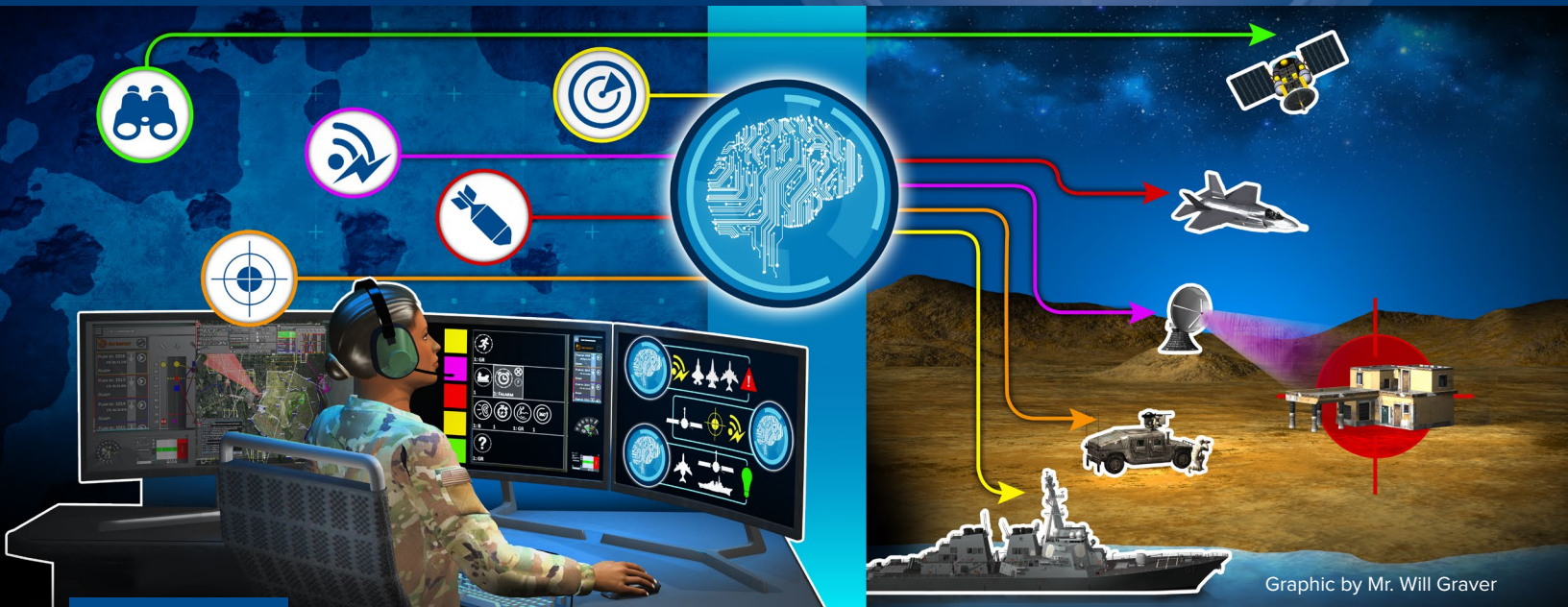


AFRL FIGHT'S ON!

THE AIR FORCE RESEARCH LABORATORY

ISSUE 68
WINTER 2023



Graphic by Mr. Will Graver

EXPLORING HUMAN-MACHINE TEAMING FOR JOINT ALL-DOMAIN OPERATIONS

The Joint All-Domain Operations (JADO) vision requires dramatic increases in the integration, speed, scale, and resilience of Air Force and DoD Command and Control systems. JADO envisions applying Artificial Intelligence (AI), computational power, innovative interfaces, enhanced communications, and other technologies to achieve these ends.

A key challenge is accomplishing this in a robust manner that is adaptable and resilient in future distributed operations, including near-peer operational contexts. Because of the non-linearity, emergence, and complexity of warfighting operations, integrated human and machine teams will be a key to maximizing combat power. By coupling and leveraging the strengths of both humans and machines, properly integrated Human-Machine Teams (HMTs) can be created that are more powerful, robust, and adaptive than applying these technologies separately.

The Joint All-Domain Planner with Adaptive Collaborative/Control Technologies (JADPACT) 6.2 project focuses squarely on this challenge by considering JADO from a warfighter-centric perspective. JADPACT will determine requirements for, develop, and evaluate advanced HMT concepts to enable future Joint All Domain (JAD) Battle Managers to create, assess, monitor, and adapt effects in the battlespace created by integrating capabilities from multiple domains (e.g., air, cyber, space, land, etc.) with the speed, scale, and resilience required to win the future high-end fight.

The project is developing a concept for a JAD Mission Commander Control Station (JADMCCS). The JADMCCS will integrate, assess, and revise several novel HMT technologies that support JAD Battle Management teams of the future in creating desired battlespace effects in accordance with commander's intent.

A key feature of this envisioned JADMCCS will be its agility to respond to unexpected situations and events. The future JAD Mission Commander will have the ability to intuitively and dynamically engage with AI/autonomous agents in order to perform various tasks across a scalable "spectrum of control" based on specific operational requirements (i.e., from fully manual without AI, to a mix of human and AI, to mostly or entirely autonomous) to achieve JAD mission objectives, with the human always retaining overall control of the system.

This work builds on previous work where a novel HMT C2 testbed (called IMPACT) was designed and demonstrated in an international exercise where, with the help of the AI, a single operator successfully managed 17 unmanned assets (air, land, and sea) simultaneously to achieve tactical base defense. The JADPACT 6.2 project will leverage successful methods and expertise from that project with a goal of developing feasible concepts to enable rapid and resilient All-Domain offensive operations. ★

Mr. Samuel Kuper, Senior Industrial and Systems Engineer, 711 HPW/RHWT
Dr Mark Draper, Research Lead: Warfighter Interfaces & Teaming CTC, 711 HPW/RHW
Dr Elizabeth Frost, Research Psychologist, 711 HPW/RHWT

THE NEW RHW CORE TECHNICAL COMPETENCIES

To better address the changing priorities of our Air and Space Forces, the RHW Core Technical Competencies (CTCs) and Core Research Areas (CRAs) are undergoing realignment. The reorganization of the CTCs and CRAs will build on lessons learned from the previous division merger, and allow RHW to continue to pursue bleeding edge research and the Secretary of the Air Force's Operational Imperatives.

HUMAN LEARNING AND COGNITION CTC

The new Human Learning and Cognition CTC enables more lethal Air and Space Forces through research on human multisensory perception, learning, information processing, and action. The research seeks to maximize mission effectiveness by (1) Establishing a persistent, global training and test ecosystem that creates the foundation for personalized, proficiency-based readiness for multi-capable Airmen and Guardians in joint all-domain operations, (2) Creating capabilities that allow teams of humans and machines to adapt and learn together in real time in training and operational settings, and (3) Advancing considerations of human performance in system development and operational planning with digital models of perception, cognition, and action.

DIGITAL MODELS OF COGNITION CRA

The new Digital Models of Cognition CRA emphasizes research to identify computational and mathematical mechanisms to represent human perception, information processing, and behavior, including the integration of models that reflect the role of internal and external factors that modulate performance efficiency and effectiveness. The goal is to develop holistic models that support quantitative understanding and prediction of mission effectiveness across domains and at different levels of abstraction for improved systems engineering, wargaming, and operational planning.

LEARNING AND OPERATIONAL TRAINING CRA

The new Learning and Operational Training CRA emphasizes learning and understanding in the context of evolving technology. This includes research to establish an ecosystem that maximizes mission effectiveness while minimizing costs by matching technologies to learning and performance needs; supporting high resolution human and system measurement and quantitative, proficiency-centric readiness assessment and prediction at the individual and team levels; and exploring how to enable human and machine co-learning to support mutual adaptation and understanding in human-machine teams.

WARFIGHTER INTERFACES AND TEAMING CTC

The Warfighter Interfaces and Teaming CTC will conduct research to enable robust decision superiority across our Air and Space Forces by dynamically optimizing the integration of warfighter cognition with increasingly complex and intelligent machines/systems, creating maximally effective and resilient warfighting teams. This research will focus on discovering, developing, evaluating, and transitioning advanced adaptive warfighter interface technology, mission-optimized distributed team performance enhancements, communication management processes, and context-tailored intelligent decision aids/analytics to achieve and maintain decision superiority in uncertain environments against peer threats.

DISTRIBUTED TEAMING AND COMMUNICATIONS CRA

The Distributed Teaming and Communication CRA emphasizes research that explores the rapid formation, real-time assessment, and dynamically optimized performance of distributed, heterogeneous teams of warfighters as well as human-machine teams to enable rapid, agile, and robust mission operations. Research areas will include methods to enable the rapid formation of mission-effective heterogeneous teams, dynamic monitoring and assessment of team performance via optimal assemblage of novel and existing metrics, adaptive tactics for recovery from real or predicted team performance degradations, and novel distributed communication and collaboration tools, technologies and management methods that are responsive to variable network environments.

HUMAN MACHINE INTERACTIONS CRA

The new Human-Machine Interactions CRA emphasizes research to identify principles of human interaction with highly complex systems, including advanced automation and increasingly intelligent AI-enabled machines. The goal of this research is to achieve and sustain decision superiority and performance across complex and uncertain mission environments. Research areas include identifying, characterizing, and overcoming key challenges to warfighter interactions with complex and intelligent systems such as situationally-adaptive interface design and usability, knowledge representation across sensory modalities, system observability and transparency, directability, joint cognitive decision making, and maintaining calibrated trust across changing conditions. ★

Dr. Glenn Gunzelmann, Human Learning & Cognition Core Technical Competency Lead, 711 HPW/RHW

RHW RECOGNITIONS



2022 3rd QUARTER AWARDS

RHW

Civilian-Category II:
Mr. Ian Joyce

Collaboration Award:
Dr. August Capiola

Company Grade Officer (CGO):
Capt Paul Grossi

2022 4th QUARTER AWARDS

711 HPW

Civilian Category II:
Mr. Michael Dougherty

IMA Field Grade Officer:
Maj Geoffrey B. Dobson

Senior Non-commissioned Officer:
MSgt Matthew Boland

RHW

Civilian Category III:
Mr. Samuel Kuper

Collaboration Award (Team):
Joint All-Domain Integrated ISR

Company Grade Officer (CGO):
Capt John Hrabovsky

Field Grade Officer:
Maj Raphael Watson

711TH HPW/RHW

Hails

Capt David Adamski
S. Conner Campbell
Taylor Curley
Lt Venessannah Deppermann
Kent Etherton
Capt Joshua Hensrud
Lt Griffin Keune
Tiffany Kuhns
Lt Nicholas Kundrat
Lt Brett Martin
Lt Teven Miller
Erik Rodenburgh
Lt Christopher Sears
Jonathan Stella
Lt Col Scott Storm
Capt Jonathan Turner
Lt David Uzhca

Farewells

Sam Angelo
Jessica Armstrong
Eric Biggs
Jim Bliss
Lt Kyle Bucklew
Lt Alex Ciolek
Capt Mitchell Cochell
Chad Cook
Capt Foster Davis
Dave Dommett
Lt Jacob Ehrenstrom
Greg Feitshans
Sandy Felt
Lt Anissa Garnsey
Lt John Gillispie
Parker Haley
Heidi Harkins
Lt Andrew Kinzinger-Petroski

2022 ANNUAL AWARDS

711 HPW

Collaboration Award:
Acoustic Center of Excellence

Commander's Cup (Team):
Networked Integrated Tactical Exercise

Field Grade Officer of the Year:
Maj Raphael Watson

RH

Civilian Category III:
Dr. Vincent Schmidt

RHW

Administrative Excellence (Individual):
Ms. Annette Armstrong

Civilian Category II:
Mr. Michael Dougherty

Collaboration Award:
Capt John Hrabovsky

Commander's Cup Jr:
Dr. Jayde King

Commander's Cup Sr:
Ms. Hilary Gallagher

Commander's Cup (Team):
Gaming Research Integration for Learning Laboratory®

Company Grade Officer (CGO):
Capt Sarah Soffer

RHW CONTINUED

Daniel Repperger Mentor of the Year Award: Ms. Emily Conway

Harry G. Armstrong Award (Individual):
Mr. Ted Harmer

Innovation Award (Individual):
Mr. Dave Malek

International Award (Individual):
Dr. Leslie Blaha

James W. Brinkley Leadership Award (Individual): Ms. Jennifer Winner

Non-commissioned Officer of the Year:
TSgt Joel Dumont

Scientific Technical Achievement (Team):
Joint All-Domain Integrated ISR

Scientific Technical Management:
Mr. Allen Rowe

Senior Non-Commissioned Office of the Year: MSgt Matthew Boland

Supervisory Award:
Dr. John Camp

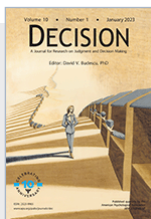
Technology Transition:
Human Language/Intel Deployment Team

Thomas S. Wells Senior Leadership Award (Individual): Mr. John Ianni

JOURNAL ARTICLES, CONFERENCE PROCEEDINGS, AND ABSTRACTS

Alarcon, G. M., Capiola, A., Hamdan, I. A., Lee, M. A., & Jessup, S. A. (2023). Differential biases in human-human versus human-robot interactions. *Applied Ergonomics*, 106, 103858. <https://doi.org/10.1016/j.apergo.2022.103858>

Alarcon, G. M., Capiola, A., Lee, M., & Jessup, S. A. (2022). The effects of trustworthiness manipulations on trustworthiness perceptions and risk-taking behaviors. *Decision*, 9(4), 388-406. <http://dx.doi.org/10.1037/dec0000189>



Alarcon, G. M., & Jessup, S. A. (2023). Propensity to Trust and Risk Aversion: Differential Roles in the Trust Process. *Journal of Research in Personality*, 104349. <https://doi.org/10.1016/j.jrp.2023.104349>

Borghetti, L., Rhodes, L. J., & Morris, M. B. (2022, September). Fatigue leads to dynamic shift in fronto-parietal sustained attention network. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 66, No. 1, pp. 606-610). Sage CA: Los Angeles, CA: SAGE Publications.

Gwinnup, J., Anderson, T., Duh, K., Enhancing Machine Translation Context with Video Object Labels. *2022 Conference on Empirical Methods in Natural Language Processing (EMNLP2022)*; <https://2022.emnlp.org>

Frame, M. E., Maresca, A. M., Christensen-Salem, A., & Patterson, R. E. (2022). Evaluation of Simulated Recognition Aids for Human Sensemaking in Applied Surveillance Scenarios. *Human Factors*, 00187208221120461.

Frame, M., Acker-Mills, B., Maresda, A., Curtis, E., Patterson, R., Buccello-Stout, R., Nelson, J., (30 November 2022); Evaluation of a Decision Support System Using Bayesian Network Modeling in an Applied Multi-INT Surveillance; *Journal of Human Factors*.

Howard, Z. L., Thorpe, A., & Fox, E. L. (2022). Switch It Up! How Context Influences the Efficiency of Redundancy Gains in a Peripheral Task. *Computational Brain & Behavior*, 1-18.

Kashani Motlagh, N., Davis, J., Anderson, T., & Gwinnup, J. (2022, December). Learning When to Say "I Don't Know. In *Advances in Visual Computing: 17th International Symposium, ISVC 2022, San Diego, CA, USA, October 3-5, 2022, Proceedings, Part I* (pp. 196-210). Cham: Springer International Publishing.

Lyons, J. B., aldin Hamdan, I., & Vo, T. Q. (2023). Explanations and trust: What happens to trust when a robot partner does something unexpected?. *Computers in Human Behavior*, 138, 107473.

Metzger, D., Miller, K., Lyon, W., Migliozi, R., Pangburn, H. A., & Saldanha, R. (2022). Host Cell Transcriptional Tuning with CRISPR/dCas9 to Mitigate the Effects of Toxin Exposure. *ACS Synthetic Biology*, 11(11), 3657-3668.

Morris, M. B., Rhodes, L. J., Borghetti, L., Haubert, A., & Gunzelmann, G. (2022). Examining attentional and memory mechanisms of the vigilance decrement with event-related potentials. *International Journal of Human Factors and Ergonomics*, 9(4), 328-349. <https://doi.org/10.1504/IJHFE.2022.10051732>

Morris, M. B., Veksler, B. Z., Noesen, B., Tuttle, J., Carpenter, B., Tran, P., & Gunzelmann, G. (2022). Human fatigue modeling in wargaming simulations. *Proceedings of the 2022 Interservice/ Industry Training, Simulation, and Education Conference*, Paper No. 22331. <https://www.xcdsystem.com/itsec/proceedings/index.cfm?Year=2022&AbID=112519&CID=944#View>.

Olaveson, T., Gee, K. L., Wall, A. T., & Johnson, J. P. (2022). Joint time-frequency domain analysis of F404 engine noise sources using event-based beamforming methods. *The Journal of the Acoustical Society of America*, 152(4), A257-A257.

Simpson, B., Kneeland, C., Flach, J. (2022). *The Dynamics of Resilient Decision Making in Organizations: Multi-Layered Model. International Decision Making 2022*, Orlando, FL.

Stevens, C. A., Morris, M. B., Fisher, C. R., & Myers, C. W. (2022). Profiling cognitive workload in an unmanned vehicle control task with cognitive models and physiological metrics. *Military Psychology*, 1-14.

Streeter, J. B., Christian, M. A., Gee, K. L., Wall, A. T., & Campbell, S. C. (2022). Assessing impact of near-ground meteorology on spectral variability in static jet aircraft noise measurements. *The Journal of the Acoustical Society of America*, 152(4), A257-A257.

Veksler, B. Z., Morris, M. B., Krusmark, M. A., & Gunzelmann, G. (2023). Integrated modeling of fatigue impacts on C-17 approach and landing performance. *The International Journal of Aerospace Psychology*, 33(1), 61-78.

Wall, A. T., Campbell, S. C., & Mobley, F. S. (2022). Microphone location investigation for standard aircraft ground run-up noise measurements. *The Journal of the Acoustical Society of America*, 152(4), A256-A256.

PRESENTATIONS

Campbell, S. C., Wall, A. T., Mobley, F. S., Rasband, R. D., & Gee, K. L. (2022). Analysis of an acoustic propagation model for sources of noise with directivity in indoor environments. *The Journal of the Acoustical Society of America*, 152(4), A161-A161.

Epps, K. A., Olaveson, T., Gee, K. L., Wall, A. T., & Swift, S. H. (2022). Near-field coherence analysis of noise from an installed F404 engine. *The Journal of the Acoustical Society of America*, 152(4), A257-A257.

Frame, M., Morgan, J., Curtis, E., Schlessman, B. (2022). *Communicating EELs: Impacts of Detail and Commander's Intent. Society for Computation in Psychology*.

Gallagher, H., Ashworth, A., Wall, A., Williams, D. (2022). *Modeling Impacts of Flashbang Exposures in Confined Spaces. SAFE Symposium*.

Gallagher, H., Williams, D. (2022) Investigating Double Hearing Protection: *Performance of Filtered Earplugs Paired with Headsets/Helmets. Battlefield Acoustics Workshop, Institute of Saint Louis, Oct 2022*.

Wall, A., Giese, A., Gee, K., Downing J., James, M., Rasband, R. (2022). *Rocket Noise Models for USDoD. NASA Acoustics Technical Working Group, NASA Glenn, OH. https://nari.arc.nasa.gov/atwg_unwg2022*

Winner, J., Sorensen, D., Gorman, J. C., Grimm, D., Jarvis, M., Robinson, F., King, J., & DiBiase, R. (2022). *Team coordination measures for en route care training: Foundations for scalable assessment. Military Health System Research Symposium. Kissimmee, FL*.



Published quarterly since 2001, Fight's ON! continues to serve as the Division publication for our partners and features innovative science and technology that is accelerating and revolutionizing readiness.

To view more issues, visit: www.afresearchlab.com/FightsOn

Fight's ON! Point-of-Contact
Patricia D. Wood, 711 HPW/RHW
patricia.wood.2@us.af.mil
937-938-4051

Cleared / Case # AFRL-2023-1702

Distribution Statement A / Approved for public release; distribution is unlimited.

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