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# Applied Robotics for Installations and Base Operations (ARIBO)

## Overview January, 2016

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# ARIBO Strategic Objectives



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- 1. Socialize users and non-users with automated systems*
- 2. Identify operational issues / develop mitigation strategies*
- 3. Generate empirical data (e.g. performance, reliability, maintenance, etc.)*

**Summary: Progress toward these objectives will accelerate tech transition delivering better, less-expensive products to warfighters**



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# Phased Deployment Mitigates Risk and Builds Trust and Confidence



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## Phase 1 (chauffeured)

- Functionally, essentially no significant difference from normal shuttle operations
- Data collection and comparison (human:robot)

## Phase 2 (safety operator)

- Driver becomes a safety operator
- Control shifted to robot and data collected

## Phase 3 (fully automated – driverless)

- Human removed from vehicle
- Lessons learned and findings applied

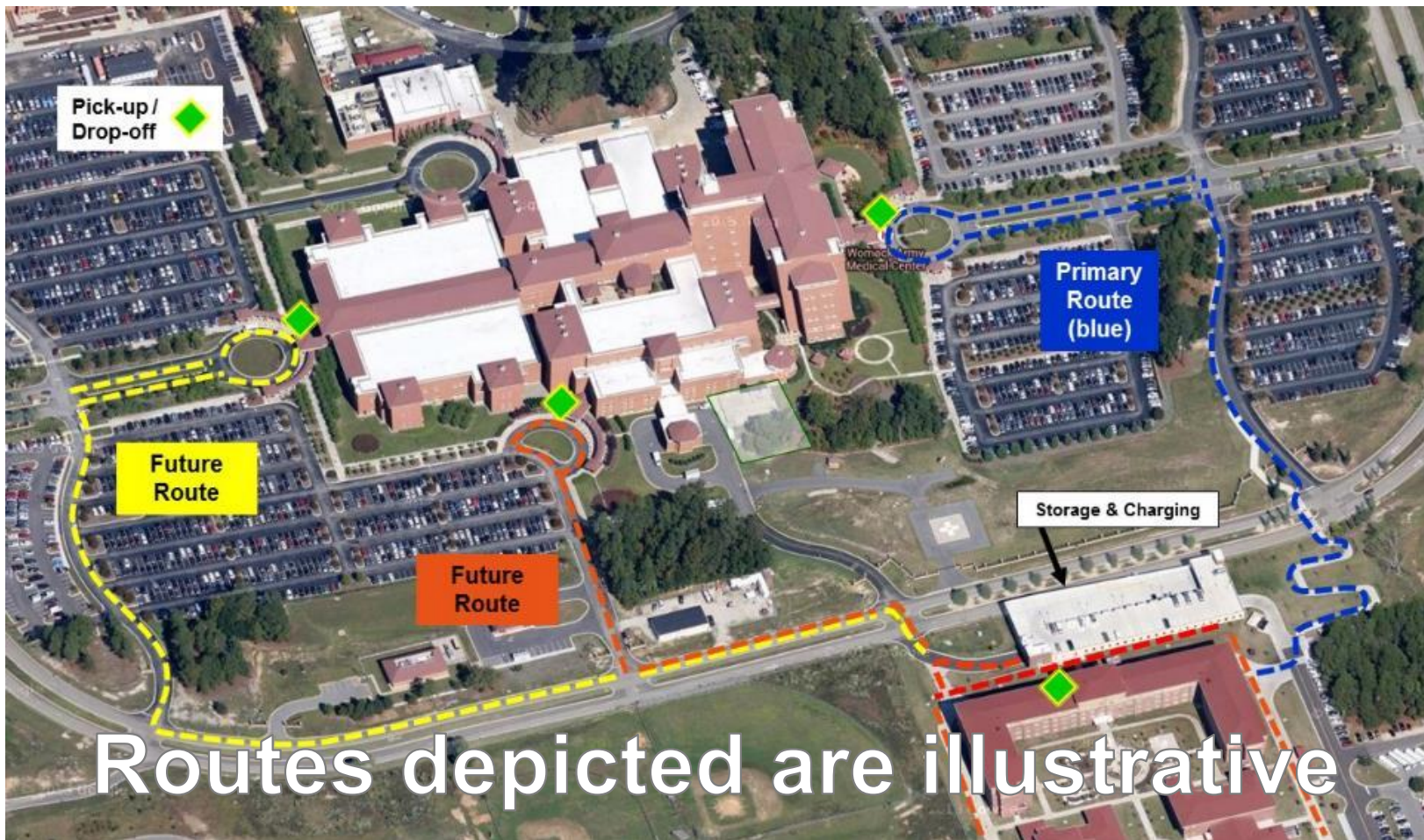




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# ARIBO Ft. Bragg

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Routes depicted are illustrative



NRI



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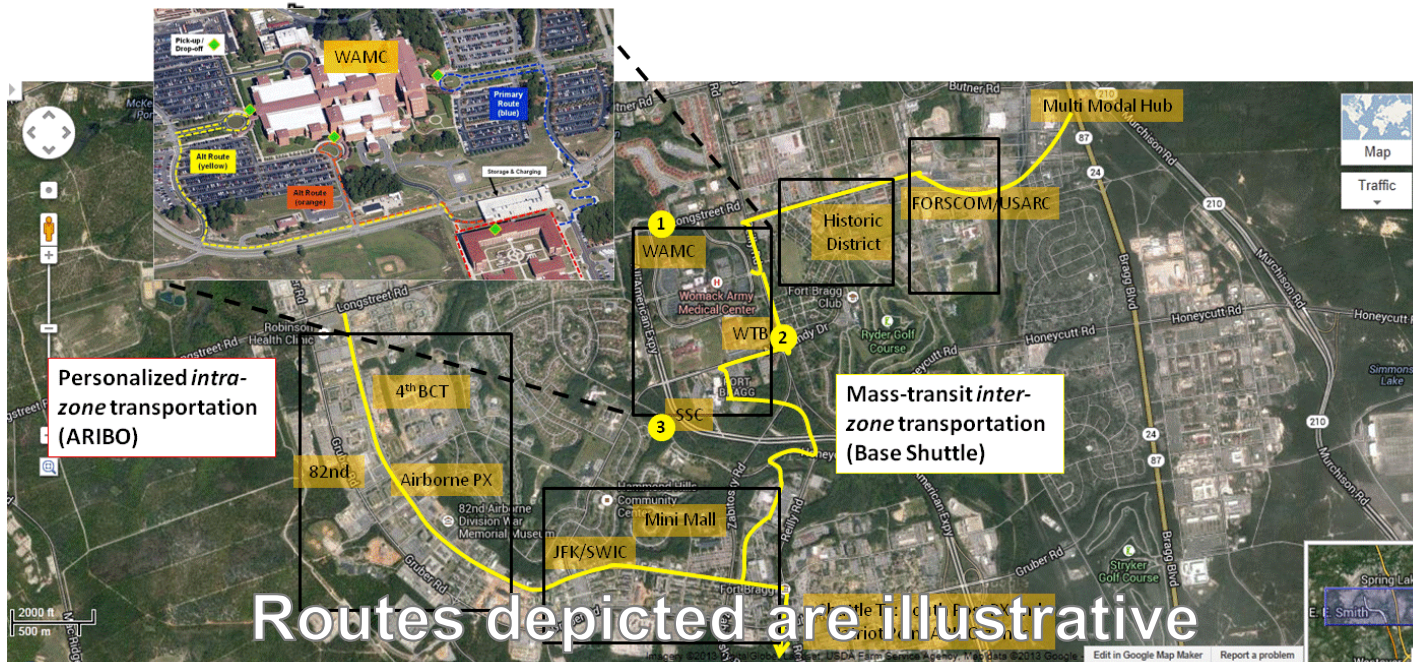


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# Embracing the idea of automation (Ft. Bragg)



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STATUS: funded,  
development

## Fort Bragg:

- Model installation for NTV management
- AV's incorporated in transportation master plan.
- Scalable solution.
- Supports district management of transportation assets
- Initial business case hypothesis based on reducing missed appointments

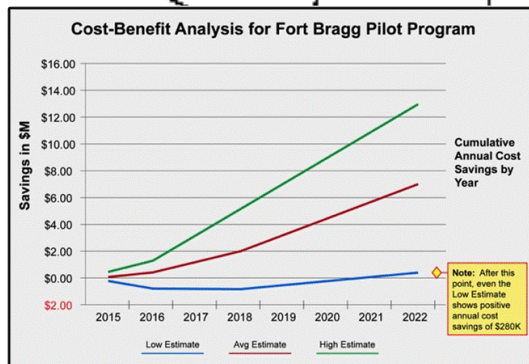


### PROJECTED SAVINGS

**\$20M** in next 7 years

#### Other Considerations:

- User Feedback
- Quality of life
- Non-user Feedback
- Technical Reliability
- Costs / Benefits
- Operational Constraints



This is an *additive* savings

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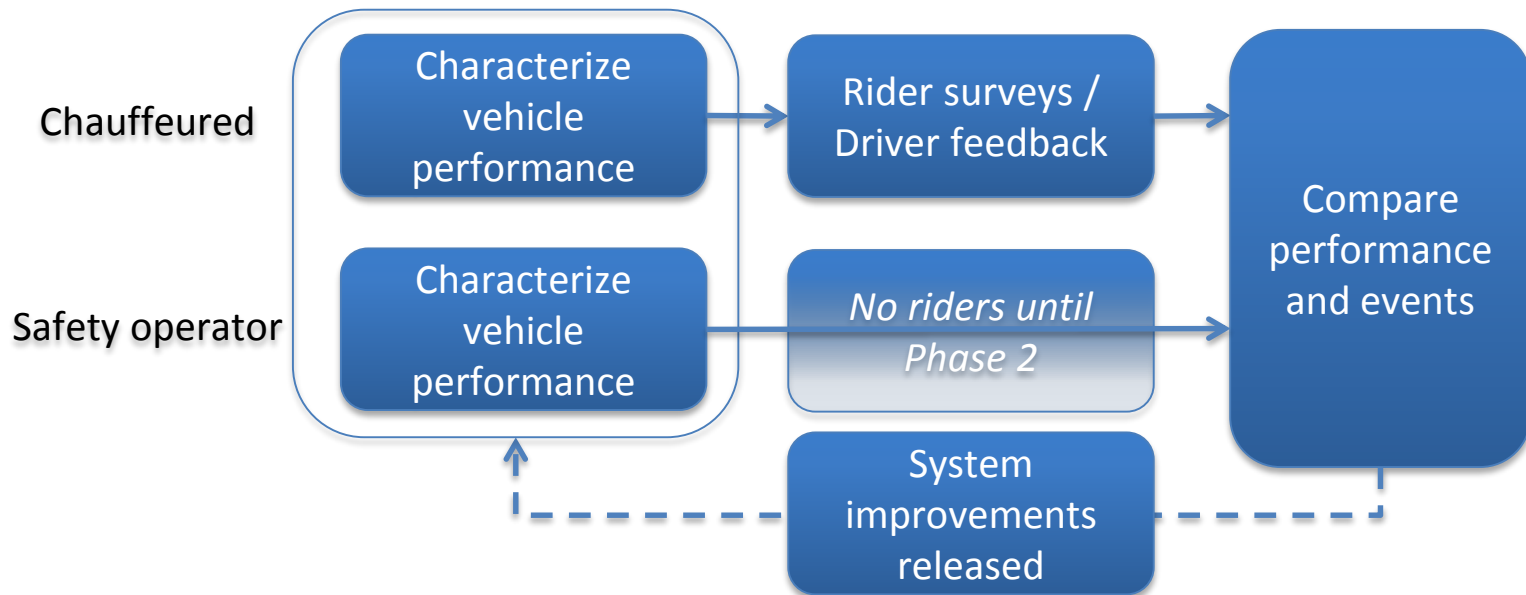
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# ARIBO Ft. Bragg Phase 1 Evaluation Methodology



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## Comparing human performance to robot performance





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# NTVs: Opportunities across many domains

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## Department of the Army Non-Tactical Vehicle (NTV) Fleet Data (2013 GSA data)

**The Army manages almost 66,000 NTVs at a cost of over \$400M**

	Inventory	Cost	Miles driven
Army-owned	10,539	\$72,219,872	55,242,115
Commercial lease	301	\$5,535,653	2,210,878
GSA Fleet	54,888	\$327,265,473	505,389,042
<b>Total</b>	<b>65,728</b>	<b>\$405,020,998</b>	<b>562,842,035</b>

*Half of these are  
passenger cars*

**1 shared car can replace 4-6  
individually operated vehicles\***

\*Source : E. Martin, S. Shaheen, J. Lidicker, "The Impact of Carsharing on Household Vehicle Holdings: Results from a North American Shared-Use Vehicle Survey." Transportation Research Record, 2010





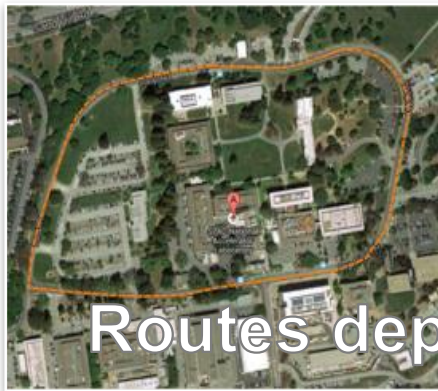
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# Simulation Experimentation: Trust Onboard the Vehicle

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## Non-emergency Door-to-Door Wounded Warrior Transit



Routes depicted are illustrative

### ARIBO Project Goals

- Improved technical reliability
- Data for informed policy decisions and system design
- Empirical data for business case development and ROI calculations
- **Increased trust & confidence in automated systems**

### Experiment 1: Trust and Dual-Task Engagement (Safety Driver)

- Completed

### Experiment 2: Trust, Control Allocation and Vehicle Autonomy (Passenger)

- Preliminary Data Analysis Complete

### Experiment 3: Trust, Transparency, and Interface Design (Passenger)

- Future Work – FY16



## Experiment 1 (complete)

### Impact to Scientific Community

- Supported the 3 Factor Model: The human element is important
- Advanced the 3 Factor Model: Possible addition of working memory capacity and coping style to the model
- Schaefer, K.E. & Scribner, D. R. (2015)

### Impact to the Army

- Provides baseline for methodology to study trust in simulation and identify design features to engender trust

## Experiment 2 (preliminary)

### Impact to Scientific Community

- Trust was high for both types of control interface designs (for a 100% reliable vehicle)
- Mixed preferences for type of control interface
- Additional analysis underway to understand the human-element of trust development

### Impact to the Army

- Provides initial insights into design features for ARIBO passenger vehicles



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## Future Research: Non-Users Impact Study

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### **Question: What is the impact of autonomy-enabled vehicles and system controls on non-users?**

This field study will characterize non-user behavior and the factors that shape their perceptions of these vehicles in situations familiar to any driver or pedestrian in typical transportation scenarios.

**Impact:** Understanding these factors will lead to better decision-making which may accelerate the introduction and acceptance of autonomy-enabled vehicles on installations providing Army savings and efficiency gains.

*We define the “non-user” as someone compelled to interact with the machine while not directly benefiting from the use of its services.*



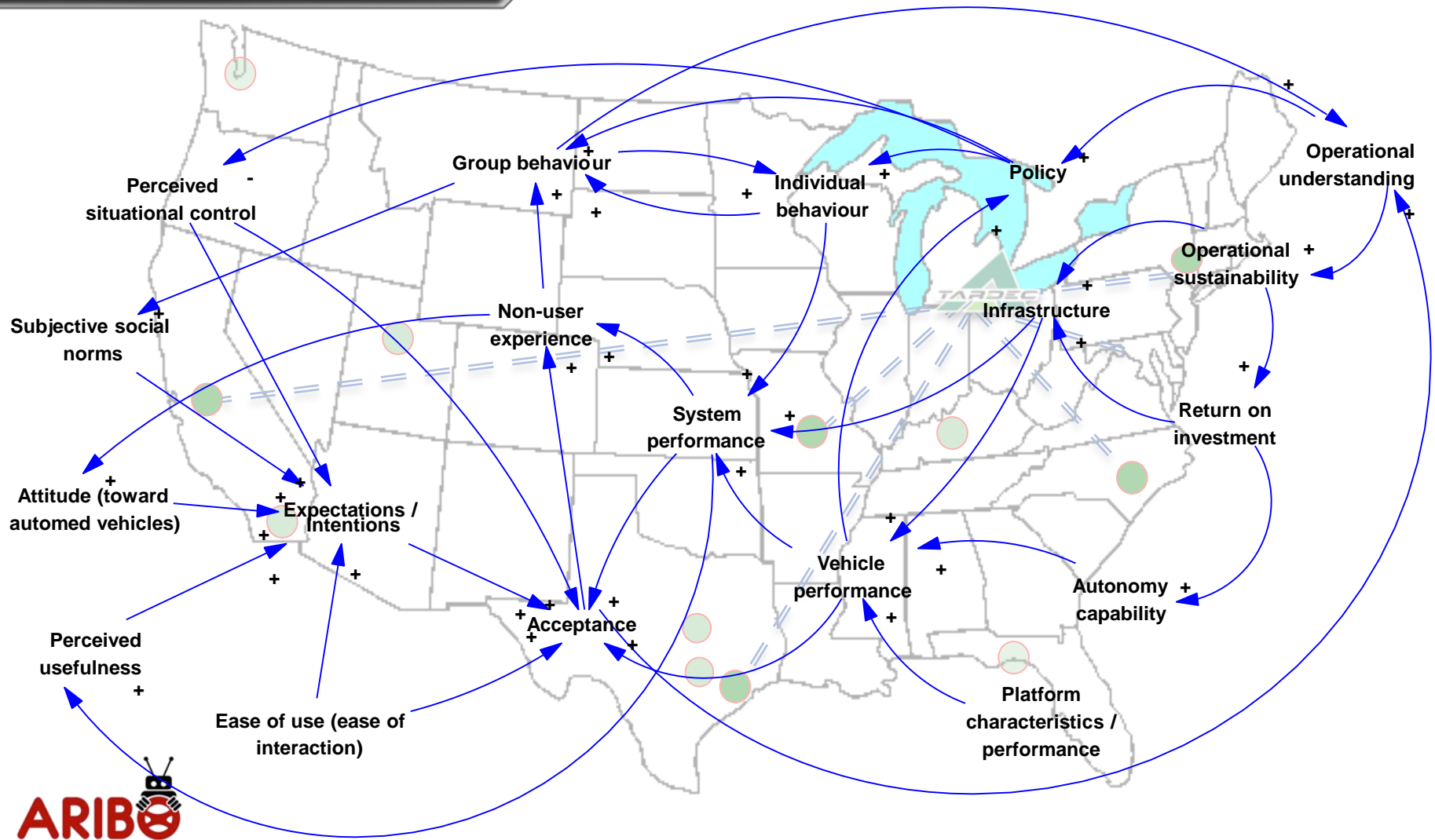


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# Non-user and system impact



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Edward Straub is a program manager and researcher with the U.S. Army. He is responsible for the Applied Robotics for Installations and Base Operations (ARIBO) program. Previous work includes consulting and strategic planning for defense organizations, automotive, and utilities companies in acquisition process improvement, organizational development, supply chain management, and software system integration. He is a former Marine and fellow at Case Western Reserve University where he received his Doctor of Management in 2015. His area of study was team dynamics and human social systems.

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Kristin E. Schaefer is an ORAU Postdoctoral Fellow with the U.S. Army Research Laboratory where she researchers trust in robotic and intelligent ground systems. She earned her M.S. and Ph.D. in the area of Modeling & Simulation from the University of Central Florida, Orlando, Florida; and a B.A. in Psychology from Susquehanna University, Selinsgrove, Pennsylvania. She currently has more than 20 journal publications and proceedings specific to the topics of trust, human-robot interaction, and modeling & simulation. Dr. Schaefer also currently serves as the General Chair for the IEEE Cognitive Methods in Situation Awareness and Decision Support (CogSIMA) conference.