Human Systems Roadmap Review

Dr. John Tangney, SES
Director, Human and Bioengineered Systems Division, ONR
Chair, Human Systems Community of Interest
Human Systems Community of Interest
Active Membership

STEERING GROUP

Dr. John Tangney  (Navy)
Dr. Ben Petro  (OSD)
Dr. Laurel Allender  (Army)
Dr. Kevin Geiss  (AF)
Dr. Michelle Sams  (Army)
Mr. Doug Tamilio (Army)
Dr. Patrick Mason  (Navy)

WORKING GROUP

Dr. Scott Galster  (AF)
Dr. Marty Bink  (Army)
Dr. Paul Chatelier  (Navy)
CAPT Sidney Fooshee
Ms. Rose Guerra (Army)
Mr. John Lockett  (Army)
CDR Brent Olde  (Navy)
Ms. Cheryl Stewardson  (Army)
Ms. Josephine Wojciechowski  (Army)

SUB-AREAS

Personalized Assessment, Education, and Training
Dr. Glenn Gunzelmann  (AF)
Mr. Rodney Long  (Army)
Dr. Kendy Vierling  (USMC)
Dr. Ray Perez  (Navy)
CAPT Sidney Fooshee  (OSD)
Dr. Sae Schatz  (ADL)
Dr. Marty Bink  (Army)

Systems Interfacing and Cognitive Processes
Dr. Todd Nelson  (AF)
Dr. Susan Hill  (Army)
Dr. Micah Clark  (Navy)
Dr. Mark Derriso  (AF)
Dr. Erica Johnson  (AF)
Dr. Caroline Mahoney  (Army)
Dr. Jennifer Serres (AF)

Protection, Sustainment, and Warfighter Performance
Dr. Mike LaFiandra  (Army)
Ms. Karen Gregorczyk  (Army)
Dr. Peter Squire  (Navy)
Ms. Stephanie Miller  (AF)
Dr. Lloyd Tripp  (AF)
Dr. John Schlager  (AF)
Ms. Roxanne Constable (AF)

Human Aspects of Operations in Military Environments
Dr. Liz Bowman  (Army)
Dr. David Scribner  (Army)
Dr. Rebecca Goolsby  (Navy)
Mr. Eric Hansen  (AF)
Dr. Edward Palazzolo  (Army)
Dr. Lisa Troyer  (Army)
Dr. Laurie Fenstermacher  (AF)
Dr. Adam Russell  (DARPA)
Vision: Develop and deliver new human-centered technologies to quantify mission effectiveness and to select, train, design, protect, and operate for measurably improved mission effectiveness.

Goals – to enhance mission effectiveness
- Integrated simulations for mission training and experimentation
- Human-machine designs for mission effectiveness
- Assessment of (candidate) operator effectiveness
- Operating through battlespace stresses
- Mastering the PMESII* battle space

*Political, Military, Economic, Social, Infrastructure, & Information
## Human Systems Community of Interest Sub-Area Thrusts

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<th>Personalized Assessment, Education, and Training</th>
<th>System Interfaces and Cognitive Processes</th>
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<td><strong>Right Person, Right Job, Right Skills</strong></td>
<td><strong>Effective, Natural Human-Machine Teaming</strong></td>
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<tr>
<td>• Training, Education, and Personnel Development</td>
<td>• Human-Machine Teaming</td>
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<td>• Personnel Selection and Assignment</td>
<td>• Intelligent, Adaptive Aiding</td>
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<th>Protection, Sustainment, and Warfighter Performance</th>
<th>Human Aspects of Operations in Military Environments</th>
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<tr>
<td><strong>Ensuring Warfighter Safety and Survivability</strong></td>
<td><strong>Our Forces Prepared for Global Challenges</strong></td>
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<tr>
<td>• Understanding and Quantifying Warfighter Variability</td>
<td>• Exploiting Social Data, Dominating Human Terrain, Effective Engagement</td>
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<tr>
<td>• Enhancement and Mitigation Strategies</td>
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Operational Concept  
Mission Effectiveness Quantification

**Capability:** Integrated, persistent Live-Virtual-Constructive (LVC) training environments incorporating adaptive training methods to accelerate Service, Joint, and Coalition Readiness

**Affordable Mission Realism – Integrated Forces – Quantified Effectiveness**
Human Systems COI S&T Focus Areas that Address Human-Machine Teaming

1. **Learning Machines**
   - Computational Models of Human Cognitive, Psychomotor, and Perceptual Capabilities

2. **Human-Machine Collaboration**
   - Intuitive, Multi-sensory, Adaptive Interfaces
   - Natural Language Interfaces

3. **Assisted Human Operations**
   - Intelligent, Adaptive Aiding

4. **Human-Machine Combat Teaming**
   - Trust Calibration and Transparency of System Autonomy
   - Metrics of Mission Effectiveness at Individual and Unit Level

5. **Autonomous Weapons**
   - Systems that can take action, when needed
   - Architectures for Autonomous Agents and Synthetic Teammates

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... and *Experiments Using Realistic Mission Scenarios*
## Service Demand Signals

### Personalized Assessment, Education and Training
- Personalized, integrated assessments and training to improve performance, accelerate proficiency and increase affordability
- Enhanced warfighter performance through scenario based training & automated performance based readiness assessments
- Maintain air superiority over complex, evolving threats using adaptive training

### System Interfaces and Cognitive Processing
- Achieve operational maneuverability through soldier-system integration
- Design systems to enable effective human machine interaction, including robotics & autonomous systems
- Enhanced interaction & trust w/ autonomous systems; increased SA for operators; reduced analyst workload

### Protection, Sustainment and Warfighter Performance
- Greater force protection to ensure survivability across all operations and environments
- Maintain health & injury recovery; reduce noise induced hearing loss
- Agile Combat Support through countering aerospace physiology and toxicology threats, reducing cognitive workload

### Human Aspects of Operations in Military Environments
- Provide situational awareness; timely mission command and tactical intelligence human-agent teaming
  - **Army Enduring Challenges**
  - **Navy Vision/Objectives**
  - **AF Core Mission/Challenges**
COI-to-COI Collaborations

- **ASBREM**
  - Human Performance Optimization Committee
  - Joint Biomedical Modeling and Simulation Initiative
  - Walter Reed Army Institute of Research (WRAIR) evaluating TAPAS as a contributor toward predictors of mental health & medical attrition

- **ASBREM, Sensors, CWMD**
  - Wearable Physiological Monitors

- **Autonomy**
  - Roadmap development: Human-Machine Teaming shared area
  - V&V Licensing Study
  - Executing Joint-Service Autonomy Research Pilot Initiatives

- **Cyber**
  - Cyber Selection and Training
  - Cyber Situational Awareness

- **CWMD**
  - Dark web concerns, social network analysis, and counter-terrorism research
Impact of Human Systems Community of Interest

Mission

Effectiveness

$450M COI Budget Has Broad Impact in Several DOTMLPF Areas

Selection, Protection

Decision Making

Human-Machine Teaming

Adaptive Training

$450M COI Budget Has Broad Impact in Several DOTMLPF Areas
SUB-AREA S&T THRUSTS
Personalized Assessment, Education, and Training
PAET Scope
Personalized Assessment, Education & Training (PAE&T)

Research and development in personnel assessment will produce integrated measures and adaptive testing for more precise assessment of individual potential, yielding improved personnel selection and assignment. Meanwhile, work in education and training will produce competency-based systems grounded in quantitative metrics to enable personalized, proficiency-based training to accelerate acquisition and enhance operational performance. The end result is more capable warfighters with decreased training costs.

**Thrust Area 1:**
Training, Education, and Personnel Development

*S&T Focus Areas on Roadmap:*
- Realistic, secure, and adaptive LVC environments
- Persistent and personalized readiness assessment and tracking
- Multi-Level modeling for readiness management
- Computational cognitive science research to support model and agent development for training and operational support

**Thrust Area 2:**
Personnel Selection and Assignment

*S&T Focus Areas on Roadmap:*
- Predictors: Expand/refine non-cognitive measures (e.g., Tailored Adaptive Personality Assessment System)
- Outcomes: Expand/refine behavior and performance data
- Models: Expand/refine predictive analytic model for integrated cognitive plus non-cognitive measures to predict attrition, performance, and behaviors
HUMAN SYSTEMS COI SUB-AREA: Personalized Assessment, Education, and Training

VISION
A readiness ecosystem that ensures the right person has the knowledge, skills, and experiences needed to be mission ready for a dynamic and uncertain 21st century operating environment.

- Improved Selection & Assignment
- Increased Apprenticeship
- Combat Mission Ready
- More capable Warfighters
- Today
- Future

Distribution Statement A: Approved for Public Release
Our Story

• **Challenges**
  • More unpredictable and asymmetric adversaries
  • Dynamically evolving operational environments
  • One solution does not meet all
  • Reduced manning
  • Diverse personnel pool
  • Budget & manpower constraints
  • Better training at point of need

• **S&T Solutions**
  • Adaptive LVC environments that keep pace with operations
  • Human Science models for assessment and training
  • Performance measurement and assessment to tailor training
  • Cognitively-based instruction, agents and training schedules
  • Science of Learning
<table>
<thead>
<tr>
<th>Delivering the Mission</th>
<th>Delivering Capability (i.e., End States)</th>
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<tbody>
<tr>
<td><strong>Education &amp; Training Practices and Technologies</strong></td>
<td>• Persistent, interoperable learning “ecosystem” …with personalized measurement; readiness tracking</td>
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<tr>
<td>that Support Efficient and Effective Development</td>
<td>• Secure LVC joint/coalition training environments …with realistic constructive teammates/adversaries</td>
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<tr>
<td>of Mission Readiness and Cognitive Agility</td>
<td>• Consistently high-quality training and education, tailored to individuals and available when needed</td>
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<td>• Increased insight into personnel (data) informs individual learning decisions and mission planning</td>
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<tr>
<th>Key Technical Challenges</th>
<th>Example Program Successes</th>
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<tr>
<td>• Leverage learning sciences and technology to reduce resource costs (cost, manpower, time)</td>
<td>TXA AITT</td>
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<tr>
<td>• Tailor training to individuals to enhance warfighter capabilities and agility</td>
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<td>• Measure, track, &amp; warehouse quantitative, proficiency-based performance measures</td>
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<td>EXPERIENCE API</td>
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<td>PPO</td>
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Training, Education, and Personnel Development Roadmap

- **Mission Need**: Education & Training Practices and Technologies that Support Efficient and Effective Development of Mission Readiness and Cognitive Agility

- **Military Capabilities**
  - Secure LVC joint/coalition training environments
  - Individually tailored training and education
  - Persistent, interoperable learning “ecosystem”

- **Secure LVC joint/coalition training environments**
  - Secure, integrated LVC environments
  - Adaptive and valid cognitive agents
  - Proficiency-based performance measures/analyses

- **Individually tailored training and education**
  - Secure, scalable, on-demand joint and coalition LVC events
  - Integrated Infrastructure for Human-Machine Team Training
  - Warehousing & using (big) learning data

- **Persistent, interoperable learning “ecosystem”**
  - Pedagogical models

- **Technical Goals**
  - Secure, scalable, on-demand joint and coalition LVC events
  - Integrated Infrastructure for Human-Machine Team Training
  - Warehousing & using (big) learning data

- **S&T Focus**
  - Large Scale Computation for Human-Machine Training & Assessment
  - Adaptive, Multi-level Constructive Models
  - Agent-based Instructional Systems

- **Participation Legend**:
  - Army
  - Navy
  - Air Force
  - Marines
  - OSD/Joint

- **Shading Legend**:
  - Dark: Funded
  - Light: Not/partially funded

- **Timeline**:
  - 2016
  - 2018
  - 2020
  - 2022
  - 2024
  - 2026
# Training, Education, and Personnel Development

## Program Detail (1)

<table>
<thead>
<tr>
<th>S&amp;T Focus Areas</th>
<th>Near-term</th>
<th>Mid/ Far-term</th>
<th>Operational Opportunities</th>
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<tbody>
<tr>
<td><strong>Secure Environments for LVC Training</strong>&lt;br&gt;&lt;i&gt;Develop, validate, and demonstrate seamlessly integrated Live, Virtual, and Constructive (LVC) components into persistent, secure, and manageable training and operations environments across the Range Of Military Operations (ROMO)&lt;/i&gt;</td>
<td>Adaptive LVC Training for Enhanced Warfighter Readiness</td>
<td>Seamless integration of live, virtual, &amp; constructive training environments; personalized training grounded in operationally relevant proficiency assessments; Range infrastructure to support LVC integration for 4&lt;sup&gt;th&lt;/sup&gt;/5&lt;sup&gt;th&lt;/sup&gt; gen aircraft; air-ground simulation integration, scalable, adaptive constructive agents that think and act like people to support training &amp; ops</td>
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<td>Adaptive Training for C4ISR</td>
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<td>Secure LVC Advance Training Environment</td>
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<td>EDUCAT2E (see notes)</td>
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<td>Live Virtual Constructive Simulation &amp; Training</td>
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<td>Live, Virtual, Constructive Training Fidelity</td>
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<td>Future Integrated Training Environment</td>
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<td><strong>Infrastructure for Performance Measurement, Tracking, and Personalized Training</strong>&lt;br&gt;&lt;i&gt;Quantitative, embedded performance measures in training and operational systems, combined with warehousing capabilities and metrics to assess mission readiness and effectiveness over a career&lt;/i&gt;</td>
<td>Autonomous Models and Agents for Training &amp; Operations</td>
<td>Formal, quantitative measures of proficiency; Embedded performance measures in training environments and operational systems; Integrated and persistent warehousing, diagnosis, and assessment of readiness to drive personalized training requirements and career-long readiness management</td>
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<td>Learning Continuum and Performance Aid</td>
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<td>Adaptive LVC Training for Enhanced Warfighter Readiness</td>
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<td>Adaptive Training Research</td>
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<td>Total Learning Architecture</td>
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<td>Complex Cognitive Skills</td>
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<tr>
<td>Adaptive, Multi-level Constructive Models</td>
<td>FY 16</td>
<td>FY 17</td>
<td>FY 18</td>
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| Human-Machine Training & Assessment | FY 16 | FY 17 | FY 18 | FY 19 | FY 20 | **Autonomous Models and Agents for Training & Operations**<br>**Adaptive LVC Training for Enhanced Warfighter Readiness** | **Operational Opportunities**<br>Training to tailor baseline autonomous systems for specific capabilities, environments, and operations. Integration of large-scale computing resources with machine learning capabilities in LVC training environments will be a game changer in human-machine teaming by providing the opportunity for humans and machines to train separately and together in the same environments to prepare for the uncertainty of real operations. |

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**Adaptive, Multi-level Constructive Models**

More robust, valid, & Integrated mechanisms that enable constructive agents that truly think and act like people for training and operational applications; Incorporate robust capabilities for situation representation and language processing to support human-machine teaming.

**Human-Machine Training & Assessment**

We must prepare for the need to train autonomous systems for the same operational realities as humans, including training with human teammates; requires bridging among machine learning, large scale computing, and LVC.
## S&T Focus Areas

<table>
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<tr>
<th>Learning Sciences for Military Training</th>
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<tr>
<td>Adapt research on learning and training to the unique requirements of the military environment</td>
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<td>FY 16</td>
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<tr>
<td>Adaptive Training Research</td>
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<td>Total Learning Architecture</td>
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<td>Personal Assistant for Learning</td>
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<tr>
<td>Accelerating the Development of Small Unit Decision-Makers</td>
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A significant scientific base exists in the learning sciences, but most of it has been developed in non-military contexts. Adapting and extending existing research for the unique requirements of military training will improve its efficiency and effectiveness.
Technology Highlight: Predictive Performance Optimization (PPO)

Program

- Use quantitative models of human learning and forgetting to optimize and personalize training schedules

Status & Impact

- Improves training efficiency
  - Shifts from calendar-based training to cognitively principled personalization schedules
  - Minimizes training costs/time while maximizing performance effectiveness

- More effective acquisition of training objectives & more sustained proficiency

- Demonstrated to maximize performance effectiveness while simultaneously reducing time/costs in training
What? Developed by the Advanced Distributed Learning (ADL) Initiative, Experience API (xAPI) is a technical specification that facilitates the standardized documentation and interoperable communication of learning experiences (i.e., data) among disparate software systems. Essentially, it helps breakdown data stovepipes between education and training technologies.

Why? xAPI helps fuel learning analytics, not just within a single training system or course, but potentially across someone’s entire lifelong learning set of experiences. Today, xAPI has been integrated into numerous COTS systems and demonstrated in various DoD/Federal settings. Even TechCrunch recently published an article about how xAPI-based data will soon replace the standard resume!

Who Cares? Using xAPI will allow multiple, disparate learning devices (e.g., e-learning, mobile learning, simulations, physical sensors) to be used longitudinally as a cohesive system. It enables broad human performance data management and interoperable exchange. Ultimately, this will enable much improved analysis of learning/performance, better informing lifelong instructional adaptation and planning, as well as talent management activities.
Technology Highlight: Secure LVC Advanced Training Environment (SLATE)

Live, Virtual, Constructive Operational Training
Advanced Technology Demonstration Funded

- $47M demonstration of 4th and 5th generation LVC training
  - Aircraft software modifications
  - Waveform, Radio
  - Model and data processor
  - Multiple Independent Levels Encryption (MILS)
  - P5 Pod and F35 LRU form factor
  - Enhanced range infrastructure
  - Standards, data specifications, interface control docs
- Mission impact and effectiveness use cases
Success Story: Computer Generated Forces
Training Executive Agent (TXA)

Operational Challenge

“An integrated LVC training environment with today’s battle complexity is essential to improving proficiency across all current and future mission sets.” (Naval Aviation Vision 2016-2025)

Problem: High manpower to run complex virtual training

Objective: Make Computer Generated Forces (CGF) more intelligent and adaptive to training objectives

Outcome: Transitioned the Training Executive Agent (TXA) into the Navy’s Next Generation Threat System

S&T Accomplishments

- TXA monitors a training exercise and issues “directives” to other CGFs to modify behaviors according to a higher level scenario director (training objectives)
- TXA used in NIFC-CA training scenarios
- Exploring TXA usage on aviation pods, thus providing unique flexible embedded training capabilities

Return on Investment

Affordability

- Aid instructors and “pucksteers” who dynamically controls CGF during execution of a training scenario.
- Reduce number of required “pucksteers”, reduce overall training costs

Readiness

- Provide trainees with tactically realistic entities, in realistic complex battle scenarios
- Allow instructors to focus on trainee, not on playing roll in scenario
Thrust 2: Personnel Selection and Assignment

Delivering the Mission

- Initial Military Training attrition is ~10% ($1.7B cost/yr)
- IMT attrition could be reduced to ~ 8% (saving ~.34B/yr) if current S&T product (TAPAS) was implemented to assess personality. IMT attrition could be reduced to 6% (saving $.68B/yr) with FY22 S&T products.
- Reduce negative behaviors for enlisted by ~5%.
- Increase satisfaction, performance, and retention in critical specialties by ~15%.

Delivering Capability

Maintain our competitive edge in Human Capital (Force of Future).

- Reduce attrition and negative behaviors with more precise assessments of candidates for initial entry & job assignment.
- Improve performance and retention with an emphasis on critical specialties (e.g., cyber) through advancements in talent assessment.

Key Technical Challenges

- **Predictor measures**: Existing measures lack individualized precision and are not integrated.
- **Outcome measures**: Performance and behaviors are difficult to measure and systematically obtain over a career.
- **Predictive models**: Existing models are stove-piped and based on group probabilities.

Example Program Success

- Enlisted Personnel Selection – TAPAS
Personnel Selection and Assignment

Maintain our competitive edge in Human Capital ("Force of the Future", SecDef 18 Nov 2015).

- Reduce attrition and negative behaviors in the enlisted Force with more precise assessment of candidates for initial entry & job assignment.
- Improve performance and retention in critical specialties through advancements in talent assessment.

**Mission Need**

**Technical Goals**

**S&T Focus**

Predictors: Increase precision and integrate measures.

Outcomes: Improve measurement of performance & behaviors.

Models: Integrate models for individual probabilities.

Predictors: Expand/refine non-cognitive measures (e.g., Tailored Adaptive Personality Assessment System).

Outcomes: Expand/refine behavior & performance data.

Models: Expand/refine predictive analytic model for integrated cognitive + non-cognitive measures to predict attrition, performance, & behaviors.

- Improve performance and behaviors with optimal talent management across a career
- Compensatory models integrating all predictors for wide range of outcome data

Participation Legend:
- Green: Army
- Orange: Navy
- Blue: Air Force
- Maroon: Marines
- Purple: OSD/Joint

Shading Legend:
- Dark: Funded
- Light: Partially funded
- White: Not funded

2016 2019 2021 2022 2025
Personnel Selection and Assignment
Program Detail

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<tr>
<td><strong>Predictors</strong></td>
<td>FY 15 FY 16 FY 17 FY 18 FY 19</td>
<td>Expand and increase precision of Tailored Adaptive Personality Assessment</td>
<td>More precisely and fully assess individual potential and risk.</td>
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<td>Develop, refine, and validate Vocational Interest Inventories</td>
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<td>Develop and refine specialized selection tests (e.g., Cyber, UAS)</td>
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<td>Personnel Measures Research</td>
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<td>Selection for UAS Personnel (SUPer)</td>
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<td>Develop, refine, and validate behavioral outcome measures</td>
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<td>Readiness and Resilience</td>
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<tr>
<td><strong>Models</strong></td>
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<td>Predictive analytical models based on predictors and longitudinal outcomes.</td>
<td>With enhanced Talent Management, improve performance, reduce attrition and negative behaviors.</td>
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<td>Human Science Models</td>
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Predictors
Expand and refine non-cognitive measures (temperament, interests) and specialized cognitive assessments.

Outcomes
Integrate the behavioral and competency data that define criterion job performance.

Models
Expand and refine predictive analytic models for integrated personnel measures to predict attrition, performance, & behaviors.
Success Story: Enlisted Personnel Selection
Tailored Adaptive Personality Assessment System

Operational Challenge

*Decrease precision of assessing individual potential, risk, and fit to a military career.*
- 26 personality dimensions such as optimism, excitement seeking, and non-delinquency
- Applicant chooses from statement pairs generated on-the-fly based on responses

S&T Accomplishments

- State of the art personality assessment
- Developed in partnership with industry
- 2009: Limited operational screening (Army)
- 2010-2011: Administered to recruits (Navy)
- 2014: Began selection for 5 specialties (AF)
- 2015: Administered to recruits (Marines)

Return on Investment*

**Readiness**
- Reduces attrition by 5%
- Reduces Initial Military Training re-starts by 3%
- Reduces conduct incidents by 5%

**Affordability**
(attrition cost – recruiting, training)
- Current implementation saves ~ $30M/year
- Expanded use can save ~ $50M/year

TAPAS

*Which of these statements is most like you?*
- I am not one to volunteer to be group leader, but would serve if asked.
- My life has had about an equal share of ups and downs.

(example statement pair)

* Based on Army data for limited operational screening.
System Interfaces and Cognitive Processes
VISION

Warfighters teamed with machines through intuitive, personalized interfaces that enhance warfighters' mission effectiveness.
Thrust 1: Human-Machine Teaming

Delivering the Mission
- Increased capability with smaller force structure across air, land, sea, space, and cyber
  - 1 MQ-9 Operator controlling 7 simulated MQ-9s
  - Reduced ISR PED Cell Operators from 5 to 3
  - Closed Loop Medical Technology Research
- USTRANSCOM Global Mission Scheduling System
  - Reduced logistics and personnel footprint; reduced planned flying hours >2% saving $37M/yr
- Trusted synthetic teammates that provide recommendations for battlespace operations
  - Reduced manpower and training requirements
- Ability to operate safely in highly contested environments
  - Reduced exposure to personnel

Delivering Capability
Seamless human-machine interfaces enabling optimized weapon system and warfighter performance in all contested domains and mission environments:
- Demonstrate highly effective, agile human-machine teaming
- Create actively coordinated teams of multiple machines
- Ensure safe and effective systems in uncertain and dynamic environments

Key Technical Challenges
- Immature intuitive, multisensory, adaptive interfaces
- Lack of robust and reliable natural language interfaces
- Absence of effective gesture control interfaces
- Fragile cognitive models and architectures for autonomous agents and synthetic teammates
- Insufficient degree of trust calibration and transparency of system autonomy
- Immature decision support tools

Program Overview
- Intelligent Systems & Human-Robot Interaction
- Multisensory Perception and Data Presentation Interfaces
- Supervisory Control Technology Integration and Demonstration
Human-Machine Teaming

Mission Need

Military Capabilities

Technical Goals

S&T Focus

Actively coordinated teams of multiple machines in concert with human teammates executing desired mission effects

Safe & effective human-machine systems successfully operating in complex, dynamic & contested environments

Human-Robot Teaming

Gesture/Limited Dialogue-enabled UGV for Logistics Connector Missions

System Trust & Transparency

Visualization and Decision Support for Agile C2 and Cyber

Natural User-System Interactions: Reactive Interfaces

COGNITIVE ARCHITECTURES AND INTEGRATED INTELLIGENT SYSTEMS

Human-Robot Interaction

COGNITIVE ARCHITECTURES

COGNITIVE ARCHITECTURES AND INTEGRATED INTELLIGENT SYSTEMS

Military Capabilities

Participation Legend

Army

Navy

Air Force

Shading Legend

Dark: Funded

Light: Not funded

Striped: Partially Funded

Mission Need

Military Capabilities

Technical Goals

S&T Focus

2017

2021

2027

Distribution Statement A: Approved for Public Release
# Human-Machine Teaming
## Program Detail

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<td><strong>Closed Loop Medical Technology Research</strong></td>
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<td>Maximize patient care through autonomous technologies in operational environments</td>
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</table>
Success Story: Autonomy Research Pilot Initiative
Realizing Autonomy via Intelligent Adaptive Hybrid Control

Operational Challenge

Autonomous control of multiple unmanned systems for military operations

Problem: Current fielded systems fall far short of desired advanced, highly reliable autonomous cooperative behavior

Objective: Increase the robustness and transparency of autonomous control for multiple unmanned systems

Outcome: Agile and robust mission effectiveness across a wide range of situations, and with the many ambiguities associated with the “fog of war”

S&T Accomplishments

- Refined tri-service “Base Defense” challenge scenario to include more unexpected, dynamic events
- New rapid joint human-machine “Course of Action” tool
- New Task Manager capability: system workload balancing
- IMPACT “DoD Virtual Lab” refined (Year 2)
  - 1 operator x 12 vehicles (simulation)
- IMPACT Year 2 full system evaluation underway with 8 op experts
- Co-development of R&D at ARL, NRL and SPAWAR
- To date, over 30 S&T publications produced

Return on Investment

Affordability

- Reduction in logistics footprint for equipment and personnel
- Risk Reduction: Opportunities to transition IMPACT technologies to other DoD programs

Readiness

- Force multiplier: Autonomous control of multiple weapon systems with fewer personnel
Success Story:
Multi-Modal Communication Management Suite

**Operational Challenge**

**Problem:** C2 operators experience a high volume of perishable voice and chat communication across disparate systems leading to high workload and missed messages.

**Objective:** Provide comprehensive communication management software that improves real-time operator performance and workload in high comm situations.

**Outcome:** Net-centric software with integrated voice and chat, spatial audio, automatic speech recognition, keyword spotting, communication recording, search, and playback.

**S&T Accomplishments**

- Software prototype with licensed patent on IP
- Lab evaluations showing increased key-word spotting performance and reduced operator workload
- Integration into AFRL/FAA/Naval Undersea Warfare Center research testbeds
- Collaboration with Carnegie Mellon on custom speech recognition models for FAA and Domestic Event Network
- Integration and operational demonstration at Western Air Defense Sector
- Cooperative Research and Development Agreement with Global Flyte to tailor for emergency response scenarios

**Return on Investment**

**Affordability:** Intellectual Property protected; software based on open source tools and message protocols

**Readiness:** (TRL 4/5) Concept demonstrated in laboratory and operational settings; CRADA to improve readiness for emergency response domain
Success Story: Capable Manpower
Control Station Human Machine Interface (CaSHMI)

Operational Challenge

Problem:
1) Current UxV control paradigm is manpower intensive with inconsistent, proprietary HMIs.
2) A single UxV, vehicle-centric HMI metaphor does not scale for multi-UxV’s, mission management & emerging autonomy

Objective: Develop a Navy Mission-centric HMI, that enables “Parallel management” of multiple UxVs, with intermittent warfighter engagement and will scale with expected automation and technology.

Outcome: Transition UxV supervisory control HMI & supporting software architecture to AN/BYG-1 Submarine Combat System; and PMA-281 Common Control System

S&T Accomplishments

- User-Centered Design Process completed with Cross-Domain UxV operators
- Innovative software architecture enabling scalable interface implementations
- Live demonstrations of AN/BYG-1 operators using CaSHMI to provide simultaneous supervisory control of a Blackwing UAS and multiple IVER UUVs concurrently.
- Transitioned to NAVSEA PMS-425: AN/BYG-1 Submarine Combat System (APB-17) and NAVAIR PMA-281: Unmanned System Common Control System (CCS)

Return on Investment

Affordability

- Reduction in manpower requirements for increasing UxV mission employment.
- Reduction in training costs with “common” mission management interfaces

Readiness

- Enable single operator management of 2+ UxVs for an ISR missions
- Flexible task management supports dynamic mission events / requirements
- Prototype for Common HMI & controls across UxVs & Navy platforms
Success Story: Medical Technology Research
Closed-Loop Oxygen Generation and Delivery

**Operational Challenge**

*Closed-loop control of oxygen generation and delivery for military medical operations*

**Problem:** Current military environments present significant challenges to patient care in operational settings (oxygen availability, situational awareness, etc.)

**Objective:** Induces automatic changes in oxygenation delivery during mechanical ventilation in response to measured changes in patient physiology

**Outcome:** This technology has the potential to have a profound impact on the way the military medical system cares for critical care patients

**Accomplishments**

- Technology has demonstrated, in pre-clinical/clinical models, successful mitigation of hypo/hyperoxemic events (both associated with worsening outcomes)
- Generated novel mechanical ventilation/oxygen concentrator interoperable system
- The research team has received an FDA Investigational Device Exemption (IDE) to conduct a first-of-its-kind clinical trial utilizing closed loop control of oxygen delivery during mechanical ventilation in trauma patients

**Return on Investment**

This technology would maximize safe oxygen delivery and minimize oxygen/power consumption

**Affordability**

- Conserves oxygen, potentially reduces logistical planning factors

**Patient Safety**

- Maintains clinician set target equivalent to/or more often than standard of care (demonstrated in previous trial)

**Readiness**

- Force multiplier: Autonomous control of multiple patients with fewer personnel; enhanced care of wounded in austere/resource constrained environments
Thrust 2: Intelligent, Adaptive Aiding

Delivering the Mission

- Maintain mission effectiveness despite fluctuating demands: No mission degradation in a high tempo environment
- Optimized human-machine teaming: Dynamic workload allocation to improve mission efficiency
- Provides shared situation awareness and transparency between the operator and the weapon system platform: Appropriate level of operator trust
- Optimized warfighter readiness and enhanced training: Identification of relevant biomarkers indicative of operator cognitive and physiological state

Delivering Capability

Enhance warfighter effectiveness by coupling humans and machines through the use of intelligent adaptive aids to protect from being overwhelmed by complexity and workload.

- Develop models of perception and cognition
- Assess the functional state of the operator
- Real-time measurement and assessment of warfighter performance

Key Technical Challenges

- Immature tools for individual and team functional state assessment
- Fragile cognitive models
- Operationalize minimally invasive sensor suites
- To identify the appropriate biomarkers for determining operator performance
- Absence of effective gesture/non-verbal interfaces

Program Overview

- Applied Computational Neuroscience
- Cognitive Performance Optimization
- Monitoring, Predicting, and Optimizing Battlespace Awareness
Intelligent, Adaptive Aiding

Mission Need

Enhanced Warfighter Effectiveness by using Adaptive Situational Aids and Tools for Mission Success

Coupling of real-time, closed loop quantification of the warfighter and machine to achieve unprecedented mission success

Military Capabilities

Warfighter State Assessment / Prediction

Mission & Task Driven Adaptive Aiding

Technical Goals

Task and Behavior-Driven Assessment Systems

Minimally Invasive Sensor Suites

Identification of Biomarkers for Cognitive & Physiological State Assessment

Physiological, Behavioral, and Cognitive Sensing & Assessment

Cognition, Performance and Individual Differences

Computational Models of Operators’ Beliefs, Desires, Intentions and Other Mental States

Molecular Signatures

Applied Neuroscience

Gesture/Non-Verbal Interaction

Neurally Informed Displays with Individual Differences

Natural User-System Interactions: Trustworthy Proactive Interfaces

Socially-Guided Machine Learning

Human-System Co-Adaptation

S&T Focus

Mission Need

Military Capabilities

Technical Goals

S&T Focus

Participation Legend

- Army
- Navy
- Air Force

Shading Legend

Dark: Funded
Light: Not funded

2017 2021 2027
## Intelligent, Adaptive Aiding
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<td>Human-machine interaction using gestures and/or other non-verbal means to communicate/execute mission intent.</td>
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<td><strong>Applied Neuroscience</strong></td>
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<td>Monitoring, Predicting, and Optimizing Battlespace Awareness</td>
<td>Real-time, omnipresent-sensing technology, signatures of brain networks that capture changes in task performance and brain-based technologies to aid the operator and optimize team performance.</td>
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<td>Soldier Focused Neurotechnologies</td>
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<td>Advanced technology to sense, measure and quantify individual warfighter cognition and performance parameters to predict and augment warfighter performance.</td>
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<td>On-line operator monitoring and assessment technology, integrating multiple and concurrent data streams to predict and augment warfighter performance.</td>
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<td>Continuous Multi-faceted Soldier Characterization for Adaptive Technology Advancements</td>
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The Quantified Warrior

Available wearable sensors can be used to sense the cognitive and physical state of the soldier, sailor or airman.
Success Story: Optimized Warfighter Readiness
Reduction of Sleep Deprivation Induced Fatigue Stress

Operational Challenge

Identification of biomarkers predictive of performance under stress

Problem: Fatigue is an important concern throughout today’s 24/7 operations – performance degradations cause mishaps, reduced accuracy & slow reaction time.

Objective: Evaluate efficacy of transcranial direct current stimulation (tDCS) to reduce cognitive declines caused by fatigue.

Outcome: Evidence suggests tDCS is twice as effective and lasts at least 3 times as long as caffeine. In addition, test subjects report feeling less fatigued and more energetic 24 hours post-stimulation.

S&T Accomplishments

- Successfully demonstrated large effects of tDCS on cognition and mood under sleep deprivation conditions
  - Evidence suggests tDCS could be a fatigue mitigation tool more powerful than caffeine.
- Study findings have been replicated within AFRL and outside of AFRL laboratory
  - Illustrates effects are large and robust
- Developed tDCS paradigm (electrode placement, current intensity, stimulation duration) effective for stimulant-like effects

Return on Investment

Affordability

- Reduces risk of fatigue-related mishaps and injuries.

Readiness

- Provides Airmen with a tool to mitigate effects of fatigue for up to 24 hours during long duration missions – improves mission effectiveness and performance
Success Story: Human-Machine Integration
Advanced Wearable Technology for Dismounted Operators

Operational Challenge

Dismounted operators require greater situational awareness (SA) and an integrated tactical ensemble.

Problem: Power/data cable hazards and responsive multiple patient monitoring

Objective: Increase the battlefield airman’s SA: easily operate and increase interoperability of BAO & GAO kit components

Outcome: Medical responsiveness on the battlefield; minimize operator’s need to “look-down”; and easily operate body-worn devices

S&T Accomplishments

- Developed personal area optical data connection to link head-worn devices with body-worn devices such as headsets, HMDs, tablets, radios, etc.
- Developed person-to-platform optical data connection to link untethered Airmen to mission platforms for wireless communications.
- Developed sensor/wireless protocol agnostic casualty monitoring application and system
- Developed EUD multimodal covert/overt dismounted notifications alerting medics of patients’ urgent conditions

Return on Investment

Affordability

- Reduction in BAO & GAO kit cost due to the elimination of cabling needed to connect with body-worn devices
- Casualty monitoring device and capability can save lives

Readiness

- Remote monitoring of multiple casualties
- Ease of operating body-worn devices
- Reduction in cable hazards
- Reduced training spin-up

Operational Challenge

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Success Story: Cognitive Assessment Metrics and Emerging Reality Augmentation (CAMERA)

Operational Challenge

Problem: New sensing technologies require Warfighters to make accurate decisions based on a myriad of data while operating in chaotic environments, but assessing human use of Situational Awareness (SA) technologies in standard mission sets has not been formalized.

Objective: Develop validated cognitive workload measures and metrics to assess the impact of SA technologies on Soldier cognitive workload. Develop initial standards for cognitive and mission performance for Dismounted Soldier tasks and select Mounted Soldier duty positions.

Outcome: Increased Situational Awareness during operational missions with minimized SA technology cognitive burden on Soldier and Small units.

S&T Accomplishments

- Developed scenarios designed to variously tax cognitive workload and SA
- Developed a high-fidelity PACOM environment with local national and insurgent behavioral profiles, realistic weather, wildlife, and audio
- Completed pilot studies to establish test methodology for means to collect physiological metrics such as voice data, eye movements/pupillometry, and electroencephalogram
- Approved FY17 STO-R to develop standard documented test bed to assess impact of new SA systems on decision-making and workload during development cycle

Return on Investment

Affordability

Common Dismounted Soldier viewing and computer control experience across handheld, mounted, and thru-sight displays will reduce the costs of developing related technologies and training personnel

Readiness

SA technologies deployed more rapidly, with fewer unknown performance drawbacks, and reduced training time due to validated cognitive assessment and common viewing prior to fielding
Success Story: Computer Generated Forces Training Executive Agent (TXA)

**Operational Challenge**

“An integrated LVC training environment with today’s battle complexity is essential to improving proficiency across all current and future mission sets.” (Naval Aviation Vision 2016-2025)

**Problem**: High manpower to run complex virtual training

**Objective**: Make Computer Generated Forces (CGF) more intelligent and adaptive to training objectives

**Outcome**: Transitioned the Training Executive Agent (TXA) into the Navy’s Next Generation Threat System

**S&T Accomplishments**

- TXA monitors a training exercise and issues “directives” to other CGFs to modify behaviors according to a higher level scenario director (training objectives)
- TXA used in NIFC-CA training scenarios
- Exploring TXA usage on aviation pods, thus providing unique flexible embedded training capabilities

**Return on Investment**

**Affordability**

- Aid instructors and “pucksteers” who dynamically controls CGF during execution of a training scenario.
- Reduce number of required “pucksteers”, reduce overall training costs

**Readiness**

- Provide trainees with tactically realistic entities, in realistic complex battle scenarios
- Allow instructors to focus on trainee, not on playing roll in scenario
Protection, Sustainment, and Warfighter Performance
VISION
Enable superiority of Warfighters by understanding and overcoming operational stressors, and providing protection from threats in their environment.

This will be achieved through:
1. Understanding the factors that influence individual performance
2. Developing the ability to measure performance in the operational environment
3. Developing strategies to mitigate the effects of critical stressors on performance

Achieving this vision will enable:
1. Increased ability to perform at a higher stress level without a performance decrement or increase in injury
2. The ability to measure performance in training and operational environments
3. Warfighter protection aligned to mission specific threat, environment, and region allowing for optimal performance while maintaining protection
4. New technology capable of measuring current Warfighter state and predicting current and near term performance, resulting in 20% increase in task performance
5. Load mitigation strategies resulting in 25% decrease in metabolic cost
Protection, Sustainment, and Warfighter Performance Scope

Research and development in this area will produce better understanding of the critical environmental stressors and the human factors yielding individual performance differences in operational environments in order to enhance performance and mitigate the effects of stressors. This includes designing systems that support and exploit individual differences, and developing operationally relevant metrics to monitor and assess performance.

**Thrust Area 1:** Understanding and Quantifying Warfighter Variability

*S&T Focus Areas on Roadmap:*
- Ability to Conduct Warfighter Assessment in All Environments
- Mechanisms and Effects of Individual Differences and Critical Stressors on Warfighter Performance
- Real-Time Data Analysis and Performance Prediction

**Thrust Area 2:** Enhancement and Mitigation Strategies

*S&T Focus Areas on Roadmap:*
- Tool(s) for conducting trade off studies between protection/load, performance, and individual differences.
- Development of Augmentation Technologies and Techniques
- Design and Development of Models and Methods for Understanding Effects of Mitigation Strategies
Thrust 1: Understanding and Quantifying Warfighter Variability

Delivering the Mission

- Data analysis and performance prediction will enable improved resilience by providing critical information on Warfighter readiness.
- Understanding the underlying mechanisms through which critical stressors influence performance will enable greater performance and protection methodologies.
- Understanding individual differences in the effect of critical stress on performance will enable greater Warfighter resilience.

Delivering Capability

- Developing technology capable of objectively measuring warfighter performance in operational environments to enable real-time monitoring of Warfighter performance.
- Understanding the underlying mechanisms through which performance is influenced will provide a pathway to optimizing Warfighter performance.
- Modeling individual responses to critical stressors will enable the leveraging of individual variability as a means of improving Warfighter performance and protection.

Key Technical Challenges

- Sensors needed that are non-invasive, don’t influence performance, and provide meaningful data.
- The underlying mechanisms by which specific stressors influence performance are poorly understood.
- The influence of human variability on the effects of stress on warfighter performance is difficult to predict.
- High fidelity models that predict performance and injury and/or the impact of protection strategies on performance are lacking

Program Overview

- Determinants of hazardous biomechanics
- Ubiquitous and unobtrusive Real-World Assessment
- Impact of individual differences
Understanding and Quantifying Warfighter Variability

Mission Need

Improved readiness through quantifying and understanding the effects of critical stressors on individual warfighter state and performance

Military Capabilities

First Generation real time monitoring of Warfighter performance

Optimized warfighter performance based on understanding critical stressors

Understanding and leveraging individual variability in response to stress

Technical Goals

Define and validate operationally relevant test capabilities, metrics and measurement methods

Near term performance prediction based on real-time data

Integrated sensors and advanced models enabling near term performance prediction

Modeling of individualized response to critical stressors on warfighter performance

S&T Focus

Develop sensors capable of real-time performance monitoring

Physical Performance and Individual Differences

Real-Time Data Analysis and Performance Prediction

Warfighter Assessment in All Environments

Shading Legend
Dark: Funded
Light: Not/partially funded

Participation Legend
- Army
- Navy / Marine Corps
- Air Force

2016 2019 2021 2023 2026
# Understanding and Quantifying Warfighter Variability

## Program Details

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<td>FY 16</td>
<td>FY 17</td>
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### Physical Performance and Individual Differences

*Understanding the effects of physical stress and of individual variability on the effects of that stress on performance.*

- Determinants of hazardous biomechanics and injury
- Bioeffects: toxic particles, nanomaterials, directed energy exposures
- Effects of operational environment on pilot toxicology
- Human Integrated Performance Optimizer
  - Advanced Research focusing on Individual Differences

### Real-Time Data Analysis and Performance Prediction

*Developing the ability to predict near and far term performance decrements before they happen.*

- High resolution, wearable kinematic sensor and real-time algorithms development
- Feedback to improve Warfighter Performance
- Sustainment Technologies for Enhanced Performance of Soldiers (STEPS)
  - Real-Time Bioeffects analysis

### Warfighter Assessment in All Environments

*The development of metrics and tools for quantifying Warfighter states in any environment.*

- IMU Arrays for Warfighter Kinematic Measurement
- Omnipresent Real-World Soldier Assessment
- Aerospace Toxicology Human on a Chip
- Integrated Sensor Suite Development
- Probabilistic Risk Assessment Tools for Weapons Developers
- The ability to collect information on Warfighter state in the operational environment. This information can be used to prevent performance decrements.
Pilot Physiological Monitoring and Warning System (PPMAWS) Technology Demonstration

International CRADA
Elbit/LifeBeam Helmet Testing

2013

Foreign Comparative Test
PPMAWS integration into Joint Helmet Mounted Cuing System

2015

Next Gen JHMCS

2016

PPMAWS Demonstration
Altitude and High-G Acceleration

2019
Thrust 2: Enhancement and Mitigation Strategies

Delivering the Mission

- Physical augmentation to reduce metabolic cost by up to 25%
- Modeling and Simulation tools capable of predicting physical stress on the Warfighter to within 5%.
- Optimized load configurations and route planning leading to a 10% reduction in metabolic cost and 10% increase in operational performance.

Key Technical Challenges

- Tools to model effects of augmentation on physical performance and injury potential are still in development.
- Route planning tools require high fidelity models of human physiological response to critical stressors.
- Individual variability influences the extent to which physical augmentation can mitigate physical loads.

Delivering Capability

- Develop methods of lessening the effects of critical stressors on Warfighter performance
- Understand the underlying mechanisms by which physical augmentation and protection technologies affect performance. Set system requirements.
- Provide the tools (M&S, route planning, etc.) necessary to understand the relationship between new technology, mission requirements and operational effectiveness.

Program Overview

- Lower Extremity motor adaptations to actuation
- Effects of physical augmentation on walking efficiency
- Enhanced Technologies for Optimization of Warfighter Load

Photo property of MIT Prof. Hugh Herr 75 Amherst St., Rm. E14-374L, Cambridge, MA, 02139, (t) 617-258-6574, hherr@media.mit.edu
Enhancement and Mitigation Strategies

Improved operational performance through load mitigation technologies

Physical Augmentation Devices / Exoskeletons

Warfighter off-loading technology

Develop tools and technology to lessen effect of load, environment, and terrain on physical stress

Develop an understanding of the effects of load mitigation on performance and how to optimize it

Develop better control algorithms for physical augmentation devices

M&S tools (Biomechanical and others) capable of predicting effects of physical load on individuals

Development of Physical Augmentation Devices

Modeling Effects of Mitigation Strategies

Reducing Effects of High G Environments

Reducing Physical Load

Mission Need

Military Capabilities

Technical Goals

S&T Focus

2016  2019  2021  2023  2026

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<td><strong>Modeling effects of mitigation</strong></td>
<td>FY 15: Joint Biomechanical Modeling and Simulation Initiative FY 16: Enhanced Technologies for Optimization of Warfighter Load FY 17: 3-D Modeling &amp; Spinal Injury Assessment FY 18: Advanced Human Whole-Body Response Model</td>
<td>FY 19: Augmentation devices that are better suited to the user, resulting in increased physical performance, and less cognitive decrement resulting from physical fatigue</td>
<td>Augmentation devices that are better suited to the user, resulting in increased physical performance, and less cognitive decrement resulting from physical fatigue</td>
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<td><strong>Reducing Physical Load</strong></td>
<td>FY 15: NSRDEC Route Planning Tool FY 16: Energy Harvesting BackPack FY 17: Load Carriage / Novel Load Mitigation studies</td>
<td></td>
<td>The ability to reduce Warfighter physical load while maintaining capability and performance.</td>
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Accomplishments

• OBOGS – Mil Standard 3050 developed (Bi-service Air Force/Navy). OBOGS’ oxygens systems and their standards (operating and contamination standards).

• Multiple wearable robots are showing reduced metabolic cost during walking (treadmill and overground)

• Warfighter variability within field based settings
  – IMUs from lab to field, now instrumenting Warfighters with IMUs and getting kinematics and more in depth performance metrics in the field. Providing more in depth information than that which is gained solely from SME opinion. Think dashboard. What value does this provide?

• Laser Eye Protection ATD
Oxygen Technology Evolution

Gaseous Oxygen (GOX) Systems
- 1920

Liquid Oxygen (LOX) Systems
- 1950

F-15E On-Board Oxygen Generating System (OBOGS)
- 1990

F-22 On-Board Oxygen Generating System (OBOGS)
- 2000

Next Generation OBOGS/ Solid State OBOGS
- 2025

MIL-STD 3050 - Joint Air Force Navy
Human Aspects of Operations in Military Environments
Vision:
Using effective engagement with the dynamic human terrain to make better courses of action and predict human responses to our actions.

HUMAN SYSTEMS COI SUB-AREA: Human Aspects of Operations in Military Environments

- Rapidly identify human behavior threat signals
- Innovative planning for new mission demands
- Explanatory analytics for multi-source data
### Thrust: Exploiting Social Data, Dominating Human Terrain, Effective Engagement

#### Delivering the Mission
Effectively evaluate/engage social influence groups in the op-environment to understand and exploit support, threats, and vulnerabilities throughout the conflict space. Master the new information environment with capability to exploit new data sources rapidly
- **Defeating novel adversaries in every kind of conflict**
- **Extend capabilities for forecast, rapid planning and real-time situation awareness of human activities / behaviors and intent to operators**
  - Forecast models for novel threats and critical events with 48-72 hour timeframes

#### Key Technical Challenges
- Lack advanced modeling and complex algorithms to process new social data streams for actionable information in real-time
- Poorly understand new social dynamics including cyber-social behavior, global reach and new social innovations
- Few well developed counter-measures, TTPs and resources to guide military engagement in the human domain to impact rapidly changing crises
- Goals to drive military capabilities are reliant upon programs that are *not* fully funded and *not* structurally aligned/accountable to long-term military objectives

#### Delivering Capability
Predictive, autonomous analytics to forecast and mitigate human threats and events
- Provide real-time situation awareness
  - Engage and defeat new adversaries and tactics
  - Anticipate human crises & mission problems
- Develop data theory and algorithms
  - Develop behavioral models that reveal sociocultural uncertainty and mission risk
- Improve contextual translation & interpretation
  - Discriminating among seized documents

#### Program Overview
- **Crisis and Disaster Informatics and Models**
- **Social Network Research on New Threats** *(Daesh, Novorossiya)*
- **Text Analytics for Context and Event Prediction**
- **Foreign Language Machine Translation for Threat Warnings**
- **COI-coordinated SBIR projects for full spectrum social media analysis**
Human Aspects of Operations In Military Environments

EFFECTIVE ENGAGEMENT IN THE HUMAN TERRAIN
Planners, analysts and decision makers can create effective approaches to missions to managing human security needs and mission concerns using kinetic and non-kinetic means achieve desired end-states

MISSION NEED

MISSION CAPABILITIES

TECHNICAL GOALS

S&T

Focus

Mission Need

Military Capabilities

Technical Goals

S&T Focus

Explanatory models of adversary behavior for rapid and accurate course of action planning

Rapidly identify human behavior threat signals discourse

Exploit emerging open source platforms to counter adversary messaging

Improve translation, narrative & cultural analysis to improve strategic communication

Social Media Predictive Analytics

Sociocultural Reasoning Framework

Augmented Reality Tactical Displays and Novel Sensors

Forecast, indicators & warnings of human intent, mitigate threats and significant events

Mastering the info environment – OSINT & Social Dynamics for SA w/o data fatigue

Foreign Language translation and narrative analysis for text, video and audio

Military Relevant Transdisciplinary research on new threat actors, crisis response, and human security needs in cyber and real-world contexts

Full spectrum social media exploitation for I/W, information operations, and strategic communication

Shading Legend
Dark: Funded
Light: Not/partially funded

Participation Legend
- Army
- Navy
- Air Force

2016 2018 2020 2023 2026
## Exploiting Social Data, Dominating Human Terrain, Effective Engagement Program Details

<table>
<thead>
<tr>
<th>S&amp;T Focus Areas</th>
<th>Near-term</th>
<th>Mid/ Far-term</th>
<th>Capability Gaps/Operational Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Media Predictive Analytics</td>
<td>Content-Based Text &amp; Video Retrieval</td>
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<td>Develop real-time understanding of uncertain context with low-cost tools that are easy to train, reduce analyst workload, and inform COA selection/analysis.</td>
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<td>Data to Decision</td>
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<td></td>
<td>Foreign Language Translation &amp; Narrative Analysis</td>
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<td>Social Media Exploitation for Intel</td>
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<td>Social Media Exploitation for HADR</td>
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<tr>
<td>Augmented Reality Tactical Displays and Novel Sensors</td>
<td>Social Media Fusion to alert tactical edge Soldiers</td>
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<td>Development of devices and tactics to augment tactical edge soldiers with information analysis on-demand in dynamic environments.</td>
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<td>Person of Interest recognition and associated relations</td>
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<td>Document Exploitation on foreign printed material in field</td>
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<td>Smart Glass field use for facial recognition</td>
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<td>Transition to Army labs and Joint Operational Customers (TBD) to include NPS-Maritime Interdiction Ops</td>
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# Human Aspects of Operations in Military Environments

## Self Assessment

<table>
<thead>
<tr>
<th>Technical Challenges</th>
<th>Self Assessment</th>
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</table>
| **Big, Noisy Data with Complex Social Aspects** | • Slow but steady progress in processing unstructured text. No capabilities to assess video. Machine translations improving slowly.  
• Insufficient investment to expand, demonstrate and deliver promising models and techniques to collect and process data into actionable information. |

| Proposed Action                                                                 |
|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| • Expand investment in research to collect, filter and assemble operationally relevant social data to build models for actionable information  
• Fund new efforts in cyber-social aspects of new media, agitation propaganda and influence to detect and triage open source data effectively. |

| Additional Investment and Resulting Impact                                    |
|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| Speed scientific models to forecast crisis and COA effectiveness              |
## Human Aspects of Operations In Military Environments

### Self Assessment

<table>
<thead>
<tr>
<th>Technical Challenges</th>
<th>Assessment</th>
<th>Proposed Action</th>
<th>Additional Investment and Resulting Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowing the New Human Terrain of Conflict</td>
<td>Low investment in: • Global reach of adversaries • New capabilities and targets of opportunity • Rapid invasion and crisis escalation</td>
<td>• Expand research in cyber-social and new social threat activities in global contexts • Expand investment in forecast models and Human ISR</td>
<td>Transition best of breed technologies for proof of concept and advanced operational development</td>
</tr>
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</table>

- **ENGAGEMENT:**
  - Counter-Measures and New TTPs on the Ground and in Cyberspace
  - Very low investment in • Development of counter-measures, metrics and TTPs for new challenges in the human domain • Information operations research and military relevant aspects of crisis and crisis response • Expand research in Cooperative Theater Security for info-ops and CA for improved TTPs/metrics | Mission Effectiveness markers in intel prep of battlefield TTPs via well-defined pattern of life knowledge |
Success Story: Trident Juncture 2015: Social Media Analysis Demonstration for NATO

**Operational Challenge**

Real-Time Support of Strategic Communication During a Live Exercise

**Problem:** Social media information campaigns during live, massive exercise are brand new to NATO

**Objective:** Provide real-time understanding of the social media information environment for strategic communication situation awareness

**Outcome:** Recognition and invitation to assist NATO to develop a Digital Working Group in 2016, future engagements to be discussed for 2017

**S&T Accomplishments**

- Rapid training (>3 hours) of personnel accomplished
- Curated over 2M relevant tweets, including information attacks (trolling) and other conflicts in the information space, including 6 months of baseline analysis
- Curated and analyzed over 20K tweets and 700 Instagrams during the exercise.

Customers included NATO HQ personnel, the NATO Military Information Center staffers, JFC Brunssum public affairs, EUCOM, and other VIPs from SHAPE HQ, DSTL and HQ ARRC.

**Return on Investment**

**Affordability**

Capabilities demonstrated are 1/4th the cost of COTS tools, with 50% less manning required than COTS to achieve equivalent situation awareness

According to Department of State users.

NATO funded the travel and accommodations for USG participants (Thank to JFC Brunssum HQ)

**Readiness**

**Army and Navy have several technologies** that are ready for such technical demonstrations (shown at TJ15 as a joint effort)

NATO, NATO Allied Command Transformation and constituent NATO partner nations are very interested in closer cooperation in this kind of research and development.
Success Story: SCRAAWL: Joint Army/Navy Social Media Analysis and Models

**Operational Challenge**

*Provide real-time situation awareness and automated analytics of social media sources with low manning, at affordable cost*

**Problem**: Military and USG responders to crisis need the rapid SA that social media can provide, but must be able to rapidly see whole patterns of data flow and critical pieces of data that actionable.

**Objective**: Rapid SA from social media with low manning, with ability to discern actionable information readily.

**Outcome**: Control of strategic narratives, capability to discern and counter competitive and hostile messaging, “know what the crowd knows” about changing situations on the ground in real time.

**S&T Accomplishments**

- Real-time monitoring and 30-day backlist of breaking news and topics
- Automatic identification of viral information and rumor
- Automatic identification of suspected false accounts.
- Automatic identification of viral photos and videos
  - Transitioned to SOCOM Open Source Environment and Combat Zone Tool Kit for multiple commands

**Return on Investment**

**Affordability**

- 1/4\textsuperscript{th} the price of comparable systems
- Low training requirements

**Readiness**

- New capabilities are being added to existing commercial system, in daily operational use.
  - Joint funded by Army and Navy.
Thank You