Capable Manpower
Future Naval Capability

Revolutionary Research . . . Relevant Results

Revolutionary Research . . . Relevant Results

CMP-FY08-01 Game Based Training

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Automated Performance Assessment and After-Action Review

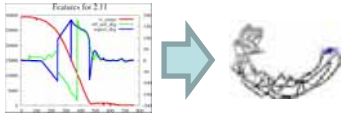
Product Description:

After-action debrief prototype which first acquires and stores an expert model of performance, then during training the student's performance is compared to the model to identify and target individual deficiencies.

TRL at Start: 4; TRL at Transition: 6

The Approach:

1. Provide examples of expert performance



2. Machine learning used to acquire expert model

3. In training, student is compared to expert model to identify and target training to individual deficiencies.

Planned Demos/Deliverables/Transitions:

- NAVAIR System Verification– Q3 FY11
- System Integration Test– Q3 FY11
- Final Acceptance Demo– Q4 FY11
- PMA205 AWTD: PE 0204571N – FY12-13
- E2: PE 0804743N– FY12-13

Warfighting Payoff:

- Reduced manpower costs using automated assessment
  (90% agreement between manual and automated assessment)
- Enhanced training effectiveness through identifying and targeting individual deficits
  (statistically significant improvement student performance compared to baseline training condition)

Automated Performance Assessment and After-Action Review

Technology Efforts Leveraged for this Product

Products Leveraged from Naval Air Warfare Center

E2 Enhanced Deployable Readiness Trainer (EDRT)

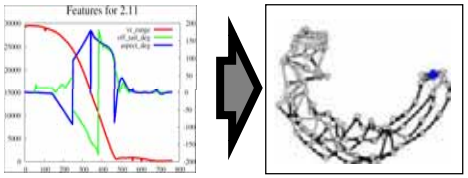
Medium-fidelity simulation trainer

Common Distributed Mission Training Station (CDMTS)

Common platform for Naval aviation simulation training

Leverages Internal R&D Investments by Sandia National Laboratories

Automated Expert Modeling and Automated Assessment (AEMASE)



1. Models performance based on demonstrated behavior
2. Assesses performance by comparing student to expert models

Primary Deliverable

Debrief tool supporting E2 simulation training integrated with E2 Enhanced Deployable Readiness Trainer

Significant Accomplishments

- Product has been selected by Sandia National Laboratories for inclusion in submission package for R&D 100 award.
- Transition for Training Cyber Defenders
  - DOE is leveraging capabilities developed through this project to improve training of cyber defenders.
  - Sandia National Laboratories conducts red-on-blue exercises for training cyber defenders from facilities across the U.S. nuclear weapons complex (i.e. Cyber TracerFire).
  - Automated performance assessment and after-action review capabilities developed for Naval Aviation are being adapted to enable Cyber TracerFire instructors to provide students improved after-action debrief.

Integrated System for Language Education and Training (ISLET)

Product Description:

ISLET provides language-in-culture learning in the target language using task-based sequences of scenarios designed for individual and team action. Instruction is in a virtual environment reflecting missions in region/country. Students progress from structured learning to open-ended practice in a multi-player game where learner motivation and persistence results in fast-paced language usage. Collection and analysis of learning is tracked.

TRL at Start: 3; TRL at Transition: 7

Planned Demos/Deliverables/Transitions:

FY-09 Initial task-based scenarios (in each language), cultural orientation components, LMS system demo and language system comparison report

FY-10 Language curriculum developed (both languages), preliminary acquisition and instructional design testing, initial component integration and game design

FY-11 Intelligent agent and game components migrated to multi-player platform, version 1a of prototype completed (both languages) and evaluated, transition to acquisition customers

Warfighting Payoff :

- Students obtain second language operational speaking/listening proficiency to levels 1>1+
- Students require 50% less direct/formal instruction
- Reduction in schoolhouse utilization of 80%
- Increase in voluntary practice time by 20%
- Provides means to retain language proficiency through on-going and reinforcing game play
- Provides dynamic assessment of language skills
- Advances science of language acquisition and game-based learning
- Develops conversational AI for high proficiency dialog

Integrated System for Language Education and Training (ISLET)

Technology Efforts Leveraged for this Product

DoD funded:

Tactical Language scenario technology developed with **DARPA** and **Marine Corps** funds in the DARWARS and Tactical Language products.

Other:

- **Information technology Promotion Agency (IPA), Japan**
  - Julius Speech Recognition Engine: originally developed as research software for Japanese Large Vocabulary Continuous Speech Recognition (LVCSR)
- **Open University**, UK; Istituto Superiore di Sanità (ISS), Italy; Microsoft, US; Google, US ; AJAX; Open Polytechnic, NZ; and other open-source contributors
  - Modular Object-Oriented Dynamic Learning Environment (MOODLE) development
- **Task-based language**
  - The Communicational Teaching Project: Research conducted on Second Language Pedagogy with support from the Institute of English, Bangalore, India and the British Council in Madras.
- **Social-interactionist Language Learning**
  - Support for SLA researchers provided by the University of Hawai'i at Manoa and National Foreign Language Resource Center
- **Communities of Practice in Language Learning**
  - Webheadsinaction.org <http://Webheadsinaction.org/> : Unfunded virtual community of language teachers started by Vance Stevens with support from WorldBridges.net <http://WorldBridges.net/> , LearningTimes.org <http://LearningTimes.org/> , and TappedIn.org <http://TappedIn.org/>

ISLET

Prototype development efforts

(DARWARS tactical Iraqi)

Applied research efforts

(Hidden Markov Models in Automatic Speech Recognition, Task-based language Learning)

Basic research efforts

(Development of Instructional Theories (Constructionist, Social-Interactionalist, etc..)

Integrated System for Language Education and Training (ISLET)

S&T Activities

Modules developed or in development -

Social Language Learning Management System

Develop an LMS that provides and tracks in real-time the types of social interactions required for effective self-directed computer-delivered language learning and skill retention.

Automated Speech Recognition and Artificial Intelligence

Develop human-computer interfaces through automated speech recognition capable of recognizing a range of learner pronunciations and errors and provide informative feedback and meaningful language practice.

Multiplayer Online Language Learning Game

Develop a 3-D virtual tasked-based language learning experience where teams of players engage in cooperative and competitive quests using the target language-in-culture to accomplish fast-paced and effective communications.

Assessment Framework

Develop a comprehensive assessment framework as a multi-dimensional, analytic tool kit that tracks and evaluates learner performance in real- and across-time while accounting for an individual's learning history and cognitive profile.

Studies completed -

Study 1 – Mini-Dialog Editor Evaluation (Evaluated author capacity to annotate and generalize example responses)
Study 2 – Baseline Dialog Data Collection and Analysis (Provide data on how learner/system performance change over time)
Studies 4 & 5 (and Study 0.1) - ISLET Cultural Component Effectiveness (Measure effectiveness of on-line learning vs. live instruction with focus on the efficacy of pedagogical features and instructional design characteristics >>selection for game.)

Studies underway -

Pilot Study 7 – Test functionality for Study 7 - Validate Methods for Comprehensive and Longitudinal Assessment for Second Language Acquisition

Studies planned -

Study 3 - Evaluation of Improvements to Conversation Virtual Human Technology (Informed by results of Study 2)
Study 7 - Validate Methods for Comprehensive and Longitudinal Assessment for Second Language Acquisition
Studies 6, 8 & 9 - Game-based studies to determine component efficacy and game strategy as central to language acquisition

Remaining development planned -

Further Integration of multiplayer game and LMS moving the second language – Iraqi Arabic into ISLET
Expand multi-player game featuring increasing language complexity as player advances through curriculum

Integrated System for Language Education and Training (ISLET)

Significant Accomplishments

Technical Advances:

Online learning research- Conducted head-to-head comparison of an 8-hour online and day-long face-to-face culture training for the U.S. Navy using different sub-sets of the same NECC Battalion immediately prior to their deployment to Iraq/Kuwait

Social language learning portal- Integrated within the ISLET LMS the web-based second language learning tools including Unity 3D multi-player language learning game, multimedia online corpus analysis tools, and automated speech recognition

Learner data analysis framework- Corpus analysis tools integrated with the LMS and the multi-player game to facilitate automated analyses of learner performance data

Speech recognition technical advances - Integrated speech recognition with the LMS and implemented authoring framework for creating simulated conversations in a foreign language

Statistical analyses tools - Developed a post hypertext preprocessor (PHP) module that pipes data to R (open source statistics package) to perform on-the-fly statistical analyses

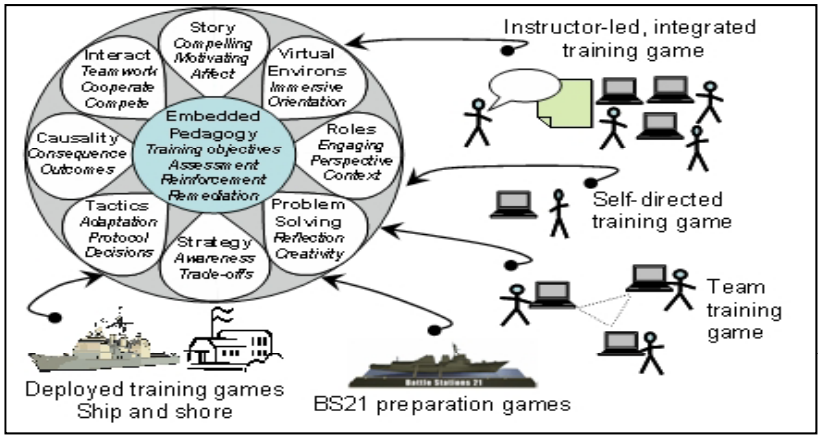
Created multi-player game entry portal and Scenario 1 – Completed Senegalese airport virtual world scene that includes many player/NPC interactions/conversations that are aligned with learning objectives of Units 0-2 in the French curriculum. An overheard conversation feature, a pronunciation hint feature (per data collected in ’09 baseline study), and a proximity conversation feature were created and implemented to facilitate the acquisition and use of language. A conversation editor was created to increase content creation efficiency

Tools for Game-Based Training and Assessment of Human Performance

Product Description:

Open-source game-based training software for recruits and sailors to (1) author training missions and (2) capture high-level behaviors, assess performance and deliver guidance and feedback.

TRL at Start: 3; TRL at Transition: 6



Planned Demos/Deliverables/Transitions:

- Annual deliveries/demonstrations; Frequent transitions
- Deliver prototype Flooding Control Trainer [FY08] (✓)
- Early transition (initial deployment and large-scale testing) of Flooding Control Trainer at NSTC [FY09] (✓)
- Deliver prototype Fire Fighting Trainer [FY10] (✓)
- Demonstrate prototype pedagogical authoring tools and infrastructure [FY10] (✓)
- Transition Fire Fighting Trainer at NSTC [FY10] (✓)
- Deliver prototype Mass Casualty Trainer [FY11]
- Transition Mass Casualty Trainer at NSTC [FY11]
- Transition pedagogical tools and infrastructure [FY11]

Warfighting Payoff:

- 50% improvement in cognitive readiness
- 10-15% improvement in skill retention
- 30% increase in skill coverage within available training time
- Improved training at RTC to prepare recruits for Battle Stations 21 capstone event
- Training in operational contexts that can be delivered in the classroom, afloat or at home

Tools for Game-Based Training and Assessment of Human Performance

Technology Efforts Leveraged for this Product

- The prototype training systems developed for Naval Service Training Command (NSTC):
  - Open-source, government owned, no licensing fees
  - Leverages the Delta3D game engine (supported by ONR and other Navy funds, Managed by Naval Postgraduate School)
  - Integrated with the DARWARS Learning Management System in Real World (Developed under ~$60M in DARPA funding)

- The prototype pedagogical authoring tools and infrastructure have been integrated with several game engines:
  - Full integration with Delta3D game engine
  - Basic integration with Unity3D game engine (COTS product)
  - Basic integration with VBS2 game engine (COTS product, heavily used in DoD)

Damage Control Trainer Experimental Results

- Team transfer study showed significant improvements (24% to 80%) in performance
- Hardened version with six missions officially deployed at RTC in Master Training Schedule at all electronic classrooms (1600 computers). Two 1-hour sessions of three missions each.
- Observed two classes (of 88 recruits) playing the latest three missions (Fire Fighting, Advanced Flooding Control).
  - recruits had no unexpected problems with the interface or with the training content
  - All recruits were able to play the first two missions to completion and to play the final mission at least once to completion or failure. Most recruits were able to complete the final mission successfully.
  - Recruits were informally questioned as a group after the session. Recruits' impressions of the game were positive and the perceived benefit was high.
  - RTC/NSTC determined that further validation was not required.

Significant Accomplishments

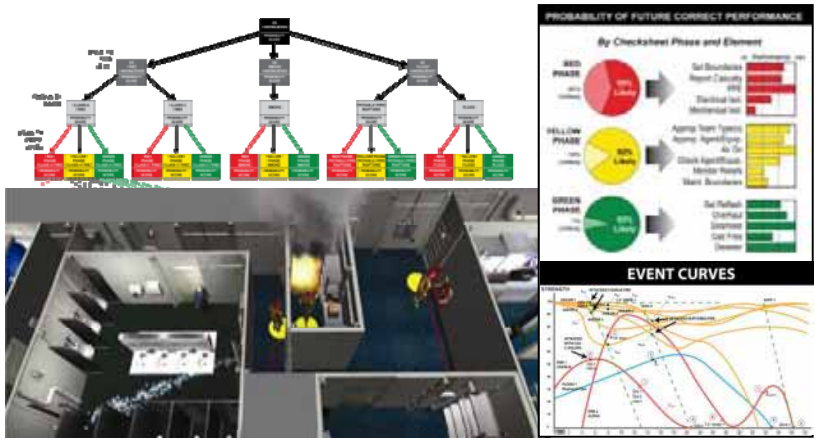
- Empirical validation of training outcomes exceed minimum transition requirements
- Full transition of VESSEL DCT (Flooding Control and Fire Fighting missions).
- 14 studies completed or in progress exploring the impact of different game design features on learning outcomes. Combination of empirical and analytic studies
- Over 21 publications (book chapters, conferences, workshops)
- Edited book, accepted by top-tier publisher, on the guidelines that have been identified by the EC performers and members of the community.
- Authoring tool (VITAL) developed for this product released open-source Nov 2010

- **Recognition:**
  - The VESSEL team won the National Training and Simulation Association (NTSA) 2010 Modeling and Simulation Award for Outstanding Achievement in Training (I/ITSEC, 30 NOV 2010, Orlando).
    - The award was given based on success in developing and fully-deploying an effective serious game, efforts to advance the science of game-based learning, and efforts to grow an active community of interest within the Modeling and Simulation community, as well as release of open-source authoring tools.
  - Honorable mention for Best Paper Award at I/ITSEC 2010 on paper describing survey results.

Advanced Technologies for Automated Performance Assessment in Games

Product Description:
Automated assessment and performance reporting tools developed within a damage control game-based simulation training system for fire-fighting and flooding.

TRL at Start: 3; TRL at Transition: 6



Planned Demos/Deliverables/Transitions:
- Instrumented and Valid Game-based Assessment System (IVA) – 1Q10
- Advanced Psychometric Analyses and Reporting Tools (APART) – 1Q10
- Integrated IVA/APART System – 2Q11
- Assessment Software Products – 1Q10-3Q11

Transitions
- Great Lakes Naval Training Center–3Q09-3Q11
- Center for Naval Engineering—3Q10-3Q11

Warfighting Payoff:
- Improved ability to think through uncertainty; develop innovative concepts, capabilities, and strategies; fully exploit advanced technologies, systems, and platforms; understand cultural/regional issues; and conduct operations as a coherently joint force.
- Assessment tools and metrics will improve quality of assessments and reduce development cost and time by an order of magnitude

Advanced Technologies for Automated Performance Assessment in Games

Technology Efforts Leveraged for this Product

- Office of Naval Research
  - Training Models and Tools for Adaptive Learning
    - Objective: Conduct research on instructional design and assessment of complex knowledge and skills
    - Relevant findings/technology: Ontology-based assessment models and tools, including CIC assessment tool, TAO sandbox, and use of Bayes nets for embedded assessment and reporting

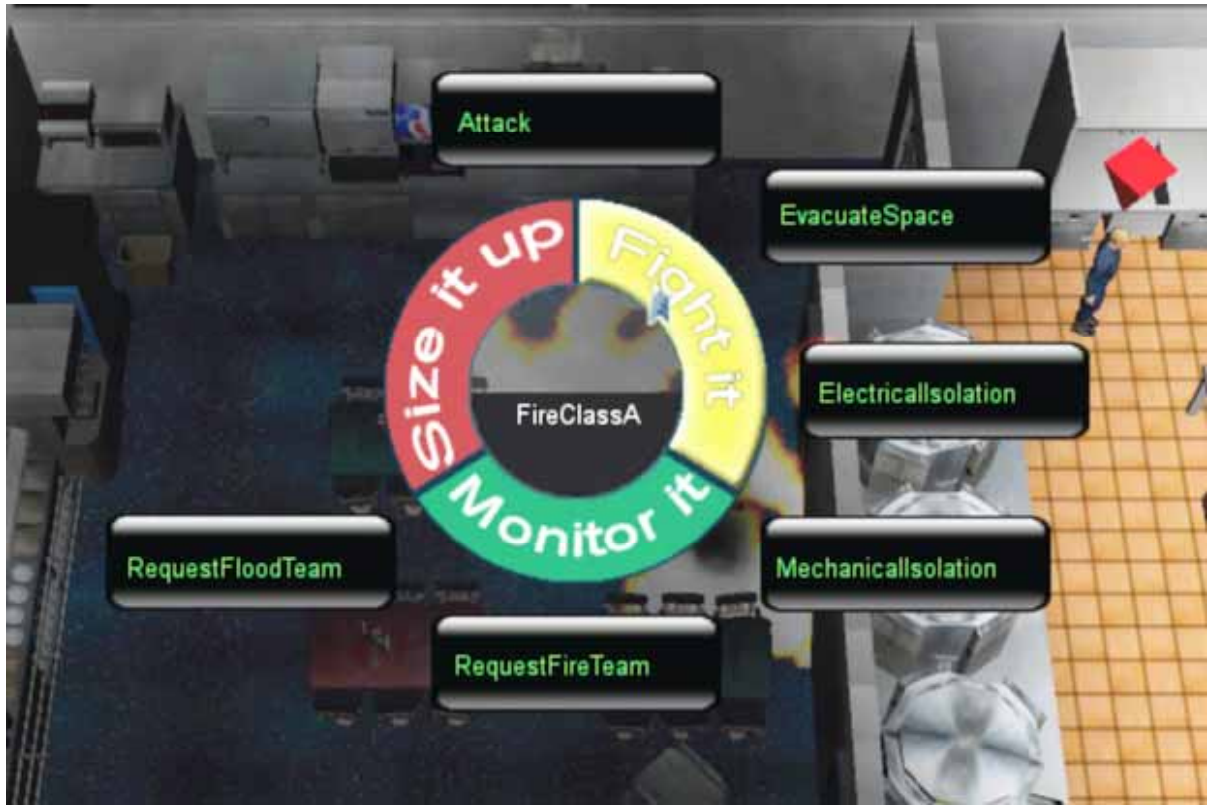
- STEM Transitions (in process)
  - Gates Foundation
    - Building a Conceptual and Organizing Platform for Secondary Mathematics Formative Assessments
  - Department of Education
    - National Center for Research on Evaluation, Standards, and Student Testing

- Applied Technology from:

  - GeNIe – used for Bayesian network design and computation
  - MatLab – used with game/simulation for automated integration of static and dynamic Bayesian networks
  - Unity3 – 3-D game and simulation development tool used to create the damage control simulator

Player Assumes Multiple Roles

- Player can selectively assume specific roles as needed to guide strategies and tactics in the game.
  - **List of Available Roles:**
    - Repair Locker Leader
    - Scene Leader
    - Investigator
    - Electrician
    - Gas Free Engineer
    - Fire Team
    - Re-Flash Watch
    - Flood Team
    - De-smoke Team
    - Overhaul Team



Example: player actions available when scene leader is selected.

- Audience
  - Repair Locker Leader
  - DCCT Trainers
  - Shipboard Damage Control Team Members
  - CNE Fire-fighting School Students
- Usage
  - Schoolhouse training and assessment
  - Shipboard training, practice, and assessment

Revolutionary Research . . . Relevant Results

CMP-FY08-03 Human Systems Integration

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Exceptional Expertise for Submarine Command Team Decision Making

Product Description:

Develop and transition a submarine command decision making training. Deliver innovative strategies for revolutionizing On-Board Training (OBT) and operational performance measurement and assessment for submarine command teams.

TRL at Start: 3; TRL at Transition: 6

Planned Demos/Deliverables/Transitions

- Demo – Adaptive Systems for Accelerated Expertise "proof of concept" demonstration
- Deliver – Empirically validated set of performance measures and metrics
- Deliver – Adaptive Systems for Accelerated Expertise Concept Of Operations Document
- Deliver – Adaptive Systems for Accelerated Expertise – "Blueprint" Requirements Document
- Deliver – APB-13 white paper

Warfighting Payoff:

Improved submarine command team decision making in high stress/high contact environments via:

- empirically validated set of performance measures and metrics, which will be used to monitor continuous performance improvement of submarine command teams.

- framework for intelligent scenario-based training that will leverage the best available training and assessment practices while incorporating emerging results from the science of learning and human performance.

Exceptional Expertise for Submarine Command Team Decision Making

Technology Efforts Leveraged for this product

	PROGRAM	DESCRIPTION	SPONSOR
1990	**TADMUS**—Tactical Decision Making Under Stress	Established principles and guidelines for improving team performance through training and decision support	ONR 6.2
2000	**RRLOE**--Rapidly Reconfigurable Line-Oriented Event Generator	Developed software for commercial aviation industry to rapidly generate scenarios for simulation-based training	FAA
	Fostering Adaptability for Cognitive Readiness	Generated principles for training adaptive performance in military crews to ensure cognitive readiness	OSD
	SUMMIT--Systems for Understanding & Measuring Macrocognition in Teams	Developing relevant, valid, reliable, and diagnostic metrics of cognition and collaboration in teams	ONR MURI
	SMART--Standardized Metrics Assessment of Readiness and Training	Providing system-related metrics to assess training outcomes in submarine teams	PMS425 SBIR
2009	**DIVES**--Data Integration for Validation and Effectiveness of Systems	Developing real time measures of operator and team performance in submarine tactical missions	PMS425 SBIR

Intelligent Performance Assessment Capability to Support Training and Operations

Identify Individual & Team Tasks, Performance Requirements & Learning Objectives

Provide libraries, databases & other tools

Define Scenarios & Trigger Events

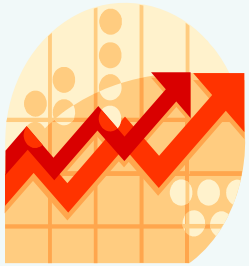
Automatically generate scenarios

Develop Models & Measures to Assess Individual & Team Performance

Develop performance measurement plans

Collect Performance Data in Operational or Simulated Environment

Automatically assess team & operator performance



Correlate Performance Data with Standards

Employ intelligent diagnostic algorithms

Diagnose Performance Deficiencies & Root Causes

Generate debriefing reports, templates & feedback

Provide Feedback & Assign Remedial Activities

Generate remedial scenarios for subsequent training

Aid Real-Time Command Decision Making

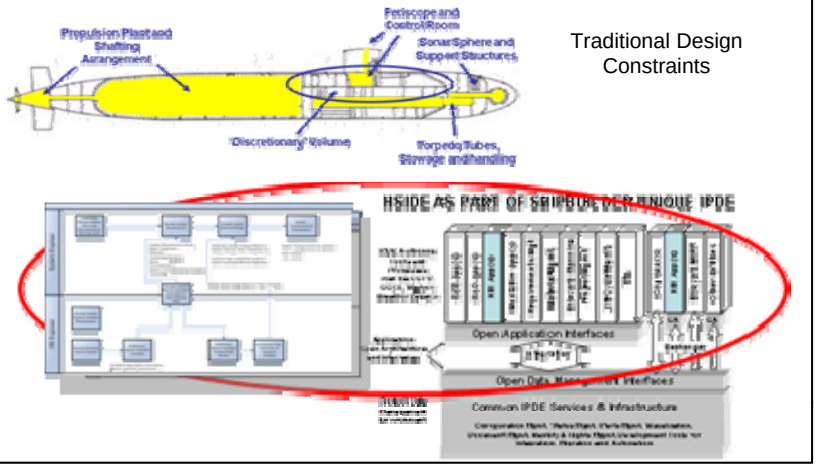
Provide real-time performance information

HSI Design Environment

Product Description:

A prototype and operational construct, processes, methods and software specifications to merge the full spectrum of Human Systems Engineering into the Navy's standards based, open-architecture, Integrated Product Data Environment.

TRL at Start: 3; TRL at Transition: 6



Traditional Design Constraints

Planned Demos/Deliverables/Transitions

- FY11: Deliver Phase I integrated tools and processes to support the Operability Studies portion of the HSIDE infrastructure.
- FY12: Deliver Phase II integrated tools and processes to support the Habitability, Maintainability, Safety and Health, and Personnel Survivability Studies portion of the HSIDE infrastructure.

Transition – FY12: Incorporation into VA Class Blk IV and/or ORP Programs of Record via PMS 450 and/or PMS 397 respectively for production level development to allow operational fielding and full integration with employed IPDE(s).

Warfighting Payoff:

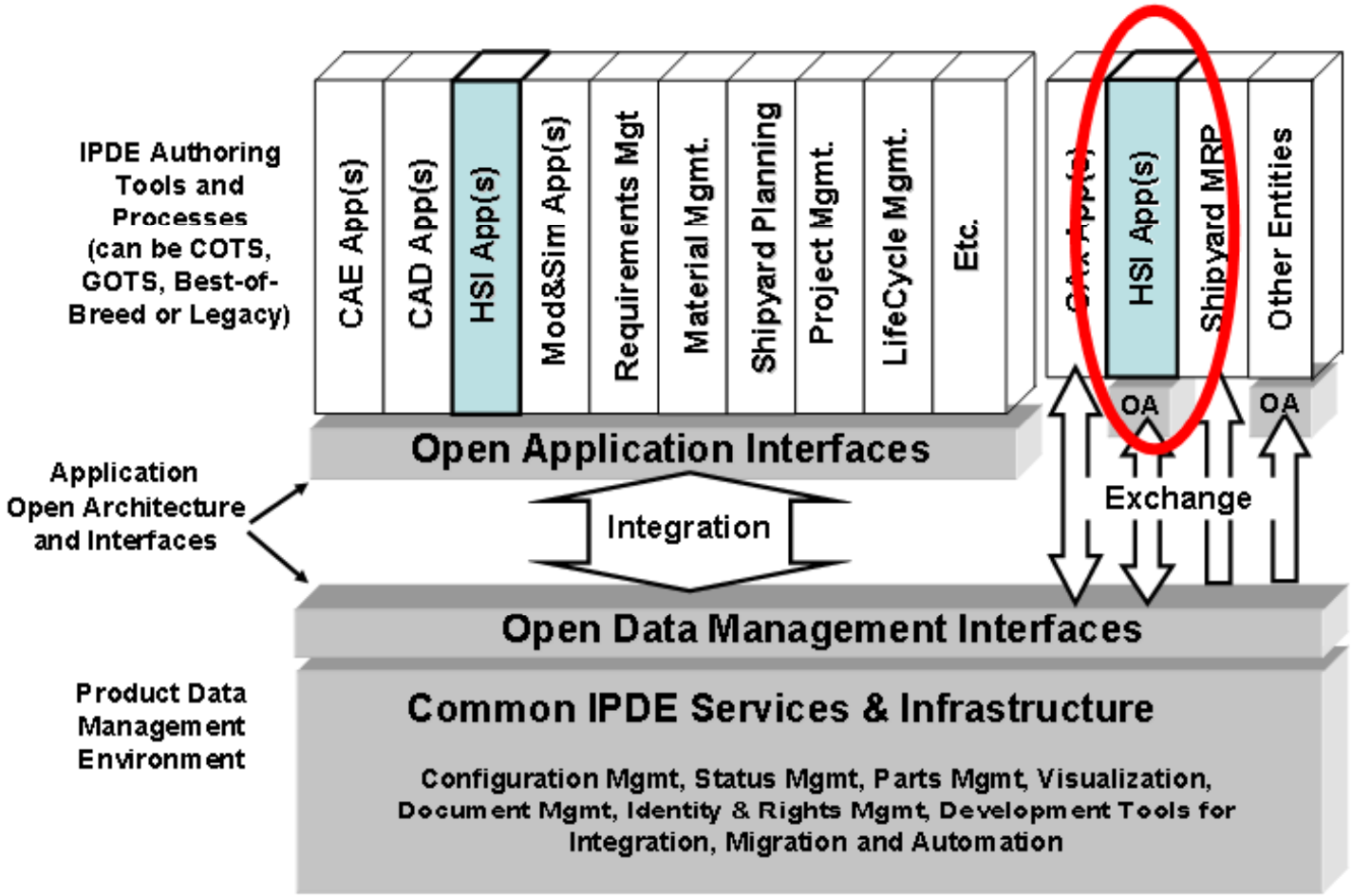
- A cost-effective ship design optimized for crew size, operability and military effectiveness
- The process will decrease acquisition and total ownership costs while maintaining or increasing the military effectiveness of the resulting system.
- Increase in cognitive resources available for mission performance while maintaining stealth and safety

HSI Design Environment

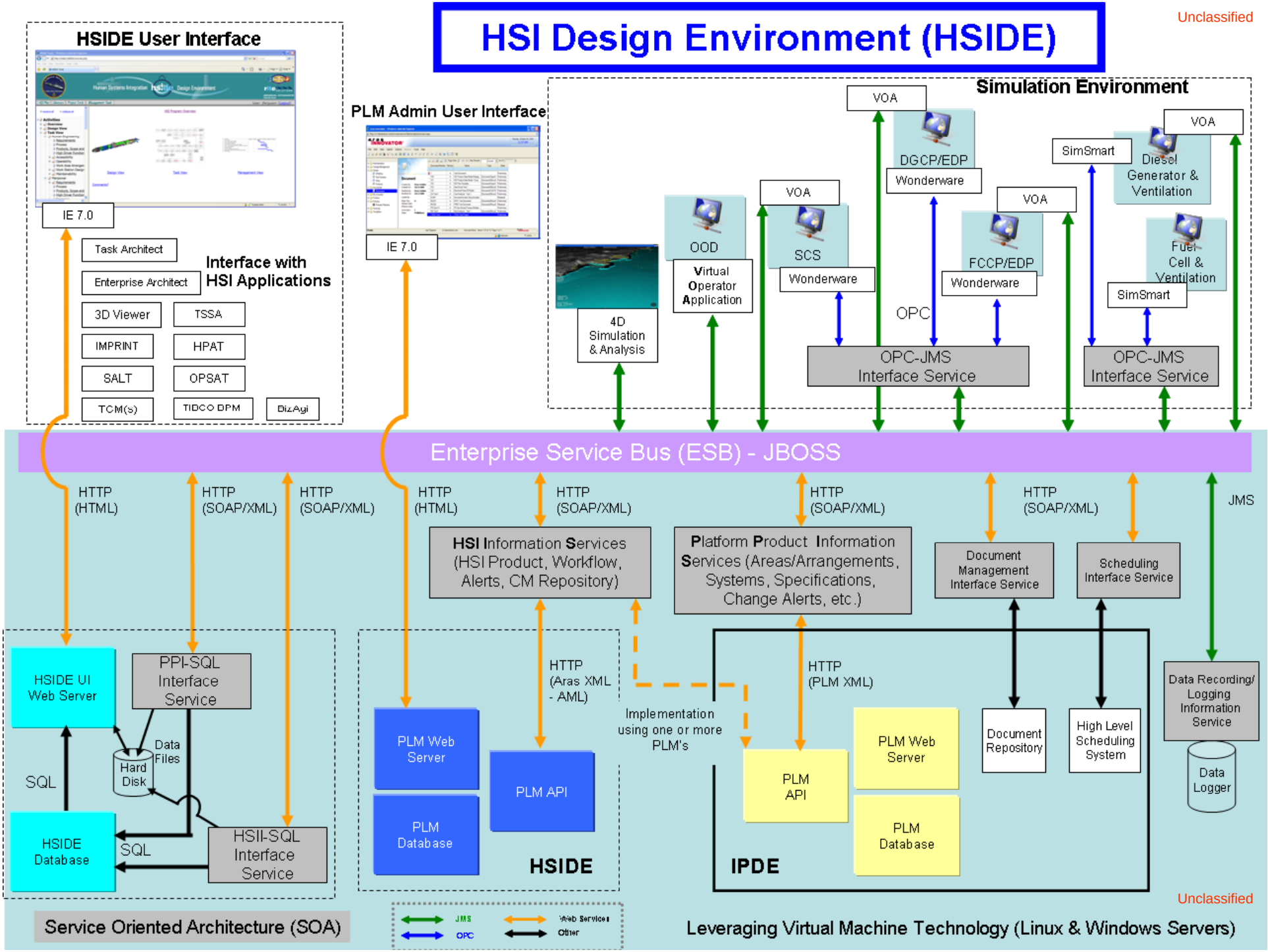
Technology Efforts Leveraged for this Product

- D&I:
  - Use of linear programming methodology and 3-dimensional constraints to predict officer complement for SSNs
- SBIR/Mantech technologies:
  - National Shipbuilding Research Program ISSE
    - Navy Product Data Initiative
    - Improved Methods for Generation of Full-Ship Simulation/Analysis Models
    - Enabling Shipbuilding Interoperability (ISE-6)
    - Integrated Shipbuilding Environment (ISE)
- TechnCombat System of the Future (SBIR N05-149ology efforts from other services, DARPA, government labs, industry, etc.
  - Center for Innovation in Ship Design – CREATE Program Ship Design Tools, Data Models and Interoperability
  - US Army, performance analysis tools (IMPRINT)
  - NSWC-CD – LEAPS – Modeling and Simulation / Design interoperability

HSIDE AS PART OF SHIPBUILDER UNIQUE IPDE



HSIDE capabilities expected to be integrated in a manner similar to planning, manufacturing, LCM or other major modules


HSI Design Environment (HSIDE)
Unclassified
HSIDE User Interface
IE 7.0
Task Architect
Enterprise Architect
Interface with HSI Applications
3D Viewer
TSSA
IMPRINT
HPAT
SALT
OPSAT
TCM(s)
TIDCO BPM
BizAgi
PLM Admin User Interface
IE 7.0
Simulation Environment
VOA
DGCP/EDP
Wonderware
VOA
SCS
Wonderware
OOD
Virtual Operator Application
4D Simulation & Analysis
VOA
FCCP/EDP
Wonderware
SimSmart
Diesel Generator & Ventilation
VOA
Fuel Cell & Ventilation
SimSmart
OPC
OPC-JMS Interface Service
OPC-JMS Interface Service
Enterprise Service Bus (ESB) - JBOSS
HTTP (HTML)
HTTP (SOAP/XML)
HTTP (SOAP/XML)
HTTP (HTML)
HTTP (SOAP/XML)
HTTP (SOAP/XML)
HTTP (SOAP/XML)
JMS
HSI Information Services (HSI Product, Workflow, Alerts, CM Repository)
Platform Product Information Services (Areas/Arrangements, Systems, Specifications, Change Alerts, etc.)
Document Management Interface Service
Scheduling Interface Service
HSIDE UI Web Server
PPI-SQL Interface Service
Data Files
Hard Disk
SQL
HSIDE Database
SQL
HSII-SQL Interface Service
HTTP (Aras XML - AML)
PLM Web Server
PLM Database
PLM API
HSIDE
Implementation using one or more PLM's
HTTP (PLM XML)
PLM API
PLM Web Server
PLM Database
IPDE
Document Repository
High Level Scheduling System
Data Recording/ Logging Information Service
Data Logger
Unclassified
Service Oriented Architecture (SOA)
JMS
OPC
Web Services
Other
Leveraging Virtual Machine Technology (Linux & Windows Servers)

Mission Performance Optimization

Product Description:

Mission visualization software toolset developed using "Task-Centered Design" approach that provides:

- Situational awareness on mission process, status, delays, products, & problems
- Dashboard displays with concise status information about user selectable mission items

TRL at Start: 3; TRL at Transition: 6

Planned Demos/Deliverables/Transitions:

- POR = MEDAL EA – Mine Warfare Environmental Decision Aids Library Extended Architecture
- PMS-495 Mine Warfare PEO LMW Littoral and Mine Warfare
- HCI Guidelines & Usability Analysis to MineNet Tactical
  - July 2009, May 2010, July 2010, 2011 dates pending POR delivery est May, July for MEDAL iteration #5.
  - Mission Process and Mission Execution Dashboards, Mission Timeline, HCI Form Builder/Editors, Mission Process Modeler.
    - Spiral 5 Toolset March 2011
    - Spiral 6 Toolset October 2011
    - MPV Tool to C2RPC FNC ONR 31 – January 2011

Warfighting Payoff:

- Reduce complexity such that access to critical information for any MIW focal task is maximum 1 click away.
- reduce by 50% workload for MCM Task Group to manually generate mission reports.
- Reduce by 50% workload to generate PowerPoint mission briefs. (current = 3 crewmembers 8AM, 8PM briefs)
- Increase from non-existent today to 100% MIW mission information portability and scalability.
- Incorporate min 50% goal 100% MIW mission focal tasks into Task-Centered MPO design.
- Improve mission process awareness to 100% of mission critical processes.

Mission Performance Optimization

Technology Efforts Leveraged for this Product

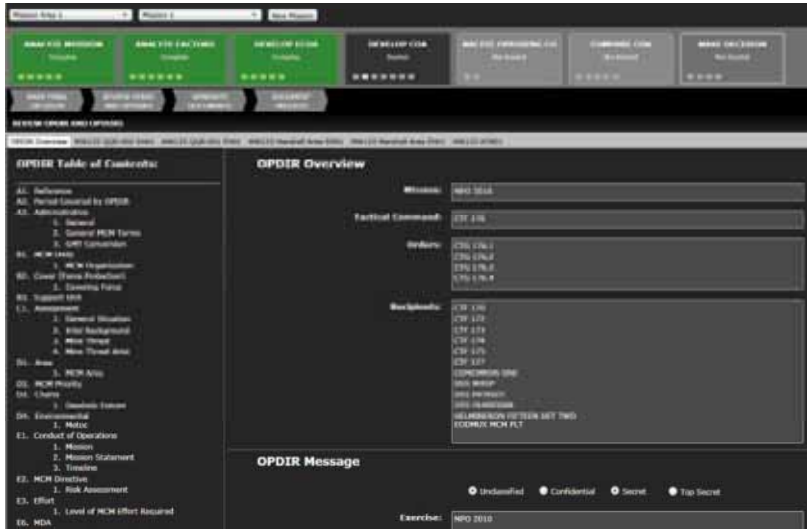
- ONR 6.2 and 6.3 History & Pedigree:
  - Advanced Tomahawk Human Computer Interface (FNC 2002-2005)
  - Multimodal Watchstation (6.2, 6.3 1997-2001)
  - Supervisory Control Combat Systems (6.2 1997-2000)
  - Navy Adv Information Mgmt Evaluation System (6.3 1991-1996)
- Coast Guard - Sector Project Los Angeles Long Beach (LALB) Department of Homeland Security (DHS)
  - (Mariner CommandBridge Toolset)
- MEDAL EAv1.0 (FY13) – PMS495 PEO LMW

Mission Performance Optimization (MPO)
Mission Process Views (MPV)

Mine Countermeasures (MCM) Warfare – Commander's Estimate

An intuitive, easy to use, visual and form based planning tool for development of Commanders Estimate of the Situation (CES).

← CES Process Visualized



- Conducted usability tests with MCM Warfare Subject Experts.

Mission Performance Optimization (MPO)
Mission Process Views (MPV)

Mine Warfare – Mission Execution

Mission Process Views for MCM provide task status, navigation, and contextual filtering for support of MCM situational awareness.

Collaboration: Mission Process View tool is being leveraged in ONR Code 31 C2RPC FNC prototype.

Mission Performance Optimization (MPO) Integrated Visualization

FUTURE MEDAL EA v2 Integrated Visualizations

Provide a full scale integrated MPO tool suite for mission situational awareness during MCM mission execution and re-planning launched from MEDAL-EA.

FY11-12 Goals:

- Increase design fidelity and run additional usability tests.
- Continue integration of MINEnet Tactical data services.
- Installation & Integration into NAVSEA Panama City MEDAL Test Bed.
- Signed Level A TTA.

Significant Accomplishment

MEDAL-EA Iteration 4 Integrated Visualizations

Integrated “mini-transition” test widget into MEDAL –EA Iteration 4. Provided proof-of-concept for the MPO integration strategy into MEDAL-EA. Eliminate future transition risk due to software component issues.

Data Services Driven Information Content In a Net-centric Service Oriented Architecture

Mine warfare personnel will have means to track mission progress and status from tactical unit level to aggregated Battle Group level

State-of-the-Art Multi-Modal Tools for Increased Situational Awareness in SONAR

Product Description:

An integrated spatial (3D) audio rendering capability for the spherical and towed arrays that enables sonar operators to 1) simultaneously discriminate and monitor multiple acoustic signals in 360° of azimuth; 2) determine relative contact position by bearing and by elevation; and 3) more fully use the human ears' innate signal detection, sound differentiation, and cueing abilities to increase opportunities for detection and tracking.

TRL at Start: 3; TRL at Transition: 6

Multi-modal workstation comprised of technology and tools that allow the fuller use of operators' aural-visual senses.

Planned Demos / Deliverables / Transitions:

- Deliverable - human performance measurement process, tools, data, and analysis to support testing and evaluation of spatial (3D) audio via the PEOIWS5A Advanced Processor Build (APB) Process to support transition (FY10)
- Deliverable – a spatial (3D) audio workstation prototype (advanced technology demonstrator) for the spherical array (FY09 Demo) and the towed array (FY10 Demo)
- Transition – an integrated spatial (3D) audio rendering capability for the spherical and towed arrays via APB Process (FY11)

Warfighting Payoff:

- Full-time aural monitoring of contacts in all directions
- Immediate alerting for significant aural events, pop-up contacts, maneuvers, transients in all directions
- 2X improvement in aural detection time for multiple contacts in high contact density environments (HCDE)
- 20% improvement in tracker management for high contact density environments (contacts attended in parallel)
- 25% increase in perceived situational awareness
- 10% reduction in control use (audio cursor activity)

State-of-the-Art Multi-Modal Tools for Increased Situational Awareness in SONAR

Technology Efforts Leveraged for this Product

Organization	Type	Technologies, Data, and Processes
JHU/APL	Academia	• Adaptive Research Process • Augmented Audio Processing (AAP) algorithm (PEOIWS5) • Engineering Measurement Program (EMP) acoustic data (PEOIWS5) • Advanced Processor Build (APB) Step Process (PEOIWS5)
NSMRL	Government	• Anechoic chamber facility and measurements (USN, ONR) • Head Related Transfer Functions (HRTFs) (Many) • Split auditory channel research findings (ONR)
NUWC	Government	• Generic Passive Sonar System (GPSS) (NUWCNPT) • SMMTT AWESIM Scenario Generator (NUWCNPT, NSWCCD, NAVAIR TSD) • Spatial Audio Logger (SAL) (NUWCNPT)
AuSIM	Industry	• AuSIM 3D audio rendering system • Multi-channel gain processing algorithm • Portable multi-listener demonstrator
UMich **NYU**	Academia	• Audio Granularization algorithm • Spatialized Audio Renderer • HRTFPref, FindAbout, and TellAbout spatialization assessment tools
GD-AIS **SAIC**	Industry	• Acoustic data (ONI) • ACINT Mission Scenarios
3rd Parties	Various	• Head Related Transfer Functions (HRTFs) (Wright-Patt AFB)

Advanced Technology Demonstration Hardware Built

GPSS Processors
8 Intel Dual-Dual-Quad core
Linux Supermicro SMPs

GPSS Workstation
1 Intel Dual-core
Linux Dell
Workstation

AuSIM Spatial Audio
Intel Dual-Dual-core
Windows Workstation

Spatial Audio Enables Increased Warfighter Performance for the Spherical Array

- ✓ Increased detection of metallic transients, active emissions, and state changes
- ✓ Increased situational awareness, with richer descriptions of sounds
- ✓ Can be used as “normal” part of watch in broad band operations for Safety of Ship
- ✓ Potential classification aid
- ✓ Prototyped training tools provide for perceptual awareness and practice
- ✓ Technology demonstration provides a potential training platform via SMMTT/AWESIM
- ✓ **Spatial reasoning is not part of selection criteria for sonar operators**
- ✓ Some system changes are necessary:
  - Individual HRTFs / HRTF library (software)
  - Head tracker (or avatar software)
  - 10-pin coupler
  - Aviation X Adaptor
  - 1 Dual-Quad-core SMP per D/E per workstation

Unmanned Vehicle Control & Monitoring HCI for Amphibious Operations

Product Description:

Robot control interface and HCI to allow a single operator to safely and efficiently control multiple semi-autonomous Unmanned Surface Vehicles (USVs) with integrated sensor packages.

TRL at Start: 4; TRL at Transition: 7

Planned Demos/Deliverables/Transitions

- Validate baseline HCI performance requirements for single-vehicle one operator control. (PMS-420, LCS Mission Modules, FY08)
- Demonstrate HCI for multi-vehicle control one operator controlling at least two USVs. (PMS-420, LCS Mission Modules, FY09).
- Results from user interface improvement experiments will be integrated into the next version of Multi-robot Operator Control Unit and delivered to LCS USV programs for Spiral B deployment. (PMS-420, LCS Mission Modules, FY09, FY10).

Warfighting Payoff:

1. Continuous operation two vehicles under all workload conditions.
2. Continuous 99%+ object interpretation, multiple video streams with time-sharing of tasks.
3. Operator successful MOCU use with < 2 hrs training.
4. Operator SA GT 95% for Key Mission Components.

Unmanned Vehicle Control & Monitoring HCI for Amphibious Operations

Technology Efforts Leveraged for this Product

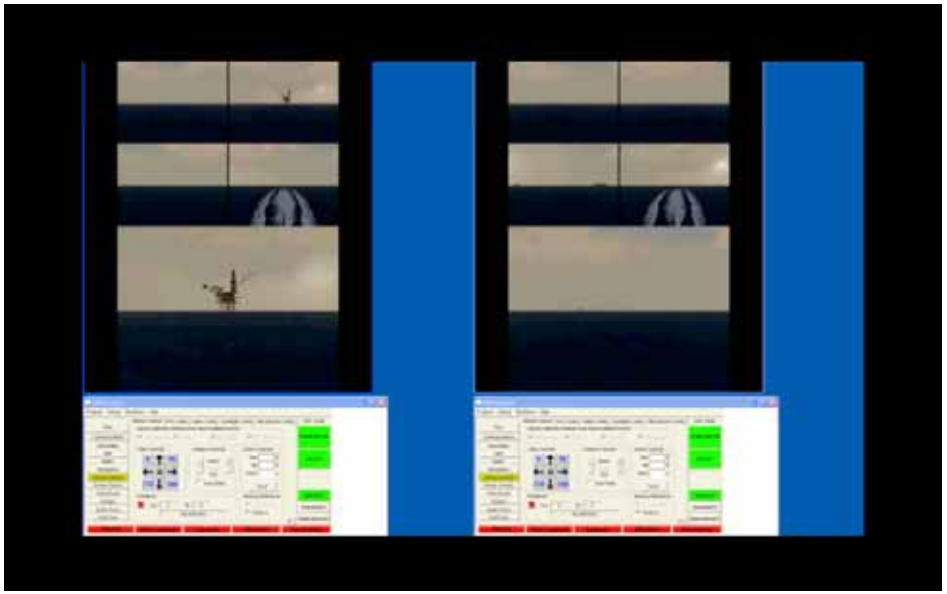
- R3V Remote Robotic Reconn Vehicle – US Army MOCU Version 2002-2003.
- SPARTAN USV ACTD 2003-2006 – early USV MOCU Version 1.
- NAVSEA Littoral Combat Ship Mission Modules ASW/MIW Version 2 2006 – present.
- AEODRS (Advanced Explosive Ordinance Disposal Robotic System) – commenced 2010.

Baseline MOCU Testing

Baseline MOCU Screen 1

- Simulated USVs
- Transited two USVs from the host ship to the mission operations area.
- The scenario was designed to elicit performance of critical tasks.
- In several instances scenario events were purposely scheduled in close time proximity to heighten mental workload and assess attention management capabilities under challenging conditions.

Baseline MOCU Screen 2



- The scenario required the subjects to perform many task including:
  - Take control of USVs
  - Download and execute preplanned routes
  - Set emergency maneuver actions
  - Etc.

Advanced Design

Visual Display

Controller

Replace tedious, slow and high visual workload demand from on-screen window-based control format with a simple game controller…

Significant Accomplishments

- **Accomplishments:**
  - Advanced MOCU HCI software modules demonstrated September 2010.
  - Developed initial game controller mapping to USV manual control actions.
  - Developed Visual Detection model for scanning for obstacles on horizon in USV cameras. Will be used to guide alert timing in MOCU design.
- **Product:**
  - Demonstrated for the first time the new integrated multi-robot operator control unit software - core controller for LCS Mine Warfare and Anti Submarine Warfare Mission Modules - using a live unmanned surface vehicle on Mission Bay, CA off Ballast Point.
    - This critical milestone successfully demonstrated that ONR's software architecture will allow a single LCS Organic Offboard Vehicle Operator to safely and efficiently control two semi-autonomous unmanned surface vehicles with integrated sensor packages.

Revolutionary Research . . . Relevant Results

CMP-FY08-05 Strategy for Our People

William “Kip” Krebs, Ph.D.

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Navy Manpower and Personnel Modeling, Simulation, and Optimization Tools

Product Description:

Integrated decision support analytical tools to assist military community managers to forecast and assess the effects of enlisted and officer behavior (e.g., recruitment, retention, career decisions, education benefits, etc.) resulting from both proposed and current Navy policy decisions.

TRL at Start: 3; TRL at Transition: 6

Planned Demos/Deliverables/Transitions:

- 2010 – System architecture design, architecture, requirements analysis
- 2010 – Continuation forecasting models
- 2010/2011 – Algorithm and agent development
- 2011 – Reclassification predictive model; LCS training methodology alternatives
- 2012 – Algorithm and agent integration into software architecture
- 2012 – LCS crew selection/composition models; CBT curricula alternatives; non-cognitive profiles of performance predictors to inform classification
- FY13 – Transition to BUPERS-3

Warfighting Payoff:

In support of *Strategy for Our People 2016*, the suite of decision support analytical tools will meet the CNO and SECNAV goal of creating a more agile, competency-based workforce that integrates the total force and adopts personnel policies to make the Navy competitive in the marketplace. The modeling tools will support policy, strategy, planning, and programming decisions. Modeling and analysis results will enable leadership to make strategic, policy and investment decisions, and identify and close gaps identified by forecast demand signals.

Navy Manpower and Personnel Modeling, Simulation, and Optimization Tools

Technology Efforts Leveraged for this product

D&I: Navy population cluster sampling algorithms for collecting attitudinal data for community management model validation and continuation forecasting.

SBIR: Agent-based modeling and simulation environment to simulate the effects of personnel policy changes.

STTR: Methodology for finding efficient solutions to general, large mixed-integer problems enabling large-scale end strength planning and community management modeling.

World Class Models: Agent-based simulation toolset allows Navy decision makers to run what-if scenarios to forecast the impact of their tactical and strategic initiatives at a high level of detail and accuracy.

Revolutionary Research . . . Relevant Results

CMP-FY08-06 Training & Assessment for Expeditionary Warfare

Roy Stripling, Ph.D.

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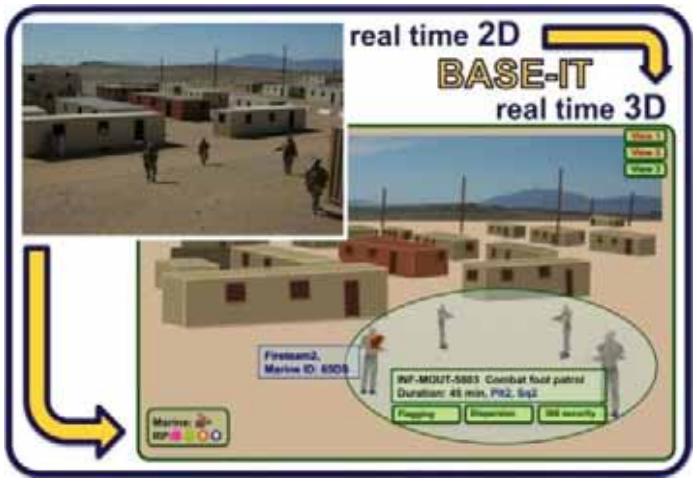
Behavioral Analysis and Synthesis for Intelligent Training (BASE-IT)

Product Description:

Integrated system for instrumented ranges for Full Spectrum Operations in Urban Terrain, with support for:

- Wide area sensor tracking system and camera management.
- Real time automatic ingesting of 3D data
- Automated behavior analysis and performance evaluation
- 2 ½ D and 3D visual exploration of recorded events. 3D visualization includes examination of 'what-if' scenarios.
- Library of training scenarios

TRL at Start: 4
TRL at Transition: 6



Planned Demos/Deliverables/Transitions:

Demos: Q4 '08, Q4 '09 and Q4 '10

Deliverables:

- 3D Marine Position and Posture
- Behavior analysis and performance evaluation
- Behavior synthesis ('what-if' scenarios) : Planning Tool
- Advanced field-deployable display platforms
- 2 ½ D and 3D visualization systems
- Transition customers:
  - USMC PM TRASYS
  - USMC TECOM

Warfighting Payoff:

1. Amplified and extrapolated training value of physical training range – new training opportunities for time before and after.
2. Amplified effectiveness of After Action Review given to the unit.
3. Enabled paths for USMC-wide benefits: automated analysis of historical data and trends.

- Increase unit preparation for training in physical ranges (50%)
- Increase unit performance in physical ranges (50%)
- Decrease in skill decay (50%)
- Increase in range operational efficiency (60%)

Behavioral Analysis and Synthesis for Intelligent Training (BASE-IT)

Technology Efforts Leveraged for this product

ONR:

- VIRtual Training and Environments – VIRTE project
- Video FlashLight project.
- APELL 2G project.
- Wide Area Visuals for a Simulator in a Box, and Front-Projective Display for Virtual Environments projects. (additional funding: DARPA)
- Computing for Real World Acquisition, Display and Immersive Training project.

DoD:

- DELTA3D open source game engine.
- Various Soldier Modeling projects.
- Tactical Video Capture System – TVCS.
- Instrumented - Tactical Simulation Engagement System (I-TESS)
- ActVision
- Deployable Intelligent Projection Systems for Training project.
- Technology for Full-Body Tracking project.
- 3D Content Extraction from Video Streams project.

Other:

- Label Me, open annotation tool.
- Office of the Future project.

BASE-IT

Prototype development efforts:

multi-camera synchronized video capture system; multi-sensor data capture system; 2 ½ visualization system; 3D visualization system; urban warfare planning tool; intelligent training system; multi-projector physical-virtual sand table display;

Applied research efforts:

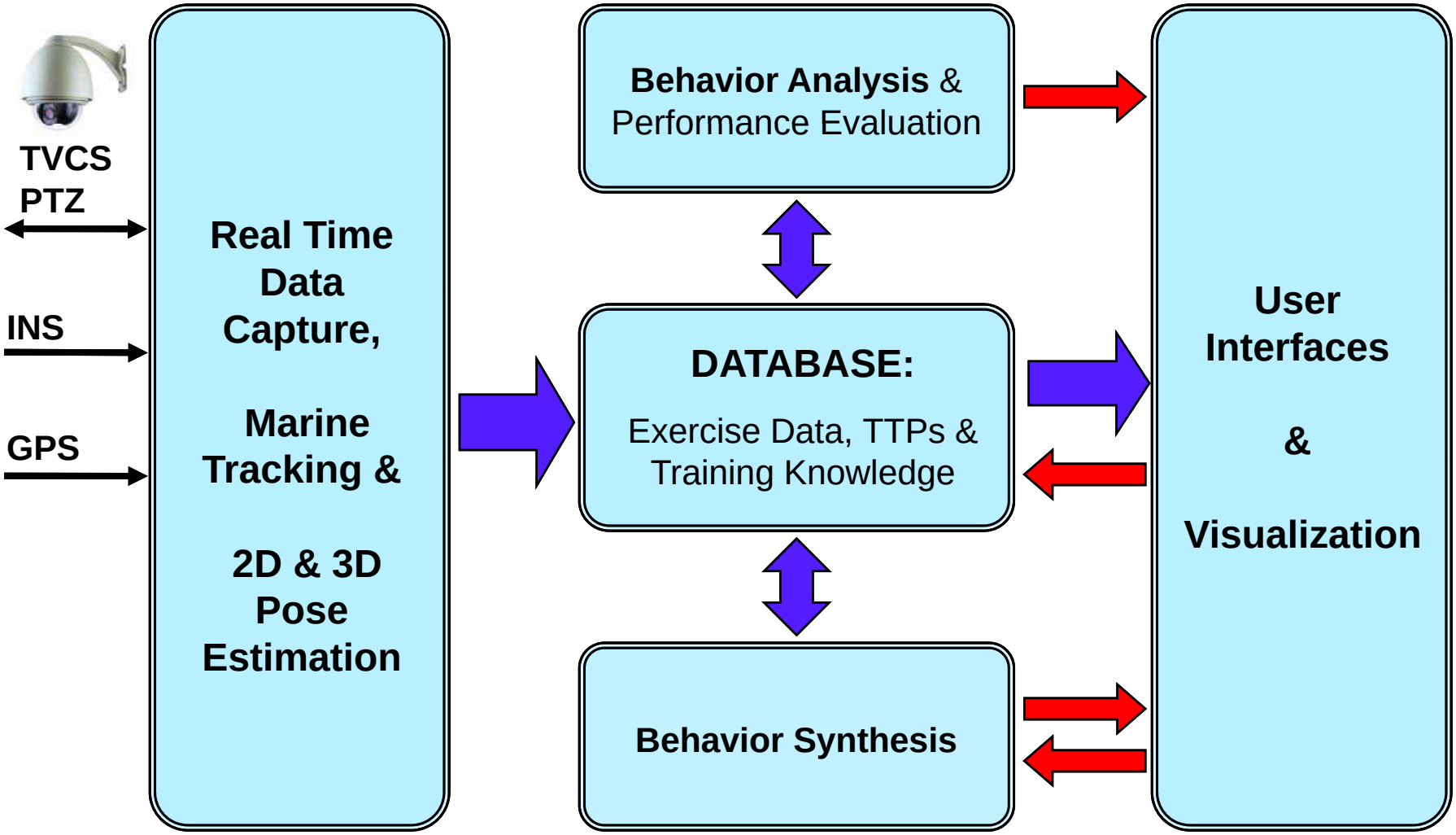
domain analysis (urban warfare training); user validation studies; fitting skeletons to volumetric human data; recognition of human/Marine postures, head, torso and weapon orientation from 2D images; automatically recognition of events and actions within a finite-state machine framework; adaptive state-guided performance evaluation; blending of multi-projector imagery on height field surfaces;

Basic research efforts:

markerless motion capture; continuous automatic multi-projector calibration; multi-sensor fusion (fusing video and GPS); global and procedural performance metrics for individual and group behaviors; human behavior modeling;

Behavioral Analysis and Synthesis for Intelligent Training (BASE-IT)

System Diagram



Data flow

Control signals, alerts & queries

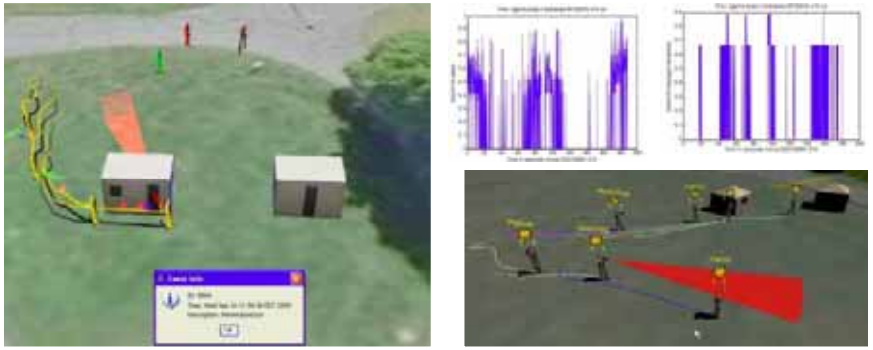
Behavioral Analysis and Synthesis for Intelligent Training (BASE-IT)

Project Accomplishments

Multi-sensor data acquisition system for multiple cameras, GPS and IMU. Video and GPS based accurate Marine position and pose tracking. Automated Active Camera Tracking of multiple objects in a wide area, Multi-camera control and Multi-view Fusion.

Intelligent training system that integrates visualization of ground sensors on a site model with symbolic activity and event view.

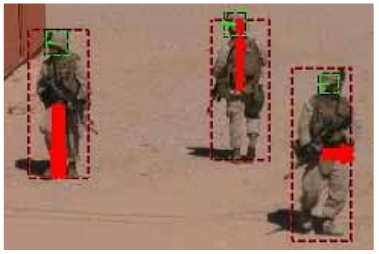
→ Exhibited in USMC/PM TRASYS booth, I/ITSEC 2009



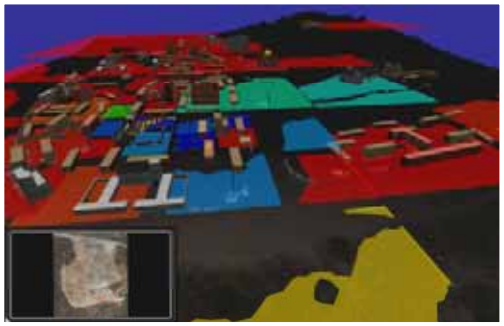
Automated behavior analysis and automated state-driven individual and team performance evaluation in complex scenarios.

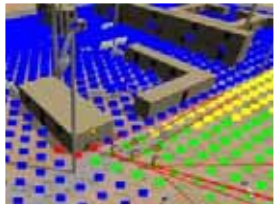
Behavioral Analysis and Synthesis for Intelligent Training (BASE-IT)

Project Accomplishments



Automated recognition of human (Marine) postures, head, torso and weapon orientation from 2D images.





Human (unit) behavior models: Designed and implemented models for fire team movement, cover avoidance, dynamic threat location model and overwatch sector analysis, scaling to Kilo 2 range. First detailed sim model of unseen threats, and first credible visual search model

→Best paper award, AIIDE 2010 (C. Darken, D. McCue, M. Guerrero)

→Exhibited in USMC/PM TRASYS booth, I/ITSEC 2009

Domain analysis and user/SME validation of visual simulation of small unit behavior.

→ Best paper nomination, I/ITSEC 2010 (A. Sadagic)

Behavioral Analysis and Synthesis for Intelligent Training (BASE-IT)

Project Accomplishments

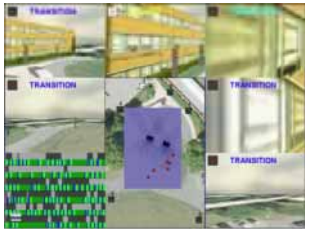
New methods for Continuous Cooperative Calibration in Multi-Projector Displays (IPU). Proof-of-concept prototype handheld system for Coyotes.

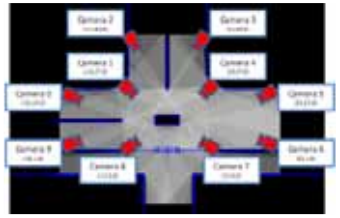
→IPU: Leverage / transition with SBIR (Renaissance Sciences Corporation)

Prototype of a Projector-based Physical Sand Table for Mission Planning and After Action Review.

→Second copy of the sand table built for NPS

→Exhibited in USMC/PM TRASYS booth, I/ITSEC 2009





Markerless, Semi-automatic 3D posture-from-video pipeline (3D posture extraction) for multiple individuals, from multiple outdoor video streams. Developed and simulated an approach/algorithm for optimal camera control (many pan-tilt-zoom cameras capturing many moving targets over a wide area

Next Generation Expeditionary Warfare Intelligent Training (NEW-IT)

Product Description:

NEW-IT supports Enhanced Operations by addressing the need for "skilled instruction" during simulation based training. NEW-IT is delivering a prototype *Instructional Support System (ISS)* driven by empirically evaluated instructional theories and methodologies, to help improve training and reduce the risk of the acquisition Program of Record (POR). Prototypes integrated w/ USMC's Deployable Virtual Training Environment:

- Adaptive Instructional Support System (ISS)
- Science of Learning & Impact Assessment

TRL at Start: 3; TRL at Transition: 6

Pictured: A Marine works with the NEW-IT software

Planned Demos/Deliverables/Transitions:

- v1.0 – (Released 3/09; v0.5 Released 9/08); v1.0 test at EPME
- v2.0 – (Planned 3/10; v1.5 Released 9/09); v1.5 test at II MEF
- v3.0 – (Final Transition Planned 9/11); TEE in development
- Continual publications in scientific community via journals, books, conferences, and dissertations

Transition

- USMC Ground Combat Supporting Arms Systems- Deployable Virtual Training Environment; PE 0206623M
- Level-A TTA signed June 2009

Secondary Transition

- FITE JCTD and the Pendleton IIT have already integrated the NEW-IT software into their systems.

Warfighter Payoff:

↑ Operational Effectiveness ↑ Instructional Effectiveness

By building automated, intelligent instructional and learning strategies into systems, scenario-based training will be more efficient, the workload on instructors will be reduced, and more training time will be applied to effective training activities.

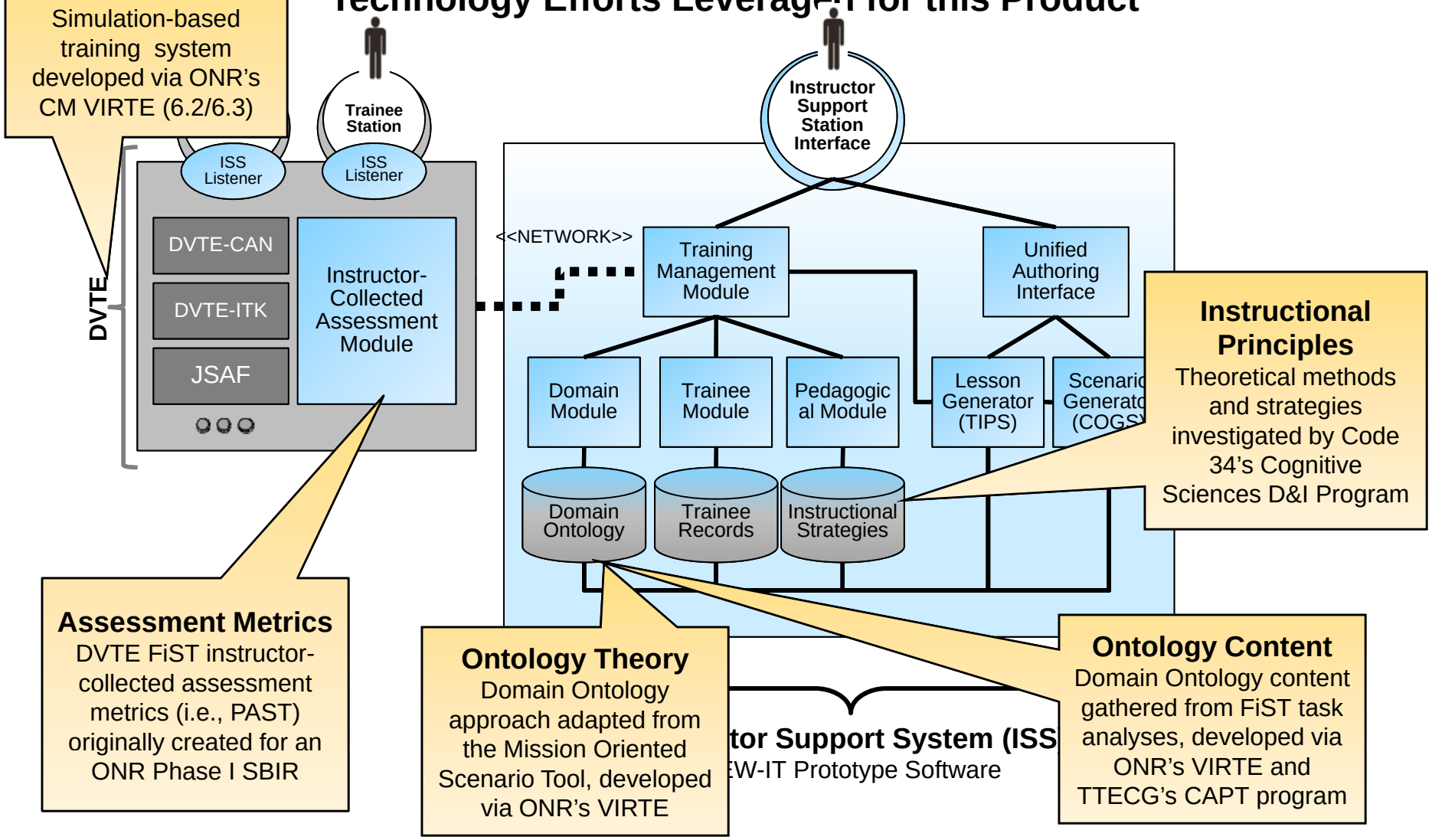
- 30% decrease in the time to setup a training operation
- 80% of users are able to identify a scenario that matches targeted Training & Readiness (T&R) objectives

Assessment to Date (Evaluated with ISS V1.0, Aug 2009)

- **25%** improvement in Instructor Performance (i.e., efficiency)
- **71%** improvement in Instructional Quality (i.e., effectiveness)

Next Generation Expeditionary Warfare Intelligent Training (NEW-IT)

Technology Efforts Leveraged for this Product



Above: High-level diagram of the NEW-IT architecture

Next Generation Expeditionary Warfare Intelligent Training (NEW-IT)

Transition Alignment

Official Transition Path
(Level-A TTA signed June 2009)

Instructional Support System (ISS)

NEW-IT's main prototype software: Instructional Support System (ISS). Version 1.5 released (9/09). Final version (V3.0) will be released 9/11.

DVTE – Release 1.0.1.0

Ongoing interim demos and testing with Marines (e.g., at EPME [7/09] and II MEF Sim Center [10/09]). Final TEE planned for FY11.

DVTE – Release 1.3.x.x

Final release of the ISS (V3.0) will be integrated with DVTE Release 1.3.x.x. Transition will be facilitated via PMTRASYS. Final delivery of ISS: FY11.

IIT

NEW-IT ISS software already in use at Pendleton to help manage the Infantry Immersive Trainer

Additional NEW-IT use expected for future SITE POR

FITE JCTD

NEW-IT ISS software already in use with FITE JCTD; used in rehearsal (10/09) and Spiral 1 demo (12/09) and Op Demos 2A (10/10) & 2B (11/10)

Increased NEW-IT use anticipated for FITE JCTD Spiral 2

Dual Use Transitions

Next Generation Expeditionary Warfare Intelligent Training (NEW-IT)

Science to Date: Impact to the Fleet

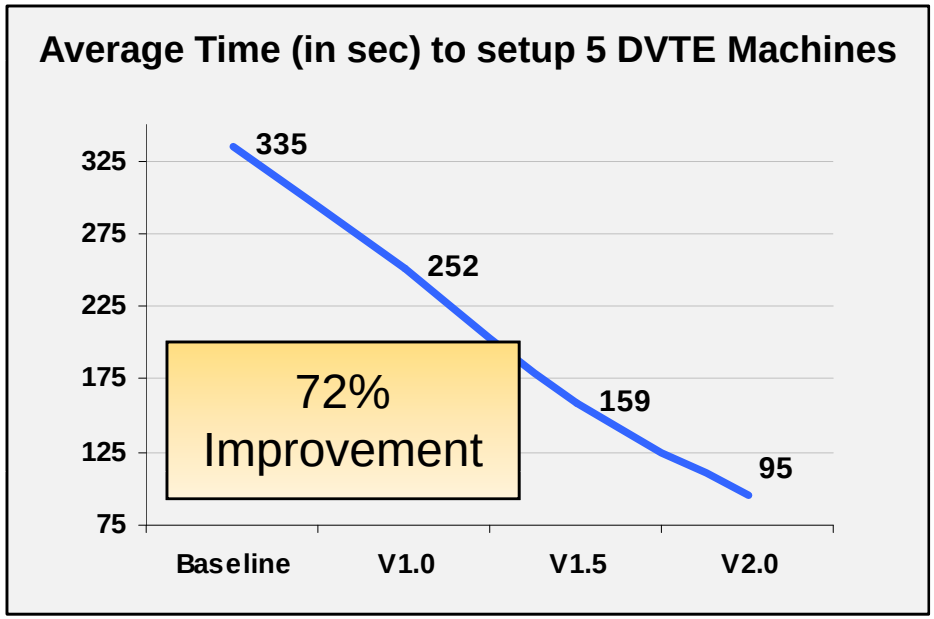
Operational Evaluation of TTA Metrics
Outcomes results from evaluation of ISS V2.0

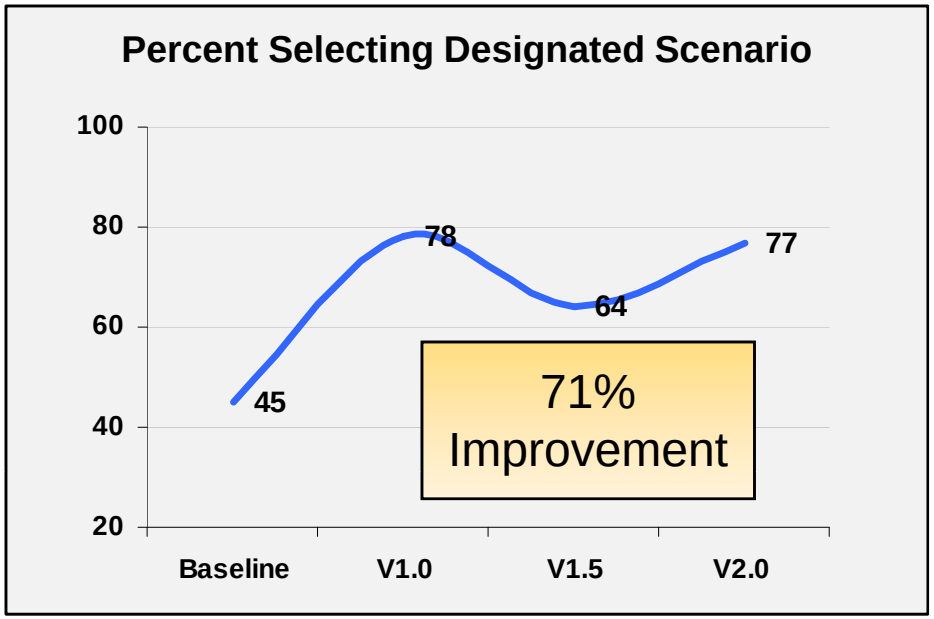
(1) Instructor Performance (efficiency)

Enhance facilitator performance: To date, 72% improvement has been found in this objective area when using ISS V2.0 (25% improvement using V1.0) versus using DVTE alone. Metric: Time to setup training operation (scenario) TTA Goal: 30%

(2) Instructional Quality (effectiveness)

Enhance instructional quality: To date, 71% improvement has been found in this objective area when using ISS V2.0 versus using DVTE alone. Metric: Selection of target scenario matching a training objective TTA Goal: 80%





Next Generation Expeditionary Warfare Intelligent Training (NEW-IT)

Science to Date: Impact to the Body of Research

Academic Products and Extension to the Science

(In addition to meeting operational needs, NEW-IT seeks to address longer-term S&T goals.)

S&T FOCUS AREAS

Learning Science

1. Metacognition
2. Application of Instructional Strategies

OUTCOMES: Reports, Extension to Science, TIPS experimental lesson authoring software (integrated with ISS), "Devil Dog" paper-based materials for Marines

Computer Science

1. Auto Scenario Generation via FL-Systems
2. Inquiry Modeling via POMDPs

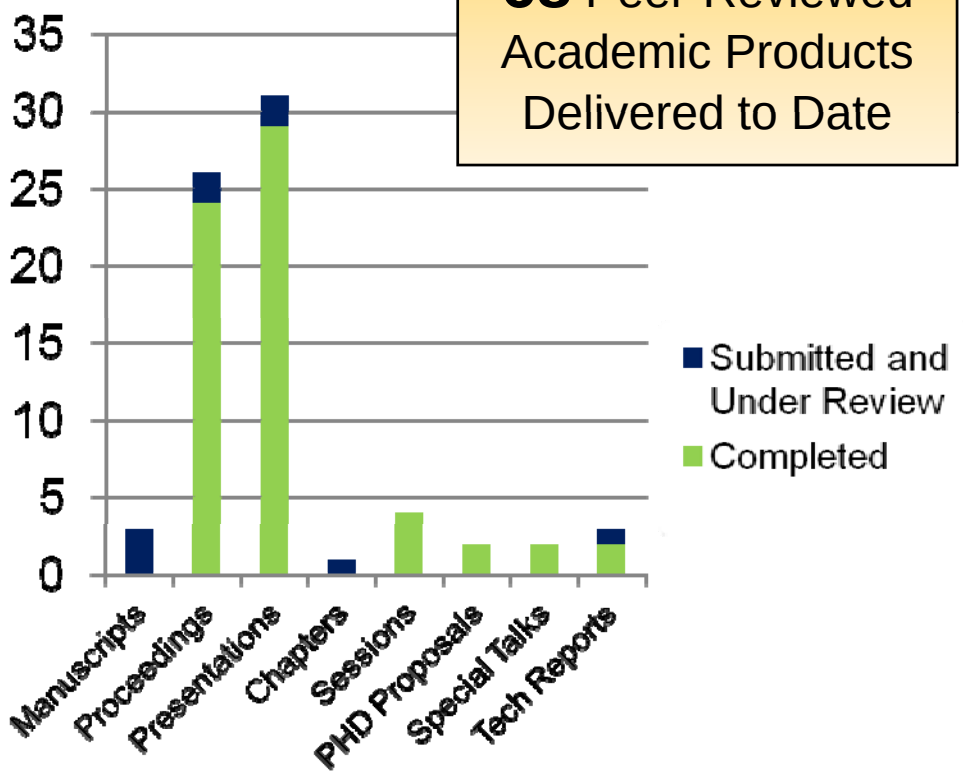
OUTCOMES: Reports, Extension to Science, COGS experimental scenario generation software (integrated with ISS); two PHD dissertations (one per topic)

Impact Assessment

1. Assessment Model for ONR S&T Lifecycles

OUTCOMES: Reports with specific recommendations for long-term product evaluation: From lab to theater…

68 Peer-Reviewed Academic Products Delivered to Date



Additional publications, including additional journal manuscripts, are in development or under review

Revolutionary Research . . . Relevant Results

CMP-FY10-01: Information Architecture for Improved Decision Making

William “Kip” Krebs, Ph.D.

william.krebs@navy.mil

Data Triage

Product Description:

Demonstrate advanced human-computer interface and team support tools to improve knowledge management across the CACC team. Reduce workload for menial tasks and shift decision focus to pro-active situational awareness and team assessments. Support seamless PBEA process workflow with continuous knowledge management across the entire mission cycle.

TRL at Start: 3; TRL at Transition: 6

Planned Demos/Transition:

- FY11 – Spatial Arrangement Studies
- FY12 – Usability Test of Decision Aid prototype
- FY13– Usability Test of Information Flow prototype
- FY14 – final transition of prototypes for VA Class Blk IV & ORP via APB and SWFTS processes

Warfighting Payoff:

- Improved situation awareness of mission goals and context
- Efficient assessment and sorting of mission priorities and team work allocation
- Efficient transition of information from planning to team discussion (briefing) through execution and after-action assessment

Data Triage

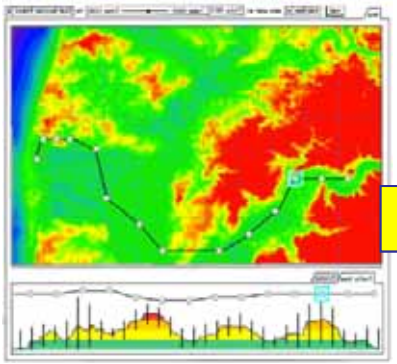
Technology Efforts Leveraged for this Product

ONR 6.2
Variable Coded Symbology (D&I)
Navy Adv Information Management Eval System (D&I)
Task Manager (D&I and FNC)
Dynamic Visual Linking (D&I)
Knowledge Web/Wall (D&I)
Combat Systems Supervisory Control (D&I)

ONR 6.3
Multi-Modal Watchstation (FNC)
Advanced Tomahawk HCI (FNC)
Mission Performance Optimization (FNC)

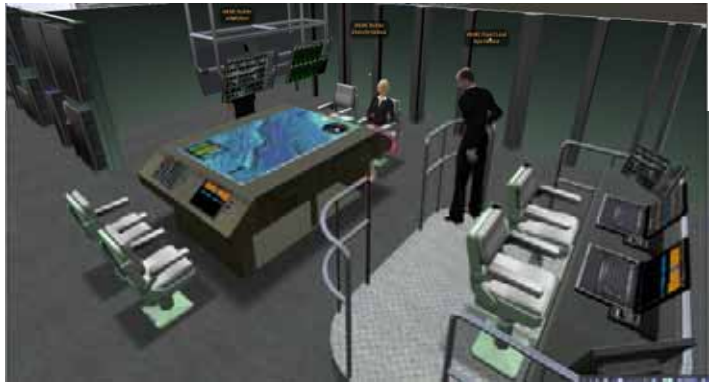
SBIRs
MARS Consortium Phase 3
Mikel Inc.
Asset Inc.
Rite Solutions Inc.

PMS-425 C2 Arrangements Study and Experimentation (CASEX)
December 2010 Event
June 2011 Event



Virginia Class Block V
Ohio Replacement Program

Command & Control Center Information Architecture Concepts



C2 Center of the Future….

Virginia Block IV and Ohio Replacement Partnership

C2 Center Spatial Arrangements Effort

Oct. 2010, Dec. 2010, April 2011 Workshops; CASEX in June 2011

Fleet-Driven, Participatory Design Process to explore Spatial Arrangement Alternatives for VA Blk IV and Ohio Replacement Control Centers

- Current spatial layout problems impacting information flow were identified by the Fleet (and assisted by SMEs)
- New design ideas proposed by Fleet teams to mitigate current problems (The design process was facilitated by virtual visualization)
- Low fidelity mock-up allowed Fleet team to physically walk-through a new control room configuration
- Electric Boat verified (using CATIA) that a given design would fit within the CAC footprint

Information Architecture for Improved Decision Making

CMP-FY10-01
ONR Capable Manpower Future Naval Capability

Rapid Prototyping of Spatial Arrangement Design Concepts for the Virginia Class Block IV Submarine Command and Control Center

FY2011Q1

November 15, 2010

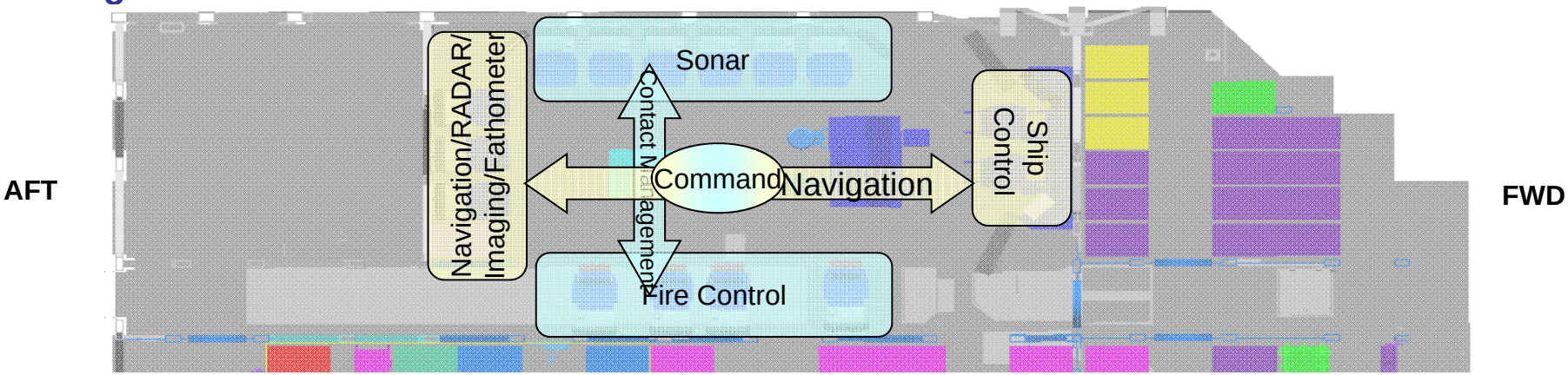
Spatial Arrangement Study Report to Electric Boat, PMS-450, PMS-425, and PMS-397 for March 2011 input

Example VA Blk III Alternative Design -- STs and FTs Co-Located --

Significant Accomplishments

C2 Center (CACC) Spatial Arrangements Study

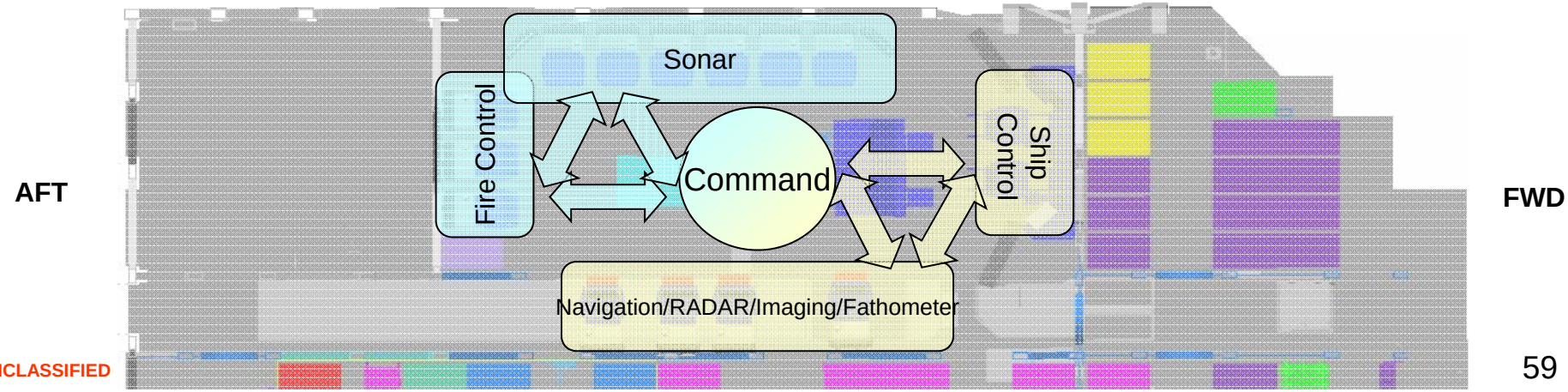
Existing VA BLK III Control Room



- Officer of the Deck has access all necessary information.
- Sonar and Fire Control have headset communications across CACC
- Contact Manager moves between Sonar and Fire Control
- Pilots have noted that it is sometimes hard to hear OOD and often hard to hear others in CACC

Fleet Concept for VA BLK IV Control Room

- Centralizing like functions improves working level Communications
- Officer of the Deck still has access to all necessary information.



Display Information with Uncertainty

Product Description:

Improve operational decision making by linking 'Data Triage' architecture simulation with realistic data sources, thereby facilitating the analysis and assessment of human operator performance for different information architecture concepts and against existing baseline performance.

TRL at Start: 3; TRL at Transition: 6

Planned Demos/Transition:

- FY11 – Proof of Concept demonstration of modeling and automated assessment of operator performance in real-time.
- FY11 – Test Mission Effectiveness Measures in Center Arrangements Study & Experimentation (CASEX).
- FY12– Test Information Flow prototype in CASEX.
- FY13– Test Knowledge Mgmt prototype in CASEX.
- Final Transition FY14 for VA Class Blk V & ORP

Warfighting Payoff:

- Information will flow at the right time to support decision making
- Sensor information will be integrated in a way that allows understanding of the raw data behind the aggregated data, yet also presents a comprehensive picture of reality
- Information sources, with their different modalities, time constants, and update rates will be brought together for the operator rather than by the operator

Display Information with Uncertainty

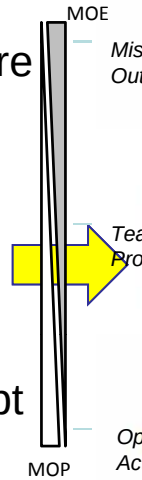
Technology Efforts Leveraged for this Product

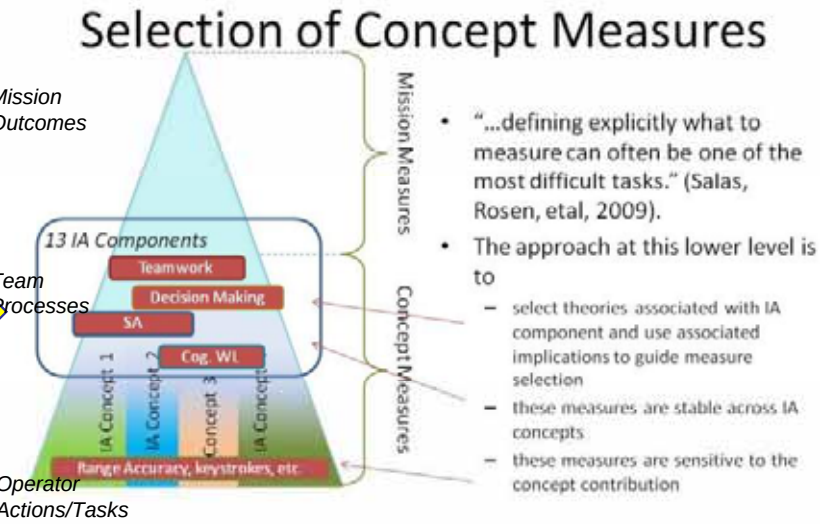
- D&I
  - TADMUS (Tactical Decision Making Under Stress)
  - Human Performance Measurement in Complex Environments
  - Response Plan Manager
  - Trainable Automated Forces
  - Basis for Assessment & Declutter
  - Cognitive Assessment and Task Management (CAT-M)
  - Command 21
  - Perspective View Comprehension
  - Unmanned Aerial Vehicle Visualization of Path Planning
- FNC
  - Knowledge Web Technologies
  - Exceptional Expertise for Submarine Command Decision Making
  - Automated Assessment and After Action Review
- DARPA
  - Neural Dynamics of Effective Team Performance
  - Improving Warfighter Information Intake Under Stress
  - Command Post of the Future
- SBIR
  - NAVSEA Combat System of the Future

Significant Accomplishments

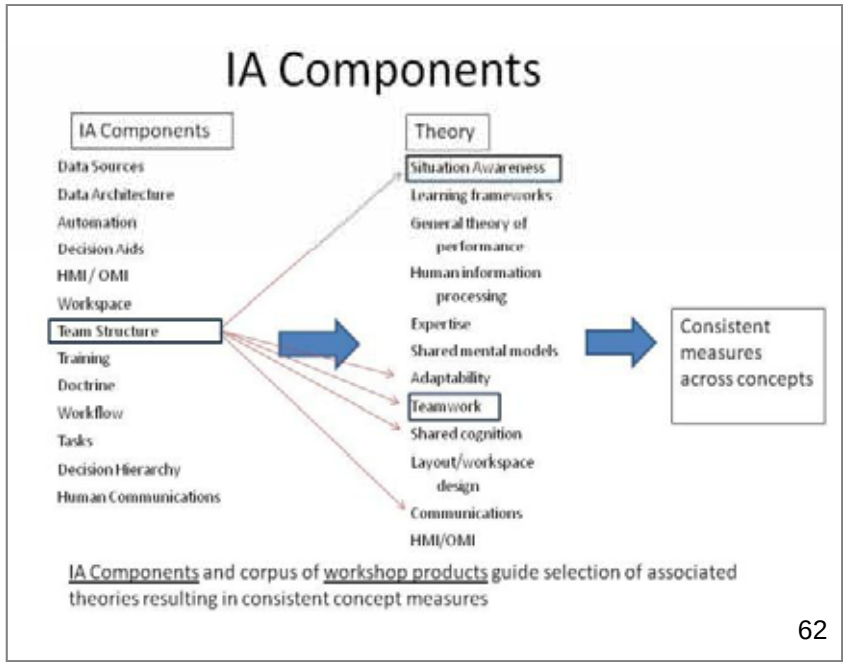
Performance Measurement Development

- a framework and strategy for guiding measure development
- mission measures tested Dec 2010 CASEX
  - approximately 250 mission outcome measures developed for PD-ISR mission area using fleet operational SME's
- selection of measures to demonstrate concept contributions in early development





- initial development of human behavioral measures will focus on Information Architecture components – in areas including Teamwork, Communication, Decision Making and Situational Awareness.
  - these measures are stable and consistent and will illustrate concept contributions and their impact to command decision making and tie back to mission outcome measures



Significant Accomplishments

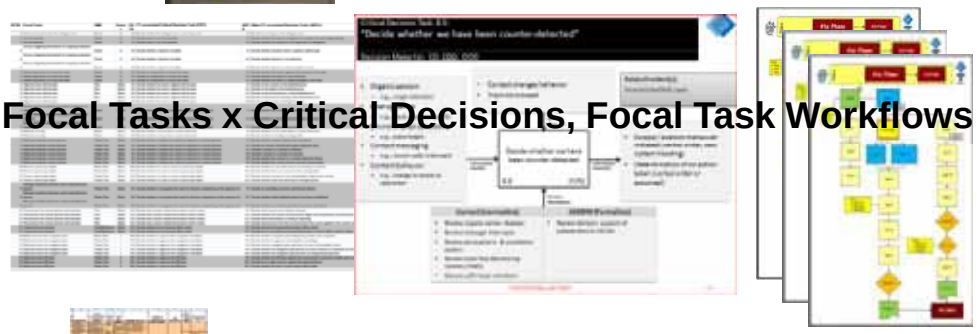
CACC of the Future Information Architecture Components

- Agile Analysis with SMEs
- Identified Critical Decision Task (CDT) workflows, 16 CDTs

- Developed Future Block V CACC Design Concept Ideas.
- Captured design ideas within "Design Illustrations".
- Selected concepts to illustrate critical Information Architecture design features in FY11 IA model.

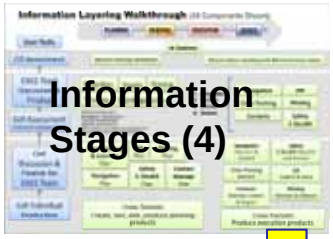
- Developed Design Human-Interfaces
- Conducted SME Cognitive Walkthrough
- Revised and improved designs.
- Selected key focal tasks, decisions and designs for PBEA x IA layers for further laboratory implementation.

Task Flows, Focal Tasks, Preliminary Design Illustrations



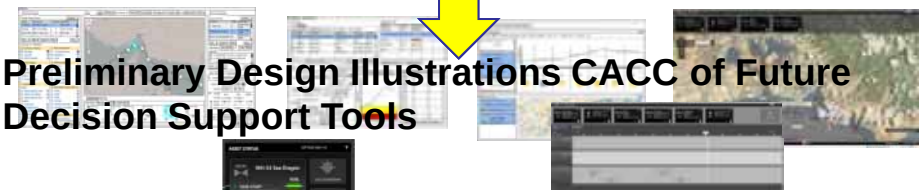
Focal Tasks x Critical Decisions, Focal Task Workflows

Candidate DI List



Information Stages (4)

Information Layers (3)



Preliminary Design Illustrations CACC of Future Decision Support Tools

Selected Tasks for FY11: ISR Planning & Briefing, Transit Planning & Briefing, After-Action Assessment.

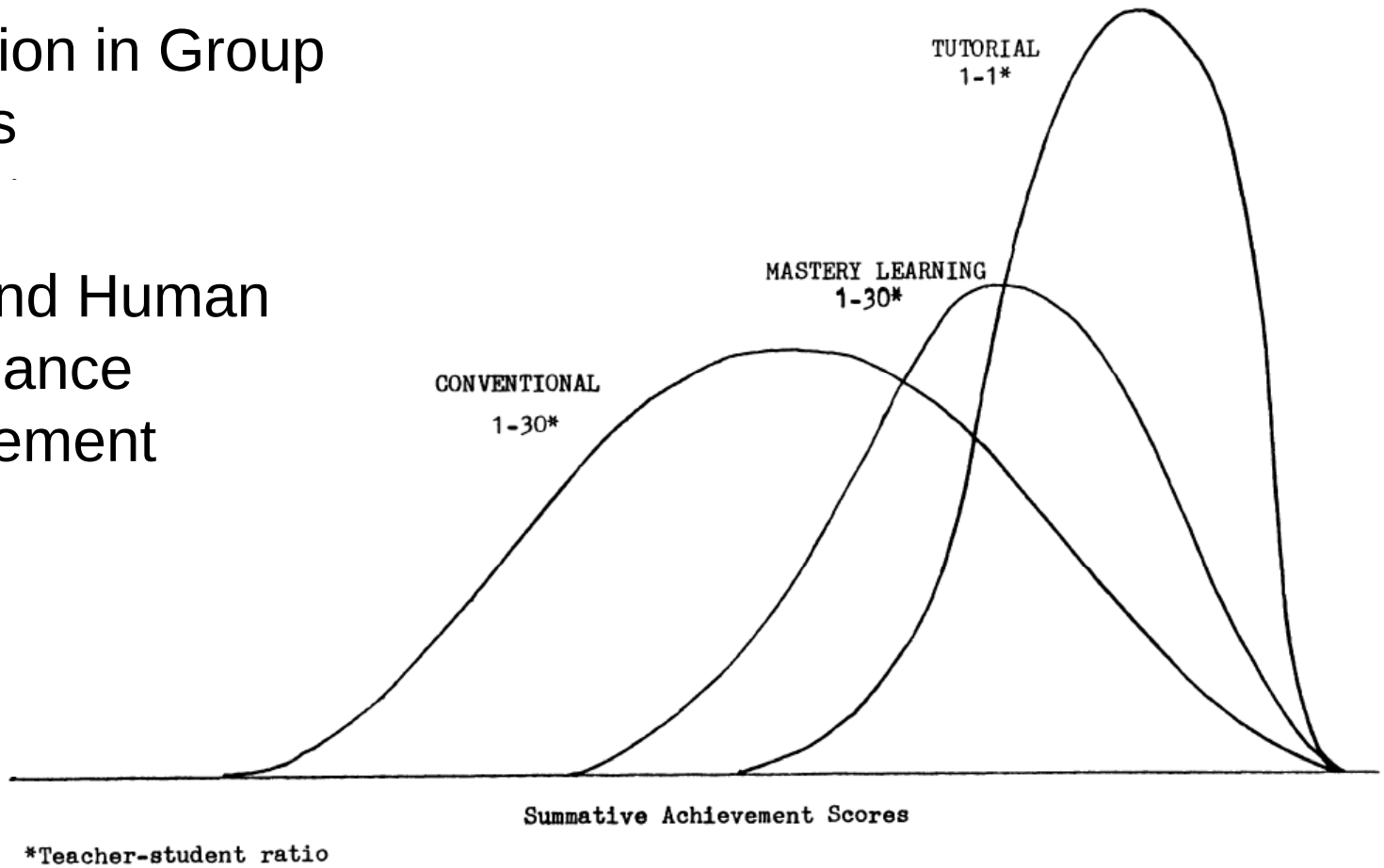
CMP-FY10-02 Adaptive Training to Enhance Individual and Team Learning and Performance

William “Kip” Krebs, Ph.D.

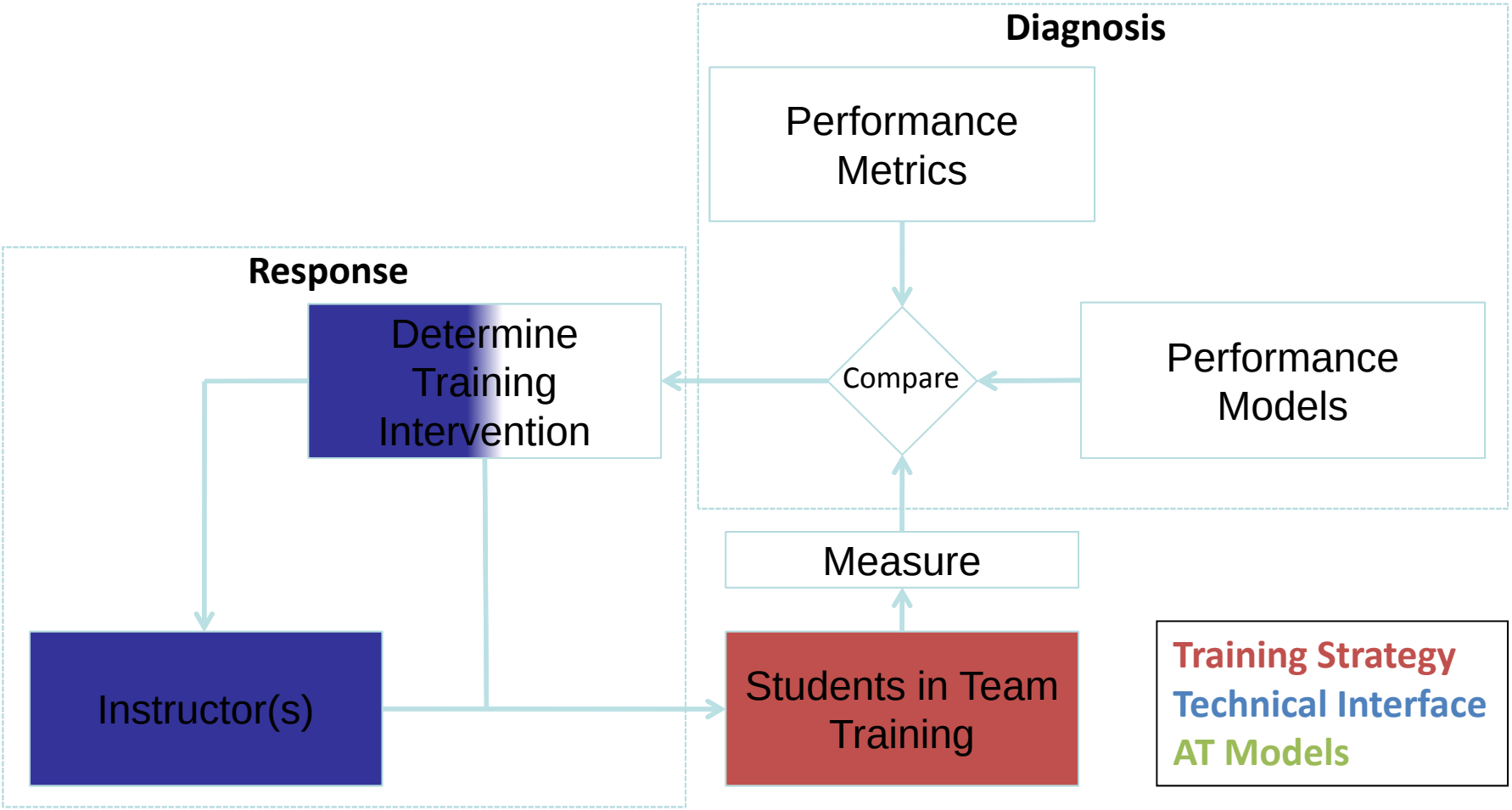
william.krebs@navy.mil

Adaptive Training

- Individualized Instruction in Group Settings
- Team and Human Performance Measurement



Adaptive Training Approach



Adaptive Training for Combat Information Center Teams

Product Description:

Develop, demonstrate and transition validated and effective adaptive training methods, processes and software components to enhance shore-based LCS CIC individual and team training.

TRL at Start: 3; TRL at Transition: 6

Bayesian network

Planned Demos/Transitions:

•Acquisition Organization: Littoral Combat Ship (PMS 501); OPNAV N86

•Individual TAO Adaptive Training Prototype Demo (FY11)

•TAO/CO Team Advanced Technology Demo (FY12)

•CIC Team Advanced Technology Demo (FY13)

•CIC Blueprint/Architecture for Final Transition (FY 13)

•Final Transition: SWOS, CSCS, LCS SBTF (FY14)

Warfighting Payoff:

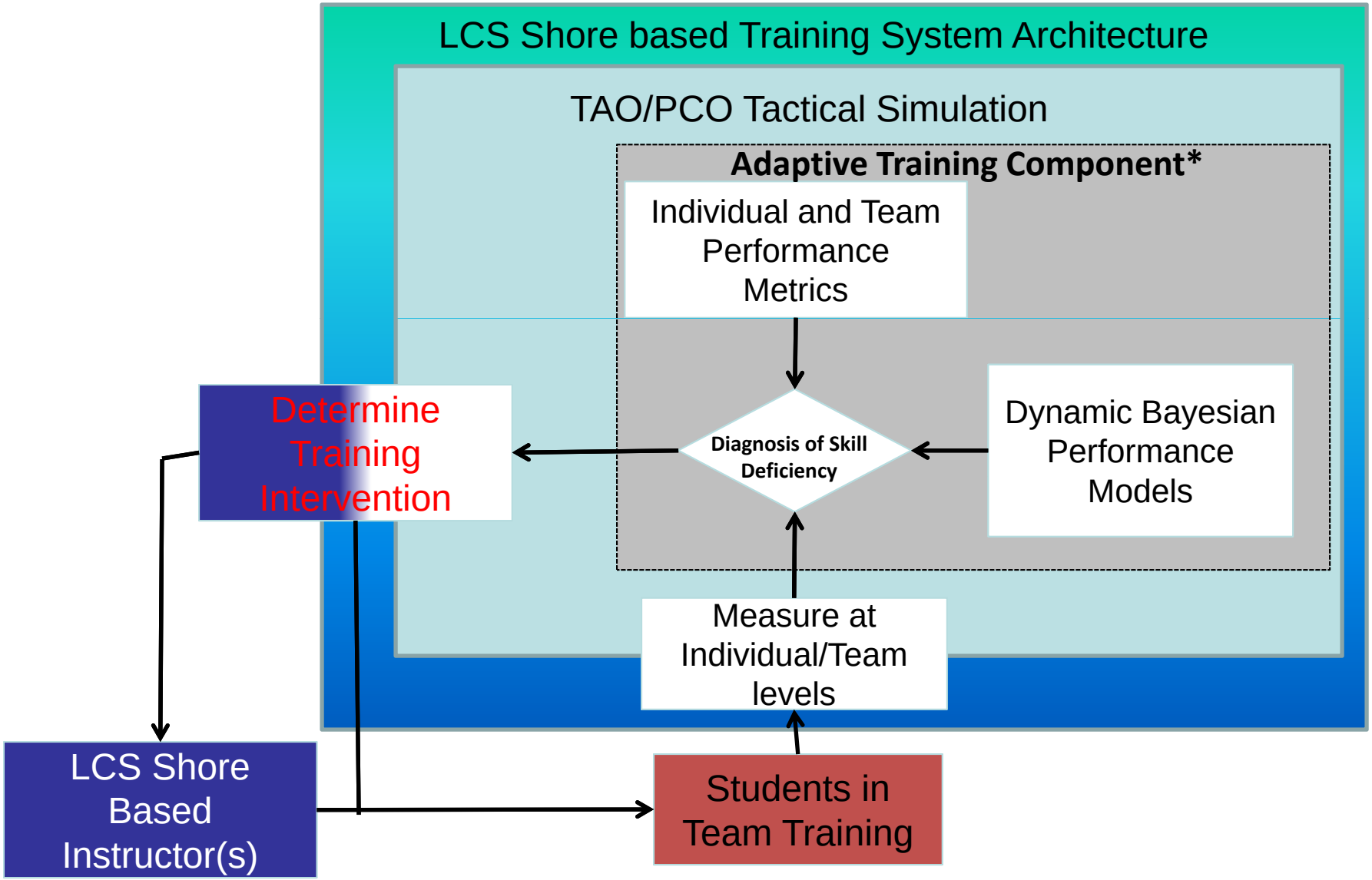
- Warfighters report aboard LCS ready for combat operations (T2Q/T2C)
- Tailored training, assessment , and remediation resulting faster acquisition of skills and higher levels of individual and team proficiency (“adaptive skills”).
- Reduction of instructor workload allowing focus on individual training deficiencies.

Adaptive Training for CIC Teams

Technology Efforts Leveraged for this Product

- Office of Naval Research Investments
  - Training Models and Tools for Adaptive Learning
  - Advanced Interface Design and Training Capability
  - Manning Affordability Initiative (MAI)
  - Tactical Decision Making Under Stress (TADMUS)
  - Advanced Embedded Training (AET)
  - Observational Skills Enhancement and Retainment Virtual Environment (ObSERVE)
- Department of Education Investments (CRESST)
- Other Efforts
  - Science, Technology, Engineering & Math (STEM) Transitions (in process)
  - Gates Foundation
  - University of Pittsburgh's Decision Systems Laboratory: GeNIe and SMILE for ontology creation
  - Mathworks MATLAB for Bayes Net implementation (static and dynamic)

ATCIC Proposed Architecture

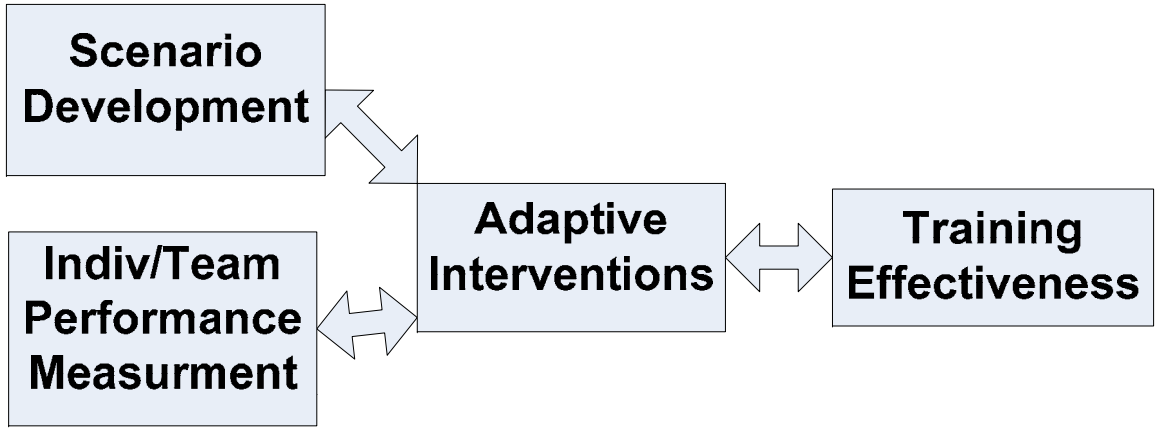


*Adaptive component as a plug-in to TAO/PCO simulation

Significant Accomplishments

- Developed prototype ontology and Bayes Net for ASW mission
- Ship, ATG, and TACTRAGRU Pacific interviews (COs, XOs, TAOs, Warfare Coordinators)
    - Determined how the Fleet currently measures training proficiency
- Coordinating with stakeholders
    - N86, SEA 21, LCS, SWOS, CSCS, LCS Training System Executive Agent (TSEA)
- Strong SWOS endorsement
- Initial analysis of interaction issues with seaframe/mission package teams

ATCIC S&T Thrusts



Development Goals	Develop task ontologies and Dynamic Bayesian network models	Specify scenario pace & complexity, type of feedback to trainee, types of cues to the instructor	Specify Individual and team performance measures; specify instructor workload measures	Develop prototype and perform iterative training effectiveness evaluations
TAO	FY 11	FY 11	FY 11	FY 11
TAO/CO Team	FY 12	FY 12	FY 12	FY 12
CI C Team	FY 13	FY 13	FY 13	FY 13
Final Transition	FY 14	FY 14	FY 14	FY 14

Adaptive Training for Submarine Navigation and Piloting

Product Description:

Develop and demonstrate validated, effective, adaptive training prototype systems to enhance individual and team training.

TRL at Start: 3; TRL at Transition: 6

Planned Demos/Transition:

- ATSNAP Proof of Concept Results (FY11)
- ATSNAP Periscope Testbed Demo (FY11)
- ATSNAP Standalone Trainer Demo (FY12)
- ATSNAP “Beta” Integration SBT (FY13)
- ATSNAP Blueprint (FY14)
- Final ATSNAP Integration to SBT (FY14)

Warfighting Payoff:

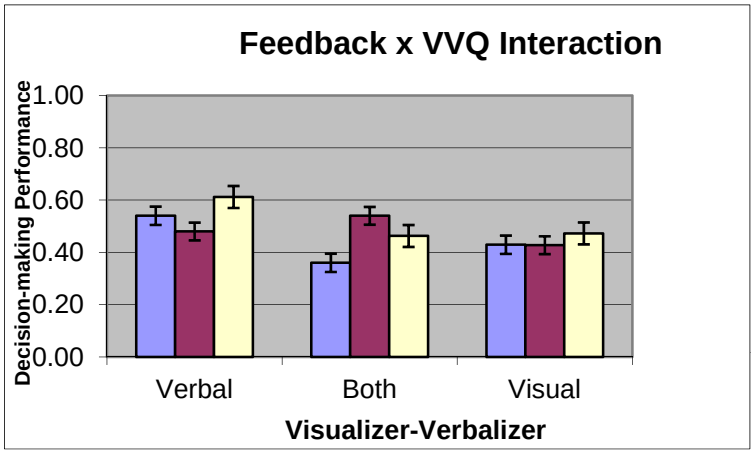
Reduce the risk of submarine collisions and groundings without increasing the number of instructors:

- Use of automated performance measurement to identify team weakness
- Individualized feedback to significantly improve team resiliency and performance

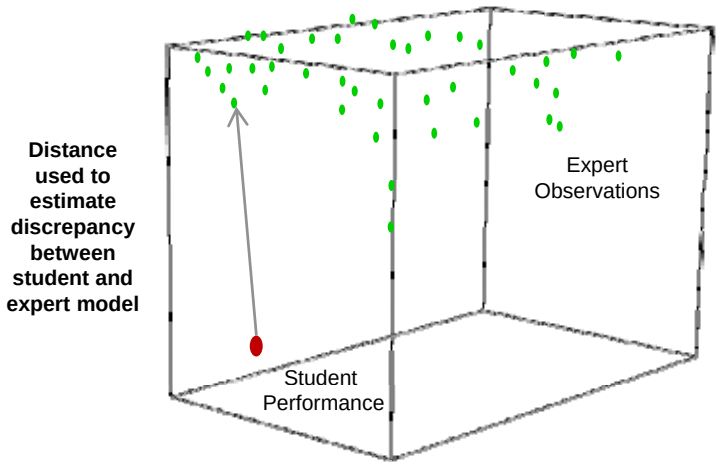
Adaptive Training for Submarine Navigation & Piloting Teams

Technology Efforts Leveraged for this Product

- ONR Discovery & Innovation Funds
  - Decision-Making Feedback and Individual Differences (NAVAIR)
  - Item Response Theory to Scenario-Based Training (NAVAIR)
- ONR Capable Manpower Future Capability Programs
  - FNC 08-03 Exceptional Expertise for Submarine Command Team Decision Making
  - FNC 10-01 Information Architecture for Improved Decision Making
- SBIR/STTR
  - STTR Phase I: Auto-Diagnostic Adaptive Precision Training for Decision-Making
- Other Agencies
  - Automated Expert Modeling for Automated Student Evaluation (DOE -Sandia National Labs)

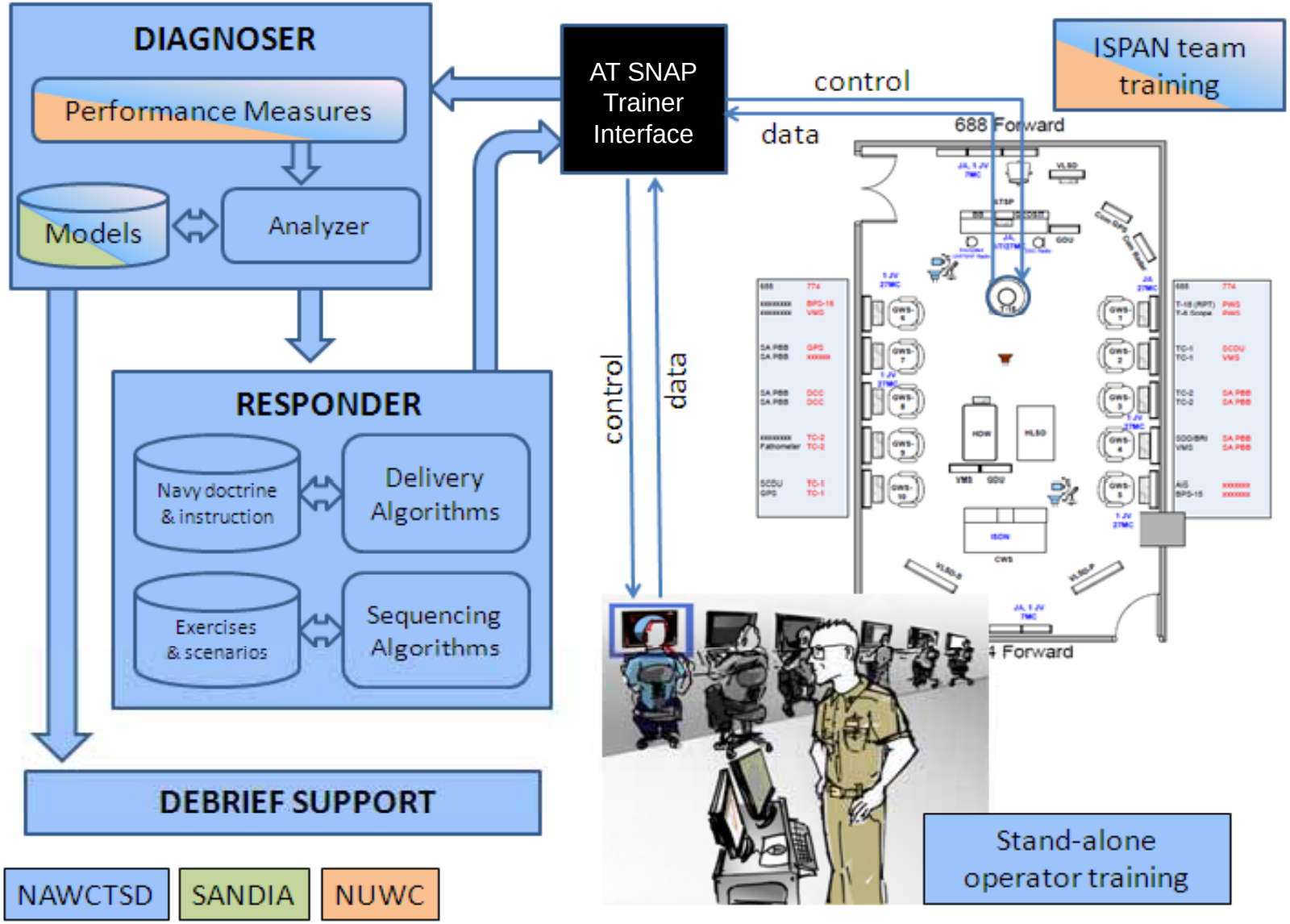


Decision-Making Feedback



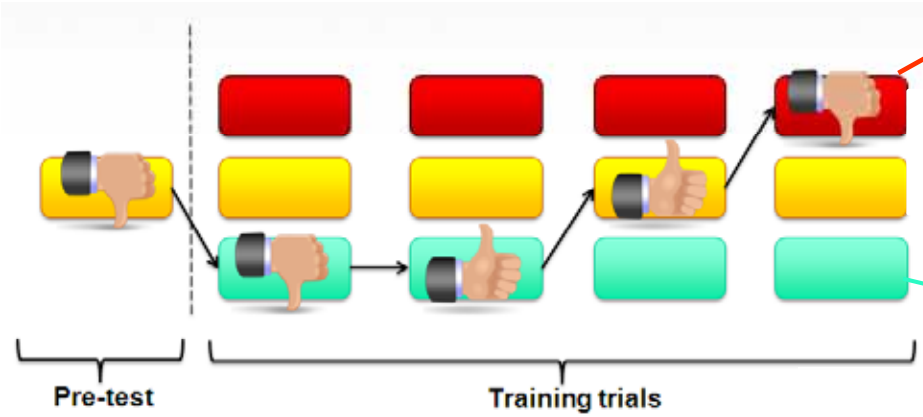
Automated Expert Modeling

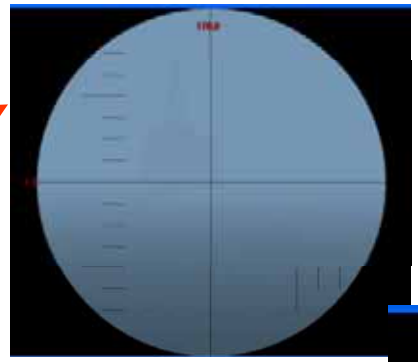
Technical Architecture



Significant Accomplishments

- Special report on the state-of-the-art in adaptive instructional approaches and technologies
  - 70 page report submitted to DTIC
- Developed a data logging sub-system to capture operator skills within SubSkillsNet
- Developed adaptive training framework for FY11 proof of concept experimentation





AT SNAP Development Strategy

Trainee	Trainer	Measurement	Explicit Performance	Implicit Performance	Individual Metrics	Team Metrics	Watch Section Metrics
Periscope Operator	Classroom	FY 11				----------	----------
Piloting Team	iSPAN	FY 12					----------
Maneuvering Watch	SBT	FY 13					

FY 14
Complete Integration into High Fidelity Training Environments

Operators Other Than Periscope Are Beyond AT SNAP Scope

Revolutionary Research . . . Relevant Results

CMP-FY11-01 Naval Next-generation Immersive Technology (N2IT)

Roy Stripling, Ph.D.

roy.stripling@navy.mil

Augmented Immersive Team Training (AITT)

Product Description:

Expand DoD virtual training architectures and enablers to allow training to take place in uncontrolled/uninstrumented facilities like barracks. It will allow Infantry Immersion Trainer-quality urban training at home station by using computer generated entities to replace Role Players

TRL at Start: 3, TRL at Transition: 6

Planned Demos/Deliverables:

- Phase 1- Prototype Demonstration - 4Q FY12
- Phase 2- Prototype Demonstration - 4Q FY13
- Phase 3- Prototype Demonstration - 4Q FY14
- Final Demo- Prototype Demonstration - 4Q FY15

Planned Transitions:

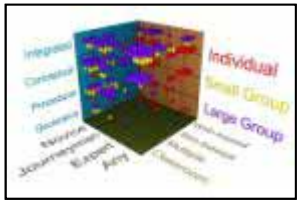
- PMTRASYS-Squad Immersive Training Environment (SITE)– 4Q FY13; 4Q FY15

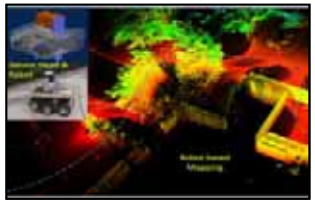
Warfighter Payoff:

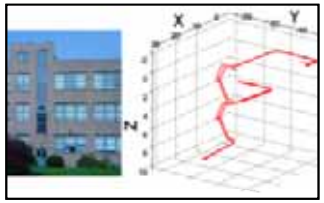
- Increased effectiveness of pre-deployment training, by providing enhanced and readily available training opportunities at home station
- Reduce cost of training by supporting in garrison training, and reducing the need for role-players and other contractors
- Enhanced sustainment of Pre-deployment Training Package (PTP) skills by providing enhanced and readily available training opportunities at home station and in deployment.

AITT

Technology Efforts Leveraged for this Product







Instructional Principles
Apply and advance foundational theories and strategies investigated by Code 34's Cognitive Sciences D&I, Capable Manpower's NEW-IT, and Code 30 HPT&E's APPLE programs.

48-Hour Terrain Model Generation
Advance semi-autonomous robotic platform with video and LIDAR mounted sensors to rapidly collect and integrate 3D model and landmark database of training area.
Prior work sponsored by ONR 30, FITE JCTD, and MCWL.

Video Odometry & Landmark Matching Tracking
Using Landmark database allows rapid matching to global simulation/AI model and incorporating a Kalman filter framework for estimating 6DOF head and weapon position & orientation estimation.
Prior work sponsored by ONR 30, FITE JCTD, and MCWL.

Object Occlusion Mapping
Advance multi - resolution stereo based depth estimation algorithms. Use computed depths and pre-built site models to do occlusion reasoning when rendering synthetic characters/objects.
Prior work sponsored by ONR 30, DARPA, and FITE JCTD.

Objective Team Performance Metrics
Build upon Code 30, BASE-IT (CM FNC) , FITE JCTD, and ongoing Infantry Immersion Trainer (IIT) efforts to develop objective individual and team performance metrics.

Existing Virtual Environments
Use current gaming Virtual Environments such as VBS2, RealWorld, DELTA 3D, and NEW-IT (CM FNC) to provide the virtual characters and effects. Prior work sponsored by PMTRASYS, DARPA, and PEO-STRI, and ONR.

Instructional Methodologies

Rapid Environment Model Generation

Wearable Tracking Technologies

Improved realism of real-time avatar rendering

Team Performance Assessment

System Integration

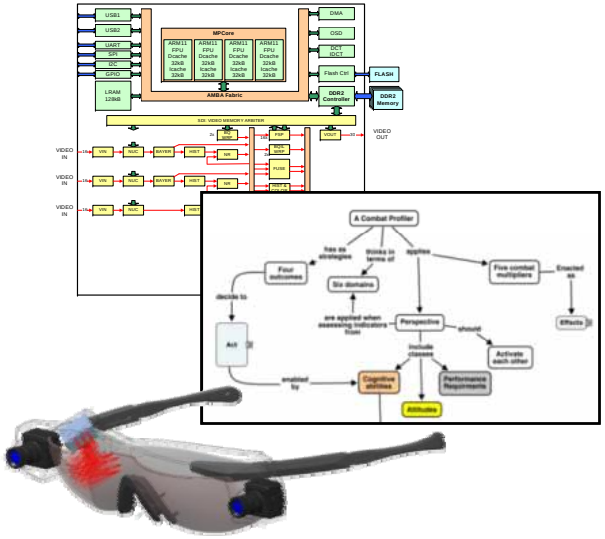
AITT Component Focus Areas

AITT

Planned Milestones/Significant Accomplishments

FY11	FY12	FY13	FY14	FY15
Research, Design & Prototype Components (SW & HW architecture, performance metrics)	**Prototype System v1** (Fire Team in static environment)	**User Testing** (Incremental software builds while preparing for v2)	**Prototype System v2 and Integrate w/PercepTs** (Squad in dynamic environment)	**User Testing & Transition** (Training Effectiveness Evaluation and Documentation)

Today



Transition

Perceptual Training System & Tools PercepTs

Product Description:

Enhance training of perceptual skills as applied to complex urban battle areas by providing methods and technologies for combat profiling pre-training, classroom supplementation, and post-training skills retention.

TRL at Start: 3, TRL at Transition: 6

PERCEPTS
PERCEPTUAL TRAINING SYSTEMS & TOOLS

Planned Demos/Deliverables

- Phase 1- Prototype Demonstration - 4Q FY12
- Phase 2- Prototype Demonstration - 4Q FY13
- Phase 3- Prototype Demonstration - 4Q FY14
- Final Demo- Prototype Demonstration - 4Q FY15

Planned Transitions

- USMC Combat Hunter program – 4Q FY12; 4Q FY13
- PMTRASYS-Squad Immersive Training Environment (SITE) – 4Q FY14; 4Q FY15

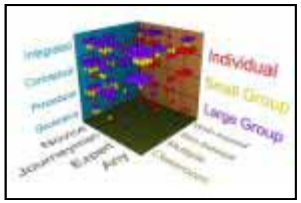
Warfighter Payoff:

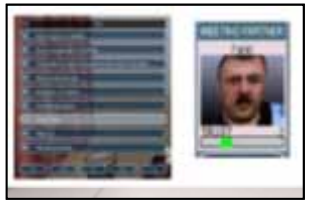
↑ Perceptual skills training efficiency and effectiveness

- Increase effectiveness of Combat Hunter-like instruction
- Increase throughput (allow more personnel to participate)
- Enable pre-training and sustainment training
- Reduce cost of training by: (a) supporting in garrison training, (b) reducing reliance on highly trained SME instructors, (c) supporting more cost-effective pre-training, and (d) reducing the need for role-players and other contractors

PercepTs

Technology Efforts Leveraged for this Product





Instructional Principles
Foundational theories and strategies investigated by Code 34's Cognitive Sciences D&I, Capable Manpower's NEW-IT, and HPT&E's APPLE programs

Combat Profiling
Leverage experience from Combat Hunter (PE 080973 IM) SME Greg Williams

Combat Hunter LOEs
Build upon limited objective evaluations conducted on Combat Hunter, sponsored by NAWCTSD (2010) and ONR (2009)

Combat Hunter LOEs
Build upon limited objective evaluations conducted, sponsored by NAWCTSD (2010) and ONR (2009)

Metrics
Build upon scenarios, metrics, and training tools developed under the Decision Training Toolkit (DTT) for C-IED Skills, sponsored by PMTRASYS (M67854-10-C-804024)

Human Behavior Models & Dynamic Tailoring
Extend training system "dynamic tailoring" to provide adaptive instruction; original work sponsored by CTTSO(HSCB), DARPA (Computer Narratives), AFRL/OSD(IMPACT), ONR (CGF D&I)

Greenware-based training optics
Optical training devices leveraged from past DSCI efforts, such as the Tracer/Burst Effects Video Injection System for MILES-CVS sponsored by PEO STRI (N61339-01-D-0716/0009 / 07-523-02-08-02-07) and DSCI IRAD.

Cutting Edge VEs
Novel, high-end VEs, such as the Embedded Battlefield Simulation System PEO STRI SBIR (W900KK-09-C-0050), and DSCI IRAD developed 3D Visual Sims MIRAGE suite of products.

Existing VEs
USMC PMTRASYS training environments, e.g VBS2 or CAN, developed through ONR's VIRTE and PMTRASYS DVTE efforts.

Instructional Methodologies | Combat Profiling Expertise | Performance Assessment | HBM & Dynamic Tailoring | Optics Simulation & Modeling | System Integration

PercepTS Component Focus Areas

PercepTs

Significant Accomplishments to Date (<6 months)

Workshops (2)

PercepTS kick-off @ ONR 8-10

TECOM Small Unit Intuitive Decision-Making Preliminary Workshop @ Quantico 11-10

Presentations (3)

Department of Defense Human Factors Engineering Technical Advisory Group

HCI INTERNATIONAL CONFERENCE

NDM 2011

Applying HSI to T&E concepts @ HFE-TAG 10-10

Submitted paper to ACI (held w/HCII)

Submitted paper to NDM

Experiments (1)

Comparing 10-Day Combat Hunter to 20-Day "Gold Standard" – Field Study @ SOI-E 12-10

Reports (1)

Comparing USMC Combat Hunter POI to USJFCOM's CODIAC POI

Academics (2)

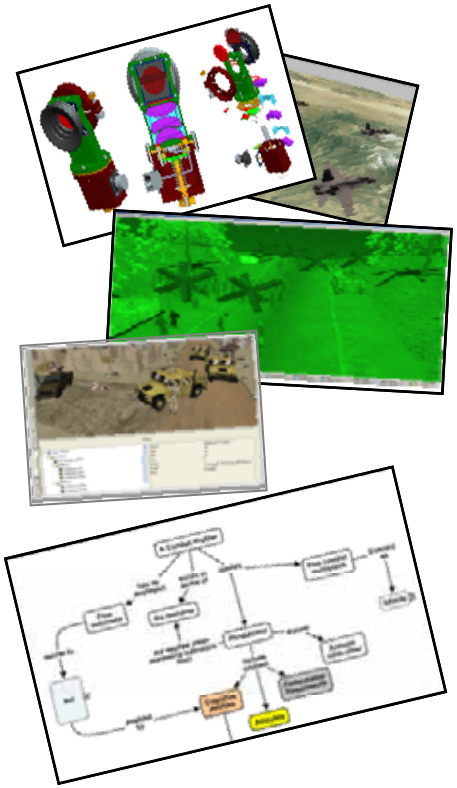
Master's Thesis: Colombo (UCF) Implicit Learning of Perceptual Abilities

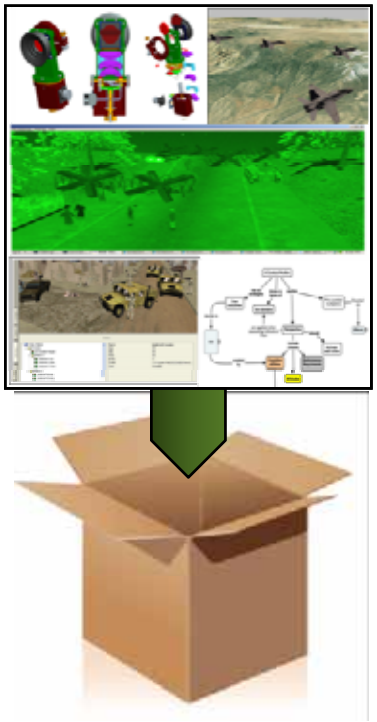
Doctoral Diss.: Taylor (UCF) Mitigating stress effects on perceptual abilities

PercepTs

Planned Milestones/Significant Accomplishments

FY12	FY13	FY14	FY15
Develop component parts (e.g., metrics, instruction, simulations)	**Test component parts** (e.g., lab, field, usability, and TEE testing)	**Integrate parts/systems** (Integrate components and begin integration w/AITT, SITE)	**Transition PercepTS Toolkit** (Iteratively revise prototypes, final transition in 4Q FY15)





Revolutionary Research . . . Relevant Results

CMP-FY11-02 Performance Shaping Functions for Environmental Stressors

Amy Bolton, Ph.D.

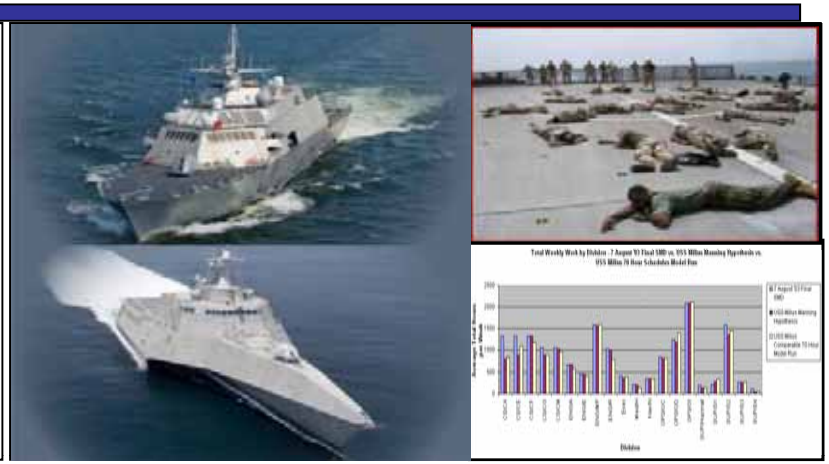
amy.bolton@navy.mil

Performance Shaping Functions

Product Description:

Validated performance shaping algorithms that predict the impact of stressors such as motion, vibration, fatigue, and temperature on Warfighter performance. Algorithms will be used as part of Systems Engineering (SE) toolsets to evaluate platforms and systems, and design future platforms.

TRL at Start: 3; TRL at Transition: 6



Planned Demos/Transitions

NAVSEA System Engineering tools and standards, NAVMAC Manpower Analysis tools/N12

- Key Demonstrations (Qtr/Yr) : Fatigue Modeling (4th/12), Motion and Heat Modeling (4th/13), Fatigue, Motion, and Heat Modeling (4th/14)
- Transitions (Qtr/Yr): MIL-STD-1472 Transition (3rd / 11), HITMM (4th/13). Final Transition(4th/15)

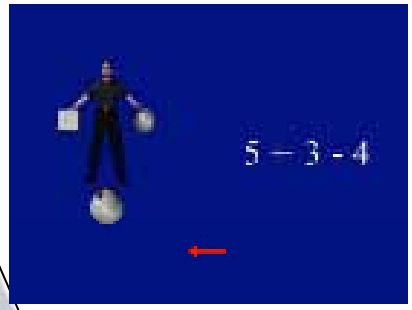
Warfighting Payoff:

- Improved prediction of human performance in complex military systems under extreme operational conditions
- Reduced human error, mishap rates, workload
- More accurate manpower estimates
- Optimize crew schedules
- Better designed platforms and systems that improve Warfighter endurance and performance

Performance Shaping Functions

Technology Efforts Leveraged for this Product

- D&I (Code 34: Dr. Hawkins)
  - Evaluating the influence of ship-like motion on fatigue models of human performance
- Other Agency Investments
  - US Army: Systems Engineering and Manpower Analysis tool sets (e.g., IMPRINT)
  - US Air Force: Decades of fatigue research and countermeasures
- Instrumentation at Naval Labs
  - Fitts' Law Task
  - Actigraphs
  - Video Cameras
  - Accelerometers
  - Surveys
  - Psychomotor Vigilance Test

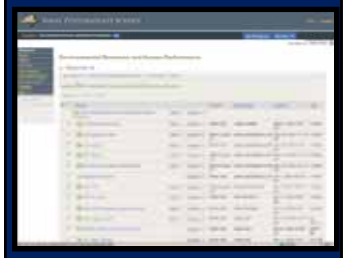


Significant Accomplishments

Meetings (5)

- PSF kick-off @ ONR 27-28 Apr
- PSF Workshop @ NSWCPC 8-9 Jun
- Data Analysis @ Navy Yard 5-7 Jan
- Fatigue Modeling Kickoff @ ONR 26 Oct
- Equipment Shakedown @ NPS 5-7 Nov

Support (2)



- Sakai Data Repository
- FY 11 Institutional Review Board (IRB) Package for LCS Rough Sea Trials

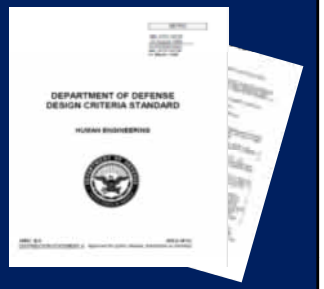
Experiments (1)

- LCS 1 Rough Sea Trials (Sea 3-5) Jan 3-13

Reports/Briefs (3)

- Motion Facility Review Report
- Briefs to Ms. Hamburger (05H), Mr. Kistler (05), PMS 501 & 420 Logistics leads, and CLASSRON.
- Reviewed state-of-the science of critical military environmental stressors

Standards (1)



- Revisions to MIL-STD-1472G Shock and Vibration Section