inadequate effectiveness and realism, primarily due to limitations that prevent interfacing with standard flight and parachute equipment. An advanced training solution will provide a reconfigurable connection for a variety of aircrew equipment and seat kits, which differ by platform.

BENEFITS

Cross-platform survival training, without the need for multiple training systems, will help avoid potential training costs, as well as allow aviators more flexibility within training systems. The increased fidelity of the training will also help aviators more effectively learn about parachute descent procedures, which are important survival procedures.

STATUS

This SBIR underwent a competitive source selection to award Phase I contracts, during which four contractors conducted feasibility analyses and designed/developed prototypes. Based on progress made during Phase I and technical feasibility of Phase II designs, the evaluation team recommended a gated Phase II award for two vendors to continue design and development efforts. Resulting prototypes from Phase II base efforts were delivered and demonstrated to personnel within the Naval Survival Training Institute. A single vendor will continue design and development efforts during FY19-FY20, working to deliver a comprehensive, reconfigurable prototype for evaluation. End user community continues to provide iterative feedback on the design and capabilities of the system.

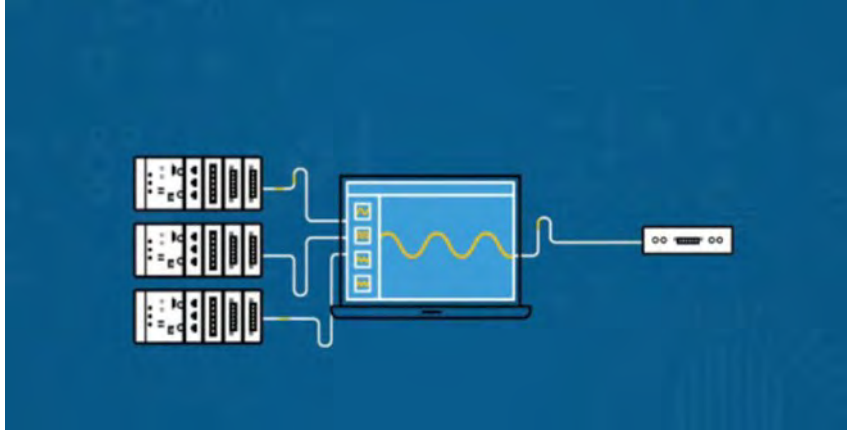
MILESTONES

- ◆ **Phase I:**
 - ◇ Four Phase I contractors status was monitored via bi-monthly progress reports and periodic status updates
 - ◇ Closeout briefs were held, resulting in Phase I Option awards for two vendors
- ◆ **Phase II:**
 - ◇ Phase II gated efforts were awarded for two vendors, resulting in a demonstration prototype
 - ◇ Phase II base period resulted in selection of a single Phase II vendor for the option period, with expansion funding
 - ◇ Software and/or hardware updates made approximately quarterly to address user feedback and provide iterative improvements in technology
 - ◇ A multi-player arcade style game was developed based on the parachute trainer, which competed in the IITSEC 2018 Serious Game Challenge and has since been installed at a local video arcade for public use
 - ◇ Phase II expansion funding supporting development and testing of virtual reality (VR) variant for evaluation and additional test units
 - ◇ Prototype test trainers have been delivered to Aviation Survival Training Centers (ASTC) for immediate use to support training of indoctrination and refresher students at ASTCs in Pensacola, July 2020 (3), Lemoore, October 2020 (1), and Miramar, August 2020 (1)

IN-HOUSE TRANSPORT DELAY KIT (219RR-21-003)

OBJECTIVE

To procure a transport delay test kit and develop in-house capability to test and troubleshoot system dynamic response in US Navy training systems.



General Depiction of Data Acquisition Kit (Courtesy of National Instruments)

PROJECT DURATION
OCT 2020-OCT 2021

SPONSOR

Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: Tech Transition

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DESCRIPTION

This project will procure the necessary equipment needed to conduct transport delay measurements including a Commercial-Off-The-Shelf (COTS) transport delay kit and a laptop computer. This transport delay measurement tool will be used within the NAWCTSD command and be available to support transport delay testing and troubleshooting as needed. Proper testing and demonstration of this equipment will show that this capability is functional and operationally ready for use.

The COTS transport delay kit includes the necessary equipment, sensors, and software package to collect transport delay measurements. Transport delay is measured from the onset of primary flight control input to the responses of the motion system, primary attitude indication (instrument response), and the visual system. Movement, such as flight control inputs and motion system outputs are generally measured with accelerometers. Visual system response and instrumentation response are generally measured with optic sensors such as a photo diode. In the case that the primary attitude indicator is an analog gauge, the data acquisition kit can accept analog inputs and outputs. The transport delay kit is designed to work across multiple training system platforms and collect measurements externally and independent of the trainer's computational systems. This effort will also procure a laptop to drive the data acquisition software. Combined, the transport delay kit and associated equipment will provide the capability to collect transport delay measurements, analyze data, and support the pilot-in-the-loop aspects of training system performance.

NEED

The GT52100 Aero Engineering Group is responsible for enforcing and maintaining system dynamic response requirements in US Navy training systems, but currently do not have in-house equipment available to measure and collect transport delay data on training systems. Controlling transport delay times between pilot inputs and visual/motion outputs is critical for reducing simulator sickness and pilot compensation to uncharacteristic response times. The need to redefine system dynamic response requirements and measure transport delay on existing training systems is slowly rising. Without in-house equipment the aero training systems group is dependent on the contractor to collect these measurements.

BENEFITS

Having this equipment and capability available will give the training systems group the flexibility and opportunities to measure and collect data, which will help drive requirements and direct the program technical approach. This capability will ensure that we are providing a simulation that is meeting the warfighter's training system needs. This equipment will also be a valuable training tool within the command and will be used to train and demonstrate proper transport delay test techniques within the aero engineering and systems engineering departments.

STATUS

Compiling list of materials and researching computer choices for purchase.

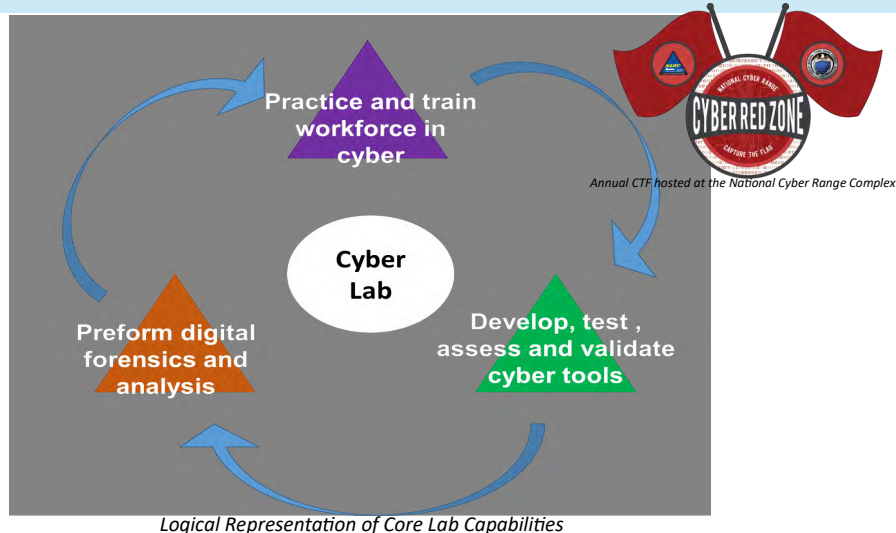
MILESTONES

- ◆ Procure transport delay measurement kit.
- ◆ Demonstrate the general capability of the equipment and that it is operationally ready for use.

NAWCTSD CYBER LAB (WFD:SG-20-005)

OBJECTIVE

This proposal has a three primary objectives to (1) develop a persistent cyber research laboratory, (2) develop a Cyber Test Capability at NAWCTSD to coordinate and execute Cyber Table Tops (CTT), Cyber Risk Assessments (CRA), and Penetration Assessments on networked and stand alone training systems, (3) train and equip the workforce in the latest cybersecurity concepts.



PROJECT DURATION
OCT 2019 - SEP 2021

SPONSOR
Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: WFD-SG

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DESCRIPTION

The Cyber Lab is a test lab to experiment with cutting edge cyber training methodologies. This lab is the sponsor for the National Cyber Range's annual Capture the Flag event called Cyber Red Zone. This event supports advanced cyber training for DoD cyber red teams. Specifically for NAWCTSD employees, the cyber lab help facilitate local cybersecurity training. In addition to training, the Cyber lab mission is to support T&E activities. Specifically the lab is setup to host and facilitate Cyber Table Top (CTTs) and Cyber Risk Assessments (CRAs) exercises for training systems. Lastly, the cyber lab at NAWCTSD supports incident response analysis for compromised training systems.

NEED

Cyber is an ever evolving field where constant vigilance is required. Threat vectors in to the training systems are numerous and programs lack the insight to mitigate all the risk on their own. Supply Chain threats, vulnerable code, and weak architecture all require a deep understanding of the threat in order to properly mitigate. In addition to identifying the threat

before a compromise, the Training System community lacks the ability to perform proper incident response on their systems. Lastly, the workforce is constantly having to expand their knowledge, skills, and abilities to combat the cyber threat. Without a cyber lab at NAWCTSD, the training community wouldn't have the infrastructure needed to mitigate the threat.

BENEFITS

The cyber lab provides the resources to train the cyber workforce and equip them to asses, mitigate and manage risk to training systems. The cyber lab also help facilitate cyber best practices such as performing CTTs. When done early in the design process, CTTs help identify and mitigate architecture flaws.

STATUS

The cyber lab is in its second year of funding and has started training personnel to support CTTs, CRAs, and other cyber skills. We have help plan and design the Cyber Red Zone exercise on the National Cyber Range. Currently we are looking in to supply chain risk management threat mitigations.

MILESTONES

- ◆ Cyber Red Zone 20-1 November/December 2019
- ◆ CTT 101 training for TSD cyber workforce– January 2020
- ◆ Cyber Risk Assessment (Georgia tech training for TSD) – virtual October 2020
- ◆ Cyber Red Zone 21-1 October/November 2020
- ◆ Cyber Red Zone 21-2 - Planned January/February 2021
- ◆ CTT in a Box training (Both Red team and Blue team) - Planned January/February 2021

RESEARCH TO ADVANCE THE ON-DEMAND HYPOXIA TRAINER FOR SURVIVAL TRAINING

OBJECTIVE

The effort seeks to continue research and development of a next generation hypoxia-training device. The goals of this research include analysis of average flow rate requirements, impacts of oxygen concentration on recovery, and continued development to enhance the system effectiveness and reliability.



Engineering testing of On-Demand Hypoxia Trainer with Aerospace Physiologists at NAS Pensacola to validate pressure on demand and initial training profile for hypoxia training.

PROJECT DURATION MAR 2018 - SEP 2020

SPONSORS

Naval Aviation Training Systems Program
Office, PMA-205
Defense Health Agency, DHA

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DESCRIPTION

This effort seeks to empirically evaluate research questions about the On-Demand Hypoxia Training (ODHT) including: 1) the impact of variable oxygen concentration on recovery rates, 2) the effect of variable flow rates on breathing and experience of hypoxia symptoms, and 3) development to refine the product based on iterative fleet validation testing. Finally, this effort will investigate parallels that can be drawn between the cognitive decrements associated with alcohol intoxication and those associated with hypoxia.

NEED

Hypoxia continues to remain a highly visible safety issue, with training being a significant part of the mitigation process. An ODHT prototype technology has been developed to overcome . However, in order to ensure a successful transition of the OHDT, additional research is necessary. These proposed studies will provide results that are essential to inform the design, establish standard operating procedures, and validate the effectiveness and reliability of a novel prototype hypoxia trainer prior to procurement.

BENEFITS

The acknowledged success of hypoxia training makes it paramount that the Navy ensures these capabilities remain available. In addition to providing a means for addressing the larger Navy research into mitigating hypoxia physiological episodes, this effort will advance the lab's understanding of hypoxia training. Further, this effort will provide the means to thoroughly investigate a novel technology to determine the effectiveness and efficiency of the devices to deliver higher fidelity training opportunities.

STATUS

Following Institutional Review Board approval, data collection was conducted to investigate average flow rate variations between individuals and impacts of oxygen recovery at various concentrations. In parallel with research efforts, the team continued to refine the design and development of the system regulator and other subassemblies based on fleet validation testing. Follow on research is being proposed to investigate breathing dynamics beyond hypoxia training (e.g., hyperventilation, air hunger).

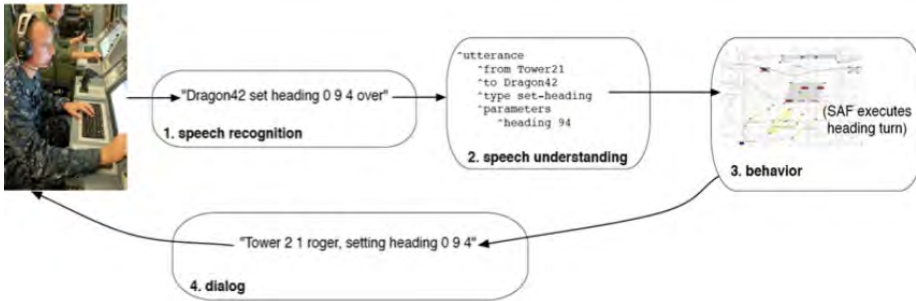
MILESTONES

- ◆ **Presentations:** Atkinson, Entinger, Tindall, Gilg, Scripture, Immecker, McEtrick, Sciarini, & Murr, (2018). A preliminary look at hypoxia compared to alcohol intoxication. Poster presented at AsMA 2018-Dallas, TX.
- ◆ **Workforce Development:** Mentored junior teammates on program management, data collection and analysis, and coordination with fleet customers.
- ◆ **Transitions:** Based on data collected, revised human machine interface designs were implemented, as well as modifications to subassembly designs to increase the fidelity of the pressure-on-demand airflow and ease maintenance. A procurement contract awarded in FY20 to deliver device to eight (8) ASTCs, with final scheduled delivery by JAN 2022 and technical data package delivery by FEB 2022.

SOLILOQUY & THE SPEECH-ENABLED SIMULATION TRAINING ENRICHMENT TOOL (SESTET) (N17A-To10)

OBJECTIVE

Develop an innovative software capability to improve the utility of structured automatic speech recognition (ASR) by allowing end-users to customize the set of supported utterances without external support.



A sample speech recognition and understanding process

PROJECT DURATION
AUG 2017 - MAR 2021

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Technology Transition (STTR)

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DESCRIPTION

The resulting software capability should be modular and flexible in nature to allow multiple aviation platforms to leverage the functionality. For example, consider U.S. Naval aviation crews that conduct similar mission sets, but have their own unique doctrinal phraseology. Although each platform may prosecute an antisubmarine warfare (ASW) mission similarly, their doctrinal phraseology is likely specific to their respective platforms. The solution should have enough flexibility to account for platform specific changes, or multiple platform accommodations. Further, the resulting software capability should include up-front “train the speaker” modules.

NEED

ASR successes within simulation-based training systems have been modest. Some domains have overcome the complex challenges that exist in implementing ASR by making use of enforced doctrinal phraseology, which the speech recognition technologies can exploit. However, in more complex and fluid training environments that are less structured, more complex natural-language processing techniques are necessary to achieve

that purpose. These environments require ASR systems with the flexibility for the instructor to customize and edit the feature.

BENEFITS

This effort seeks to provide a capability for end users of ASR-enabled training systems to edit or customize the feature to better match their particular needs, which is a significant system upgrade. Within military domains where tactics and protocols adapt over time, so the technology sought should provide training personnel with functionality to append a particular phrase or a specific term to the existing grammar.

STATUS

This STTR has undergone competitive source selection to award Phase II. Currently, two performers were selected to move forward with a gated Phase II. The two performers were selected as they both came to the problem with unique and innovative solutions to the STTR topic. The selected performers have conducted feasibility analyses, designed and developed prototypes, and are now turning the prototype systems into full technology capabilities. The Phase 2 efforts will conclude in early CY21. Additional avenues to continue this line of research are being investigated.

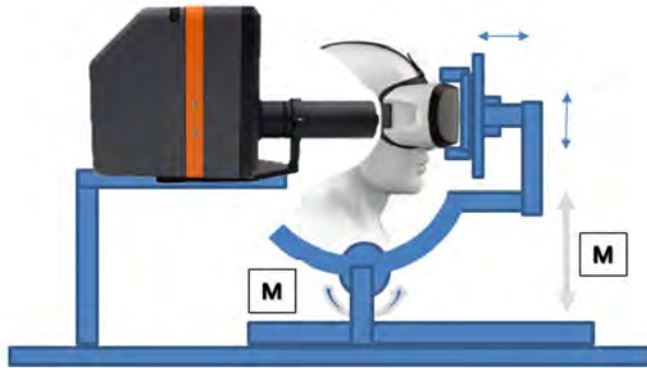
MILESTONES

- ◆ **Phase I:**
 - ◇ Closeout briefs were held with each of the contractors to discuss Phase I progress and Phase II plans
 - ◇ Phase I Option was awarded for two vendors
- ◆ **Phase II:**
 - ◇ Phase II contract awarded in October 2018 and initial technical work is in progress
 - ◇ Both performers were selected to move forward with full duration Phase 2 awards
 - ◇ Both performers have conducted usability and user interface evaluations of their respective capability
 - ◇ Transition of technology is expected as part of a communication trainer under development

STRATEGIC DEVELOPMENT OF NEAR EYE DISPLAY (NED) PERFORMANCE METRICS FOR NAVAL AVIATION TRAINING APPLICATION (SG-19-022)

OBJECTIVE

Develop techniques, tools, and procedures for measuring performance of near eye display systems (NED), such as virtual reality (VR), augmented reality (AR), and mixed reality (MR) head mounted displays (HMD).



Concept Near-eye Display Imaging Colorimeter and AR/VR Headset Testing Mount

PROJECT DURATION

APR 2019 - DEC 2021

SPONSOR

Naval Air Warfare Center Aircraft Division
(NAWCAD) | NISE: WFD-SG
Naval Aviation Training Systems Program Office, PMA-205
H-53 Heavy Lift Helicopter Program Office, PMA-261

POINTS OF CONTACT

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DESCRIPTION

This project is looking at VR/AR/MR technology and adapting existing visual system measuring techniques and procedures to NED. The Navy is seeking collaboration with developers and system integrators to develop metrics and procedures that accurately quantify performance.

NEED

The popularity and advancing capabilities of commercial VR/AR/MR headsets has opened the opportunity for the innovative application to Naval Aviation Training Applications. However, current methods for assessing visual display systems do not necessarily apply to NED devices.

BENEFITS

Knowledge within the Navy on the pros and cons and applicability of VR/AR/MR devices to Naval Aviation missions is necessary. Technology is currently

advancing quickly and it is therefore necessary to keep track of advances and capabilities and update a road map for further R&D and SBIRs. This project will generate the necessary Navy workforce knowledge and enable new subject matter experts to answer these questions.

STATUS

FY20 accomplishments included: 1) development of NED Unity 3D Test Pattern Tool, 2) collection of NED static resolution and FOV performance data on VR headsets, 3) analysis of static resolution and Field-of-view on fielded Naval aviation trainers, 4) development of NED latency measurement device 5) sharing and coordination with industry through CRADAs (FSI, NVIDIA) and HEADS SBIR, 6) follow-on work on new project for MR headset evaluation on CNATRA T-45 MR flight trainer.

MILESTONES

- 219 WFD SD award 4/9/19.
- Established CRADA with FSI July 2019.
- NISE Sec 219 End of Year Review Sep 2019.
- Complete first set of field and lab metrics Spring 2020.
- Complete development of NED mount Spring 2020 (delayed*)
- NISE Sec 219 FY20 Mid Year Review Spring 2020.
- Baseline performance of NED Summer 2020.
- Publish paper on initial results Summer 2020 (canceled*)
- Publish paper on final metrics and results Summer 2021
- Final Report Dec 2021.

* Due to COVID-19

TNG: STREAMLINING THE 3D ASSET CREATION PIPELINE WITH RAPID MESH CREATION TECHNOLOGY (WFDSG-21-016)

OBJECTIVE

To utilize emergent, automated, rapid mesh creation software that will streamline the development process to reduce the cost and time of highly detailed, realistic, game/simulation ready, 3D modeling. A streamlined process will also help to develop re-usable contract-ready language to provide a description for game/simulation-ready assets as it pertains to Virtual Interactive Shipboard Instructional Tour (VISIT)[™] and Multipurpose Reconfigurable Training System (MRTS)[®].



Screenshot of 3D modeled valves and pipe fittings from VISIT[®] VR

PROJECT DURATION

OCT 2020 - SEPT 2022

SPONSOR

Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: WFD-SG

POINTS OF CONTACT

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DESCRIPTION

The standard 3D modeling pipeline begins with a variety of source materials including photographs, videos, Computer Aided Design (CAD) drawings, and point cloud data from laser scans of the object to be modeled. Each of these source material options has their own drawbacks and therefore artists typically use a combination; gathering them is time-consuming. To counterbalance these issues, this research will seek to streamline the remainder of the 3D modeling pipeline.

NEED

The volume of 3D modeling work requested of the TechRAT Lab, VISIT[™] and MRTS 3D[®] teams is increasing dramatically, due to the demand for graphics intensive Augmented Reality (AR), virtual reality (VR), and 3D applications for training. Creating the game/simulation-ready assets to support these development efforts is expensive and requires long lead times. Additionally, there is no standard for what constitutes a “game-ready” asset; an asset

deemed ready for a 3D desktop application might not suffice for an XR application.

BENEFITS

Developing technical experts in photogrammetry, cad-to-mesh, and photo-to-mesh techniques will improve the TechRAT/VISIT[™]/MRTS 3D[®] asset creation process, increasing training product delivery speed to the fleet. This same expertise can be applied to the cost and time estimating activities associated with acquisition. Any IPT across all Naval communities can leverage this knowledge.

STATUS

There will be two main areas of focus for this research. The first will be to explore assorted commercial software technologies to pinpoint their strengths and weaknesses. The second will be to collaborate with other labs to learn about their best practices and to avoid repeating inefficient approaches they have already identified.

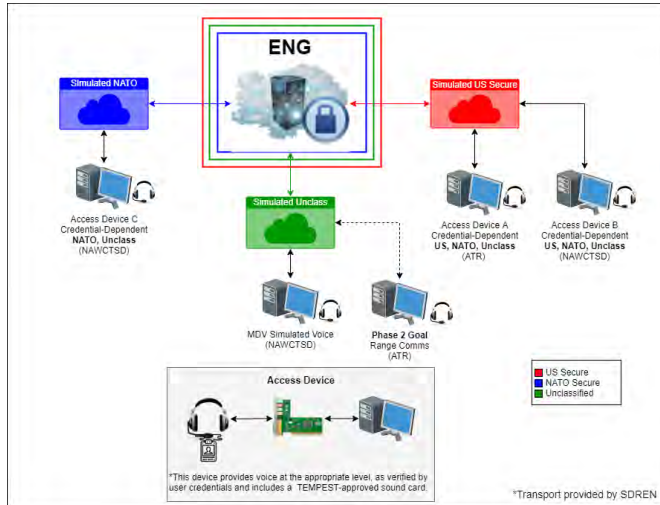
MILESTONES

- ◆ Procure software to be explored and distribute to the artists who will use them in concert with existing tasks
- ◆ TechRAT Lab Engineers to familiarize with software features
 - ◇ Attend virtual onboarding sessions for those software companies that offer one
 - ◇ Review pre-recorded tutorials offered by software companies
- ◆ Contact collaborators to review their process
- ◆ Obtain input from artists and engineers using software regarding strengths and weaknesses
- ◆ Apply selected software and process to existing source material and compare results
- ◆ Document findings with recommended process as a guide for other labs

TRAINING MULTI-LEVEL SECURITY FOR THE SURFACE/AVIATION INTEROPERABILITY LAB (SAIL)-ATLANTIC TEST RANGE (WFD5G-21-014)

OBJECTIVE

The goal of this effort is to develop and deploy a government owned Cross Domain Solution (CDS) in the operational environment of the Atlantic Test Range (ATR). The project takes an incremental approach, beginning with the refinement of use cases and concluding with the deployment of a fully accredited system.



Voice Concept Architecture

PROJECT DURATION
OCT 2020 - SEPT 2022

SPONSOR
Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: WFD-SG

POINTS OF CONTACT

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DESCRIPTION

The Atlantic Test Range often requires a CDS in order to conduct multi-level security operations (MLS). Enterprise Network Guard (ENG) is anticipated to be the first government-owned CDS to meet NSA's Raise the Bar (RTB) criteria, and is may be an ideal solution for the many use cases at ATR. This project explores the CDS requirements of the ATR and configures ENG and its associated rule sets to meet those requirements, as funding allows.

NEED

The ATR benefits from a government-owned CDS to meet its various MLS requirements and use cases. The ENG program benefits from an operational test and evaluation (T&E) and training environment to mature its technology.

BENEFITS

The Enterprise CDS deployed at ATR will provide a streamlined avenue to bring together assets from across security levels. This may improve security posture, increase exercise effectiveness, and/or enable more effective manpower utilization. This effort will also increase the maturity level of the ENG program.

STATUS

During FY21, the project will focus on gathering ATR use cases and furthering the capabilities of ENG by deploying and testing in simulated/emulated multi-level security (MLS) environments. The project will leverage integrated lab exercises such as NILE. During FY21, ENG is anticipated to be a NSA-approved CDS, so the technology will be deployed to satisfy the requirements of ATR, as defined during the FY21 concept refinement.

MILESTONES

- ◆ **FY21:** Feasibility study that includes the following:
 - ◆ CDS use case(s) at ATR that can be supported by ENG within project resource constraints.
 - ◆ ATR rulesets, as required for voice transport will be implemented in NILE 21-1 as a proof-of-concept
 - ◆ Protocol analysis
- ◆ **FY22:**
 - ◆ Update ENG Baseline, schemas and supporting rulesets.
 - ◆ Atlantic Test Range deployment strategy
 - ◆ Operational Deployment of Enterprise Network Guard (ENG) at Atlantic Test Range

TUX-FLIGHTFIT: AUGMENTED REALITY (AR) TRAINING SOLUTION FOR U.S. NAVY PR RATE (ISPR 20-011)

OBJECTIVE

Develop augmented Reality (AR) training software for commercial Head Mounted Display (HMD) systems, leveraging AR Structured On-the-job-training (S-OJT) prototype Transparent User Experience (TUX) developed for previously completed project, "Spatial Augmented Reality Training Utilizing a Transparent Display" (19WFD-SG-17-015).



Representation of Augmented Reality Structured-On-the-Job Training in action

PROJECT DURATION

JAN 2020 - SEP 2020

SPONSORS

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: iSPRINT

POINTS OF CONTACT

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DESCRIPTION

The Physiological Episodes Action Team (PEAT) identified that poor fitting of protective wear and flight equipment as a possible branch of a Root Cause Analysis (RCA) for the physiological episodes experienced by U.S. Navy pilots. Additionally, a gap was identified in Aircrew Survival Equipmentman (PR) rate training for fitting equipment on pilots. To address this gap, PR rates need structured on-the-job training (S-OJT). The training requires many scenarios to cover procedure variance for flight equipment and body types and should be scaffolded ("walk, crawl, run" style) to provide guided and unguided learning scenarios. The training will also need visual accuracy for virtualized equipment for visual cue recognition of equipment states

NEED

The throughput of current training equipment cannot adequately serve the PR rate community. To meet these training

requirements, PR rates need an augmented environment that can be rapidly reconfigured and provide a scaffolded learning experience.

BENEFITS

If successful, AR training at required fidelity can be delivered widely to many fleet communities at lower cost.

STATUS

Collaborated with Ready Relevant Learning (RRL) and their training modernization effort for PR rate, and Naval Aviation Technical Training Center (NATTC). Prototype sprint effort was completed. RRL has agreed to separately fund FY21 extended effort for content conversion and transition to PR rate training modernization.

MILESTONES

- ◆ Successfully developed prototype and demonstrated at NATTC in March 2020 to glowing response by PR rate community.

VOICE RECOGNITION TO SUPPORT ASSESSMENT OF CROSS PLATFORM SITUATIONAL AWARENESS AND DECISION MAKING (N202-098)

OBJECTIVE

Develop a voice recognition capability that can support analysis and debrief of Carrier Strike Group level decision making and Situational Awareness (SA).



Screenshot from NGTS ART

PROJECT DURATION

Phase I: 6mos Period of Performance

SPONSOR

Small Business Innovative Research (SBIR)

POINTS OF CONTACT

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DESCRIPTION

Develop a tool to analyze virtual, and eventually live training events, using speech to text (STT) technologies and natural language processing (NLP) to automatically verify the semantic content of utterances associated with relevant tactical communications. Applying this type of technology to Air Defense integrated training will enhance assessment by providing more robust and accurate assessments. The tool will allow for natural, free flowing interactions between platforms, which will result in speech recognition and understanding among groups within context. Additionally, the tool should be designed and developed to include debrief visualizations that support diagnosis and feedback of voice communication tied to context in the tactical environment at the time of the communication.

NEED

There is a need for complex, highly coordinated, system-of-systems, Air Defense missions and tactics cross-platform communications. The complexity of coordination associated with integrated tactics necessitates a significant amount of voice communications across the different platforms to provide SA and elicit decision-making. Communication is critical to cross platform coordination and overall tactic execution, yet it remains one of the most challenging training objectives to meet during Air Defense events. Specifically, there are

challenges with recognizing when a call or request for communication has been made, ensuring timeliness of communications, and providing the appropriate brevity terms and standard communications protocols. The need for timely, diagnostic feedback specific to cross-platform communications becomes critical.

BENEFITS

The development of an innovative speech recognition tool for cross-platform SA and decision-making will benefit the Fleet by significantly decreasing instructor workload, reducing human error and manpower time requirements, and automatically provide instructors with information on communication protocol adherence and timeliness to improve SA and increase debriefing capabilities.

STATUS

Conducted evaluation of 33 Phase I proposals and down selected to three performers. Contracts will be awarded to three companies in Q1 FY21 and kickoffs will be held thereafter. Phase I's will focus on defining and developing a concept for standalone, voice assessment capability for a single Air Defense platform and will demonstrate feasibility of application into the larger, integrated training system.

MILESTONES

- ◆ Conducted evaluation of 33 Phase I proposals
- ◆ Down selected to three companies
- ◆ Contracts to be awarded in Q1 FY21, kickoffs to follow

AUGMENTED REALITY BRIDGE NAVIGATION AND SEAMANSHIP TRAINER (TT-20-023)

OBJECTIVE

Join a multi-organizational collaborative effort to create an integrated shipboard demonstration utilizing augmented reality and secure wireless technologies to create a Live Virtual Constructive (LVC) training environment for the navigation team.



A sailor participating in ANTS2 demonstration. Photo Credit: NSCLANT

PROJECT DURATION JAN 2020 - SEPT 2020

SPONSOR

Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: Tech Transition

POINTS OF CONTACT

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DESCRIPTION

NAWCTSD joined the Advanced Navigation Team Shipboard Simulation (ANTS2) collaboration to provide simulations of critical navigation components such as the SPS-73 radar, AIS transponder, and sensor inputs into the tactical Electronic Digital Chart Display and Information System (ECDIS).

NAWCTSD implemented an NCTE Training Baseline (NTB) compliant High Level Architecture (HLA) 1516e gateway to allow Mariner Skills Suite (MSS) software to participate in the collaborative exercise. NAWCTSD also investigated a method to more efficiently display MSS components inside a Virtual Reality (VR) or Augmented Reality (AR) Unity scene.

NEED

This project is intended to fill a surface ship unit level training capability gap: inclusion of a ship's navigation, ship handling, and topside team in Fleet Synthetic Training (FST) events.

BENEFITS

Mariner Skills Suite will be capable of participating in future FST research and training events. Software libraries developed during this effort will be reused to support current and future NAWCTSD training requirements. NAWCTSD will leverage technologies and lessons learned to pursue future secure wireless architectures and cybersecurity Authority To Operate in classified trainer spaces.

STATUS

The project completed in SEP 20 with a successful integration and testing event. Provided federated navigation software to support an integrated shipboard demonstration utilizing augmented reality to create a Live Virtual Constructive (LVC) training environment for the navigation team. Now that TechRAT Lab can participate in future FST RDT&E events utilizing the developed NTB compliant HLA gateway, there have already been discussions with collaborators about future research building on this project. For instance, there is interest in exploring denial of GPS situations using MSS in a FST exercise.

MILESTONES

- ◆ Mariner Skills Suite NTB compliant HLA gateway implemented, tested, and demonstrated to allow MSS to participate in ANTS2 exercises.
- ◆ NAWCTSD successfully implemented a prototype native Unity plugin to demonstrate displaying MSS applications in a VR and AR Unity scene.
- ◆ Participated in final integration and testing event (Sep 2020)
- ◆ This project involved collaboration with the following organizations, who were independently funded: Naval Simulation Center Pacific (NSCPAC), Naval Simulation Center Atlantic (NSCLANT), Naval Surface Warfare Center Corona Navy Continuous Training Environment (NCTE), Naval Surface Warfare Center Dahlgren Division Dam Neck Activity (NSWCDD DNA), Huntington Ingalls Industries Defense and Federal Solutions and Arora Corporation

AUTOMATED NMETL ANALYSIS: WARFARE COMMAND & CONTROL KNOWLEDGE ELICITATION DATABASE (WC2KED) - BAR21-025

OBJECTIVE

To develop, prototype & integrate a decision making database tool to automate the analysis of Navy Mission Essential Task Lists (NMETLs) for command and control of carrier strike group missions.



PROJECT DURATION
OCT 2020-SEPT 2022

SPONSOR
Naval Air Warfare Center Aircraft Division
NISE | BAR

POINTS OF CONTACT

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DESCRIPTION

Contextualized cues will be combined with objective data and when linked to decisions for Warfare Commanders at the NMETL level will lead to improved Situational Awareness (SA) and better decision making when used to effectively debrief Warfare Commanders. We will observe LVC fleet training events, Conduct interviews and focus groups with C2 subject matter experts, and read documentation (e.g., OPTASKs, ROC/POEs) to determine sources of contextual cues available in LVC training environments; which contextual cues are relevant for specific NMETLs, how they are applied with regards to desired C2 for Warfare Commanders. C2 cues and decisions database tools that can be implemented into Joint After Action Review (JAAR) capabilities and reports; Implement findings in NAVSEA NISE funded Naval Surface Warfare Center Dahlgren Division (NSWCDD) Dam Neck Annex (DNA) product to automate NMETL analysis

NEED The department of the Navy has identified Training & Readiness (T&R) as a primary area for improvement. Currently, LVC fleet training events provide limited after action review

capabilities with regards to objective decision making measures for Fleet WCs, with little to no explicit information on how trainee decision-making compares to experts in their warfare area. Currently, there is virtually no objective measurement or diagnostic debrief capabilities of higher level C2 in Fleet Synthetic Training (FST) Events, especially with regards to Warfare Commander, linked to mission critical elements of C2 tasks. Decision Making is seen as too contextually based to accurately, objectively measure or capture.

BENEFITS

This effort will enhance Fleet ability to identify opportunities for training and provide objective measurement linked to T&R.

STATUS

FY21 new start. Conducted kick off meeting with .Naval Surface Warfare Center Dahlgren Division (NSWCDD) Dam Neck Annex (DNA) team.

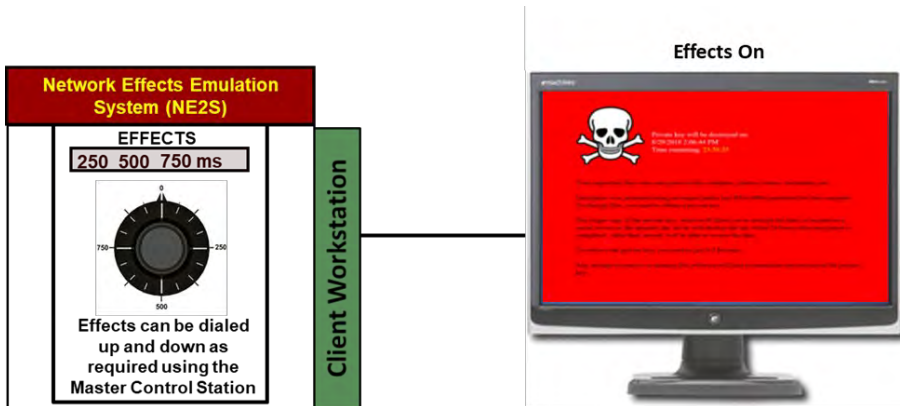
MILESTONES

- ◆ SEP 21: Prototype database with linking of cue values/configurations to C2 decisions and NMETs. This will enable experimental testing in Year 2.
- ◆ SEP 22: JAAR and ART reports; implementation of the process in NSWCDD DNA software; results of test and experimentation.

COMPUTER NETWORK DEFENSE (CND) TRAINER (N171-023)

OBJECTIVE

Develop a prototype Computer Network Defense (CND) trainer to enable CND personnel to be active participants in traditional Navy training and exercises.



PROJECT DURATION

AUG 2018 - SEP 2020

SPONSORS

Naval Air Systems Command (NAVAIR) |
Small Business Innovation Research (SBIR)

POINTS OF CONTACT

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DESCRIPTION

The CND trainer is a Phase II SBIR project that is developing a prototype software tool that safely and securely emulates cyber threats on operator workstations. The emulated threats trigger operational CND sensors and databases (e.g., Host-Based Security System) used by CND personnel to assess and maintain the cyber security of Navy networks and systems. Emulated threats are configured, deployed, and managed via a web-based Master Control Station.

NEED

Recent research within the Joint training community, the Naval Postgraduate School, and others has resulted in the development of several cyber emulator prototypes. Some of these cyber emulators have been demonstrated and deployed during exercises, in limited and small enclaves, to provide a basic cyber-degraded environment for a staff to experience and fight through. While useful in that context, these emulators are not designed or

capable of stimulating CND capabilities critical to defending our networks. What is needed is a training capability that can securely and realistically stimulate CND sensors, databases, processes, and personnel and that can be synchronized with the overall training scenario and exercise control processes and procedures.

BENEFITS

The CND Trainer will allow Navy CND personnel, ashore and afloat, to be active participants in training and exercises in a way that was previously not possible, consequently improving the cyber security of Navy networks and enhancing overall mission assurance and command and control of Naval operations.

STATUS

Phase II complete. Additional funding is pending.

MILESTONES

- ◆ Phase I
 - ◇ Two contractors selected for Phase I.
 - ◇ CND Trainer requirements developed and validated.
 - ◇ Two designs proposed and evaluated by Navy engineers and scientists.
- ◆ Phase II
 - ◇ One contractor selected for Phase II.
 - ◇ CND Trainer prototype under development and has been deployed for testing at the U.S. Army's Maneuver Battle Lab.
 - ◇ Phase II base period ends March 2020.
 - ◇ Several potential DoD and commercial transition partners.
- ◆ Phase II complete. Additional funding is pending.

CREW ROLE-PLAYER ENABLED BY AUTOMATED TECHNOLOGY ENHANCEMENTS (CREATE) N142-090

OBJECTIVE

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



Aircrewmen assigned to Patrol Squadron (VP) 8 perform pre-flight procedures aboard a Boeing P-8A Poseidon maritime aircraft in preparation to support search and rescue efforts for the missing Republic of Korea cargo ship crew in the FOURTH Fleet Area of Operations

PROJECT DURATION
OCT 2014 - DEC 2020

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)

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DESCRIPTION

This effort seeks to design and develop a software application/suite that provides a synthetic role-playing capability that will serve to enhance the training pipeline and potentially avoid costs and provide value added without the use of training aids. The required technology solution must integrate speech capabilities (i.e., recognition, understanding, synthesis), Subject Matter Expert 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.

NEED

Current Navy crew training requires the assembly of an entire crew or the use of Subject Matter Experts to support crew training. While training benefits from the additional costs associated with bringing a full crew together, some individual training could benefit from the added realism provided by crew interaction. 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 crew members.

BENEFITS

CREATE will enhance the training pipeline by streamlining the instructor's efforts during training. This will also add to the potential cost avoidance and provide value added without the use of training aids. Instructors will be able to manage more trainees at once in a more efficient manner, and be able to deliver more tailored instruction and feedback if necessary, increasing the quality of training.

STATUS

During Phase 2 and 2.5 efforts, the government worked with the contractor and transition customers to continue component research and development. Throughout this period, periodic demonstrations were conducted to the P-8A Fleet Project Team. Expansion efforts under the Phase II involved initial integration efforts with Boeing and NGTS, which were expanded upon during Phase II.5 efforts. The team works to continuously improve the speech recognition capabilities of the technology. Phase 3 began in May of 2019 and focuses on implementation and testing within the P-8A part-task trainer, as well as further speech recognition hardening and testing. The current iteration of the Phase 3 effort will conclude in December of 2020. Additional Phase 3 work will depend on resources available from the program office.

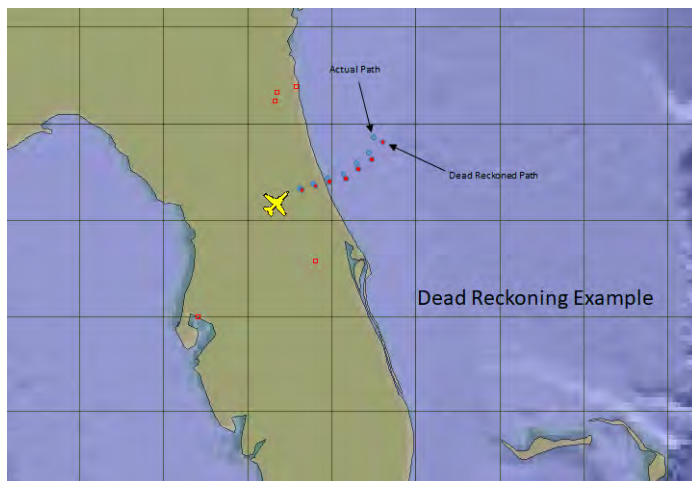
MILESTONES

- ◆ **Phase III:**
 - ◇ Phase III contract awarded May of 2019
 - ◇ Phase III focuses on the testing and integration of the CREATE system with the P-8A Part-Task Training simulators
- ◆ **Manuscripts/Publications:** Atkinson, B. F. W., Killilea, J. P., Stensrud, B., Marinier, B., Schermerhorn, P., Dettmering, C., Saadat, S., & Anania, E. C. (2017). *Crew role-players enabled by automated technology enhancements*. Proceedings of the Interservice/Industry Training Simulation & Education Conference, Orlando, FL.
- ◆ Anania, E. C., Killilea, J. P., Atkinson, B. F. W. (2018). *The application of automation systems for training - Implications of trust*. Proceedings of the Interservice/Industry Training Simulation & Education Conference, Orlando, FL.
- ◆ **Presentations:** Anania, E. C., Atkinson, B. F. W., & Killilea, J. (2017, October). *The application of automation systems for training - Implications of trust*. Presenting at the SAFE Symposium, Orlando, FL.
- ◆ **Transitions:** Components of the CREATE technology provided a baseline capability for a communications trainer under development for the VP and HSM communities.

DISTRIBUTED SIMULATION DATA MONITORING, ANALYSIS, AND VERIFICATION (WFD-SG-19-018)

OBJECTIVE

The object of this effort is to research, design, and implement enhanced distributed simulation data monitoring, analysis, and verification capability for the Federation Agreement Compliance Test Tool (FACTT) Suite.



PROJECT DURATION

APR 2019 - SEP 2020

SPONSORS

Naval Air Warfare Center Aircraft Division
(NAWCAD) | NISE: WFD:SG

POINTS OF CONTACT

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DESCRIPTION

There are two capabilities to be implemented in this effort:

1. Capability to monitor the simulation and provide user selected metrics during runtime. This capability will generate metrics related to the overall simulation traffic such as throughput and transmission delay as well as finer granularity metrics related to specific classes or instances of simulation objects such as max and average object update intervals per class or instance.
2. Capability to verify computed dead reckoning results during runtime. This capability will assess dead reckoning computation results received from simulations and flag instances where those results differ from the ones expected by a user settable tolerance.

NEED

There are many challenging areas related to testing and verification of distributed simulation data. The proposed capabilities will address some of those issues by performing data

analysis on raw simulation data and presenting them to the users in a format that is easier to understand and conducive to further analysis and assessment.

BENEFITS

This effort will speed up the analysis and testing platform compliance to the Navy Aviation Simulation Master Plan (NASMP)/ NCTE Interoperability Standard (NIS) standards.

STATUS

Completed implementation of simulation traffic monitoring and metrics computation capability. Also completed implementation of dead reckoning verification capability. Both capabilities have been delivered to the NAWCTSD IDEA Lab for their integration into the Federation agreements Compliance Test Tool (FACTT) software Suite.

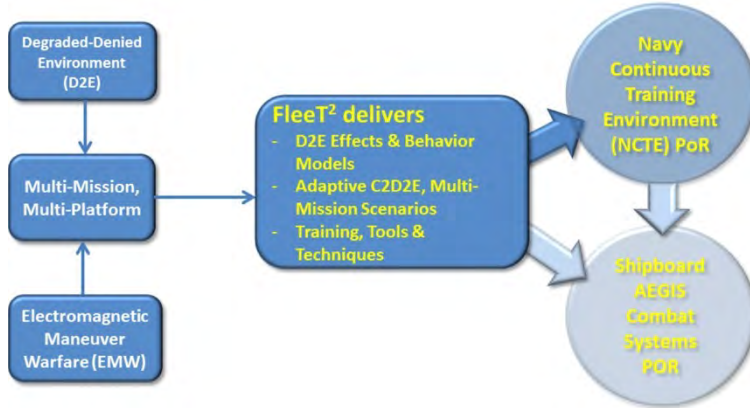
MILESTONES

- ◆ Implemented simulation traffic monitoring and metrics computation capability (SEP 2020)
- ◆ Implemented dead reckoning verification capability (SEP 2020)
- ◆ Both capabilities have been delivered to the NAWCTSD IDEA Lab for their integration into the Federation agreements Compliance Test Tool (FACTT) software Suite (Sep 2020)

FLEET TRAINING TECHNOLOGIES (FLEET2)

OBJECTIVE

Currently, the Navy plans and trains for pristine Command and Control (C2) environments. While C2 is by itself complex, the emergence of peer threats makes it even more difficult to ensure resilient C2 processes. In a Denied/Degraded Environment (D2E), adversaries may deploy a variety of tactics that create a dynamic environment, rife with additional challenges. Training in the absence of these realities presents a threat to effective C2 – a crucial component of naval surface operations. Fleet2 will provide new training approaches and technologies.



PROJECT DURATION
OCT 2017 - OCT 2022

SPONSOR
Office of Naval Research (ONR)
Code 34 Future Naval Capability (FNC)

POINTS OF CONTACT

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DESCRIPTION

FleeT2 is designed to allow trainers to build scalable phenomenology models and virtual assets to simulate, test, and train to emergent threats and technologies. The virtual constructive simulation capabilities planned for Fleet2 will allow the system to produce accurate, detailed, threat-dense, and intense scenarios that would be cost prohibitive or otherwise impossible to perform in the real world. Synthetic models can be easily modified, repeated, and adapted to train various situations, user roles, and skill levels. Ultimately, Fleet2 will allow command teams and system operators to train for integrated, cross-platform warfare against simulated peer threats with counter D2 capabilities.

NEED

Naval surface Command and Control (C2) is a broad domain encompassing the management of coordinated electronic surveillance, information integration across enterprise sensors and information sources, and personnel/asset management in support of missions. Understanding all the demands facing C2 performers is further complicated by the fact that C2 personnel operate at many echelons of command and across many specialized functional areas.

Creating the training systems and curricula necessary to support such a domain will be challenging.

BENEFITS

There are two anticipated benefits arising from the FleeT2 program. First, the fleet will have a secure environment to train to address Denied/Degraded Environment (D2E) threats. Further, the simulations will be extensible to evolving and emerging threats. Second, the fleet will be able to train for D2E operations more effectively at a lower cost. This should result in a reduction in underway deployments required for training while providing an environment that mirrors the real world.

STATUS

FleeT2 has completed Year 1 of the FNC effort under ONR Code 34. Technology development for measures, blue force capabilities in JSA and degradation models is ongoing. FleeT2 conducted 3 Focused Test Events (FTEs), 2 at Naval Simulation Center Pacific and one distributed across NCTE at Gallery Hall at NSWDDC DNA and NSCPAC. Technologies developed under this effort include enhanced performance measures in JAAR reports, red propagation visualizations using builder in SIMDIS, enhanced Red Cell C2 structures, and intelligent agents for Zulu.

MILESTONES

- ◆ A Technology Development Agreement was signed between the Office of Naval Research (Code 341), OPNAV N96 (Director, Manpower and Training), Fleet Forces Command (N72), Program Executive Office Integrated Warfare Systems Integrated Training (1IT), and the Navy Continuous Training Environment, NSWC Corona (RS20F)
- ◆ Conducted (3) FTEs with Tactical Training Group Pacific (TTGP): 1) focused on Human Performance Measurement and JAAR) focused on Intelligent Agents for Zulu mentors and 3) focused on Red Cell and EM Propagation
- ◆ Conducted Subject Matter Expert (SME) workshop at TTGLP, NAWCTSD, and via focused Technical Interchange Meetings (TIMs)

INTEGRATED COOPERATIVE ENGAGEMENT CAPABILITY (CEC) & OWNERSHIP FOR NGTS –MISSION CAPABILITIES (ICON-MC) (TT-20-093)

OBJECTIVE:

This effort seeks to develop Cooperative Engagement Capability (CEC) data link model and improve the AIM9X model fidelity and conduct effectiveness studies to better understand the impact these fidelity improvements have on training.



PROJECT DURATION
OCT 2019 - SEP 2022

SPONSOR

Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: Tech Transition

POINTS OF CONTACT

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DESCRIPTION

This effort seeks to increase the capabilities associated with internal NAWCAD assets to better support the ability to develop & test/experiment S&T products for complex air missions. Historically, NAWCAD has used the Manned Flight Simulator (MFS) facility to conduct these types of S&T activities as a proxy for operational environments as MFS is a T&E site. However, the traditional customer base for MFS are test pilots that use the high fidelity simulators to test aerodynamic characteristics of flight and capabilities such as weapon flyouts have not been required. Additionally, the simulation environment used at MFS, Next Generation Threat System (NGTS), does not simulate all the data links necessary to fully execute complex tactics like the Naval Integrated Fire Control– Counter Air (NIFC-CA). In order to make the MFS facility a viable option for conducting state of the art S&T in the Air Warfare domain, these gaps must be filled. Consequently, this effort proposes to enhance the F/A-18 E/F AIM9x ownship weapons model and to develop a CEC data link capability within NGTS to provide an organic experimentation and test capability. Additionally, this effort will conduct effectiveness studies to better understand the role model fidelity plays in skill acquisition.

NEED

To conduct experimentation & testing of S&T instructional training capabilities for complex Air Warfare missions and tactics,

simulation environment and ownship models in simulators must possess the appropriate fidelity & representative capabilities of the operational environment. Without these models complex integrated missions and tactics like NIFC-CA tactic kill chains cannot be fully trained (i.e., From the Sea), modeled, nor relevant products accurately tested.

BENEFITS

By developing/improving these models, the NAWCs (AD/TSD) will continue to advance the state-of-the-art in modeling, simulation, and training technologies for complex Air Warfare missions/tactics by providing a more robust simulation environment that more accurately represents the operational environment.

STATUS

In FY 21 (1) begin testing and develop empirical study protocol - including finalizing measures. (2) Complete AIM9x baseline development. 3) Begin CEC development. FY22 will develop models and measures based on year 1 requirements and conduct iterative verification and validations tests events with subject matter experts to ensure representative fidelity and capabilities exists. Begin CEC development.

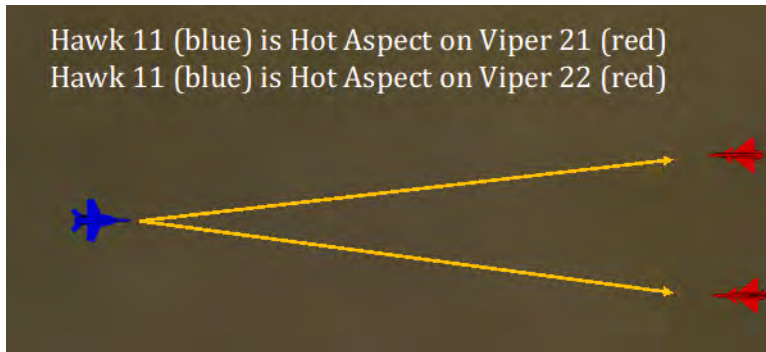
MILESTONES

- ◆ Ownship Weapons Model (AIM9x):
 - ◇ Defined requirements based on feedback gathered during AIM120 development on Integrated Warfighting Capabilities Fidelity Investigation (219BAR-17-013)
 - ◇ Completed AIM9X on-rail seeker and flyout model and began coding parser for MIL-STD 1760 messages in AIM9X interface control document
 - ◇ Developed draft model assessment document for SME testing
- ◆ CEC Datalink Model:
 - ◇ Identified CEC messaging requirements for NIFC-CA From the Sea

JOINED EVALUATION OF SIMULATION-ENABLED TRAINING FOR ENHANCED READINESS (JESTER) OSD11-CR1

OBJECTIVE

Develop a software capability to dynamically collect and assess performance data in real-time that will provide outcome data and contextual information regarding what was going on in the environment to better support instructors providing enhanced debriefs.



Screenshot from Event Recognition Capability In NGTS

PROJECT DURATION
APR 2019–APR 2021

SPONSOR
Small Business Innovation Research (SBIR)

POINTS OF CONTACT
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DESCRIPTION

Conduct research, development, and testing of a new capability, compatible and integrated with the Navy's Next Generation Threat System (NGTS) that will enable dynamic performance assessments within Live, Virtual, and Constructive (LVC) training scenarios. This work builds on prior efforts designed to enhance algorithms and methods that perform rapid assessments of readiness including: 1) perform dynamic assessment as trainee's perform, providing real-time feedback to instructors; 2) take prior events and assessments into account when assessing new events, providing nuanced and tailored feedback; and 3) enable instructors to customize and parameterize assessments to specific events, crews, and operating conditions.

NEED

Air Wing Fallon is one of the most important training opportunities in naval aviation that presents trainees with live and live-constructive training events that display complexity not presented elsewhere. The scenarios are so rich and intense that teams of subject matter experts are employed to conduct the assessments of individual aircrews and to conduct debriefs. While debriefs themselves can stretch for hours, the preparation for debrief can take just as long. In the current evaluation structure all assessment and measurement is done by hand. As training events inevitably

move to virtual environments a significant portion of this work can be offloaded from instructors. Thus, there is an opportunity to improve the current system by providing automated measurement through event recognition

BENEFITS

This effort will include individual, unit, and integrated level assessments. Extending assessment to the unit level will fill a critical gap in Naval training by allowing for more robust quality of instruction via debrief and allow Carrier Strike Group performance to be more effectively tracked over time and compared to one another to better understand proficiency and readiness prior to deployment.

STATUS

To date the team has developed a generalized and extensible Event Recognition capability (through event graphs), a user definable visualizations capability, a customizable log to display relevant event information, and a data capture ability to enable the storage of event occurrences to support machine learning. A significant portion of this effort has also involved working directly with NGTS to develop capabilities that can seamlessly integrate into the NGTS baseline source code.

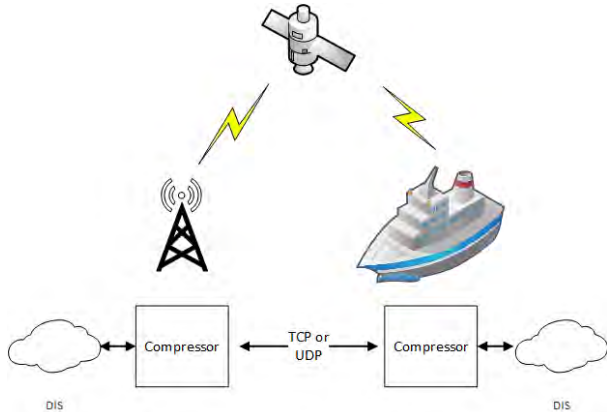
MILESTONES

- ◆ Conducted multiple virtual demonstrations / presentations
- ◆ Conducted design reviews / discussions with NGTS engineers
- ◆ Developed and presented our current architecture and plan for future development to NGTS engineering leadership for signoff
- ◆ Generated and unclassified test scenario to facilitate rapid analysis during regression testing
- ◆ Created a new prototype visualization for use in tactical range calls

LIVE VIRTUAL CONSTRUCTIVE (LVC) DATA TRANSPORT COMPRESSION (TT-020-015)

OBJECTIVE

Investigate and develop a tool to provide lossless compression modeling of training simulation data (Compressed-Distributed Interactive Simulation / Distributed Interactive Simulation) for transmission between land-based facilities and live assets over bandwidth-constrained and contested data channels. Identify techniques to cope with data loss incurred in the communications channel and recover from the data loss.



Investigate use of streaming data compression to pass modeling and simulation data over a narrow bandwidth data channel.

PROJECT DURATION

OCT 2019 - SEP 2020

SPONSORS

Naval Air Warfare Center Aircraft Division (NAWCAD) | NISE: Technology Transition

POINTS OF CONTACT

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DESCRIPTION

Modeling and simulation data occurs in small, frequent packets (typically 100-1000 bytes). Lossless compression on a single packet of this size is not possible so this compression must occur on a stream of packets. The challenges include: (1) The data compression is across a stream of packets, packet loss must be recognized and accounted for in some way. (2) Greater compression is possible across a longer stream of packets. How often should the stream state be reset to balance compression needs and packet loss.

NEED

As training begins to incorporate live ships at sea, there is increased need to pass modeling and simulation data between these ships and shore-based training assets. This data is passed over bandwidth-limited channels, such as a satellite channel. To be maximally useful, these compression techniques should be transparent to the network connection and not require pre-configuration.

BENEFITS

Interoperability is essential to supporting training in an integrated, interactive environment. Early participation in standards development ensures that the Navy's requirements are represented and that we maintain awareness of novel developments by other SISO members that may benefit our Science and Technology, Research and Development, and/or acquisition. Further, calls for quantitative data and big data analytics to understand proficiency requires access to the right

data. Therefore, it is imperative to ensure that distributed training environments support assessment of performance and provides an architecture that facilitates distributed debriefs.

STATUS

Research completed in FY20. Due to COVID-19, the demonstration event was changed to a NILE LVC event conducted in August 2020. Experimentation was conducted with three varieties of data compression. Voice traffic was encoded using a GSM Half-Rate CODEC versus the more usual mu-law CODEC, resulting in approximately 66% reduction in bandwidth for voice traffic.

A truncating compressor was used for DIS simulation data. This compressor only sends the data that matters down to the bit level rather than using standard machine data types. For example the standard DIS protocol uses 3 64-bit quantities to specify the position of an object. Adequate positional representation can be achieved with 21-22 bits per dimension. This compression achieved approximately 50% savings in bandwidth.

Finally, a streaming compressor was utilized to perform lossless compression on the simulation data compressed with the truncating compressor above. This streaming compressor accumulated protocol messages until 1000-1400 bytes were ready or a timeout elapsed (typically 10 ms), achieving better compression results. This streaming compression, when combined with the truncation compression resulted in roughly 80% bandwidth savings by both reducing the number of packets transmitted and the size of the payload.

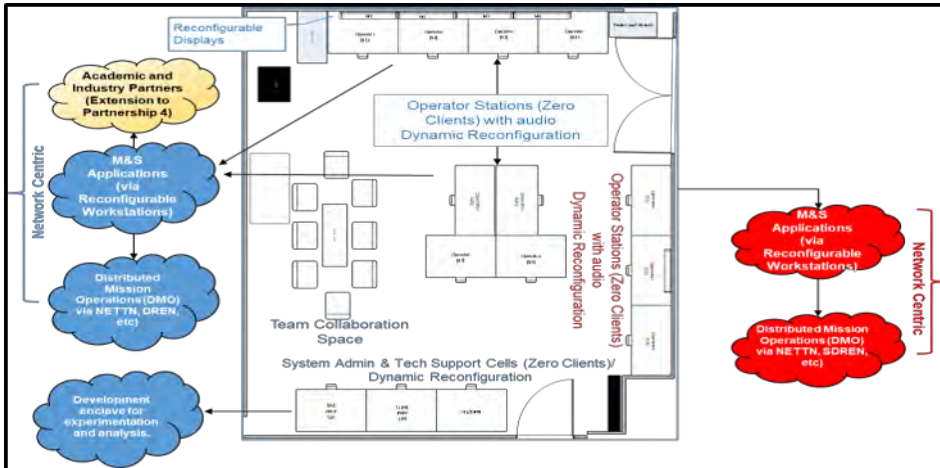
MILESTONES

- ◆ Obtain data compression library and procure two VTBe hardware units (Nov 18)
- ◆ Design and implement data compression module for VTBe. (Mar 19)
- ◆ Design and implement user controls for data compression module. (May 19)
- ◆ Conduct experimentation in lossy data environments with data compression module and explore the tradeoff between compression and loss recovery. (Jun 19)
- ◆ Conduct experimentation into the tradeoff between data truncation and lossless data compression. (Jul 19)
- ◆ Participate in delivery event with ONR-34 at a COMPTUEX. (Aug 19)

NON-PERSISTENT VIRTUAL MACHINES VIA INSTANT CLONING FOR LVC (\$G-21-018)

OBJECTIVE

Develop workforce knowledge and expertise in the technology area of Non-Persistent Virtual Machines via Instant Cloning and use the NAWCTSD Live, Virtual, Constructive Development & Operations Center (LVCDOC) to demonstrate the benefits of such an architecture when applied to LVC simulation applications.



The LVCDOC zero client-based virtualized LVC environment to which VM instant cloning will be applied.

PROJECT DURATION
OCT 2020 - SEP 2021

SPONSOR
Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: WFD-SG

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DESCRIPTION

The workforce participants will research methods to configure and implement instant cloning technology using the virtualized hardware/software available in the LVCDOC. Base operating system images will be built and secured using the applicable STIGs, and those images will become the basis for clones. Simulation applications will be installed on the base images in a manner that prioritizes flexibility. The system will be tested and demonstrated by rapidly cloning simulation applications across zero clients in the LVCDOC lab, and then rapidly changing to a new configuration.

NEED

Although the implementation of Instant Cloning in commercial Virtual Machine architectures is well-understood, that is not the case when applying the technology to specific LVC training applications (e.g. NGTS, AMIE, JSAF, JBUS, JAAR, etc). These applications often have computing and OS configuration requirements that are outside the norms of typical commercial applications, and they are typically tested on specific baseline OS and hardware configurations. The

challenge is getting each particular application to function correctly and reliably in an environment for which they were not originally designed. Implementation of this technology at NAWCTSD will provide in-house developed systems and laboratories, such as the LVCDOC, to more flexibly scale and meet demand associated with LVC events.

BENEFITS

One purpose of this effort is to develop workforce knowledge and expertise in Virtual Machine technology, implementation of Instant Cloning, and the application of those concepts to LVC training applications. The breadth of LVC efforts taking place at NAWCTSD (including RDT&E and Acquisition) provides many areas for the individuals who are involved in this project to promulgate the knowledge and experience gained.

STATUS

This is an FY21 New Start. Project recently began; instant cloning technology is currently being researched by LVCDOC engineers.

MILESTONES

- ◆ Workforce participants will research the methods to configure and implement the technology using the hardware/software available in the LVCDOC (e.g. zero clients, VMWare)
- ◆ Selected upgraded graphics hardware and software licenses required will be purchased and installed
- ◆ Base operating system images will be built and secured using the applicable STIGs, and those images will become the basis for the clones. Simulation applications will be installed on top of the base images in a manner that prioritizes flexibility.
- ◆ LVC simulation applications that will be considered for demonstration include NGTS, AMIE, JSAF, JBUS, MDV, and JAAR.
- ◆ Final system will be tested and demonstrated by rapidly cloning simulation applications across zero clients in the LVCDOC, and then rapidly changing to a new configuration.

VERIFICATION AND VALIDATION OF HIGHER FIDELITY CONSTRUCTIVE ENTITIES FOR UAS TRAINING (BAR-18-054)

OBJECTIVE

This research effort (1) assessed the impact of using live data within the Next Generation Threat System (NGTS) to improve training realism and fidelity of constructive entities and to verify the gains in training effectiveness and efficiency that result for UAS operators and Naval Aviators and (2) created a controlled training effectiveness evaluation (TEE) process that can be replicated and generalized to component trainers across domains.



Raw input data reflecting real-world, white shipping behavior. This data helps to quickly populate scenarios, reducing operator workload.

PROJECT DURATION
OCT 2017 - SEP 2020

SPONSORS

Naval Air Warfare Center Aircraft Division
(NAWCAD) | NISE: BAR

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DESCRIPTION

Utilizing science of learning research principles, we empirically evaluated the effects of higher fidelity training stimuli on performance. Using the Dynamic Adaptive and Modular Entities for UAS (DYADEM) capability, we conducted a controlled experiment with novice participants and the fleet to test our hypotheses (investigating reported instructor workload), collected quantitative/objective data, and created a method of assessing a capability meant to improve a training system without adding training content. Specifically, we wished to explore the effects of the new capability on performance, distinct from the NGTS training content.

NEED

Currently, the impact of the DYADEM capability on workload and performance has yet to be investigated or verified. This is due both to a lack of experimental control in applied/operational training settings as well as a lack of process or methodology that is needed to scientifically and systematically test the training effectiveness of technology that does not add additional training content but rather enhances current training fidelity.

BENEFITS

The impact of the proposed work will improve training not only for UAS but for P-8 and Triton, increase NGTS capabilities, inform training decisions, and predict what the impact will be on the fleet community as well as determining the return on investment for component training. The findings from this research will be used to drive future TEE studies to show value in Naval training capabilities. Additionally, this research offers guidance for LVC Test and Training to optimize individual and collective test and training capabilities through development, expansion, and refinement of live-virtual-constructive capabilities across test and training environments, learner populations, and across domains, systems, and security levels.

STATUS

In FY20 the team Engineering & Pilot Testing: (1) Completed engineering testing & usability pilot testing (2) Ran participants as pilots to test materials on novice users. Data Collection: Ran 180 participants through the study using the Mechanical Turk platform. Data Analysis: (1) Reviewed data and determined analysis plan. (2) Completed statistical analysis of participant data (3) Authoring a Final Report to be submitted to sponsors.

MILESTONES

- ◆ Engineering and Usability Testing (AUG 2019)
- ◆ Data Collection Completed (FEB 2020)
- ◆ Completed statistical analysis in support of hypothesis testing (SEP 2020)

VIRTUAL TACTICAL BRIDGE EMBARKED (VTBe) AUGMENTED STATUS HUB (VASH) (RPC-21-011)

OBJECTIVE

Advance the remote status capabilities of VTBe via creation of the VASH tool. Integrate into the VTBe microservices model for remote procedure call and status display for discovery, operational status information display, and curated control for training mission operators.

PROJECT DURATION
OCT 2020 - SEPT 2022

SPONSOR

Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: RPC

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VASH Concept Architecture

DESCRIPTION

Virtual Tactical Bridge-embarked (VTBe) Augmented Status Hub (VASH) is a software tool with auto discovery capabilities and real-time status/configuration display of embarked VTBe devices and bridges. Emerging LVC technologies like Virtual Tactical Bridge-embarked (VTBe) have established a new embarked training capability previously not available to the fleet. With VTBe, the fleet can begin to develop new training techniques and objectives based on the coming extension of voice to the virtual battle space while underway and beyond the horizon. This new capability carries an augmented need for better visualization of the configuration and status of components utilized to bridge Live-Virtual (LV) domains.

NEED

Prototype VTBe pack up kits are currently in use by the fleet. A persistent onboard solution - Virtual Tactical Bridge Embarked Synthetic Radio (VTBeSR) - will soon begin scaled deployment to the fleet. Experimentation, prototyping, and

demonstration events thus far have not attempted to operate to the level that utilization will soon demand. Without a high level central status and management platform like VASH, fleet training planning will grow too difficult to organize for larger distributed events. VASH is conceptualized and intended to be a compatible participant of the emerging Distributed Global Planer (DGP) philosophy also under development at the Concept Development and Integration Laboratory (CDIL) within NAWCTSD Orlando.

BENEFITS

This technology will help the fleet, mission planners and event operators, to more accurately observe the real time status of the complex array of geographically dispersed system components.

STATUS

FY21 is the initial kickoff of this effort expected to run through FY22.

MILESTONES

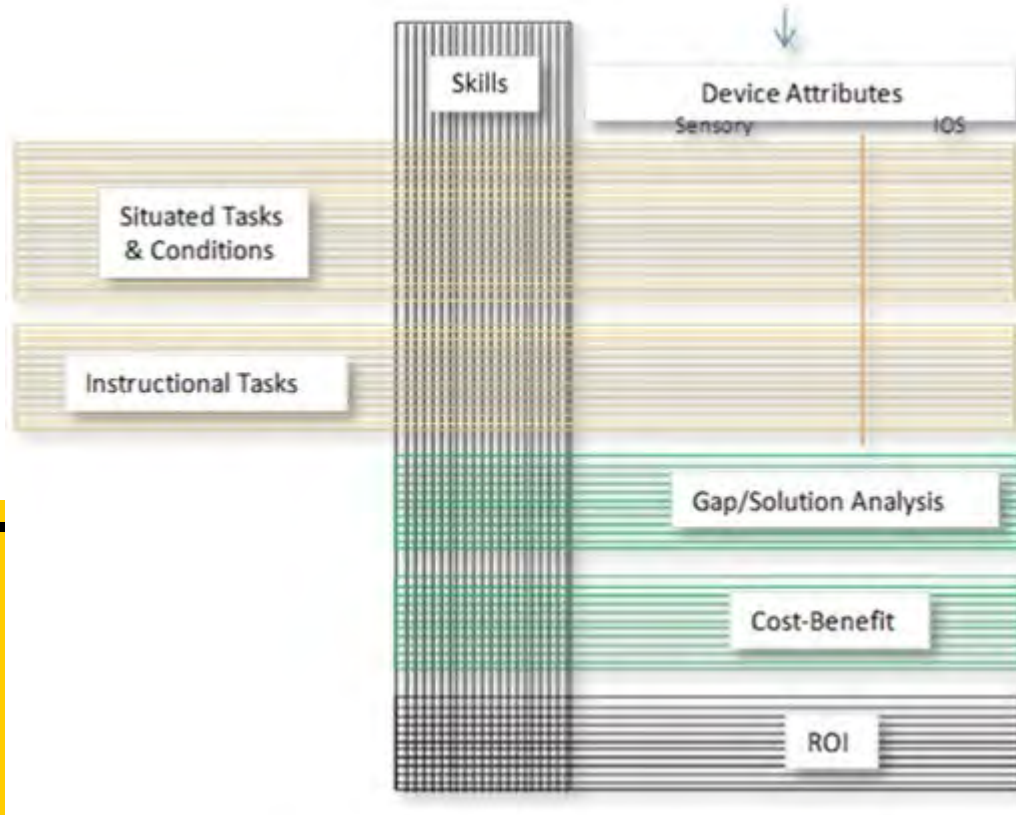
- ◆ FY21 Goals – Clear definition of requirements and use case definitions. Critical design capture and performance data collected and analyzed. Establish developmental laboratory test bench.
- ◆ FY22 Goals – Completed software development, tested and documented. Use during a live Fleet Synthetic Training event and results data collected/analyzed.

CORE CAPABILITY 4: HUMAN SYSTEMS ANALYSIS, DESIGN AND EVALUATION

AIR-4.6 supports and improves human performance through the analysis, design, evaluation, and acquisition of cost-effective training solutions that are both responsive and proven to meet learning, performance, and readiness requirements. This capability is utilized across aviation, surface, undersea and cross warfare domains. Through the application of analytical methods, grounded design theories, and instructional design principles, analysts conceptualize, evaluate, and optimize the design and implementation of training systems and pipelines.

The following Technology areas comprise this Core Capability:

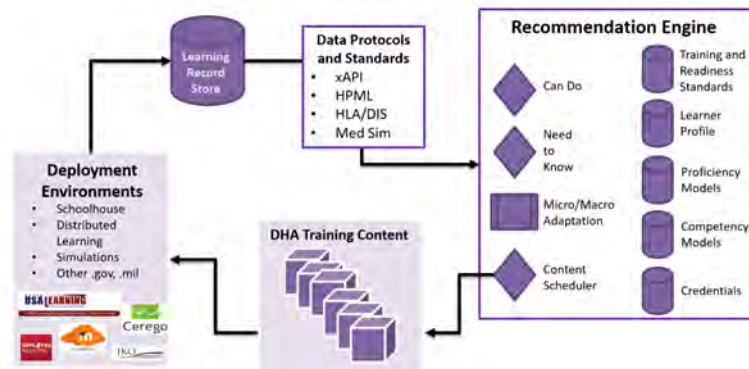
- Content Design
- Training Optimization Analysis
- Training Effectiveness Evaluation (TEE)



MILITARY HEALTH SYSTEM TOTAL LEARNING ARCHITECTURE (TLA)

OBJECTIVE

The goal of the effort is to begin the ambitious task of moving the DHA community to a holistic learning architecture. The Total Learning Architecture (TLA) will attempt to define DHA's unique learning needs, strategies to present them, and mechanisms to deliver them.



PROJECT DURATION
OCT 2018 - JAN 2022

SPONSORS
Defense Health Agency Training and Education Directorate (J-7) and the Program Manager for Medical Simulation and Training (PM MST)

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DESCRIPTION

NAWCTSD with academic and industry partners developed the requirements and science and technology roadmap necessary to enable a Total Learning Architecture to provide the Military Health System (MHS) with the infrastructure to support lifelong learning or collect enterprise/ individual metrics on competencies and readiness.

NEED

The DHA TLA is being developed to address the following MHS issues:

- Incomplete training enterprise infrastructure and analytics for training, education, and human performance
- Fragmented linkages between education, training, and operational goals
- Inconsistencies and inefficiencies in performance and talent management

BENEFITS

Development and transition of a TLA will 1) provide an integrated and enterprise-wide education, training, and human performance

improvement infrastructure; 2) provide a data-driven framework for training and education; 3) enable lifelong, blended, data-driven, and responsive training ; and 4) facilitate continuous competency maintenance.

STATUS

Year 2 of this effort resulted in:

- TLA Component Level Functional Requirements Document
- Measurement and Assessment Strategy Research
- An analysis report as to whether this type of infrastructure is needed for Military Health system patient education.

MILESTONES

- ◆ Draft TLA Component Level Functional Requirements Document (Dec 2020)
- ◆ Draft Measurement and Assessment Strategy (Dec 2020)
- ◆ Patient Education Infrastructure Analysis Report (Dec 2020)
- ◆ Total Learning Architecture Interoperability Analysis Report (Sep 2021)
- ◆ Total Learning Architecture Market Research Report (Sep 2021)

OCEANOGRAPHY TACTICS TRAINING FOR EMPLOYMENT READINESS (N182-119)

OBJECTIVE

Develop a software-based tool to rapidly generate web-based animated training content for employment of advanced oceanography tactics and is capable of incorporating adaptive content presentation based on learner progress through knowledge assessments.



TRITON
Systems
Inc.,
example of
animated
training
scenario.

PROJECT DURATION

SEP 2018 - SEP 2021

SPONSORS

Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)

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DESCRIPTION

The Navy's crawl-walk-run approach to aviation training provides learning opportunities through mixed media beginning with classroom lectures and computer-based training, engagement with equipment through individual and part task training, and finally aircrew training in high fidelity simulation-based or live environments. Early computer-based training focuses on very specific foundational skills and teaches them in a vacuum. To address this issue, the Navy advocates building a capability that allows instructors or Subject Matter Experts (SMEs) to easily build training scenarios that are immersive and interactive physics-based animations and models.

NEED

This effort addresses the unidimensionality of early computer-based training by providing opportunities for trainees to start combining and building upon skills. The goal is to increase the accessibility of remediation or advanced skill development training opportunities by providing instructors with tools to rapidly develop web-based training content that animates advanced oceanography tactical employment to provide learners with the opportunity to remediate challenging skills and/or increase their skill base. Additionally, the capability should allow instructors and SMEs to build in assessment and

consider intelligent tutoring functionality to ensure trainees have a degree of mastery before moving forward.

BENEFITS

Navy leadership has called for technologies that help to advance the Navy's crawl-walk-run approach to aviation training. This effort seeks to provide learning opportunities through mixed media beginning with classroom lectures and computer-based training, engagement with equipment through individual and part task training, and finally aircrew training in high fidelity simulation-based or live environments.

STATUS

This effort is currently in its Phase II base period. The kickoff for the Phase II base period was conducted in early December FY20 at the contractor's facility in Madison, VA. The contractor enrolled in the SBIR/STTR Transition Program (STP) for FY20-21. A progress update meeting and demonstration is tentatively planned for Q1FY21. The base period of Phase II ends in Q4FY21 and decisions by the government to award the option period will be made in Q3FY21 to avoid funding gaps.

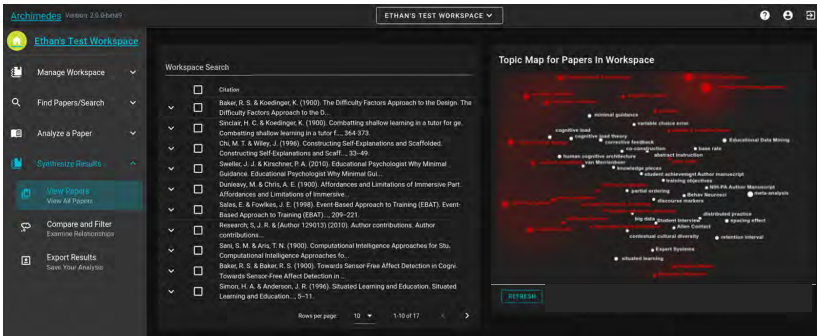
MILESTONES

- ◆ **Phase I:**
 - ◇ Proposals from 14 vendors were evaluated for technical approach, qualifications, and commercialization
 - ◇ Three contractors were selected for Phase I awards
 - ◇ Kickoff meetings are scheduled for early November
 - ◇ Base period closeout briefs will be held in early March
- ◆ **Phase II:**
 - ◇ Phase II kickoff meeting was held in DEC 2019
 - ◇ Software and prototype development shall continue until JUL 2021
 - ◇ Software and prototype testing and delivery expected on or before SEP 2021
 - ◇ Phase II Option period decision to be made between JUL-SEP 2021

ARCHIMEDES (N17A-TOO4)

OBJECTIVE

The objective of this project is to develop an intelligent tool to aid researchers in finding and synthesizing learning and cognitive science literature and providing compelling, data-based information and visualizations to support training system acquisition decisions. For example, the tool would support analysts trying to answer questions such as: "What training system fidelity is needed to facilitate learning and transfer?"



PROJECT DURATION
SEP 2018 - DEC 2021

SPONSOR

Naval Aviation Training Systems Program Office, PMA-205
Naval Air Systems Command (NAVAIR) Small Business
Innovative Tech Transition Research (STTR)

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Navigation, search results and visualizations facilitating synthesis and understanding of complex learning science literature

DESCRIPTION

This Phase 2 STTR effort will result in a cloud-based tool leveraging a learning science ontology to support intelligent literature search, analysis, synthesis and reporting of complex information. The tool provides users with:

- guided query formation and expansion supported by topic mapping visualizations.
- literature results review through intelligent paper markup and annotation.
- synthesis, characterization and visualization of data and relationships across multiple papers.
- Exportable results, e.g., table of structured notes taken across papers)

NEED

The work performed for this effort supports the Advanced Instructional Techniques Technology Area.

BENEFITS

The tool will improve training system quality by assisting users in extracting, synthesizing and providing learning and cognitive science based evidence for acquisition related recommendations. Users - analysts and decision makers - will gain a more comprehensive understanding of issues related to a query - not only theoretical and empirical evidence synthesized to support an "answer" to the query, but also an understanding of, e.g., gaps in the research, who is performing related research and within which organizations, what trends are exhibited in research over time. Information of this type is especially relevant when dealing with cutting edge technologies.

STATUS

Two performers are in year 2 of Phase 2. One performer is near the end of the period of performance, entering option tasking; while the other is extending the period of performance at no cost.

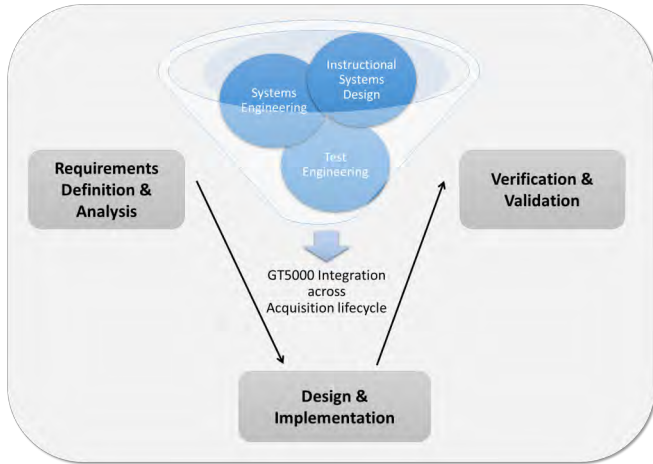
MILESTONES

- ◆ Functional end to end prototype demonstrations providing a basic suite of usable features for use by stakeholders and users.
- ◆ Spiral development to add ability for users to: create, manage and share distinct workspaces, Ability for users to create workspace-specific labels and notes, Visualization of topics for papers chosen for the workspace, Ability to capture notes while viewing/reading a paper, Ability to compare and filter papers based on notes and labels.
- ◆ On-going software releases.
- ◆ User feedback and usability evaluations.
- ◆ Tool deliveries Dec 2020 and Dec 2021.

CAPABILITIES BASED ACQUISITION FOR TRAINING SYSTEMS— INTEGRATED TRAINING (XXX)

OBJECTIVE

The goal of this effort is to develop and implement cross-competency training courses in the areas of: Training Needs Analysis, the Transition from Analysis to Design Documentation focused on Capabilities, and the Test and Evaluation of Training Systems based on Capability Requirements. Intended audience of training is currently scoped to members of the RDT&E (GT5000) workforce with anticipated growth across more disciplines.



CBA—integrated training of GT5000 workforce

PROJECT DURATION
OCT 2019 - SEP 2021

SPONSOR
Naval Air Warfare Center Aircraft Division-
NAWCAD | NISE: WFD:TRG

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DESCRIPTION

The Capabilities Based Acquisition for Training Systems—Integrated Training course provides cross-functional training designed to enhance GT5000 workforce knowledge, skills, and abilities related to the acquisition of training systems. Through this course of study, individuals will gain skills in training system requirement definition and analysis, design and implementation, and verification and validation. Unique to this course, participants will gain familiarization with the roles and responsibilities of Instructional Systems Designers, Systems Engineers, and Test Engineers, along with opportunities for collaboration across functions.

NEED

VADM Grosklags and NAVAIR leadership have expressed the need for “speed to the fleet” and for capabilities based acquisition. NAVAIR (Mr. Newton) has also pressed for hands-on training in the IPT environment to better support MAO. As deliverers of capabilities based training systems, GT5000 employees need more specific training on approaches to capabilities based

acquisition and opportunities to better integrate products and processes across disciplines.

BENEFITS

Improvement to training IPT’s ability to meet rapid acquisition and capabilities based acquisition through enhanced collaboration across GT5000 and resulting improvements in acquisition products and processes.

STATUS

In FY20, the effort began by establishing a cross-functional SME team and creation of a Wiki SharePoint for SME collaboration, project tracking and configuration management of deliverables. Defined course objectives and learning objectives for all modules, outlined course conduct plan, and developed content for first half of course— 2.5 days for Requirements Analysis and Definition module. Briefed effort to PMA205 leadership and senior leaders of Competency.

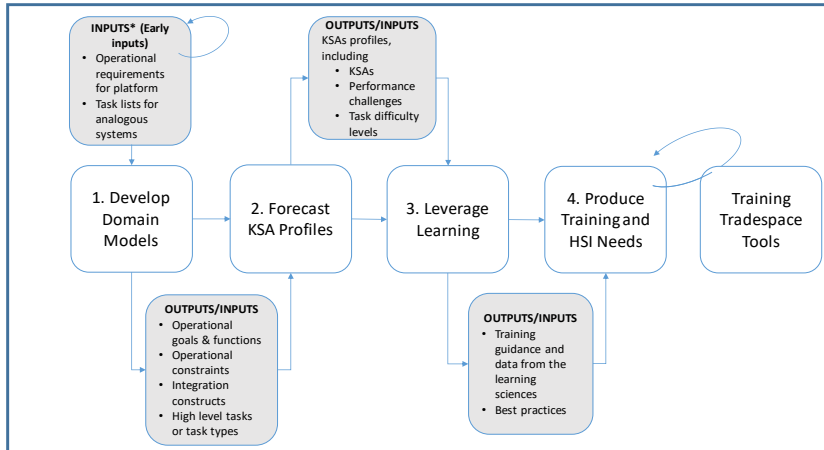
MILESTONES

- ◆ Defined Course Objectives and Learning Objectives for the Requirements Definition and Analysis, Design and Implementation and Verification / Validation modules
- ◆ Developed 2.5 day content for Requirements Analysis and Definition (ISD Competency)
- ◆ Briefed effort to PMA205 leadership and garnered interest in expansion of work outside of RDT&E
- ◆ Preparing for pilot roll out of learning objectives and course content with the intent of obtaining feedback focusing on within discipline content is effective and across GT5000 personnel collaboration is highlighted. Will modify as necessary
- ◆ Once course is finalized will conduct full course with students, preferably from IPTs

FUTURE VERTICAL LIFT (FVL) TRAINING CONCEPT

OBJECTIVE

Develop a corpus of training guidance that can be applied to the FVL program, in particular to the Army Future Long-Range Assault Aircraft (FLRAA) variant. Demonstrate that the Training Requirements for Rapidly Acquired and Complex (TRRACS) methodology is responsive to training design challenges associated with the accelerated acquisition of advanced complex



TRRACS Process for the Early Identification of Training Requirements

PROJECT DURATION
SEP 2019 - SEP 2021

SPONSOR

Department of the Army
Program Executive Office, Aviation
Future Long Range Assault Aircraft
(FLRAA) Project Office

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DESCRIPTION

The Future Vertical Lift (FVL) program is a multiservice initiative to develop the next generation of helicopter technologies. The purpose of this effort was to test the Training Requirements for Rapidly Acquired and Complex Systems (TRRACS) methodology through the application of the CH-53K and V-22B use cases. These analyses support the development of FVL relevant training requirements in step with accelerated acquisition timelines. Analyses focused on identify requirements that prepare operators and maintainers for warfighting characterized by integrated operations that rely on use of advanced technologies.

NEED

Accelerated acquisition stresses traditional methods for training system development because it forces key decisions regarding the skills to be trained and media selections to be identified before technical platform design details are known or even before a specific platform has been selected for development. This is further complicated with modern systems that rely on advanced automation and autonomous systems that may not have existed in the predecessor aircraft.

BENEFITS

This research provides the Army FLRAA program, and other FVL stakeholders, with a holistic and agile approach to training systems needs. The TRRACS methodology allows for linkages between complex Knowledge, Skill and Attitude (KSA) profiles to execute tasks associated with advanced technologies with empirically supported instructional approach best practices and training technologies for decision making early in the acquisition cycle.

STATUS

The results of the analyses demonstrated that the use of analogous platform use cases with the TRRACS methodology can successfully define design challenges of advanced complex technologies early in the acquisition timeline. Next steps for this effort will iterate on early training solution planning through media and fidelity analyses to identify critical KSAs and associated critical attributes in traditional and advanced training media types to support the training.

MILESTONES

- ◆ Refined the TRRACS methodology and tested its applicability on multiple analogous platform use case analyses for pilots and aviation maintainers
- ◆ Developed multiple technical reports on the findings from CH-53K and V-22 for pilot and maintainer analyses
- ◆ Conducted numerous high visibility, senior level briefs and built consensus among stakeholders from a variety of competencies and agencies.
- ◆ Developed modified approaches to future media, fidelity and trade-off analyses to further define training needs and technology solutions unique to the Army FLRAA variant
- ◆ Identify critical KSAs associated critical attributes in traditional and advanced training media types to support FVL training (Jul 21)
- ◆ Document final results in a technical report (Sep 21)

CNATRA TH-57 VIRTUAL REALITY TRAINING EVALUATION

OBJECTIVE

Investigate the use of virtual reality technology to support self-study, event preparation, and event remediation in order to enhance performance for TH-57 student naval aviators (SNAs) at Chief of Naval Air Training (CNATRA).



PROJECT DURATION

OCT 2019 - SEP 2020

SPONSORS

Naval Air Warfare Center Aircraft Division
NAWCAD | NISE: BAR

POINTS OF CONTACT

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DESCRIPTION

The Research Psychologists in NAWCTSD's Science for Training Evaluation, Analysis, Learning and Theory (STEALTH) Lab are developing and executing a device capability evaluation plan. The purpose of this evaluation is to inform CNATRA leadership on the effectiveness of virtual reality (VR) devices to improve training and desired training outcomes (e.g., performance in the aircraft, reduction in re-flies) for the TH-57 community.

NEED

- Operational Requirement: NASMP IV Priority 5: "Continue strategy refinement to provide a basis of understanding the potential for leveraging technology to solve the training challenges of the future."

- PMA-205 Strategic Initiative to investigate utility of Virtual and Augmented Reality.

BENEFITS

If effective, the Navy could incorporate the VR devices in the CNATRA curriculum as supplemental, part-task training. These devices have the potential to provide training opportunity for stages that currently only use live aircraft training. Potential benefits include additional training utility and practice time, decrease in training cost, and increase in student performance within the aircraft.

STATUS

Contract awarded to deliver ten TH-57 VR part-task trainers to NAS Whiting Field. The research team is finalizing the experimental design for the training effectiveness evaluation.

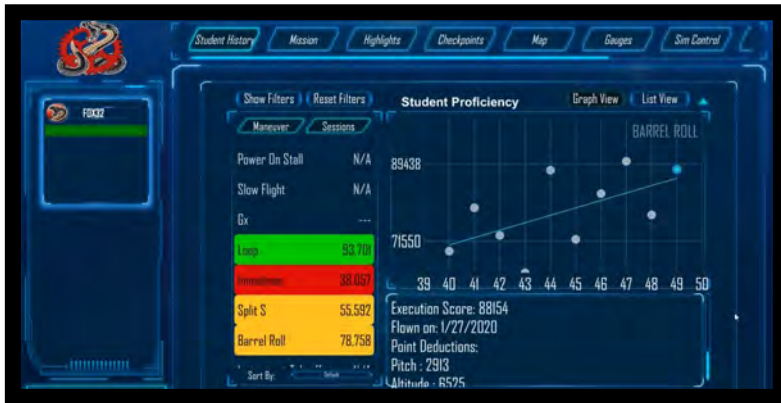
MILESTONES

- FEB 2020: TH-57 Ryan Helimod Mark IIIs will be delivered to NAS Whiting Field
- FEB-APR 2020: NAWCTSD will collect data from the SNAs via in-person and online data collection measurement
- MAY 2020: NAWCTSD will facilitate focus group discussions with CNATRA Instructors, Engineers, and Leadership
- MAY-SEPT 2020: NAWCTSD will analyze data and summarize findings in a technical report

CNATRA T-6B VIPER® EVALUATION

OBJECTIVE

This effort is intended to develop and investigate the incorporation of the Virtual Instructor Pilot Exercise Referee (VIPER®) capability into primary aviation training at Chief of Naval Air Training (CNATRA). Discovery Machine, Inc. is adapting VIPER for naval aviation primary training, and NAWCTSD will examine the effect of scheduled VIPER practice on student naval aviator (SNA) flight performance.



VIPER Instructor Dashboard

PROJECT DURATION

SEP 2019 - DEC 2021

SPONSOR

Naval Aviation Training Systems Program Office, PMA-205
Naval Air Warfare Center Aircraft Division (NAWCAD)

POINTS OF CONTACT

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DESCRIPTION

Discovery Machine, Inc. is adapting their Virtual Instructor Pilot Exercise Referee (VIPER®) for the T-6B virtual reality part-task trainers (VR-PTTs) used by Chief of Naval Air Training (CNATRA) for primary student naval aviators (SNAs). During the VIPER® evaluation, SNAs will be scheduled to practice in the T-6B VR-PTT with or without VIPER® feedback. The research team will use the resulting data to examine the effectiveness of the T-6B VIPER® for improving SNA performance, including reflays, unsatisfactory flights, event grades, and time to train.

NEED

- 2018 National Defense Strategy requirement: integrate technology to enhance readiness
- Naval Aviation Simulation Master Plan (NASMP) IV Priority 5: refine strategy to “provide a basis of understanding the potential for leveraging technology to solve training challenges”
- PMA-205 Strategic Initiative: Investigate the utility of Virtual and Augmented Reality

BENEFITS

This evaluation will produce objective training effectiveness data that will inform the use of virtual reality (VR) instructors in aviation training. By contributing to the military’s knowledge of VR training best practices and enhancing self-practice opportunities for SNAs, it has the potential to reduce training cost per SNA, increase training pipeline throughput, and improve pilot performance to enhance safety and mission effectiveness.

STATUS

In FY20, an initial set of 33 VIPER maneuvers were developed, delivered, and modified according to subject matter expert (SME) feedback. Development and validation of additional set of 8 maneuvers began. VIPER was migrated to Prepar3D Version 5 and installed at CNATRA with login control via authorized user CACs. Currently, Discovery Machine, Inc. is working with SMEs in an iterative process to address issues identified during instructor pilot usage.

MILESTONES

- ◆ JAN 2020: Initial maneuver set delivered for instructor pilot (IP) testing
- ◆ MAR 2020: Revised maneuver set delivered
- ◆ APR 2020: Bug fixes, airport support, and CAC-based login control delivered
- ◆ AUG 2020: Received IRB approval for evaluation
- ◆ SEP 2020: New maneuvers and Prepare3D V.5 software upgrade was delivered to CNATRA
- ◆ OCT 2020: IP maneuver feedback sessions began
- ◆ NOV 2020 - AUG 2021: Conduct data collection and focus groups
- ◆ JUL - AUG 2021: Analysis of performance data and SNA feedback
- ◆ DEC 21: Document results in Technical Report

EFFECTIVENESS ASSESSMENTS OF MIXED & IMMERSIVE REALITY FOR AVIATION TRAINING (N171-021)

OBJECTIVE

To develop a methodology that results in a capability to investigate the training effectiveness, comparable utility, and return on investment of an augmented reality solution for applied training task.



Sample Augmented Reality headset used for testing toolkit

PROJECT DURATION
MAY 2017 - NOV 2020

SPONSORS
Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)

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DESCRIPTION

Augmented reality (AR) has been on the cusp of ushering in a training paradigm shift for over a decade by allowing overlays of a digital world on real platforms. Although the Navy and industry counterparts have been exploring the value of using AR technology in training, few rigorous measurements of effectiveness have been conducted of AR itself, as well as comparing it to other related training technologies. Yet, as technology improves, AR remains a promising training capability as it enables embedded “train as you fight” training. The Navy is seeking an analysis tool grounded in a methodology that supports comparison of AR and alternative solutions for a representative training environment.

NEED

The resulting tool will include development of generalizable, best-of-breed methodology that will allow researchers to quantify the effectiveness of modern AR training and how AR training performance compares to related technologies. This effort focuses on delivering a rigorous measurement of

effectiveness of AR and ability to calculate return on investment or design solution tradeoffs of comparative technologies.

BENEFITS

The core benefit is the development of a tool that has the capability to measure the training effectiveness, comparable utility, and return on investment of an augmented reality solution for applied training task.

STATUS

During Phase I efforts, performers identified feasibility solutions and produced early rapid prototypes for AR and alternative training solutions (e.g., handheld tablet training, game-engine based virtual environment training) for aviation training. A single performer was selected for a Phase II award that began in November of 2018. This work will focus on building out the training effectiveness evaluation tool. Tool testing and completion is scheduled for early FY21. Final prototype analysis tool will be delivered November 2020.

MILESTONES

- ◆ Phase I progress and initial Phase II proposals included experimental design plan, including identification of applicable methods of assessing effectiveness, utility performance comparisons, and return on investment analyses
- ◆ Phase II contract awarded to single vendor, with a capability demonstration of the tool prototype at I/ITSEC 2018
- ◆ Publications:
- ◆ Abich, J., IV, Murphy, J., Eudy, M., & Killilea, J. (2019). Considerations for training effectiveness evaluations of emerging technologies. Proceedings of the 12th MODSIM World, Norfolk, VA, April 22-24, 2019
- ◆ Abich, J., IV, Murphy, J., Pierce, M., & Killilea, J. (2019). Process validation of a modified training effectiveness evaluation framework. Proceedings of I/ITSEC 2019, Orlando, FL, December 2-5, 2019 (submitted)
- ◆ Nov 20: Final prototype analysis tool to be delivered

Evaluating and Improving the Naval Aviation Survival Training Program: *Evaluation of Spatial Disorientation Curriculum Enhancement*

OBJECTIVE

To perform a training effectiveness study of the Spatial Disorientation (SD) curriculum in its current state in order to define appropriate upgrades to the training products used in the NASP curriculum and provide Commercial Off The Shelf (COTS) system(s) recommendation to bridge identified gaps.



CAMP LEMONNIER, DJIBOUTI. A 303rd Expeditionary Rescue Squadron HH-60 Pave Hawk practices brownout landings near Camp Lemonnier, Djibouti, March 22, 2014. Brownout occurs when the rotor wash causes dirt, dust or sand to become airborne which can cause the crew to lose sight of the ground. (U.S. Air Force photo by Staff Sgt. Staci Miller/RELEASED).

PROJECT DURATION

JAN 2019 - JUN 2021

SPONSORS

US Army Medical Research and Development Command

POINTS OF CONTACT

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DESCRIPTION

In the Naval community, Spatial Disorientation (SD) and Situational Awareness (SA) are significant contributing factors to the majority of aviation mishap events. The Navy spends millions of dollars on safety training every year to educate aviation personnel of the warning signs to SD and loss of SA but the training lacks customizable visualizations of actual SD and SA events. The Naval Aviation Survival Training Program (NASTP) uses the SD curriculum for initial and refresher training for all aircrew designated to fly in all type/model/series (TMS) Naval aircraft. Maintained at the Naval Survival Training Institute (NSTI), SD curriculum is PowerPoint based lectures intended to introduce and expose trainees to various types of SD that can be experienced in the aviation domain.

NEED

Recently, Navy Medicine Operational Training Center (NMOTC) was designated as Curriculum Control Authority (CCA) for the NASTP. Gaps were identified in the resources and expertise needed to conduct a transfer of training analysis for all SD and SA training in order to recommend updates to ensure learning objectives are met. This need was identified by the NASTP Trainer Management Team (TMT), in a point paper by the OIC of NSTI, and in a Training System Requirements Analysis (TSRA) conducted by the Naval Air Warfare Center-Training Systems Division (NAWCTSD).

Additionally, the TSRA indicates that the very nature of how SD training is delivered to trainees needs to be updated in order to achieve training objectives.

BENEFITS

This effort seeks to leverage advances in virtual reality and modeling and simulation for Commercial off the Shelf (COTS) recommendations that would enhance current SD and SA training by allowing users to set scenarios based on mishap data to recreate SD and/or SA events. The end product would provide trainees with a better understanding of the warning signs of SD and loss of SA for more impactful training.

STATUS

This effort started in FY19 with contract award to support research efforts. In FY20, the contractor facilitated a kickoff meeting to set initial planning strategy for the effort. A training gap analysis was executed to capture knowledge, skills, and abilities associated with existing and future SD/SA training. In addition, the contractor finalized a market analysis of potential COTS technology available for the training effective study. Currently, the contractor has drafted an initial study design that leverages results from the training analysis and market research to identify appropriate training medium for SD/SA curriculum enhancements.

MILESTONES

- ◆ Conducted kickoff meeting to set initial planning strategy
- ◆ Evaluated existing SD training procedures and curriculum via site visits, demonstrations, and interviews with interviews and demonstration of technologies at NAS Pensacola, FL (Multi-Station Spatial Disorientation Demonstrator (MSDD), Barany Chair, and WingMAN); NAMRL, Dayton, OH (SD training videos, and Kraken a distortion research device); Informational exchanges with the Army and Air Force in Q2-Q3 FY20.
- ◆ Conducted a detailed market analysis of existing SD training solutions and developed a training technology matrix for SD illusions to identify appropriate COTS products to supplement training (delivered OCT 2020).
- ◆ Documented experimental design and drafted the IRB protocol (draft delivered SEP 2020)
- ◆ Presented a poster at the U.S. Naval Aeromedical Conference (USNAC; FEB 2020)

Evaluating and Improving the Naval Aviation Survival Training Program: Initial Operational Evaluation & Upgrade for the Normobaric Hypoxia Trainer (9A19)

OBJECTIVE

To conduct an effectiveness study to analyze current physiological hazards curriculum, more specifically, hypoxia training to identify gaps and provide technological enhancements to the newly acquired Normobaric Hypoxia Trainer (NHT).



Device 9A19 Normobaric Hypoxia Trainer (NHT) undergoing system testing in at the Aviation Survival Training Center, Jacksonville, FL.

DESCRIPTION

Currently, the Naval Aviation Survival Training Program (NASTP) is transitioning from the hypobaric chamber to the Normobaric Hypoxia Trainer (NHT) for physiological hazards training. The NHT is designed to safely expose aircrew and aviators to a high-altitude, low-oxygen aircraft environment. Training scenarios involve instructors monitoring trainees as they complete a series of operationally-relevant tasks on computer tablets/simulator within the NHT while the atmospheric equivalent altitude slowly increases to 25K'. Performance is then assessed and outcomes from training will assist aircrew in recognizing symptom indicators, completing proper procedures to alleviate symptoms, and efficiently performing emergency procedures using actual aircraft life support equipment in order to prevent hypoxia related mishaps.

NEED

As part of the current installation plan, each NHT will be delivered with six tablet computers for training six aircrew positions. However, the tablets will not include simulation/software based domain-relevant tasks. This gap results in no cognitive or psychomotor tasking for aircrew during training

which has been identified by the NASTP Trainer Management Team (TMT). Additionally, developmental testing of the NHT at Aviation Survival Training Center (ASTC) in Jacksonville has revealed opportunities to improve situation awareness by upgrading the COMNET software control and the instructor/operator (IO) stations. These identified upgrades will enhance trainee safety, improve trainee throughput, and increase training effectiveness.

BENEFITS

Through this effort, NHT will receive technology enhancements for both instructor and trainee that directly impacts the NASTP curriculum, translating to increased readiness, improved warfighter performance, and increased survivability.

STATUS

Design and development of distractor task completed. Revised mock-ups completed for Instructor Operating Station (IOS) graphic user interface (GUI). Installation of the IOS GUI software and Distractor Tasking Application completed in SEP 2020. Iterative usability feedback has been collected SEP to NOV 2020 to inform final software delivery in FY21.

PROJECT DURATION

APR 2019 - JUN 2021

SPONSORS

US Army Medical Research and Development Command

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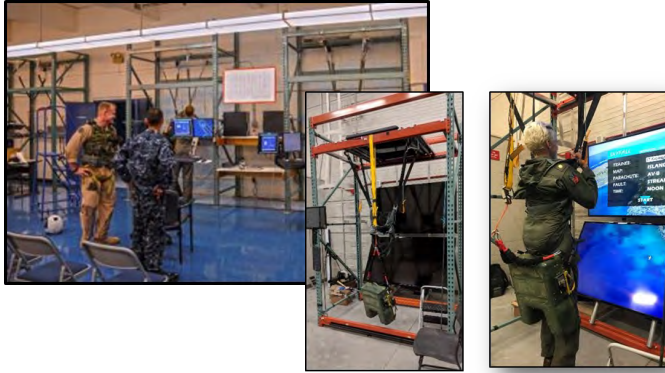
MILESTONES

- ◆ Performed formative and summative evaluations of the aircrew training task in FY20
- ◆ Iterated development of the aircrew distractor tasking software, delivering version 3.0 to the NAS Jacksonville Aviation Survival Training Center (ASTC) at (SEP 2020)
- ◆ Performed formative and summative evaluations of the IOS GUI in FY20
- ◆ Completed development and installation of IOS version 2.0 to the NAS Jacksonville ASTC (SEP 2020)
- ◆ Identified and documented areas to advance software for communication architecture and IOS, developing a backlog for future development considerations

VIRTUAL REALITY PARACHUTE DESCENT TRAINER (DEVICE 9C4/9C4A) EVALUATION

OBJECTIVE

To complete a comparative training effectiveness study between the current VRPDT to contemporary Commercial Off The Shelf (COTS) systems. This effort will help determine if upgrades to the existing system are capable of closing existing gaps or if a COTS solution is capable of providing aviators training on DPs, malfunctions and decision-making with the requisite training quality and effectiveness, supportability, and training realism.



Current virtual reality based parachute trainer and proposed next generation parachute training solution.

DESCRIPTION

In the Naval community, aviation survival training is an important focus area. The Naval Aviation Survival Training Program (NASTP) uses the VRPDT to conduct initial and refresher training for all aircrew designated to fly in parachute equipped fixed wing aircraft. The VRPDT is an immersive training device with embedded parachute descent scenarios which allows students to practice procedures to get safely from the aircraft to the ground, reinforcing what is learned in the classroom. Additionally, the simulation can present parachute canopy malfunctions which students must correctly identify in order to perform the corrective procedures.

NEED

The current configuration of the VRPDT does not support F-35 which is needed at multiple Aviation Survival Training Center (ASTC). Additionally, other type/model/series (T/M/S) aircraft may not be adequately represented. This gap has been identified by the Naval Survival Training Institute (NSTI) and the Trainer Management Team (TMT). Physically, the VRPDT has numerous problems due to the system's inability to interface with standard flight and parachute equipment across all T/M/S of aircraft. Also, being based on 25-year-old technology, the limited field of view (FOV) of the head mounted display (HMD) system reduces the

quality and effectiveness of training. Further, the dated display, graphics capabilities, and equipment configurations do not provide the appropriate level of physical and environmental fidelity to train all required tasks. Therefore, there is a need to compare the current system to modern commercially available solutions capable of closing the gaps listed above.

BENEFITS

The results from this effort will be used to determine if a Commercial Off-the-Shelf (COTS) solution is capable of closing the gaps identified by the TMT and inform acquisition decisions of parachute decent training systems for all eight ASTCs.

STATUS

This effort kicked off in FY19. Market research analysis identified available commercial off the shelf training solutions compared to the legacy and Small Business Innovation Research prototypes. A Cognitive Task Analysis (CTA) identified core Knowledge, Skills, and Abilities necessary for parachute training that focuses on malfunction correction, emergency procedures, and decision-making. A comparative effectiveness evaluation is in planning to compare virtual reality headset based systems compared to display based technologies to evaluate feasibility and cost effectiveness between systems.

PROJECT DURATION

JAN 2019 - SEP 2021

SPONSORS

US Army Medical Research and Development Command

POINTS OF CONTACT

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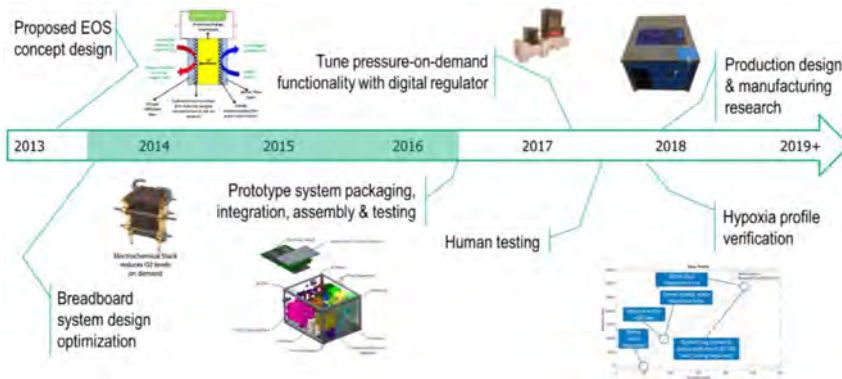
MILESTONES

- ◆ Evaluated existing parachute decent training procedures and curriculum and compare to CTA findings to refine learning objectives and training concepts
- ◆ Conducted a detailed review of available parachute training technologies to inform a market research analysis; presented finding to stakeholders at relevant conference
- ◆ Documented experimental design and in process of IRB protocol review for approval
- ◆ Comparative training effectiveness research study between two systems expected in FY21
- ◆ Findings will be presented at appropriate conferences or peer-reviewed journals at the end of FY21

MASK-ON HYPOXIA TRAINING DEVICE (N132-093)

OBJECTIVE

The effort seeks to support the technology transition of a next generation hypoxia-training device under development as part of NAVAIR SBIR N132-093. The goals of this research include analysis of logistical concerns, human factors evaluations, and human testing to validate the fidelity and effectiveness.



Development timeline of an On-Demand Hypoxia Trainer based on research and development conducted under SBIR Phase I, Phase II and Phase II.5 efforts.

PROJECT DURATION

NOV 2013 - OCT 2019

SPONSOR(S)

Naval Air Systems Command (NAVAIR)
Small Business Innovation Research (SBIR)
Naval Aviation Training Systems Program
Office, PMA-205

POINTS OF CONTACT

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DESCRIPTION

This effort will conduct the research and development efforts necessary for validating the fidelity, safety and concept of operations of the On-Demand Hypoxia Training Device under development for transition to PMA-205. In addition to the required research, we intend to conduct separate independent tests and evaluations to document the performance parameters and benefits of the novel technology for existing and potential acquisition communities. Specific tasks include: research and analysis of logistic requirements for training technology; conduct Human Factors Evaluation of the instructor console; conduct human testing with a military aviator population; and validation of training system.

NEED

As hypoxia continues to remain a highly visible safety issue, focus on a range of potential mitigation solutions is imperative. While a variety of engineering solutions aimed at the aircraft are being considered and tested, the final line of defense will remain in the hands of our trainers.

BENEFITS

The acknowledged success of hypoxia training makes it paramount that the Navy ensures these capabilities remain available. In addition to providing a means for addressing the larger Navy research into mitigating hypoxia physiological episodes, this effort will advance the lab's understanding of hypoxia training. Through usability analyses, researchers will document ways to increase the ease of use of the instructional capability. Further, this effort will provide the means to thoroughly investigate a novel technology to determine the effectiveness and efficiency of the devices to deliver higher fidelity training opportunities.

STATUS

Phase II efforts have resulted in a refined system prototype, human research, maintenance and sustainment analysis, as well as refining processes via research for manufacturing, reliability, and sustainability of the system. Transition is planned for FY20, with a procurement contract of 40 units for delivery to the 8 Aviation Survival Training Centers through FY21.

MILESTONES

◆ Phase II.5

- Contract awarded based on Technology Transition Agreement from PMA-205 (May 2017-Aug 2018)
- Refined prototype developed to support engineering and human testing
- Fleet engineering testing conducted to refine pressure on demand capability

◆ 2nd Phase II

- Contract awarded to refine design and manufacturing research and development (July 2018-Apr 2019)

- Refined prototype developed to support engineering and human testing
- Iterative usability testing of system and endurance and reliability testing in process
- Contract awarded based on Technology Transition Agreement from PMA-205 (MAY2017-AUG2018)
- Closeout briefs were held with each of the contractors to discuss Phase I progress and Phase II plans
- Phase I Option was awarded for two vendors
- Phase II.5 contract awarded based on Technology Transition Agreement from PMA-205 (MAY2017-AUG2018)

- Refined prototype developed to support engineering and human testing
- Fleet engineering testing conducted to refine pressure on demand capability
- IRB approved for human subjects testing
- Preliminary device documentation and drawings delivered
- Second Phase II contract awarded to refine design and manufacturing research and development (JUL2018-APR2019)
- IRB approved for human subjects testing
- Iterative usability testing of system in progress
- Endurance and reliability testing in process

PROJECT AVENGER EVALUATION

OBJECTIVE

The objective of this project is to evaluate the training effectiveness of Project Avenger, the Primary Syllabus component of Naval Aviation Training Next. The evaluation will provide analysis of student naval aviator (SNA) performance, as well as recommended improvements for future iterations of Project Avenger.



T-6B Virtual Reality Device Usage

PROJECT DURATION

SEP 2020 - DEC 2021

SPONSOR

Naval Aviation Training Systems Program Office, PMA-205

POINTS OF CONTACT

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DESCRIPTION

As a part of Naval Aviation Training Next, Chief of Naval Air Training (CNATRA) has developed and begun to implement Project Avenger, an update to their Primary Syllabus that leverages an adaptive syllabus, extended reality, and mobile learning to address Strike/Fighter production challenges. Project Avenger is intended to produce more self-sufficient pilots while also reducing time to train. The research team will compare the performance of Project Avenger's student naval aviators (SNAs) to that of SNAs in legacy training, as well as collect SNA and instructor pilot (IP) reactions to provide success metrics and improvement recommendations for Project Avenger.

NEED

- Naval Aviation Simulation Master Plan IV Priority 5: refine strategy to "provide a basis of understanding the potential for leveraging technology to solve training challenges"
- PMA-205 Strategic Initiative: Investigate the utility of Virtual and Augmented Reality

BENEFITS

CNATRA intends to expand Project Avenger to replace all legacy-style Primary training in the next few years. This evaluation will produce training effectiveness data to identify successes and areas for improvement of Project Avenger. In doing so, it will help CNATRA maximize training efficiency and performance outcomes, leading to increased training pipeline throughput and mission effectiveness. It will also inform best practices for future development of aviation training syllabi.

STATUS

CNATRA began the first class of Project Avenger in late FY20. The research team delivered evaluation plans to CNATRA for approval and held a kick-off teleconference to finalize evaluation plans and identify subject matter experts to support the effort. Performance data requests have been submitted to CNATRA for Project Avenger and legacy syllabus SNAs. Based on the first installment of Project Avenger performance data, which differs from legacy-style performance tracking, data analysis planning was finalized.

MILESTONES

- ◆ 1 SEP 2020: Data collection of first class of Project Avenger SNAs began ($n = 20$)
- ◆ 8 OCT 2020: Evaluation kick-off teleconference with primary training and Project Avenger leadership
- ◆ 2 NOV 2020: IRB Protocol approved
- ◆ APR 2021: Feedback and recommendations focus group with Avenger IPs and leadership
- ◆ MAY - JUN 2021: Analysis of performance and SNA feedback data
- ◆ JUL - OCT 2021: Technical report writing, review, and delivery to PMA-205
- ◆ DEC 2021: Technical report publication submission

NAVAL AIR WARFARE CENTER TRAINING SYSTEMS DIVISION



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.

FY20 NAVY LOCAL IMPACT AT A GLANCE

| | |
|------------------------|--|
| STEM Program Launched | 2009 |
| Geographic Reach | Brevard County Orange County Osceola County Seminole County Volusia County |
| Employee Participation | 1 part-time site coordinator 78 Employees 15 mentors (robotics and Blankner) |
| Interactions | 3,963 Teachers 12,775 Students |

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.

FLIGHT LAB AFTERSCHOOL

OBJECTIVE

The goal of this effort is to support the Office of Naval Research's mission of fostering Science, Technology, Engineering, and Mathematics (STEM) education for students. Through the Flight Lab at the Orlando Science Center, an aviation simulation classroom, students are able to engage with hands-on, immersive, USMC/Navy-specific, STEM-related content via afterschool programs. By reinforcing STEM learning through experiences that model real-world careers, we endeavor to inspire future generations to explore STEM careers—especially STEM careers within aviation in the Navy and USMC.



Above left. Entrance to the Flight Lab at OSC

Above right. Students enjoying the Flight Lab

Left. Inside of the Flight lab at OSC

PROJECT DURATION

JAN 2019 - AUG 2021

SPONSORS

Office of Naval Research, ONR-34

POINTS OF CONTACT

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DESCRIPTION

The Flight Lab Afterschool program uses the TEQGames-developed Flexible Aviation Classroom Experience (FLEX-ACE), within the Orlando Science Center's Flight Lab, to teach students STEM concepts via an immersive, aviation-centered virtual reality (VR) laboratory. The program focuses on underserved audiences, including girls in STEM, and includes four 9-week cohorts recruited from afterschool clubs in the greater Orlando Metro area. These students engage with the aviation-themed immersive content nine times over a semester. The program effectiveness is assessed via pre- and posttest performance on aviation-specific and general STEM knowledge, as well as simulated flight performance.

NEED

It is essential for the USMC and Navy to maintain recruitment of top STEM talent, as STEM fields are critical to the effective training and performance of the Warfighter. However, many adolescents lose interest in STEM early in their academic careers—sometimes as early as the 3rd grade. Thus, there is a need to provide meaningful, educational opportunities for youth to experience STEM “beyond the textbook.” It is imperative to get children engaged in STEM in interactive ways—hence, the immersive, game-based learning environment offered by FLEX-ACE.

BENEFITS

- Support the DoD and ONR's mission of fostering K-12 STEM education.
- Engage 5th-12th grade students with hands-on, immersive USMC/Navy aviation experiences.
- Inspire and motivate the next generation to explore STEM careers.
- Provide opportunities for evaluation and assessment of the impact of immersive STEM programs on students and the community.

STATUS

Fall 2019 consisted of four 9-week cohorts, with ~19 - 25 students per group, who participated in nine ~45 - 60 minute visits over the semester. Missions included simulated flights a) around Washington, D.C. to identify historical landmarks; b) over Alaska to drop medical supplies to targeted locations; and, several other engaging scenarios. The learning and flight performance assessments for Fall 2019 ended in early JAN 2020. Analyses of the pre- and posttest data (for the 27 students who completed both) revealed a learning gain of ~21% (standard deviation = 26%). Results also showed modest improvements in student flight performance. All planned afterschool workshops for 2020 were cancelled due to the pandemic. However, the effort will be continuing in JAN 2021 as a “virtual field trip” experience.

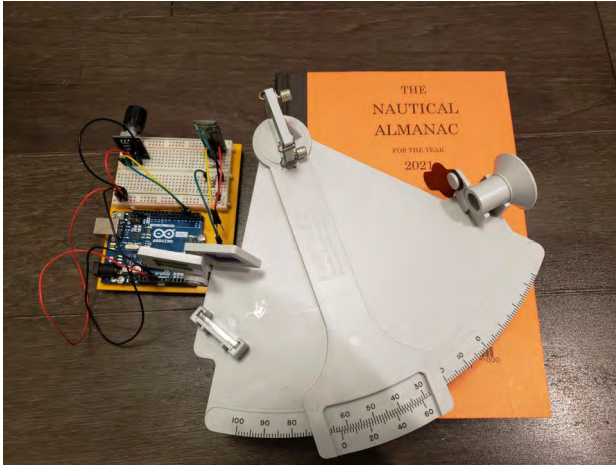
MILESTONES

- ◆ April 2019 – Program Kick-off with ONR
- ◆ Aug 2019 – Finalized missions (8 new aviation missions developed) and assessment materials; completed participant outreach/recruitment efforts
- ◆ Dec 2019 - Presented overview of effort at IITSEC “CYBER TRAINsitions” Workshop
- ◆ Jan 2020 - Completed all Fall 2019 Cohort sessions and assessments with a total of 285 student participants
- ◆ Jan 2020 - Analyzed learning gains and flight performance improvement data from Fall 2019 Cohorts
- ◆ Feb & Sep 2020 - Provided project status presentation at ONR Technical Review meetings
- ◆ Sep 2020 - The Flight Lab has reached 8,581 students and community members since 2018!

STEM SEXTANT

OBJECTIVE

This effort will develop a mixed reality application to enable students to learn and practice celestial navigation skills using a sextant in an immersive 3D environment. Additionally the team aims to provide designs, specifications, instructions, for building a sextant, giving students the opportunity to develop engineering skills including 3D printing and sensor wiring.



Mark 3 Sextant, Arduino Uno with breadboard. Photo Credit: Eric Peterson

PROJECT DURATION
AUG 2020 - MAR 2021

SPONSOR
Office of Naval Research

POINTS OF CONTACT

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DESCRIPTION

Students will practice STEM skills by building a mixed reality (MR) sextant that will connect to a virtual reality application built by a NAWCTSD development team. This application will teach teams how to perform celestial navigation through practice exercises, visualizations, and game features.

CAD models for printing the sextant and code for programming the microcontroller will also be provided. Educators leading the event can customize the experience to meet the skill levels of student participants by allowing teams to generate their own CAD or program the microcontroller themselves.

Several studies are planned over the duration of the project, including assessments of student satisfaction, perceived usability, interest in STEM topics and careers, and training effectiveness.

NEED

Celestial navigation is being taught by the Navy again after being dropped from the curriculum in the 1990's. In the event of GPS failure or denial of GPS attacks, sailors need to be able to navigate accurately using celestial bodies.

BENEFITS

Students will learn about how the Navy uses celestial navigation to mitigate threats to the fleet. As this subject is one many sailors struggle with, there is potential to transition the application to a fleet funded training product.

STATUS

The team is currently in the process of designing the electronics for the virtual sextant and creating the virtual environment in which the celestial navigation training will take place. A pilot event is planned for the second quarter of FY21.

MILESTONES

- ◆ Develop virtual world in Unity game engine
- ◆ Design and develop sextant mock-up and integrate into virtual world
- ◆ Add instruction, hints, and feedback
- ◆ Work with local high school to validate effectiveness of training and accuracy of sextant design documents

LABORATORY CAPABILITIES

At the Naval Air Warfare Center Training Systems Division (NAWCTSD), we have many laboratories engaged in research and development. These labs work to advance the state-of-the-art in training technologies in human factors, human-machine interfaces, augmented reality and virtual reality, data analysis, acoustics and sensors, visual systems, data analysis, fabrication, interoperability, Live-Virtual-Constructive (LVC) applications and technologies, communications, and more. The following section provides summaries the capabilities and expertise in the labs.



Acoustic Training and Simulation (ATaS) Lab



CAPABILITIES

- SME support with Real-Time Acoustic Training System Tuning
- Development and Maintenance of Acoustic Databases
- Data updates based on dynamics of Intel
- Database Distribution
- Target Tuning
- NCTE ASW database standard
- Update and provide appropriate databases for Foreign Military Sales (FMS) of Aviation ASW/Acoustic Trainers.

TOOLS

- The **ATAS Database** contains detailed data on Contacts (ships, submarines, torpedoes, and biologicals) using over 100 tables.
- The **Common Sensor Database (CSDB)** contains detailed data on Sensors (DICASS, DIFAR, MAC, and Towed Array) using over 150 tables.
- The **Active Emitter (AE) Database** contains detailed data on active sonars for contacts and sensors using over 40 tables.
- **Digitized Sounds** provide audio for Contacts and Sensors.
- **CASE FI Single Node** Acoustic processor used to adjust fidelity of acoustic contacts prior to fleet delivery.

MISSION

Provide current sensor and acoustic data used in modeling and simulation across Navy Anti-Submarine Warfare training devices.

EXPERTISE

- Navy Subject Matter Experts – Anti-Submarine Warfare, Underwater acoustic analysis
- Systems Engineer – Configuration Management

For More Information Please Contact

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BATTLE LAB

Basic & Applied Training & Technology for Learning & Evaluation Lab

MISSION

Conduct and manage science and technology (S&T), research and development (R&D), transition and acquisition consultation efforts through the application of cognitive science, behavioral research and training evaluations to improve training and human performance in a variety of learning environments.

EXPERTISE

- Human Performance Assessment; Data Science & Effectiveness Analyses
- Synthetic & Distributed Training Enhancements & Evaluation
- Aviation Training for Survival, Aircrew, & Maintenance
- Instructional Technology Improvements & Adaptive Training
- Accelerating the Development of Small Unit Decision Making
- Team Resilience Strategies for Tactical Combat Casualty Care

For More Information Please Contact

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CAPABILITIES

- **Human Performance Analytics Research, Development & Implementation** including individual and team performance, performance measurement authoring tools, databases for performance trend analysis and data analytics, computational techniques for evolving data for trend identification, tools for evaluating data re-use to enhance training scenarios and performance assessments, and standards for increasing interoperability of human performance analysis.
- **Synthetic Environments Research, Development & Implementation** including standards support and interoperability mission effectiveness analyses, researching cross domain management tools, integrated behavior modeling and speech analysis for synthetic teammates, skill adjustments for automated behavior modeling, and speech recognition support tools.
- **Instructional Strategies & Methods for Team Training** including digital integrated representation of the tactical environment, tailored training and assessments, decision making training strategies, learning management systems, resilience training strategies and methods, and adaptive training.
- **Aviation Survival Training Research, Development & Implementation** including hypoxia training enhancements, parachute descent procedure and malfunction training, and mishap and spatial disorientation training.
- **Instructional Technology Improvements** including next generation manned-unmanned teaming concepts, data science driven aircrew performance measurement and proficiency tools for debriefing and evaluation, machine learning support for malfunction troubleshooting, workload assessment
- **Aircrew & Maintenance Training Systems Improvements** including oceanography tactics training, maritime intelligence-surveillance-reconnaissance training, physiological episode distractor application, and communication training.

TOOLS

- Post Mission Assessment for Tactical Training & Trend Analysis (PMATT-TA)
- Techniques to Adjust Computational Trends Involving Changing Data (TACTIC-D)
- Crew Role-player Enabled by Automated Technology Enhancements (CREATE)
- Accelerating the Development of Small Unit Decision Making (ADSUDM)
- Squad Overmatch (SOvM) / Team Overmatch (TOvM)
- Oceanography Tactics Training for Employment Readiness (OTTER)
- Radio Operations Guidance and Education Resource (ROGER)

Concept Development & Integration Lab (CDIL)



CAPABILITIES

Electronic Communications Subject Matter Expertise:

Voice Communications (Analog & Digital);
Live-Virtual-Constructive Interoperability;
RF Propagation / Terrain Modeling

Cyberwarfare Training:

Realistic emulation of Network and Host based
Cyberspace attacks; USS Secures Capture the Flag

Rapid Prototyping / Proof of Principle Development:

Requirements -> First Article Test;
System Interoperability; DoD Standardization

Software Development

Hardware / Electronic Design & Fabrication

TEMPEST Separation & Certification

Technology Research:

RF Communications; Modeling & Simulation;
Cyberwarfare Training

Acquisition Support:

Technical Consulting / Market Surveillance /
Documentation Review

TOOLS

Windows, Linux & Embedded Development Environments

Altium Designer

Atmel Studio (micro-controllers)

Microsoft Visual Studio / IntelliJ

Solidworks

MISSION

Research and Development of specialized, interoperable Live-Virtual-Constructive applications and technologies; provide smart buyer awareness to training system acquisition programs.

EXPERTISE

- Live—Virtual Communications
- Live & Virtual Radio Management
- RF Communications Modeling
- TEMPEST Certification
- After Action Review (AAR) applications
- Rapid Prototyping (Software & Hardware)
- Embedded Systems Development
- System Interoperability
- Modeling & Simulation Standards

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Interoperability, Design, Engineering, and Application (IDEA) Lab

MISSION

Support research, development, test and evaluation of training systems interoperability. The lab provides tools for visual systems analysis, database development, system integration and command demonstrations.

EXPERTISE

- Training Systems Integration
- Cross Domain Solutions for training systems
- Training Systems Interoperability Standards
- Simulation Test and Integration
- Simulation Protocol Test Tools
- Agile Software Development

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CAPABILITIES

- **Interoperability Test and Integration Tools** enabling automated testing, logging and stimulation of training systems.
- **Simulation Bridge and Gateway** products to translate between differing standards and other simulation standards/protocols.
- **Virtual and Constructive Test and Integration Support** verifying training system interoperability and an active test bed for research.
- **Controlled Interface and Cross Domain Solution** development and sustainment to support distributed mission training.
- **Out-The-Window (OTW) visual, sensor, terrain, and 3-D model databases** to provide maximum source data reuse across training devices for various Type/Model/Series platforms.

TOOLS

- Network connections to the Navy Continuous Training Environment (NCTE), NMCI SIPR and NIPR
- Visual Studio, SVN, Jira, Confluence, NetBeans
- 180 degree visual display w/ 4 DLP Projectors
- 4 Channel PC based IG & Video Switch

LVC Development and Operations Center (LVCDOC)



CAPABILITIES

- **Network centric environment** created to be persistent and rapidly reconfigurable, supporting Research and Development (R&D) and Test and Evaluation (T&E) for LVC initiatives across all Navy platforms including aviation, surface, and undersea, in partnership with other Government organizations, Industry stakeholders, and academic institutions.
- **Interoperability Assessment and Validation** across all stages of the System Engineering Integration and Test process as a measure to accelerate LVC technology development and reduce risk.
- **Conduct technology test and integration preparation events** to improve the quality and speed of integrating new M&S capabilities into Distributed Mission Training (DMT) events.
- **Classified, Unclassified or Mixed Mode Operation** enabled by Enterprise Network Guard (ENG), a Government owned/developed, state-of-the-art Cross Domain Solution (CDS) supporting data and voice in multiple security domains across the Navy training enterprise.
- **Connection to Training Networks** to capture, store, and reuse M&S data to support analysis, development, testing, and experimentation.
- **After Action Review** to trace mission training from objectives to effectiveness.
- **Experimentation** of cutting edge hardware and software, leveraging operationally-relevant data.

TOOLS

- **Distributed Simulation Standards (HLA, DIS, TENA)**
- **Protocol Conversion (JBUS & AMIE)**
- **Constructive Simulations (NGTS, JSAF, & OneSAF)**
- **Joint After Action Review (JAAR)**
- **Cyber Effects (Network Effects Emulation System (NE2S))**
- **Command and Control (C2PC)**
- **Network Monitoring/Analysis (WAN Emulation)**
- **Cross Domain Solution/Multi-Level Security (Enterprise Network Guard (ENG))**
- **Digital Radio Management (DRMS) for tactical voice transport and coordination.**

MISSION

The LVCDOC is a network centric environment that provides a reconfigurable, dynamic LVC integration domain supporting Research and Development (R&D) and Test and Evaluation (T&E) of new technologies and methods, and encouraging collaboration among LVC stakeholders.

EXPERTISE

- Modeling and Simulation
- Virtualized Network Environments
- Hardware/Software Integration
- System-of-Systems Interoperability
- Cross Domain Solutions
- Multi-Level Security
- Tactical Voice Transport
- Cyber Effects
- After Action Review
- Computer Science & Engineering
- Information Assurance

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Live, Virtual, Constructive, Modeling & Simulation (LVCMS) Lab

MISSION

Development of computer software, including computer system architecture and system software organization for Live, Virtual, and Constructive Modeling and Simulation Trainers, specializing in Anti-submarine Warfare and Virtual At-Sea Training Systems.

EXPERTISE

- Computer Scientists
- Computer Engineers
- Subject Matter Experts

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CAPABILITIES

The LVCMS Lab capabilities include the development of computer software, including computer system architecture and system software organization for Live, Virtual, and Constructive Modeling and Simulation Trainers, specializing in Anti-submarine Warfare and Virtual At-Sea Training Systems.

- **Bravo Air Crew Tactical Team Trainer (BATTT)** The Anti-Submarine Warfare (ASW) Virtual-at-Sea Training (VAST) Bravo Acoustic Tactical Team Trainer (BATTT) system is a networked, PC-based, deployable trainer designed to support integrated and coordinated ASW tactical training and enhance team decision making
- **Romeo Air Crew Tactical Team Trainer (RATTT)** is a networked, PC-based, deployable trainer designed to support integrated and coordinated ASW tactical training and enhance team decision making
- **P-3 Air Crew Tactical Team Trainer (PACT3)** provides the first ever PC-based (small foot-print, low cost) training capability for currently fielded P-3 Maritime Patrol Aircraft that can be reused with very minor flight dynamics model modifications to represent the Navy's future P-8A Maritime Patrol Aircraft, allowing cross platform (Aviation, Surface, Undersea) coordinated ASW integrated team training.
- **Bravo Romeo Acoustic Stimulation System (BRASS):** BRASS for Sea Combat Commander (SCC) is a NAWCTSD effort for providing the Anti-Submarine Warfare (ASW) characteristics of the MH-60R Helicopter Platform stimulating the Aircraft Carrier Tactical Support Center (CV-TSC) using the SAU07000 message standard.
- **Mine Countermeasures Aircrew Training System (MCATS)** The AN/AQS-24B Sonar Mine Detecting Set is a high-speed, high-resolution sonar system with the capability to implement a laser line scan (LLS) sub-section for the detection, classification and identification of mine-like objects.

TOOLS

- Passive Generator for realistic audio for passive sensors
- APModule used for realistic audio for active sensors
- DOG to provide environmental data for ocean modeling
- Visual Studio
- HLA Gateway

Multipurpose Reconfigurable Training System 3D[®] (MRTS 3D[®]) Lab



CAPABILITIES

The Multipurpose Reconfigurable Training System 3D[®] (MRTS 3D[®]) family of trainers provide virtual training environments simulating a variety of platforms, weapons, and communications systems. Each trainer consists of government owned and developed simulation software running on a stand-alone network of Commercial-Off-The-Shelf (COTS) hardware and software components. A single MRTS hardware trainer can shift between multiple software simulation applications in a few minutes. This capability enables the school to use one hardware suite to give photo-realistic virtual training on several different systems in a single day.

The MRTS 3D trainers are used in both Sailor pipeline courses and in pre-deployment team training. The instructor can manage configurations and scenarios while the students follow procedures, interact with the touch screens, and coordinate with the other stations during the various training scenarios

FIELDED / NEW PROJECTS

Fielded MRTS 3D Trainers

- VIRGINIA Torpedo Room
- 2015 VIRGINIA EDG
- 2016 MEPP Ops & T/S
- 2016 VIRGINIA VLS Block I/II
- 2017 VIRGINIA VLS Block III



New Projects

- Standardized IOS & SDK
- FM EDG Ops & Maint
- LOS ANGELES 2nd & 3rd WLC
- EMALS/AAG Ops & Maint
- MQ-4C Triton Avionics Maint
- SLQ-32 Maintenance
- JCC Radio Trainer
- VIRGINIA HM&E Systems
- USA Vehicle Maintenance
- AEGIS MMSP Maintenance

MISSION

To provide fully immersive training environments via a common architecture for low-cost, rapidly-deployable training solutions.

EXPERTISE

- Computer Scientists
- Computer Engineers
- Graphic Artists
- Subject Matter Experts

SUPPORTED SITES

- Groton, CT
- Guam
- Kings Bay, GA
- Norfolk, VA
- Pearl Harbor, HA
- Pensacola, FL
- San Diego, CA
- Bangor, WA



For More Information Please Contact

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Submarine Surface Piloting and Navigation Training Laboratory (NAVLAB)

MISSION

Provide full trainer life cycle support for the SPAN/VESUB submarine navigation trainers of record including software/systems development, integration test, design, packaging, and fielded updates.

EXPERTISE

- Computer Engineers/Scientists
- Submarine Subject Matter Expert

DEPLOYMENT LOCATIONS

- Bangor, WA (SSBN/SSGN)
- Kings Bay, GA (SSBN/SSGN)
- Groton, CT (SSBN/SSGN/Virginia/SSN 688/SSN 21)
- San Diego, CA (SSN 688)
- Norfolk, VA (Virginia)

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CAPABILITIES

The lab utilizes an integrated development environment and modular test berth to perform trainer support functions:

- Software design and development from Fleet requirements to Fleet Acceptance, based on In-House Development Process (iDP) and In-House System Engineering Technical Review (iSETR).
- Immersive, mixed-reality environments for multiple submarine baselines
- Modeling and simulation of tactical systems
- Distributed system design using High Level Architecture (HLA) and TCP/IP network.
- Modeling and simulation of virtual harbor navigation
- Software integration and testing facility
- System Delivery and Upgrade with full technical and logistics support

The Submarine Piloting and Navigation (SPAN) Trainer

The SPAN trainer provides team and individual training in piloting and navigation principles of a surfaced submarine for the Helmsman, Fathometer Operator, Navigation Center Operator, Voyage Management Operator, Contact Coordinator, Periscope Operator, RADAR Operator, Officer of the Deck, and Lookout. The team uses navigation techniques and simulated on-board equipment to ensure the ship is safely piloted and navigated in various harbors, under variable environmental conditions.

Virtual Environment for Submarine Ship Handling (VESUB) Trainer

The VESUB trainer is a virtual reality-based computer system utilizing immersive Virtual Environment and Head Mounted Display (HMD) technology. The trainer consists of Commercial-Off-The-Shelf (COTS) hardware and software integrated with custom software as a system. It is comprised of an Instructor Operator Station, visual system, student station, voice recognition/synthesis system, audio system, and multiple screen displays. It provides the Officer Of the Deck (OOD) student individual instruction in the knowledge and skills necessary to successfully and safely pilot and maneuver a surfaced submarine through restricted harbors/waterways avoiding collisions and grounding.

TOOLS

- Microsoft Visual Studio, Team Foundation
- HLA using MAK RTI/VR-Link
- GDIT VShip for hydro model

Rapid Design, Development and Fabrication (RD2F) Laboratory



CAPABILITIES

- **Turnkey Training System and Technology Design and Production** including proof of concepts, rapid prototypes, limited quantity productions, and life-cycle extension upgrades.
- **Virtual Environment and Game-based Technologies** including simulation-based training system development, Augmented and Virtual Reality integration, interactive/immersive courseware, 3D terrain and content development, hand-held toolset/equipment integration with virtual environments, and user experience design.
- **Enterprise Data Analysis, Modeling and Tool Creation** including enterprise-scale data mining and root cause analysis, AI-based predictive model creation and validation, statistical trend analysis, custom data engineering applications, and enterprise data visualization.
- **Software Application Development** including cross platform mobile development, distributed and embedded applications, real-time embedded control, machine vision and intelligence, natural language processing, adaptive applications, intelligent agents, instructor support and after action review software.
- **Electronics Design and Fabrication** including circuit design, prototype and small-quantity circuit board production, wired and wireless interfaces, firmware development, device fabrication and assembly, and production of electronic test equipment suites.
- **Mechanical Design and Fabrication** including part and assembly design, electro-mechanical and -optical devices, pneumatic systems, 3D modeling, virtual prototyping with 3D assemblies, and fabrication using a variety of materials (plastics, non-ferrous metals, stainless steels). Additive and subtractive manufacturing process are supported for both prototype and low rate production.

TOOLS

- AAA Game Engines (e.g. Unity 3D & Unreal 4)
- Local High Performance Computing Stack (~7 PFLOPS Tensor Performance)
- Visual Studio, Team Foundation, Jira, Kubernetes, Spark, Keras, Tensor-Flow, Anaconda, Xamarin, etc.
- Computer Aided Design (CAD) and Manufacturing (CAM)
- Computer Numeric Control Machining
- Fused Deposition Modeling (FDM) and Polyjet 3D Printing

MISSION

Provide the Commander NAWCTSD with an in-house, rapid-response design, development, and production capability for advanced modeling and simulation technology products.

EXPERTISE

- Modeling and Simulation
- Computer Science / Data Science
- Mixed Reality Systems
- Mobile Technology
- Rapid Design and Production
- Agile Software Development
- Electromechanical Systems
- Embedded Systems
- Hardware/Software Integration

For More Information Please Contact

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Ready Relevant Learning (RRL) Lab

MISSION

The Sailor 2025 Ready Relevant Learning (RRL) Lab supports the test and evaluation of training content and technologies in support of the goal to provide the right training at the right time in the right way for Sailors. The lab is currently testing Navy eLearning (NeL) courses and Virtual Simulations that have been developed for the Operations Specialist (OS) rating A-School and Global Command and Control System-Maritime (GCCS-M) training.

EXPERTISE

Test & Evaluation of: HTML 5 NeL courses, Instructional Virtual Simulations, Standalone courseware, mobile courseware .

For More Information Please Contact

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CAPABILITIES

- Unclassified NeL Course Content and Hosting.
- Government Acceptance Testing (GAT) of RRL Course Content.
- Data Collection/Analysis of current state and future training course requirements.

TOOLS

- TRANET Unclassified Network
- NETC Virtual Desktop Installation (VDI)
- Navy eLearning (NeL) TestTrack System
- NeL Atlas Pro/Enterprise Training Management Delivery System (ETMDS)
- Government Content Acceptance Testing (GCAT) Environment
- NeL Content Hosting and Reports Management Service (CHaRMS)
- Micro Focus Fortify
- NETC Test Tool

Surface Training Advanced Virtual Environment (STAVE) Laboratory



CAPABILITIES

The STAVE lab supports the Virtual Ship Training System (VSTS) a modular virtual training environment network infrastructure located at Littoral Combat Ship Training Facilities (LTF). The LTF VSTS supports individual, multiple, and team training for Seaframe and Mission Module Detachment (MMDDET) crew to train to qualify (T2Q) watch stander and train to certify (T2C) team training requirements. The virtual environment is networked with all physical simulators for visualization, communications and systems operations to enable expanded individual and team training events. The STAVE Lab provides configuration management of the IVSE courseware, Virtual Ship Training Systems (VSTS) products and various trainers and training systems located at the LCS Training Facilities (LTFs).

Cybersecurity Support – The LCS Lab serves as the repository of updates and patches for the unconnected trainers (not only LCS). Utilizing synchronization of repository databases, the lab can scan for patches and updates and download those required for an unconnected trainer.

Prototyping – Training Equipment Change Requests (TECRs) can be prototyped and tested in the lab before deploying them in a production environment.

External Product Integration – The LCS Lab have utilized the baselined VSTS environment to integrate, setup, and test with external products, adding training capabilities to the LTFs.

Virtual Ship Training Systems (VSTS) – Provides Network Infrastructure Services, Sustainment, Cyber security, and Centralized Management of Training Systems.

STAVE-LCS IT – Information Technology training system that brings the LCS ship IT environment virtually to train Sailors on managing the IT systems of the ship.

Virtual Reality Laboratory (VRL) - Student and Instructor Station Hardware Platform that can support multiple training environments.

Immersive Virtual Shipboard Environment (IVSE) - Install and test Courseware into hardware platform. Integrate to VSTS and create baselines for distribution to LTF.

TOOLS

- Microsoft System Center Configuration Manager (SCCM)
- Virtualization Technologies
- Centralized Management Systems

MISSION

Support developmental systems, rapid configurability, special hardware and software requirements and sustainment of Littoral Combat Ship Training Systems.

EXPERTISE

- Information Technology
- Cyber Security
- System Engineering
- Software Integration
- Instructional Systems Design

For More Information Please Contact

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STEALTH LAB

Science for Training, Evaluation, Analysis,
Learning and Theory Lab

MISSION

Conduct Research and Development to support the design and development of training programs and instructional tools through application of advanced technologies, training effectiveness evaluations and human-computer interface design.

EXPERTISE

Research Psychologists (B.S./M.A./Ph.D.'s)

- Applied Experimental
- Human Factors
- Industrial/Organizational
- Modeling and Simulation

For More Information Please Contact

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CAPABILITIES

Support for Design and Development of Training Programs and Instructional Tools

- Front End Analysis Tools/Techniques
- Cognitive Task Analyses for multi-teams and systems
- Job Task Analysis
- Personnel Selection
- Types of Feedback
- Adaptive Training
- Multi-culture Teams

Application of Advanced Technologies in Training Systems

- Live, Virtual, and Constructive (LVC)
- Augmented Reality
- Games and Gamification
- Multi-user Virtual Environments
- Virtual Worlds

Training Effectiveness Evaluations

Human Computer Interface Design

PROJECTS INCLUDE

- Live, Virtual, and Constructive (LVC)
- Multidisciplinary Extended Reality Team
- Investigation of Training Fidelity for Carrier Qualification and Precision Landing Modes
- Fleet Training Technologies (FleeT2)
- Fleet Adaptive Multilevel Measurement for Operations & Unit Systems (FAM2OUS)

STRIKE LAB

Simulation and Training Research to Improve Knowledge and Effectiveness



CAPABILITIES

- **Adaptive training (AT) system design and development.** We utilize cognitive theories and science-based principles to guide all aspects of AT development including task analyses, performance metrics, user interface design, assessment algorithms, instructional adaptation algorithms instructional content (including scenario development), & iterative system evaluations.
- **Instructional strategies research** aimed at understanding which instructional techniques work best for the particular task and for the individual trainee in order to optimize learning. For example, we perform basic research on the type, timing, content, valence, and modality of feedback, scaffolding, hinting/cueing, and individual differences.
- **Application of advanced technologies in training systems** including virtual and augmented reality, game-based training, and human behavioral modeling in scenario-based training systems. We seek to understand how and when to incorporate these advanced technologies in our training systems to improve learning outcomes and efficiency. Our perspective is to instantiate these technologies in a thoughtful way to maximize our return on investment rather than incorporating technology for technology's sake.
- **Training effectiveness evaluations** aimed at quantifying learning and/or performance improvements gained from the training systems we developed. We emphasize robust data collection efforts in order to assess short-term or long-term transfer and/or knowledge retention in addition to user reactions data. This approach allow Fleet decision-makers and stakeholders to make evidence-based determinations regarding the successful implementation of our training approaches.
- **User interface design and usability testing** including both formative and summative techniques such as use cases, proof of concepts, focus groups, heuristic evaluations, usability studies, science-based and/or data-driven design & re-design recommendations.

TRANSITIONED RESEARCH PRODUCTS

- Submarine Electronic Warfare Adaptive Training System (SEW-AT)



- Periscope Operator Adaptive Training System + (POAT+)



MISSION

Apply cognitive science and human factors engineering to improve warfighter readiness through optimal training and system design. Perform research to improve the instruction implemented in training systems in order to maximize learning and/or performance.

EXPERTISE

- Human Factors
- Cognitive Science
- Experimental Design
- Statistical Analyses
- Adaptive Training
- VR/AR/MR
- Individual Differences
- Training Effectiveness Evaluations
- User Interface Design
- Usability Testing

For More Information Please Contact

**NAWCTSD Technology Transfer
Program Manager**

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Technology Research Applications Team (TechRAT) Laboratory

MISSION

Provide simulation and media solutions for the naval aviation, undersea warfare, surface warfare, and special warfare training communities.

EXPERTISE

- Modeling and Simulation
- Extended Reality Systems
- Rapid Design and Production
- Agile Software Development
- Computer Science
- Navigation Training
- Haptic Data Gloves
- Mobile Technology
- Adaptive Training

For More Information Please Contact

NAWCTSD Technology Transfer
Program Manager

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CAPABILITIES

- **Software Application Development** including individual and team training simulations, replay and after action review, mobile applications, scenario authoring tools, image generators, emulations of tactical and commercial equipment, and gaming area authoring tools.
- **Turnkey Training System Design and Production** including proof of concept, rapid prototypes, limited quantity productions, and life-cycle extension upgrades.
- **2D/3D/VR Virtual Tours** including panoramic photography-based virtual tours, 3D rendered virtual tours, and virtual reality tours. Virtual tours provide familiarization and procedural training, interactive courseware, and embedded media files.
- **Research Testbed Design and Development** to facilitate research activities including data collection, usability studies, adaptive training, and haptic device investigation.
- **Reality Capture** including 3D laser scans, photo references, 360° video references, wearable and optical motion capture.
- **Building Virtual Environments** from source material including: Computer Aided Design (CAD), 3D point clouds, photogrammetry, and traditional modeling.
- **Integrating with External Systems** including stimulating commercial and tactical hardware and software and implementing training network protocols.

TOOLS

- Unity 3D
- Visual Studio, Team Foundation, Perforce
- 3D Studio Max, Allegorithmic Substance Designer
- Computer Aided Design (CAD) and Manufacturing (CAM)
- Small and Medium Scale Fused Deposition Modeling (FDM)
- 3D Laser scanner
- 360° video camera
- OptiTrack visual motion tracking system

Trident Training System (TTS) Lab



CAPABILITIES

- **Turnkey Training System and Technology Design and Production** including proof of concepts, rapid prototypes, limited quantity productions, and life-cycle extension upgrades.
- **Software Application Development (EOG/AEAG)**-Implements automatic shutdown logic. Simulates operational status and annunciation displays. Implements cursor selectable simulation options via the displays. Implements sequential steps of operational procedures as they are selected. Detects and annunciates operator errors. Simulates cell liquid levels. Simulates effects of manual overrides of solenoid valves and pressure control valves. Simulates oxygen pressure and D/P regulator control loops
- **Electronics Design and Fabrication** including circuit design, prototype and small-quantity circuit board production, wired and wireless interfaces, firmware development, device fabrication and assembly, and production of electronic test equipment suites.
- **Mechanical Design and Fabrication** including part and assembly design, electro-mechanical and -optical devices, pneumatic systems, and fabrication using a variety of materials (plastics, non-ferrous metals, stainless steels). Additive and subtractive manufacturing process are supported for both prototype and low rate production.

TOOLS

- **Electrolytic Oxygen Generator Front Panel Simulator**
- **CITECT Software**
- **Peripheral Component Interconnect (PCI) eXtensions for Instrumentation (PXI) architecture.**
- **LabVIEW**

MISSION

Provide full trainer life cycle support for the Trident Submarine Damage Control Trainer and the Electrolytic Oxygen Generator / Automated Electrolytic Oxygen Generator Simulator (EOG/AEOG) training systems. The lab manages software/systems development, integration test, design, packaging, and fielded updates. It uses an integrated development environment and modular test berth to perform these trainer support functions.

EXPERTISE

- Modeling and Simulation
- Electromechanical Systems
- Software Development
- Rapid Design and Production
- Hardware/Software Integration

For More Information Please Contact

**NAWCTSD Technology Transfer
Program Manager**

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TECHNOLOGY TRANSFER (T2)

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 more information, please send an email to: ORLO.Orlando_Tech_Transfer@navy.mil.



CENTRAL FLORIDA TECH BRIDGE AND THE TECH GROVE



NavalX was established in Feb 2019 as an initiative of the Assistant Secretary of the Navy for Research, Development, and Acquisition to serve as the Dept. of Navy (DON) workforce "super-connector," focused on scaling non-traditional agility methods across the DON workforce.

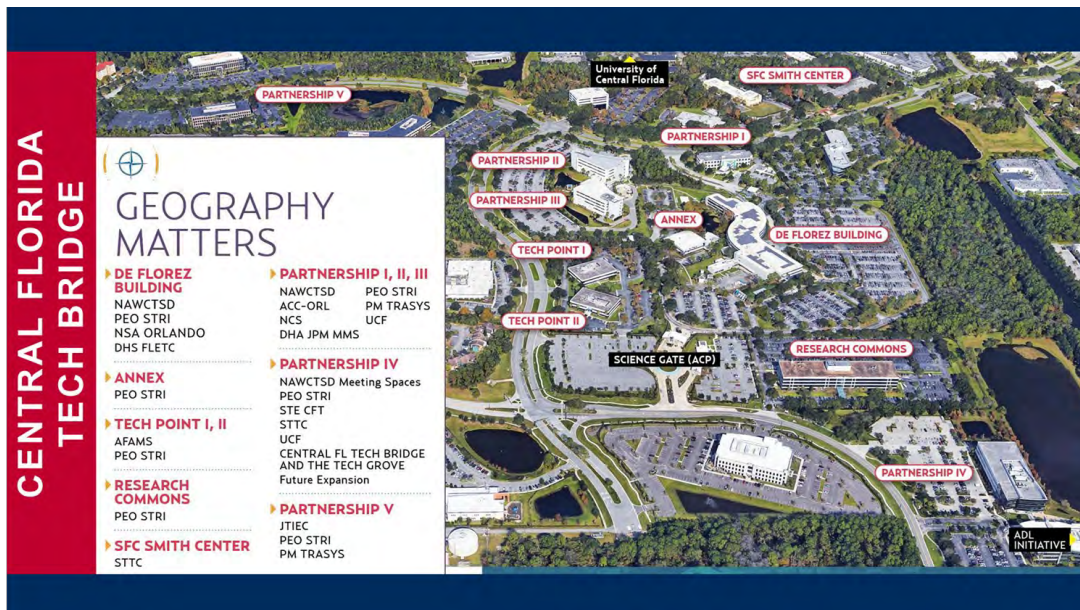


Take a Tour and Get Connected:

<https://www.secnav.navy.mil/agility/>

Brought Us:

- **Central Florida Tech bridge** facilitates collaboration, innovation and exploration between, Small Businesses, Entrepreneurs, Labs, Academia Team Orlando and Government Stakeholders.
- **Tech Grove** is the public facing platform forged through a partnership between NAWCTSD and the University of Central Florida Research Foundation to solve challenging Warfighter problems.



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