Human Systems Community of Interest

Dr. Michelle Zbylut – CoI Chair

Dr. Kendy Vierling - Personalized Assessment, Education, and Training

Dr. Mark Draper – Systems Interfaces and Cognitive Processes

Dr. Mike LaFiandra – Protection, Sustainment and Warfighter Performance

Vision and Mission

VISION

Develop and deliver technologies to enable, sustain, enhance, and quantify human performance for measurably improved mission effectiveness.

MISSION

Enhance mission effectiveness through:

- Integrated simulations for mission training, experimentation
- Human-machine designs for mission effectiveness
- Assessment of operator effectiveness
- Protecting operators through battlespace stressors
- Mastering the political, military, economic, social, infrastructure, and information systems (PMESII) battle space

Human Systems Community of Interest Active Membership

STEERING GROUP

Dr. John Tangney (Navy)
Dr. Patrick Mason (Navy)

Dr. Rajesh Naik (AF Acting)
Ms. Lisa Sanders (SOCOM)
Dr. Ben Petro (OUSD)

Dr. Corde Lane (Army)
Dr. Thomas Davis (Army)
Dr. Michelle Zbylut (Army)
Dr. Robb Wilcox (Army)

WORKING GROUP

Dr. Kelly Ervin (Army)
Ms. Rachel Weatherless (Army)
Dr. Jessie Chen (Army)
Dr. Jill McQuade (AF)

Ms. Roxanne Constable (AF)
LCDR Jacob Norris (Navy)
Ms. Karen Gregorczyk (Army)

Dr. Paul Chatelier (Navy)
Dr. Kristy Hentchel (Navy)
LTCol Eric Midboe (OUSD)

SUB-AREAS

Personalized Assessment, Education, and Training
Dr. Kendy Vierling (USMC)
Dr. Ben Files (Army)
Mr. Rodney Long (Army)
Dr. Pete Khooshabehadeh (Army)
Dr. Greg Ruark (Army)
Dr. Sae Schatz (ADL)
Dr. Harold Hawkins (Navy)
LCDR Pete Walker (Navy)
Dr. Mark Livingston (Navy)
Dr. Jim Pharmer (Navy)
Dr. Ray Perez (Navy)
Dr. Melissa Walwanis (Navy)
Dr. Shannon Salyer (OPA)
Dr. Michael Nugent (DLNSEO)
Dr. Kimberly Pollard (Army)
Dr. Glenn Gunzelmann (AF)

Protection, Sustainment, and Warfighter Performance
Dr. Peter Squire (Navy)
Dr. Mike LaFiandra (Army)
Dr. John Ramsay (Army)
Ms. Betty Davis (Army)
LCDR Josh Swift (Navy)
Dr. Karl Van Orden (Navy)
Dr. Sandra Chapman (Navy)
Dr. Kristy Hentchel (Navy)
Mr. Keith King (Navy)
Dr. Curt Grigsby (AF)
Dr. John Schlager (AF)
Dr. Morgan Schmidt (AF)
Dr. Kendy Vierling (USMC)

Systems Interfaces and Cognitive Processes
Dr. Mark Draper (AF)
Dr. Laurie Fenstermacher (AF)
Dr. Jeff Palumbo (AF)
Dr. Tammy Chelette (AF/ Autonomy CoI)
Mr. Ed Davis (AF)
Mr. Eric Hansen (AF)
Dr. Tom McKenna (Navy)
Dr. Jeff Morrison (Navy)
Dr. Rebecca Goolsby (Navy)
Dr. Katherine Cox (Army)
Dr. Caroline Mahoney (Army)
Dr. Jeff Hansberger (Army)
Dr. Edward Palazzolo (Army)
Dr. Lisa Troyer (Army)
Dr. Dale Russell (Navy)
Dr. Dan Zelick (AF)
Dr. Jennifer Serres (Army)

Service Demand Signals

DoD 2018 National Defense Strategy	Military readiness = more lethal force
	Performance optimization; sustained mission readiness in extreme environments
Close Combat Lethality Task Force	Optimize the physical preparedness of personnel
	Prepare squad through realistic training in immersive high-stress environment
Army The Army Vision The Army Strategy U.S Army Modernization Strategy The Army People Strategy	Smart, thoughtful, innovative leaders → new talent mgt-based personnel system
	Soldier lethality spanning shooting, moving, communicating, protecting, sustaining
	Next Generation Combat Vehicle: Human and non-human teams at new levels
	Rapid expansion of synthetic training environments, simulations capabilities
Navy A Design for Maintaining Maritime Superiority	Augmented Warfighter Priority: Enhance decision-making and Human-Machine teaming
	Science-based practices to support leader development, better decision making
Naval R&D: A Framework for Accelerating to the Navy and Marine Corps After Next	Scalable Lethality: Enable directed energy (low cost, high precision standoff strike)
Air Force	Human-Machine Interface: Right information + right person + right time = right decision
Air Force Future Operating Concept	Agile innovative airmen in performance optimized teams for multi domain operations
The Science and Technology 2030 Initiative	Rapid effective decision making

Human Systems CoI Taxonomy

Sub-Areas	Thrusts
Personalized Assessment, Education, and Training	Personnel Selection and Assignment
	Training Design, Assessment, and Readiness Monitoring
	Advanced Learning Technologies
System Interfaces and Cognitive Processes	Understanding Human/Cognitive Processing
	Human-Machine Interaction and Aiding
	System Level Interfaces and Teaming
Protection, Sustainment, and Warfighter Performance	Sensing, Monitoring, and Assessment
	Enhancement Technologies and Techniques

Mutual CoI-to-CoI Research Interests

Biomedical CoI

- Autonomous medical evacuation
- Biomedical modeling and simulation
- Predictors of mental health and medical attrition
- Modernization of biotechnology data and analytics infrastructure

Biotechnology CoI

- Human Machine Teaming (HMT)

Autonomy

- Human-Machine Teaming (HMT)
- Verification and Validation (V&V)
- Trust

C4I

- Human Decision Making

DE

- Bioeffects

CWMD

- Dark web concerns
- Social network analysis
- Counter-terrorism research

Cyber

- Cyber selection and training
- Cyber situational awareness

Biomedical, Sensors, CWMD

Wearable physiological monitors

Industry Engagement

Independent Research & Development Technology Interchange Meetings IR&D TIMs Upcoming in June 2020

- Co-hosted by HS/Biomedical/Biotech CoIs
- This engagement has broad goals to increase awareness, stimulate collaboration, and seek alignment between industry's IR&D innovation investments and DoD's high-priority science and technology needs and corresponding acquisition sustainment roadmaps.
- Participants: DTRA, DARPA, Army, Navy, Air Force, USMC, others
- https://defenseinnovationmarketplace.dtic.mil/technology-interchange-meetings/

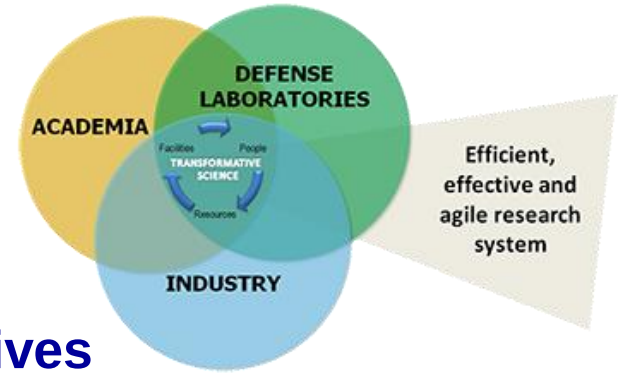
ADL iFest - August 30, 2021 - September 1, 2021

I/ITSEC – December 2021

Academic Collaborations

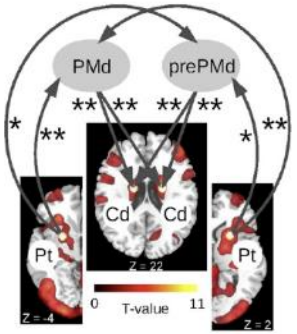
Centers of Excellence

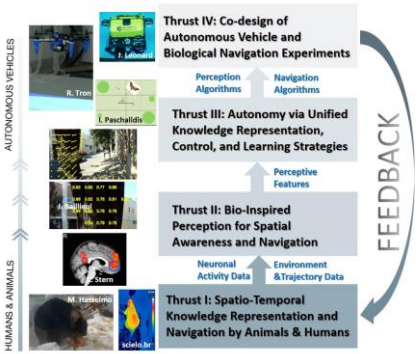
- Human-Machine Teaming at Carnegie Mellon
- Biotechnology at Northwestern
- Directed Energy Bioeffects Institute (DEBI)
- TUFTS– Center for Applied Brain and Cognitive Sciences

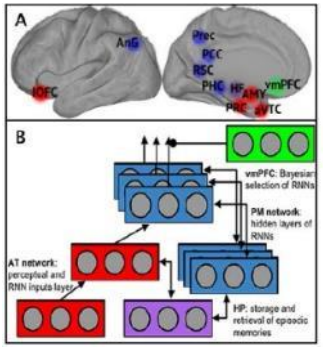


Multidisciplinary University Research Initiatives

- Active Perception and Knowledge Exploitation in Navigation and Spatial Awareness
- Neural Circuits Underlying Symbolic Processing in Primate Cortex and Basal Ganglia
- A Computational Cognitive Neuroscience Approach to Understanding Event Representation and Episodic Memory







ARL Open Campus

ARL's Open Campus is a collaborative endeavor, with the goal of building a science and technology ecosystem that will encourage groundbreaking advances in basic and applied research areas of relevance to the Army. Through the Open Campus framework, ARL scientists and engineers (S&Es) will work collaboratively and side-by-side with visiting scientists in ARL's facilities, and as visiting researchers at collaborators' institutions.

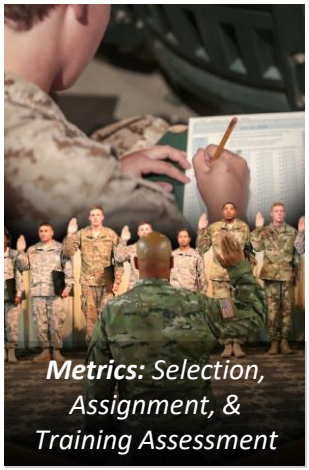
1.0

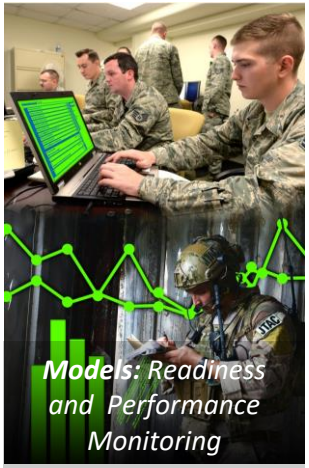
Personalized Assessment, Education, and Training

Right Person, Right Job, Right Skills

VISION

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





OPERATIONAL OPPORTUNITIES:

- Train-as-we-fight opportunities with Live Virtual Constructive (LVC) environments for current and future systems
- Learning environments tailored to training objectives
- Advanced learning technologies that facilitate personalization and deliberate practice at the point-of-need
- Technological advances that enable new training paradigms
- Individualized, proficiency-based assessments of training effectiveness and operational performance
- Talent management functions personalized through big data

ENDURING CHALLENGES:

- Increased technological parity with adversaries
- Inadequate ranges for training advance weapon system capabilities (e.g., 5th gen aircraft, residential encroachment)
- Live training potentially reveals capabilities to adversaries
- Dynamic, evolving operational environments and adversaries
- Requirements outpace opportunities and resources to train
- Ineffectiveness of one-size-fits-all, Industrial Age training
- Sparse data for manpower, education, and training decisions
- Limited capacity to leverage personnel diversity

1.0 PAE&T Taxonomy

1.1 Personnel Selection and Assignment

1.1.1: Individualized Measures of Aptitude

1.1.2: Career-Long Outcome Measures (area to further explore)

1.1.3: Predictive Models for Performance and Retention

1.2 Training Design, Assessment, and Readiness Monitoring

1.2.1: Data and Learning Sciences

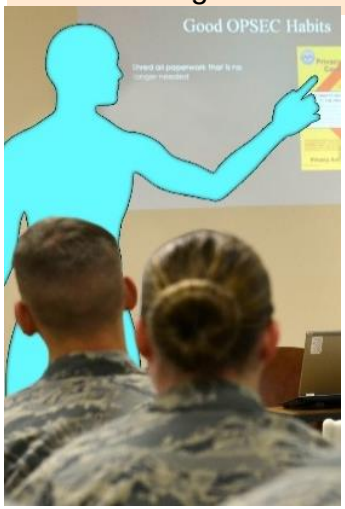
1.2.2: Cognitive and Performance Modeling

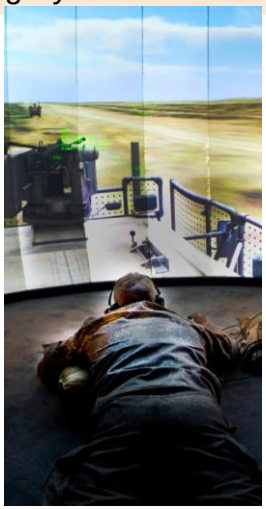
1.2.3: Innovative Training Design and Methodologies

1.3 Advanced Learning Technologies

1.3.1: VR/AR/MR and Integrated Simulations

1.3.2: Intelligent Tutoring Systems





TECH/CAPABILITY GAPS:

- Developing and integrating predictor measures that have individualized precision
- Developing or improving measures of operational performance and behavior that could inform decisions about career trajectory and future assignments
- Integrating currently stove-piped predictive models that are based on more than just group probabilities
- Warehousing and using (big) proficiency-based performance measures to inform training and operational decisions
- Adapting learning sciences to military contexts
- Conducting training and assessment in human-machine teams
- Developing and employing models, agents, and algorithms as synthetic training entities and for real-time readiness monitoring
- Securely integrating LVC environments
- Assessing virtual, augmented, and mixed reality technologies for training
- Creating software instructors for personalized training interventions

1.0 PAE&T Success Stories

Advancing the State-of-the-Art in Distributed Learning Through Public Outreach

Federal E-Learning Science & Technology

iFEST

innovation • instruction • implementation

Challenge: During pandemic restrictions, many DoD components needed a forum for interagency, industry, and academic sharing of distributed learning technologies, best practices, policies, and programs.

Accomplishments:

- Successful transition of annual iFEST conference from in-person to virtual format.
- Created an interactive conference portal and event agenda featuring senior executives, thought leaders, and project managers.
- Registration for the virtual 2020 event surpassed in-person participation in 2019 by 25%, and content also increased by 25%.
- Virtual event access remains open through end of 2020.

1.0 PAE&T Success Stories

Connected, Device-Assisted Learning, Anytime Anywhere

Challenge: Use emerging technologies to improve access to training, increase knowledge retention, and allow training data analytics: *Personalized eBooks for Learning* (PeBL).

Accomplishments:

- Developed ePub3 standard and PeBL eBook reader which improves learner engagement through enhanced content personalization and new forms of interactivity.
- Instrumented with the Experience API (xAPI) to standardize learner data collection, sharing, and analytics.
- Upcoming deployment of PeBL enhanced version of Marine Corps Doctrinal Publication-7 *Learning,* to ~180K Marines. Expected in early FY21.

1.0 PAE&T Success Stories

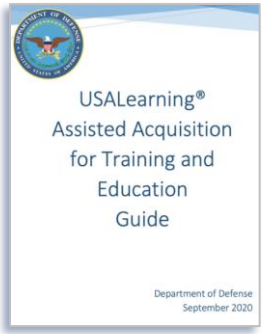
DoD-Wide Interoperability for Education and Training Systems

Challenge: Connect disparate, siloed education and training systems into an interoperable ecosystem that leverages enterprise data analytics to improve readiness and reduce costs.

Accomplishments:

- *Total Learning Architecture* "reference implementation" is now being demonstrated in collaborations with DHA, NAWCTSD, NETC, AETC, TRADOC, PEOSTRI, DAU, NPS, DCSA/CDSE, and others.
- Multiple commercial interoperability standards established for learner data collection and sharing.
- Prototype tools and technologies developed to facilitate the adoption and deployment of the next generation of education and training products.
- Streamlined DevSecOps pipeline to expedite integration and testing of learning technologies and products.

Education and Training Acquisition Reform

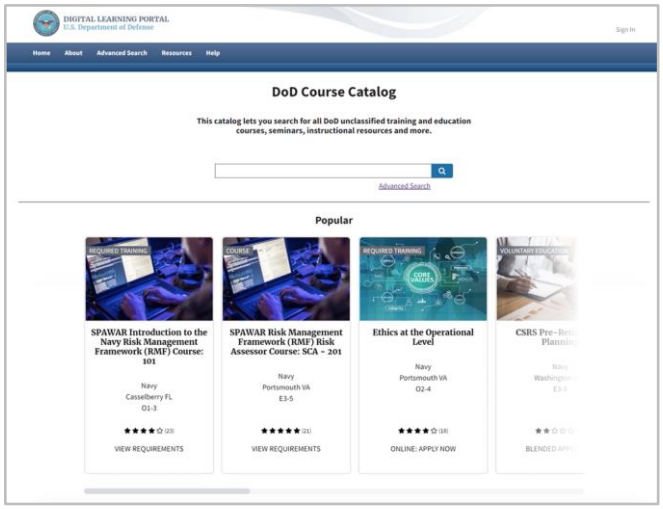


Challenge: Improve how DoD buys and maintains digital learning software and services.

Accomplishments:

- Part of CMO-led *Enterprise Digital Learning Modernization* reform effort, approved in July 2018.
- Acquisition focus includes eliminating redundancies, maximizing shared services, and streamlining procurement of education/training products and services across the DoD.
- OPM's USALearning providing "Assisted Acquisition" portal to leverage DoD buying power through procurement services.
- USALearning DoD Assisted Acquisition guide developed and targeted for September release/distribution.

Enterprise Digital Learning Modernization (EDLM) Reform Effort

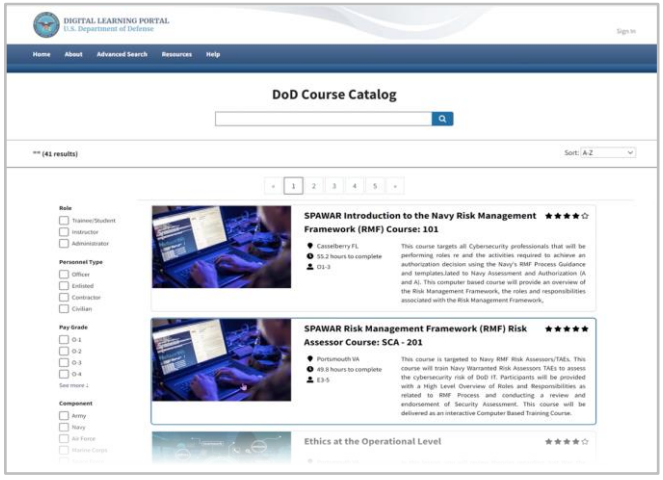


Enterprise Course Catalog

Portals federate local course catalog data from different DoD components into a single defense-wide directory with semantic search capabilities.

DoD users will be able to experience one seamless interface to discover all DoD course information instead of going to multiple locations.

- Aggregates tens-of-thousands of DoD course listings
- Uses commercial standards (IEEE P2881) to harmonize how courses are described (better support of big data, AI/ML, and analytics)
- Makes all DoD course catalogs interoperable & reduces duplications
- Anticipate developmental testing in FY21; anticipate Initial Operational Capability in FY22



Enterprise Learner Record Repository

A federated data fabric of learner data that relies on commercial standards and APIs to expose traditionally stove piped learner data across the DoD enterprise.

Maintains ownership and stewardship of the data with existing owners.

- Expose education/training outcome data in an interoperable, career-long system
- A federated solution to look at learner records from across the DoD
- Learning data pulled from existing, authoritative sources
- Currently working on R&D; anticipate early testing in FY21

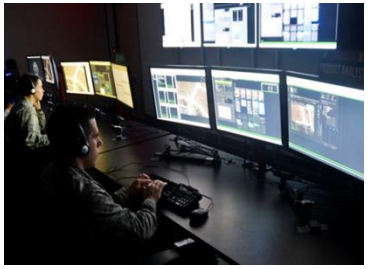
2.0 Systems Interfaces & Cognitive Processes

Effective, Natural Human-Machine Teaming

VISION

Warfighters teamed with agents and machines through intuitive, individualized, and adaptive interactions that enhance mission effectiveness.

Multi-Domain Operations



Manned-Unmanned Teaming

Team Performance Assessment

Quantified Warrior

OPERATIONAL OPPORTUNITIES:

- Enhance warfighter effectiveness by coupling humans & intelligent machines to maximize performance in the fog of war
- Real-time measurement, assessment and prediction of warfighter performance & functional state
- Adaptive human-machine interfaces for optimized weapon system and warfighter performance in contested environments
- Rapid, intuitive decision aiding & course of action analyses
- Manage perceptual abilities to exploit information throughput
- Field demonstrations in applied environments

ENDURING CHALLENGES/NEEDS:

- Mission effectiveness metrics & baselining
- Workflow models for teams
- Robust cognitive models & architectures for autonomous agents
- Multisensory adaptive interfaces that enhance, not interfere
- Robust, reliable natural language interfaces
- Dynamic calibration of system transparency to need
- Contextually aware dynamic decision support
- Tools for individual & team functional state assessment (Sensors & Algorithms)
- Identification of biomarkers for operator performance
- Coordination methods for teams of multi-adaptive systems.
- Interfaces that adapt to individual differences

2.0 SICP Taxonomy

2.1 Understanding Human/Cognitive Processing [WITHIN HUMAN]

2.1.1: Perception (Unitary and Multi-sensory)

2.1.2: Dynamic Operator Functional State Assessment

2.1.3: Cog Neuroscience/Performance Augmentation

2.2 Human-Machine Interaction and Aiding [HUMAN-MACHINE]

2.2.1: Advanced Interface Methods (Adaptive, Multi-modal)

2.2.2: Intelligent Decision Aiding/Support

2.2.3: Dynamic/Adaptive Task Allocation and Authority Transfer

2.2.4: Trust Calibration & Transparency

2.3 System Level Interfaces & Teaming [HUMAN-SYSTEM]

2.3.1: System Analyses and HSI (Organization)

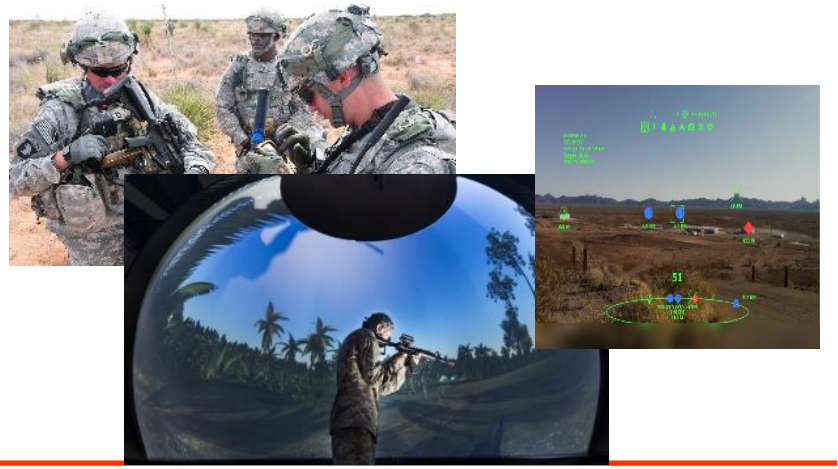
2.3.2: Team Processes, Performance, & Metrics (Shared SA;Cohesion)

2.3.3: Data Analytics/ Socio-Cultural Analytics/ Exploitation Tools

2.3.4: System Interface Design and Application

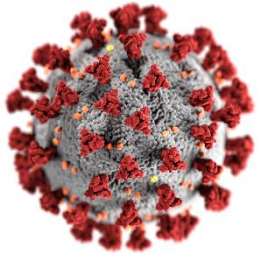
TECH/CAPABILITY GAPS:

- **Perception research– especially in areas of multi-sensory modeling/exploitation**
- **Design guidelines for reliable, real-time assessment of operator functional state**
- **Joint cognitive H-A decision making**
- **Baselining for envisioned capabilities**
- **Foundational research on distributed H-H-A teaming affordances**
- **Team performance metrics development**



2.0 SICP Success Stories

MASTR-E Collaborating on COTS sensor-based study to advance COVID-19 early predictors and human performance research



Challenge: CCDC SC MASTR-E Program will lead a symptomology and physiology data collection in active duty military cohort to support model development and testing of susceptibility to illness predictive algorithms.

Technical Approach: This tri-service (CCDC SC, NHRC, AFRL) and academia team, will support U.S. Army Medical Research and Development Command's (MRDC's) Military Infectious Disease and Military Operational Medicine Research Program, by teaming with 4th Battalion, 31st Infantry Regiment, 2nd BCT, 10th Mountain Division (LI) to monitor up to 1000 Soldiers for a period of 1 year to understand how physiological, cognitive, and behavioral data can lead to understanding this susceptibility.

Impact:

- This approach will enable short term targeted testing of the most vulnerable, maintain unit readiness and support long term idea of a predictive algorithm evaluation that enable screening and triage for unit members while maintaining the end objective of optimizing the human weapon system.

Development and Evaluation of In-Cockpit Cursor Control for Display Interaction: *RHINO POINTING*

Challenge

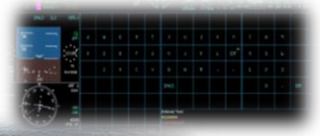
- 5th/6th-Gen aircraft will have Large Area Display touch screen
  - Use violates HOTAS philosophy for fighter aircraft ops
  - Precision suffers in dynamic conditions (e.g., vibration)
- Eye tracking (ET) technology not currently suitable for cockpit use

Solution

- ***Rhino Pointing (RP):*** Team (AFRL, TPS, U of Iowa) developed in-cockpit prototype head-slaved cursor system

Approach

- In-house lab development/evaluation prior to in-flight testing
- AFRL/OPL integrated system
- 7 TPS pilots flew total of 14 sorties comparing RP, ET, and Touch



Results

- Each method judged to have military utility; complementary
- Operator-recommended future interface combining strengths of each
- Arango Memorial Award winner for Society of Experimental Test Pilots paper

2.0 SICP Success Stories

Operator focus on Space C2 Joint Emergent Operational Need (JEON)

Challenge:
Space operators need interfaces to integrate data related to space threats to promote SA/

Tech Approach:
Developed 2 apps aimed at situation analysis and “at-a-glance” overview centered on: Impact, likelihood, and urgency of emerging threats.
The 711th has transitioned multiple technologies related to space C2. Most recently, RH lead one of the lines-of-effort (LOE) for the AFRL/RV-lead Space C2 Joint Emergent Operational Need (JEON). This LOE entailed establishing an overarching human-system interface (HSI) for the collection of applications* used by the new National Space Defense Center (NSDC). This HSI was developed in 3 segments related to Awareness, Action and Overview

Accomplishment/Impact:
Transitioned to National Space Defense Center in July 2020

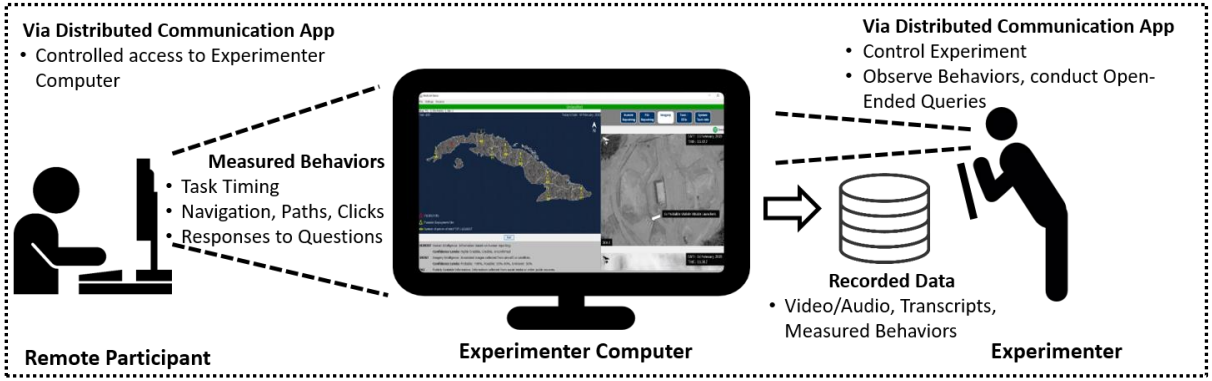
Innovations in Distributed Experimentation During COVID

Challenge

- COVID-19 stay-home order put abrupt halt on in-house research activities
  - Direct study oversight and use of specialized equipment/facilities no longer feasible
  - Requirement to conduct research that informs adaptive interface development remained
  - However, variable research constraints necessitated multiple remote testing capabilities

Approach

1) Utilize contemporary meeting/video collaboration apps (e.g., Zoom) to collect unclassified research data on analytics of sense-making

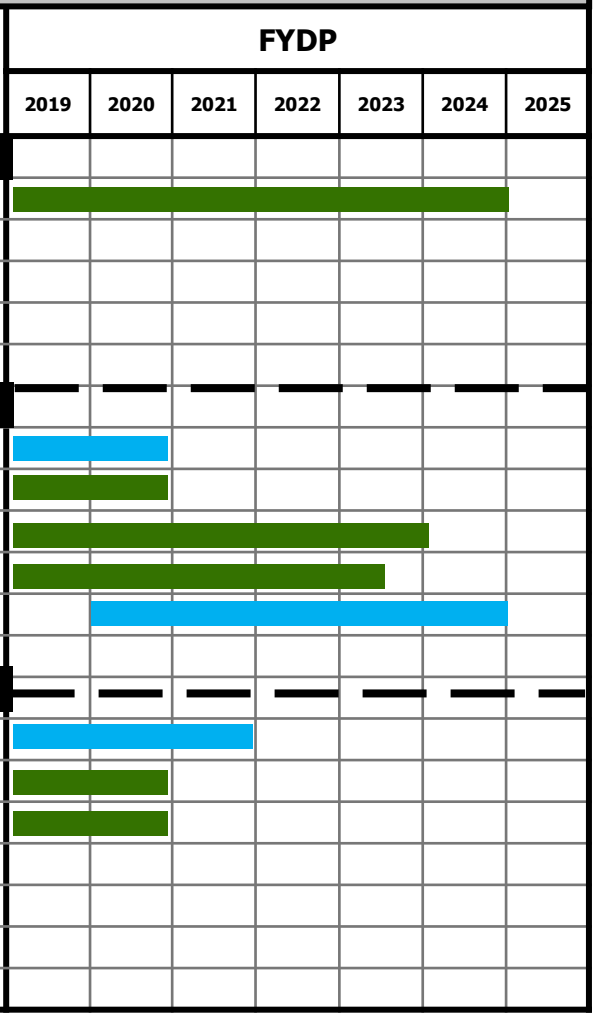


2) Develop new research kit on portable platform (Android tablet) for communication and perception research, ensuring stimulus control for highly-trained subjects

2.0 SICP Thrusts and Focus Areas

Army | Navy | AF | Other

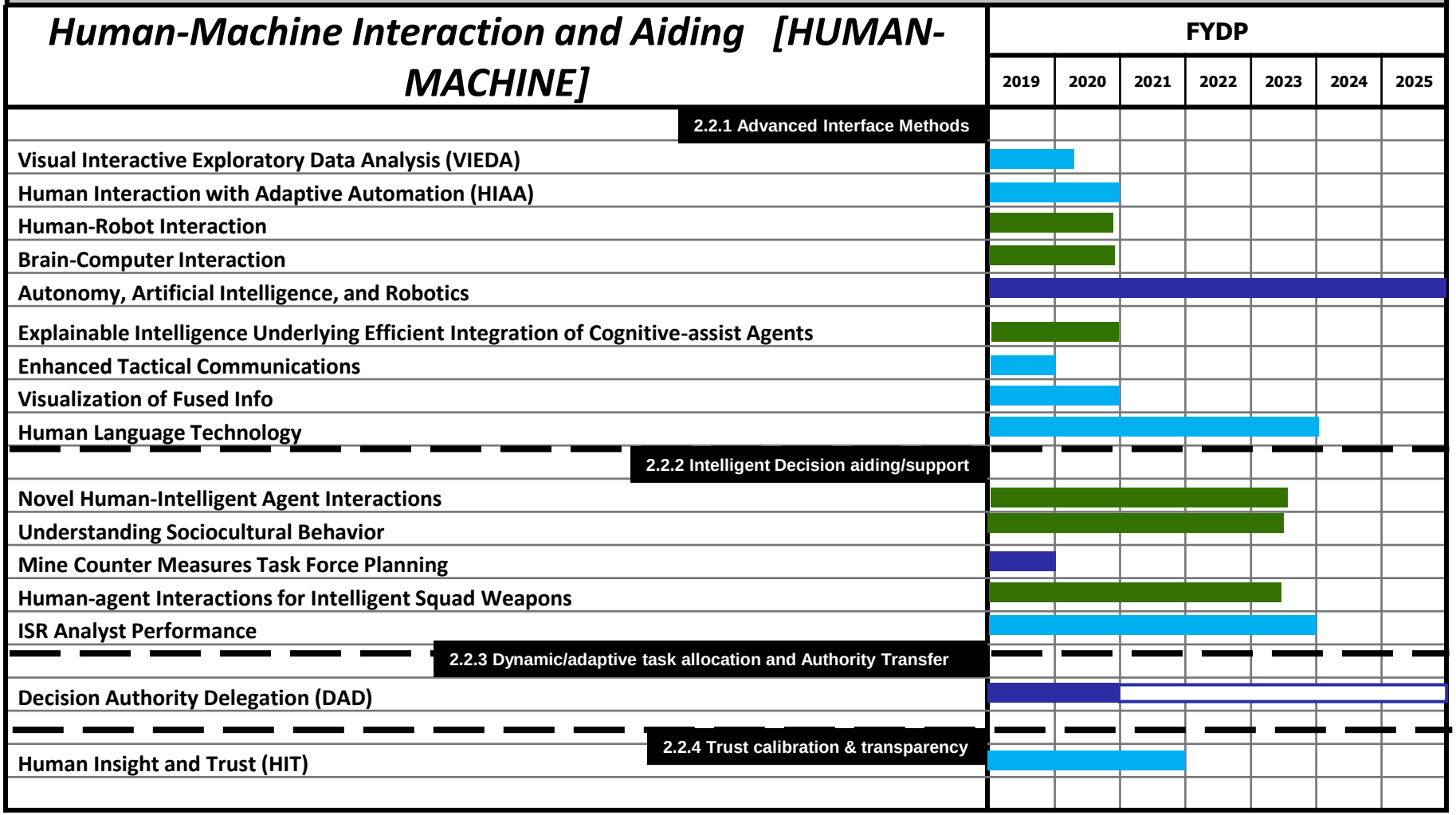
Understanding Human/Cognitive Processing [WITHIN HUMAN]



2.0 SICP Thrusts and Focus Areas

Army | Navy | AF | Other

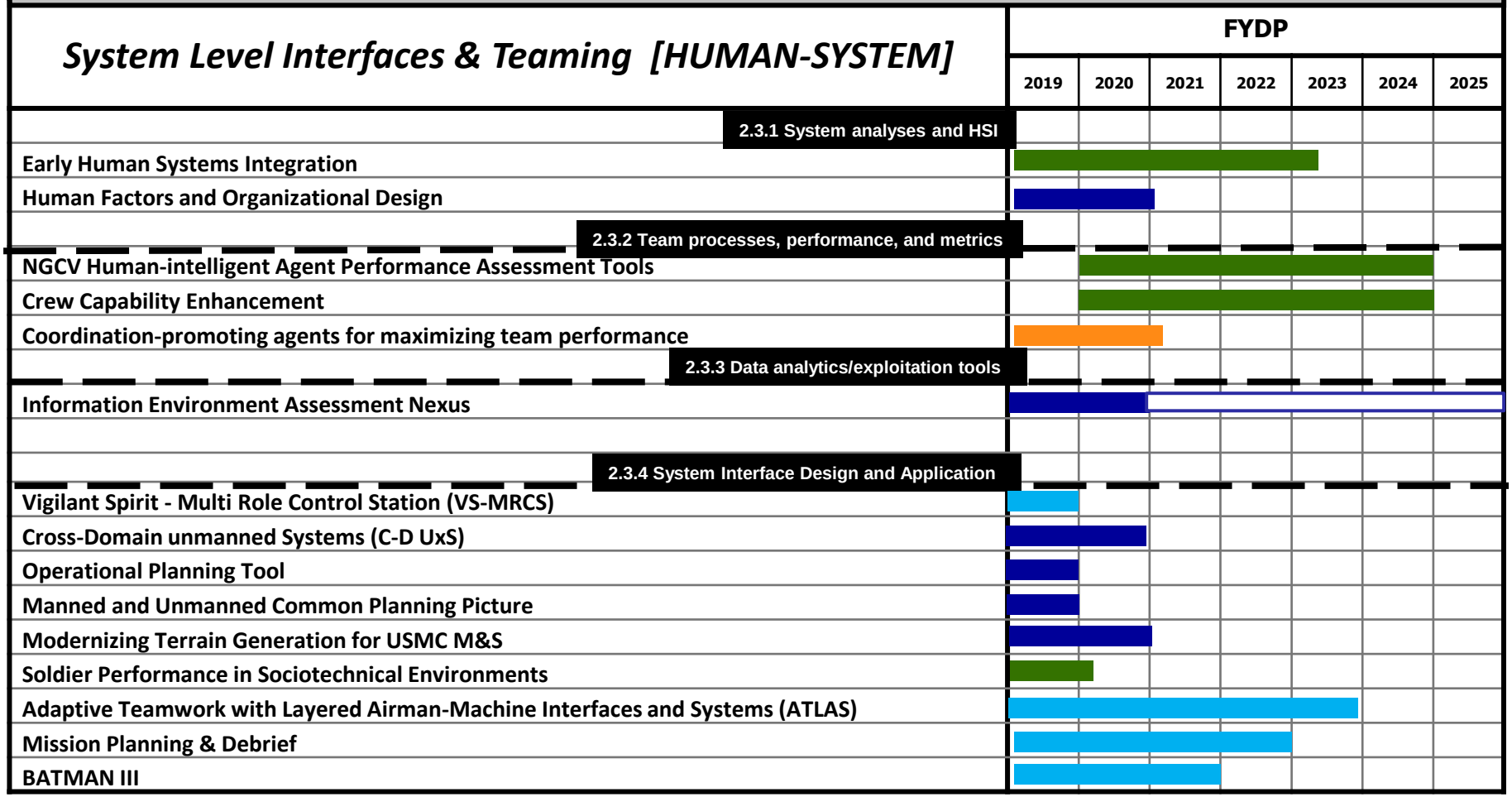
Human-Machine Interaction and Aiding [HUMAN-MACHINE]



2.0 SICP Thrusts and Focus Areas

Army | Navy | AF | Other

System Level Interfaces & Teaming [HUMAN-SYSTEM]



3.0 Protection, Sustainment, and Warfighter Performance

Ensuring Warfighter Safety and Survivability

VISION

Enable superiority of Warfighters by understanding and overcoming operational stressors, and providing protection from threats in their environment.

Nutrition and Sustainment

Exoskeletons for Physical Augmentation

Wearable sensor technology

Protection and performance optimization

OPERATIONAL OPPORTUNITIES:

- Ubiquitous and unobtrusive real-world, real-time performance assessment will provide information on warfighter readiness
- Optimizing Warfighter performance by understanding the impact of individual differences
- Enhanced technologies for optimization of warfighter load resulting in reduction in metabolic cost and increase in operational performance
- Optimized nutrition to modulate and enhance health and performance

ENDURING CHALLENGES:

- Real-world, real-time performance assessment relies on large amounts of data and advanced algorithms that have not yet been developed.
- Differences in the ways individuals respond to stress require individualized models that account for human variability in order to optimize performance.
- Warfighters are exposed to combinatorial stressors that complicate study outcomes related to stress-induced health and performance decrements
- Transitioning from correlative biological measures to causative performance outcomes

3.0 PSWP Taxonomy

3.1 Sensing, Monitoring, and Assessment

3.1.1: Sensing and Monitoring

3.1.2: Assessment

3.2 Enhancement Technologies and Techniques

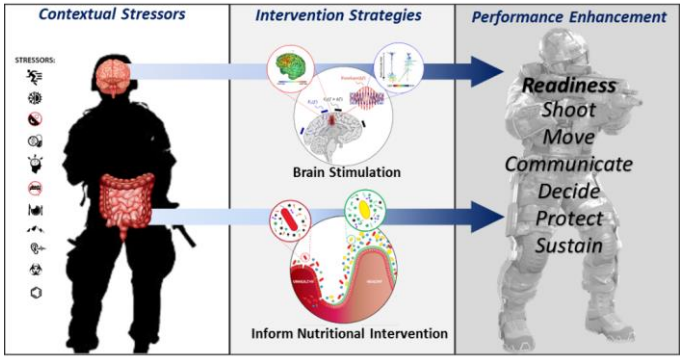
3.2.1: Training Enhancements

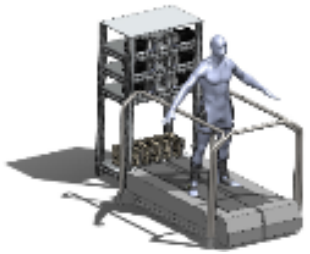
3.2.2: Physical Augmentation

3.2.3: Molecular Interventions & Treatments

TECH/CAPABILITY GAPS:

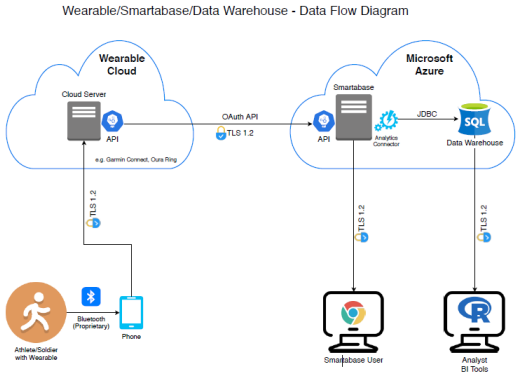
- Sensor technology and the data collection/analysis infrastructure that is needed in order to collection real-time real world performance data, and make that data useful, are lacking.
- Algorithms that account for the influence of human variability on warfighter performance need to be developed.
- Understanding the who, what, when, and how concerning the application of materiel and non-material enhancement interventions (e.g. neurostimulation)
- Understanding of how the gut microbiome responds to exposures (military stressors, nutrient intake), impacts of these responses on nutrition status and performance, and whether nutrition interventions could modulate this axis to optimize warfighter performance is lacking

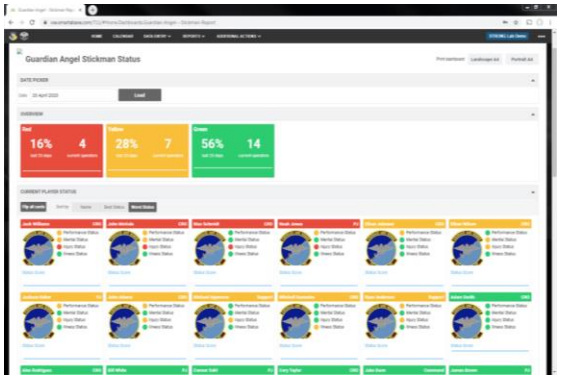




3.0 PSWP Success Stories

Authority to Operate Certification for Human Performance Data Management System





Challenge: The challenge of this effort between ONR and the Air Force Research Laboratory was to investigate the development, implementation and utility of a Human Performance Management Platform (HPMP) for both data collection and analytics to support measurement, assessments, and tracking of human performance metrics at select military pilot sites. The next step was to then demonstrate enabling capability as a prevention based countermeasure, both of which were accomplished.

S&T Accomplishments:

- ONR and Air Force Research Labs project deployment of HPMP to Marine Corps, Naval Special Warfare, and Air Force sites.
- These activities informed USSOCOM's decision to move forward with this HPMP solution across the SOF-Enterprise
- USSOCOM obtained Authority to Operate (ATO) certification Jun 20 for Smartabase HPMP to support the Preservation of the Force and Family (POTFF) program

3.0 PSWP Success Stories

DoD Sleep Meeting

ONR led a key DoD meeting on sleep research with the goals of

1) establishing awareness of ongoing DoD funded research focused on sleep and its role in Human Performance
2) improving alignment amongst the services
3) providing opportunities for collaboration.

The two-day event brought together over 100 researchers, stakeholders, and operators with the common interest of optimizing the health, readiness, and performance of the Joint Force.

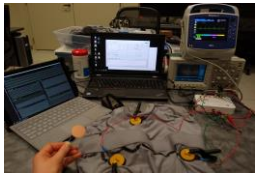
It also showcased outstanding basic, applied, and advanced technology development sleep research through 34 briefs from 20 groups which included DoD labs, academia, and industry where researchers presented their work.

Retired and active duty operators representing the Army, Navy, Air Force Special Forces also shared their operational experience and the effect sleep has played in their jobs and on their lives.

Results: Several prominent and emerging areas of focus were identified in DoD sleep research, such as scheduling & modeling, sleep assessment, and biomarkers of sleep debt/fatigue. This was coupled with existing roadblocks and challenges hindering interagency collaboration (e.g. overwhelming administrative burden). A path forward is currently under development and there will be an overview document on DoD sleep requirements, notable papers, and an overview slide deck of the DoD funded research efforts.

3.0 PSWP Success Stories

Integrated Cockpit Sensing (ICS)





This effort was established to allow real-time pilot alerting to physiological issues in flight while collecting and storing sensor data for root cause analysis. The program was also to address gaps in flight-compatible component sensor technologies and reduce false alarm rate through data fusion. The challenge was high-TRL sensor component integration with common data storage platform and standalone pilot alerting capabilities to enhance pilot decision making given any unexplained physiological events in flight.

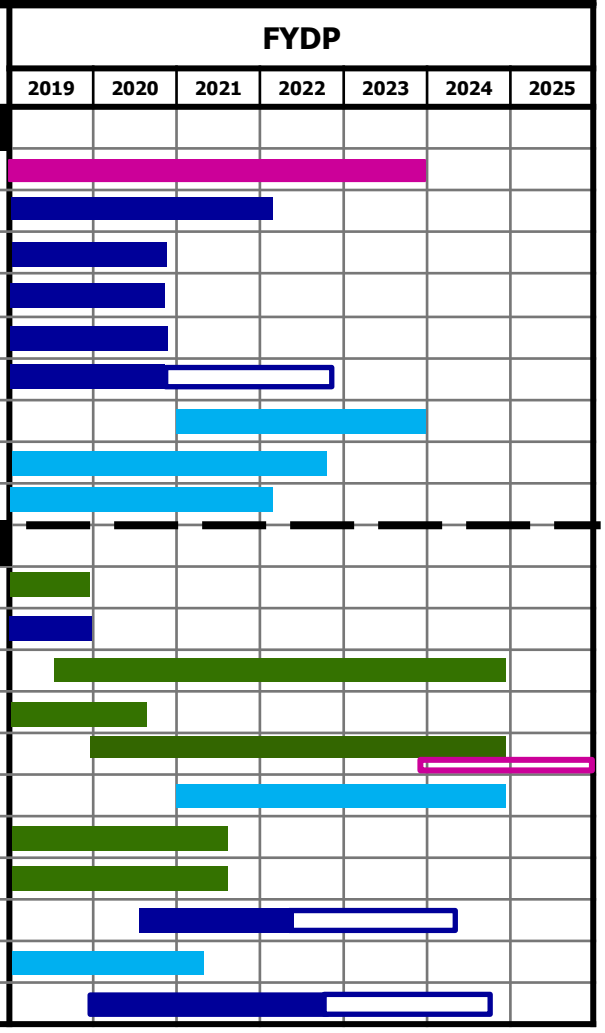
S&T Accomplishments:

- Completed benchtop testing, static aircraft seat evaluations, dynamic physiological sensor evaluations, upper pressure garment evaluations, centrifuge evaluations and lastly, hanging harness evaluations.
- The Lockheed Martin, In-Cockpit Physiological Monitoring program utilized pilot mounted physiological sensors, feeding pilot health messages via their Open Mission Systems to enable cockpit integrated cautions and warnings. The close-out demonstration postponed due to travel restrictions during the COVID pandemic.
- Conducted 77th Fighter Squadron Flight Test over 8 weeks at Shaw and Nellis AFB, collecting 77 hours of in-flight data by outfitting F-16 pilots with sensors to monitor cabin pressure during training missions. Goal was to determine if depressurization was the cause of physiologic symptoms while also testing device efficacy. The sensors recorded the partial pressure of oxygen, percentage of oxygen delivered, ambient pressure, cabin pressure, and acceleration during flight. One pilot reported physiological symptoms of dizziness and air hunger; after following standard operating procedures he was able to complete his flight. The potential physiological episode did not align with abnormal data, enabling multiple causal factors to be ruled out while highlighting that additional research and development is needed in the exploration of the root cause of physiological episodes.

3.0 PSWP Thrusts and Focus Areas

Army | Navy | AF | Joint

3.1 Sensing, Monitoring, and Assessment



3.1.1 Sense and Monitor

- MASTR – E Optimizing Human Weapon System
- Human Performance Monitoring and Augmentation
- Body-worn Wireless Neurophysiological Monitoring Network / OMNI
- Performance Evaluation of Newly Available Sleep Assessment Devices
- Hypoxia Alert and Mitigation System
- Physiological Beacon
- Fatigue Optimized Cognition Under Stress (FOCUS)
- On-Board Oxygen Generating Systems (OBOGS)
- Integrated Cockpit Sensing

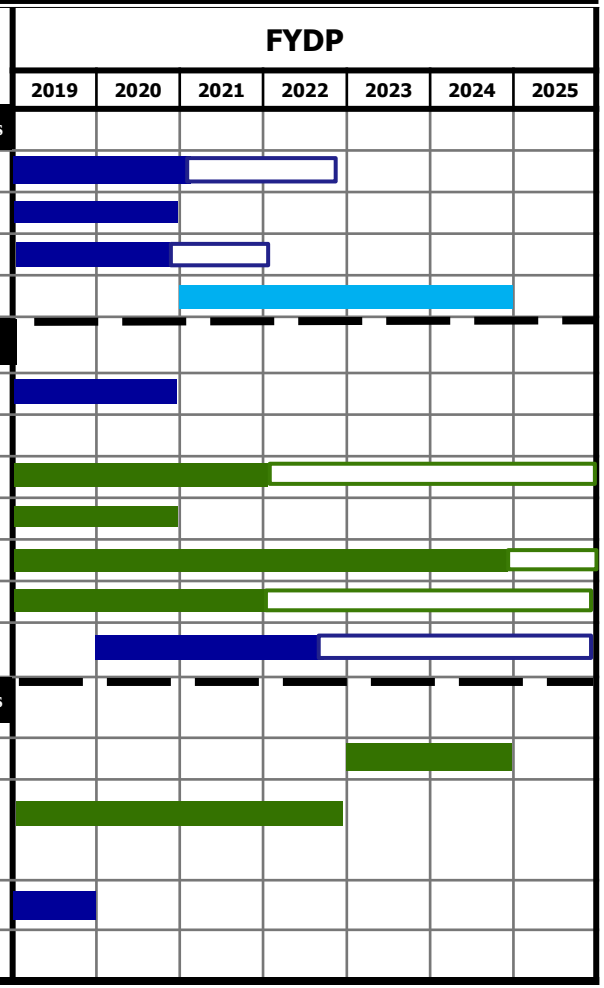
3.1.2 Assessment

- Measuring & Advancing Soldier Tactical Readiness & Effectiveness (MASTR-E) Pilot
- Fitness and Body Composition as Predictors of Musculoskeletal Injury Risk
- Human System Design Guidance for Head-Borne Systems
- Dynamic Marksmanship Characterization: Novice vs. Expert
- MASTR-E Program (SUPRA, TSMA, Field, Prediction)
- Human Digital Twin (HDT)
- Physical and Cognitive Overburden of Small Team Performance
- Human Performance in Dismounted Operations
- Incapacitation Prediction for Readiness in Expeditionary Domains
- Airman Data Analysis and Performance Tracking System
- Human Performance Assessment and Recommendations for Training and Operations

3.0 PSWP Thrusts and Focus Areas

Army | Navy | AF | Joint

3.2 Enhancement Technologies and Techniques



3.2.1 Training Enhancements

- Adaptive Training Protocols (ATP)
- FitForce Planner (FFP)
- Strengthening Health &Improving Emotional Defenses (SHIELD)
- Just-in-Time Multi-Mission Airman

3.2.2 Physical Augmentation

- Naval Noise Induced Hearing Loss
- Exoskeletons:
  - Advancement of Exoskeletons for Movement & Maneuver and Sustainment
  - Determination of Lower Extremity Joint Actuation Requirements
  - Research for Advanced Soldier-PA System Interaction
  - Technology for Human Interactions
- Lightweight Atmospheric Dive Suit (LADS)

3.2.3 Molecular Interventions & Treatments

- MASTRE- Recovery Probiotic Field Experimentation
  - ➢ Leverage Biotechnology COI Optimizing Warfighter Health & Performance subgroup gut microbiome, performance nutrition, and nutritional factors supporting immune function, muscle recovery work
- PHITE: Precision High Intensity Training through Epigenetics

Backup

Human Systems CoI Taxonomy Evolution

Sub-Areas	Former	Current 2020 Thrusts
Personalized Assessment, Education, and Training	Personnel Selection and Assignment	Personnel Selection and Assignment
	First Principles for Training Design	Training Design, Assessment, and Readiness Monitoring
		Advanced Learning Technologies
System Interfaces and Cognitive Processes	Human Information Interpretation & Influence	Understanding Human/Cognitive Processing
	Intelligent, Adaptive Aiding	Human-Machine Interaction and Aiding
	Human-Machine Teaming	System Level Interfaces and Teaming
Protection, Sustainment, and Warfighter Performance	Critical Stressor Mitigation Strategies	Sensing, Monitoring, and Assessment
	Understanding and Quantifying the Effects of Critical Stressors	Enhancement Technologies and Techniques
		Bioeffects