1. The Warfighter Effectiveness Research Center (WERC) at the US Air Force Academy

The WERC is a research laboratory at the United States Air Force Academy conducting basic and applied research to enhance warfighter effectiveness. The WERC conducts a wide range of research and design projects for operational customers. This research is based in the behavioral sciences and connected to a wide range of disciplines and collaborators across government labs, academia, industry, and military operators to generate the most innovative and effective solutions.

1.1 Facilities

The USAFA Research Center maintains seven dedicated research laboratory spaces (see Figure 2). Each laboratory is equipped with Ethernet, campus wireless internet, and commercial internet. Additionally, the laboratories are connected via local area network to select offices within the Research Center’s footprint. This allows for any computer or robot connected to the local area network to be controlled remotely at several locations during Wizard-of-Oz Paradigms. The Research Center provides a shared office for Postdoctoral Researchers, Developers and Research Assistants located adjacent to the offices of the Principal Investigators.

1.2. Major Equipment

Across the three laboratories in the Research Center, each experimental station contains a desktop computer running experimental software, two computer monitors, and peripherals (keyboard, mouse, head-phones, etc.). The Research Center contains a battery of robots that can be programmed for experiments: Furhat Robot, Ghost v60 Robotic Dog, Pepper Humanoid Robot (Softbank Robotics; one (1) in Laboratory 2), Nao Humanoid Robot (Softbank Robotics; one (1) in Laboratory 3), Baxter Collaborative Robot (Rethink Robotics; 1 in Laboratory 1), Create 2 Programmable Robot (iRobot; four (4) in Laboratory 2), Cue Robot (Wonder Workshop; six (6) in Laboratory 1), and Cozmo Robot (Anki; six (6) in Laboratory 1).

Figure 1. Air Force Tesla Model X exterior (left) and interior (right) during earlier conducted parking studies (Tenhundfeld et al., 2019; 2020).

Figure 2a-b. (a) The Autonomous Flight Testbed with cadet participant and (b) F-35 pilot’s dashboard display.
The WERC has also established a mobile research laboratory known as HART (Human-Automation Research in a Tesla) mobile lab (see Figure 1). This mobile lab environment is set up in a 2017 Tesla Model X car, equipped with various automated features which include lane-following, adaptive cruise control (ACC), and automated parking. The car has been instrumented with several biometric collection devices.

One of our newest technologies, the Ghost Robotics Vision60, is making an impact at USAFA and a central feature of capstones in Model-Based Systems Engineering and human-machine teaming:

![Image of Ghost Robotics Vision60](image)

### 1.3. Other Resources

The United States Air Force Academy Research Office provides budget assistance and administration. The Academy also subscribes to Sona Systems, an online university research service that enables universities to recruit and manage research participants. Each year, USAFA cadets enrolled in Behavioral Sciences 110 and 310 have the option to participate in research studies through Sona in exchange for extra credit. Researchers at USAFA have access to a participant pool of two-thousand (2000) students per academic year.

### 2. Relevant Grants

#### 2.1. AFOSR Grant Research Overview and Approach

The issue of trust in autonomy and AI will be at the forefront of successful technology integration into future military operations. It is unclear if more advanced technologies will exacerbate trust, attentional, and resource allocation challenges or help improve these systems. Furthermore, the high-stakes environment in which AI and autonomy will be deployed in the military, such as remotely-piloted aircraft and the F-35, increase the potential for costs (or vulnerability) to the human-AI system. Therefore, foundational studies are needed to understand the influence of these technologies on decision making, ethics, and overall performance outside of lab environments. We proposed a series of studies along two research aims to examine human-intelligent agent trust...
development, maintenance, and repair in real-world environments. The first research aim, Adaptive Calibrated and Effective human-autonomy and algorithmic Systems (ACES), is a three-year set of capstones for cadets, faculty, and collaborators to understand the symbiotic relationship between humans and intelligent technologies. This aim focuses on issues of explainable AI, transparency and how these designs affect trust calibration and repair, especially in situations of high uncertainty and in cases where the algorithm outperforms humans. The research is executed in our customized research testbeds including the F35 simulation as well as the Tesla Model X research vehicle (see Figure 1). The second research aim is to investigate the influence of a socially intelligent and ethical mission assistant (SIEMA), which is envisioned to either be virtual or a robotic agent, on human-autonomy team performance. Given the proliferation of many types of intelligent machine agents, including physical robotic systems and virtual agents, and the commitment of the DoD to develop and deploy them widely, there is a need for these agents to exhibit a degree of ethical competence. We are investigating SIEMA’s ability to provide ethical advice and 2) its ability to effectively communicate ethical decisions and information in a human AI-teaming context. The research is executed in testbeds that have been adapted for ethical scenarios and critically examine the relationship between ethical and effective human-AI team performance. Outcomes of both projects are extending theories of trust and human-machine teaming by identifying relevant contextual and design factors, uncovering the social influence of intelligent technologies on humans, and defining team ethical performance metrics applied to ecologically-valid tasks and environments.

2.2. Human-Machine Teaming Research Emphasis

To date, our grant has been extremely productive in terms of both the high-quality scholarly output as well as the productive collaborations we have established. Since the start of the WERC, we have published 15 manuscripts including 12 journal papers and 3 conference proceedings in high quality outlets with an additional three journal publications currently in revision (see Appendix). To highlight some successes, we published one paper (Tossell et al., 2022) in the Proceedings of the National Academies of Sciences (PNAS, impact factor 12.78). This work that was also covered by...
the Economist and Time Magazine. Additionally, we received a best-paper award for our work on creating and evaluating the trustworthiness of a GPT-enabled moral robot advisor at the HICSS conference (Momen et al., 2023). The study of ethics in human-machine contexts is a new emphasis (see above poster). We have also pioneered an entirely new autonomous driving methodology to assess trust in automated driving that has resulted in several publications (Madison et al., 2021; Hsieh et al., 2022; Momen et al., in revision). Through this grant, we have established numerous productive collaborations leveraging the unique status of the USAFA-WERC as a hub including with Beth Phillips at George Mason University, Jonathan Gratch at the Institute of Creative Technologies, Nathan McNeese at Clemson University, Tom Williams at the Colorado School of Mines, Leanne Hirschfield at the University of Boulder, Marlena Fraune at New Mexico State University, Tony Hsieh at Texas A&M University, Stephen Fiore at the University of Central Florida, Gregory Funke at AFRL Dayton Ohio, Anthony Ries at ARL, Adolfo Escobedo at Arizona State University, Nancy Cooke at Arizona State University, and Nathan Tenhundfeld at the University of Alabama Huntsville.
Example WERC Publications 2021-2023


Some WERC Publications 2017-2020


Social Robots. In *Companion of the 2020 ACM/IEEE International Conference on Human-Robot Interaction* (pp. 287-289)


head-mounted displays. The International Journal of Robotics Research, 0278364919842925


