AFRL
FIGHT'S ON!
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LINES OF EFFORT

The last issue of Fight's On! highlighted the Warfighter Interactions and Readiness Division (RHW) reorganization, in particular the new research structure. The new Core Technical Competencies (CTCs) are each made up of two Core Research Areas (CRAs). These CRAs are each comprised of multiple Lines of Effort (LOEs) so that researchers can more precisely focus on the bleeding edge concepts and technologies needed for modern and future warfighters. Each LOE and the innovative work being performed is discussed throughout this issue.

DIGITAL MODELS OF COGNITION CRA

INFORMATION MASTERY IN COGNITIVE WARFARE

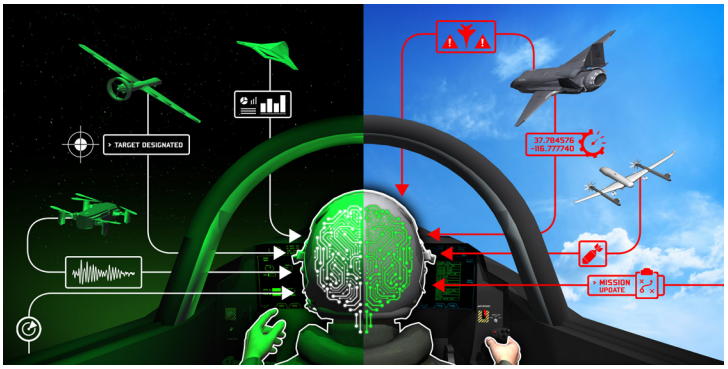
The Information Mastery in Cognitive Warfare LOE is working to enable warfighters to anticipate, operate, and adapt to rapid changes in the information environment. Work is focused in three interdependent areas.

1. **Characterization of Operations in the Information Environment** - Descriptive and anticipatory analytics that derive from network and content data to inform assessment and decision making re: information maneuvers and strategies
2. **Scalable Models for Cognitive Warfare** - Develop models at different scales to examine different social dynamics and features that impact individual and group cognition
3. **Resilience to Malign Influence** - Develop experiments that examine the underlying psychological mechanisms of influence and test methods to build resilience

DIGITAL MODELS OF COGNITION CRA	HUMAN-MACHINE INTERACTIONS CRA
Holistic Models for Decision-Making LOE LEAD: DR. FRANK MOBLEY	**Rapid Joint-Cognitive Awareness** LOE LEAD: DR. PAUL HAVIG
Information Mastery in Cognitive Warfare LOE LEAD: DR. KATIE LARSON	**HMI-Enabled Decision Superiority** LOE LEAD: DR. ERIC GEISELMAN
Team Optimization and Recovery LOE LEAD: MS. JESSICA BARTIK	**Warfighter Learning Technologies** LOE LEAD: MR. TED HARMER
Dynamic Team Performance Assessment LOE LEAD: DR. GREGORY FUNKE	**Co-Learning for Adaptive Human and Machine** LOE LEAD: MS. JENNIFER WINNER (ACTING)
DISTRIBUTED TEAMING & COMMUNICATION CRA	LEARNING & OPERATIONAL TRAINING CRA

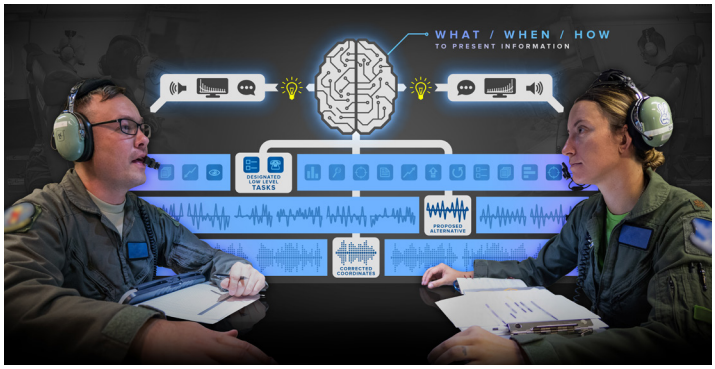
HOLISTIC MODELS FOR DECISION-MAKING

The Holistic Models for Decision-Making LOE is developing models of cognitive systems that support quantitative understanding and prediction of mission effectiveness involved in controlling crewed aircraft and Collaborative Combat Aircraft (CCA) within the Next Generation Air Dominance (NGAD) family of systems for decision superiority. This effort develops computational and mathematical models to represent human perception, information processing, decision making, and action within tactical environments. Considerations include the internal and external factors that modulate cognitive performance efficiency and effectiveness within tactical environments as well as the development of learning theories and mechanisms across cognitive components to advance robust cognitive models with high predictive validity and interpretability.



Graphics by Mr. Will Graver

DISTRIBUTED TEAMING AND COMMUNICATION CRA



DYNAMIC TEAM PERFORMANCE ASSESSMENT

The Dynamic Team Performance Assessment LOE is working to enable the rapid formation, real-time assessment, and dynamically optimized performance of distributed heterogeneous teams of warfighters as well as human-machine teams to promote rapid, agile & robust mission operations. Research areas include methods to support the rapid formation of mission-effective heterogeneous teams, dynamic monitoring of team performance via optimal assemblage of novel and existing metrics, and real-time contextual aids from team communication. The LOE's focus is currently on four interconnected projects:

1. **Novel Team Performance Metrics** – Providing advanced real-time performance assessment methods and analytics
2. **Team Trust Contagion** – Studying real time, objective measures of trust spread in multi-mixed teams
3. **Contextualized Communication Machine Learning (ML)** ML to deliver distributed, dynamic measures of teamwork and machine understanding of multisensory data and communication to ensure optimized decision-making
4. **Agile Communication for Teamwork** – Adaptive communication interfaces enabling effective multi-mixed teams in Joint All-Domain Command and Control (JADC2)

Work on these projects will enable warfighters to rapidly extract meaning from complex, uncertain, and multi-dimensional data sources. Empowering warfighters of present and future battlefields to manage information from disparate sources, attend to a greater number of concurrent tasks, and more effectively collaborate within distributed teams will aid operations in contested or denied environments.

Image courtesy of AFIT

Graphics (top) by Mr. Will Graver

TEAM OPTIMIZATION AND RECOVERY

Teams working in complex, distributed communication environments can struggle to coordinate and maintain situational awareness. Disparate and uncertain JADC2 data needs to be integrated and acted upon, and current state-of-the-art conversational artificial intelligence (AI) systems and the supporting technologies are not optimized for dynamic military Human-Machine Teaming (HMT) operations. To address these issues, the Team Optimization and Recovery LOE has a prioritized focus on exploring and maturing tools for JADC2 team coordination, collaboration, and agility to ensure maximum team performance. Work for this LOE includes designing, developing, and evaluating team optimization and recovery technologies to enhance communication, coordination, and improve decision making among distributed teams. Research areas include interfaces to support joint tasking and team shared awareness (SA) across multiple domains as well as conversational AI technologies to enable high bandwidth natural communications.

Distributed teaming research, JADC2 information integration, and enhanced, naturalistic conversational AI systems for teaming are all part of a larger effort toward exploring and maturing tools and methods for JADC2 team coordination, collaboration, and agility. Expected benefits of this research is enhanced human-machine teaming via tailored, naturalistic interactions, all-domain agility and decision superiority via integrated cross-domain interfaces, and robust distributed teaming via calibrated information exchange.

HUMAN-MACHINE INTERACTIONS CRA

RAPID JOINT COGNITIVE AWARENESS

Decision superiority requires continual situation awareness. Rapidly developing this awareness throughout the human-machine system will be key in the complex and uncertain warfighting environments of the future and today. The Rapid Joint-Cognitive Awareness LOE seeks to achieve decision superiority by optimizing human understanding of and engagement with increasingly complex, highly automated, and AI-enabled machines. The LOE's focus will be on developing human-centric interfaces and interaction strategies for improved AI/automation transparency, closed-loop adaptive systems that are responsive to warfighter state, and advanced techniques for effectively visualizing large, complex data sets.

Continued on next page

Research and development is focused across three projects:

1. **Multi-level Transparency for Human-Autonomy Interaction (HAI)** – When, why, and how should AI/ML/ Large Language Model (LLM) be transparent or translucent?
2. **Closed-loop HAI Adaptation** (a collaboration with RHB) How should Human-Machine Interactions (HMI) adapt intelligently to the current operator state?
3. **Information Visualization with Uncertainty** – How to rapidly find answers in large, complex datasets?

Potential results and products include transparency methods (analytic assumptions, interface features, learning affordances, and joint human-AI training), adaptive HMI processes, and intuitive information conveyance. Ultimately, this work will result in increased warfighter trust, reliance, and effectiveness for advanced automation and AI systems while providing the capability to leverage untapped data sources for improved decision-making.

Graphic by 711 HPW/RHWI

HMI-ENABLED DECISION SUPERIORITY

Optimizing warfighter interface engagement efficiency and decision-making requires achieving synergies from concentrated HMI focus and expertise across mission platforms. The HMI-Enabled Decision Superiority LOE is working toward these decision superiority goals by optimizing human engagement with increasingly complex, highly automated, and AI-enabled machines. The focus will be on delivering capabilities for continuous planning for command and control (C2), next generation interfaces for complex intelligent platforms, and interfaces tailored for emerging Cognitive Warfare (CogWar) concepts.

Meeting future threats will require continuous planning for improved agility. Emerging CogWar concepts require novel human interface technologies and warfighter state sensing to maintain SA, manage threats, and deploy capabilities. Products from this LOE can be expected to provide continuous planning tools for agile decision making, common Pilot-Vehicle Interface (PVI) across airframes that offer enhanced capabilities for retrofit and next generation platforms, and tools for deploying CogWar effects toward adversaries while defending against their respective efforts, such as deception, influence, etc.

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Dr. Glenn Gunzelmann, Human Learning & Cognition CTC Lead, 711 HPW/RHW
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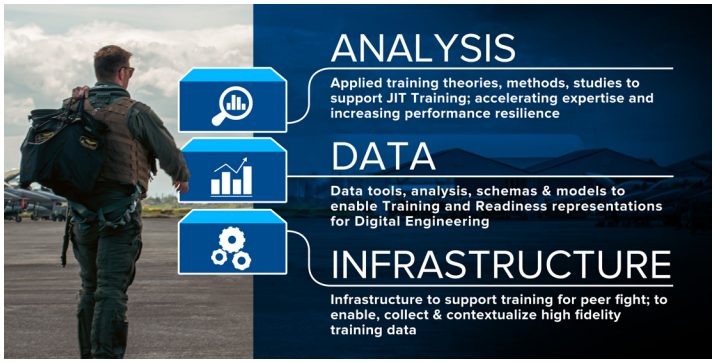
LEARNING AND OPERATIONAL TRAINING CRA

WARFIGHTER LEARNING TECHNOLOGIES

The Warfighter Learning Technologies LOE is defining, developing, and experimenting with personalized, proficiency-based readiness applied in dynamic multi-domain environments to enable decision superiority and operational success. This work will create the infrastructure to support blended/effects centric integrated mission training to combat peer adversaries, the data needed to understand, track, and support mission readiness across training modalities, and the skills and instructional methods needed for Airmen and Guardians to adapt to changing mission needs.



CO-LEARNING FOR ADAPTIVE HUMAN AND MACHINE TEAMS

Future Air Force operations will call for teams of crewed and uncrewed systems working together with responsible AI and multi-capable Airmen and Guardians. Creating mission ready and effective teams requires members of a team training together as a team. The Co-Learning for Adaptive Human and Machine Teams LOE will lay the foundation for methods and technologies to support the interactive learning between humans and AI-enabled technologies, as well as adaptive team training paradigms with relevant test and evaluation approaches to ensure uniquely effective human-autonomy team members. These teams need to understand each other's capabilities, learn new content flexibly from and with each other through real time interactions, and adapt to and perform in uncertain, rapidly changing, and unknown situations. Achieving these goals will result in mission-ready team proficiency and decision making. ☆

Graphics (above) by Mr. Will Graver

PUBLISHED CONTENT (FEBRUARY - MAY 2023)

JOURNAL ARTICLES / CONFERENCE PROCEEDINGS

Curley, T., Borghetti, L., & Morris, M. B. (in press). Gamma power as an index of sustained attention in simulated vigilance tasks. *topiCS*.

Mobley, F. (2023, May). Classification of SUAS propellers with auditory feature extraction methods. In *INTER-NOISE and NOISE-CON Congress and Conference Proceedings* (Vol. 266, No. 2, pp. 102-113). Institute of Noise Control Engineering.

Morris, M. B., Rhodes, L. J., Borghetti, L., & Haubert, A. (2023). Vigilance end-spurt patterns in event-related potentials. *Brain Research*, 1812, 148396. https://doi.org/10.1016/j.brainres.2023.148396.

Rasband, R., Mobley, F., & Reeves, M. (2023, May). Characterization of unmanned aircraft system acoustic noise. In *INTER-NOISE and NOISE-CON Congress and Conference Proceedings* (Vol. 266, No. 2, pp. 906-914). Institute of Noise Control Engineering.

Seals, S. M., & Shalin, V. L. (2023). Long-form analogies generated by chatGPT lack human-like psycholinguistic properties. *arXiv preprint arXiv:2306.04537.*

Veksler, B., & Morris, M. (2023). *Caffeine countermeasures and fatigue modeling of aircrew in wargaming simulations* [Meeting Abstract]. Aerospace Medicine and Human Performance, 94(4), 286.

PRESENTATIONS

Call, L. (2023, February 13-17). *Advanced Radar and Jamming in DIS* V8. 2023 Simulation Innovation Workshop.

Curley, T., Blaha, L., Fallon, C., Morris. (2023, March 15). *Age and Anthropomorphism in Perceptions of Good Digital Teammates*. Human Machine Teaming COI Series – Pacific Northwest National Laboratory (PNNL).

Draper, M. (2023, February 28). *Human-AI Teams in Future Multi-domain Operations: Challenges to Maintain Meaningful Human Control.* Arizona State Workshop on Human-Autonomy Teaming.

Morris, M. B. (2023). *Individual differences in human-machine teaming*. Invited talk at the Pacific Northwest National Laboratory Human Factors Symposium. Pacific Northwest National Laboratory, Richland, WA.

Piper, B., & Mator, J. (2023 March 1) *The Contagion Effect of Trust in Multi-UAV systems*. National Defense Industrial Association 2023 Meeting.

Van Cutsem, J., Morris, M., Kelley, A., & Gunzelmann, G. (2023). *The fatigue countermeasures toolbox: A guide to facilitate personalized application*. Presentation at the Ramstein Aerospace Medicine Summit and NATO Science & Technology Organization Technical Course, Garmish-Partenkirchen, Germany.

Winner, J. (2023, April 14) *Perspectives on Education & Simulation: Where Do We Stand.* HFES Training TG Meeting.

Winner, J. (2023, April 14). *Training Research for the Future Military Medical Training System.* HFES Training TG Meeting.

RHW RECOGNITIONS

2023 1st QUARTER AWARDS

RH

Civilian Category III:
Dr. Chris Brill

Civilian Category II:
Mr. Matthew S. Scharf

RHW

Company Grade Officer:
Capt Andrew J. De Garmo

Non-Commissioned Officer:
TSgt Andrew C. Pauldine

Airman:
SrA Ried C. Clevenger

Collaboration (Team):
ATLAS: Adaptive Teamwork w/Layered HMI and Systems

711TH HPW/RHW

Hails

Maj Nathan Andling
Jim Bliss
Lt Seth Bohn
Lt Joshua Broekhuijsen
Erica Bucio
Capt Raymart De Asis
Craig Hillier
Sheng Li
Brad Schlessman
Valay Shah
Ben Steinhauer
Kristoffer Smith-Rodriguez

Farewells

Lt Samuel Braudt
Shari Brewer
Tammy Chelette
Jimmy Cline
David Day
Charles Gregory
Ashley Haubert
MSgt Jeffrey Held
Lt Taylor Jones
Alex Hooper
Maj Jason Lingle
Scott Macbeth
Lt Patrick Mei
Luke Nelson
Logan Rura
Brandon Schroll
Luke Waggenspack

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711 HPW/RHW Core Research Areas:
- **Digital Models of Cognition**
- **Distributed Teaming & Communication**
- **Human-Machine Interactions**
- **Learning & Operational Training**