Applied Robotics for Installations and Base Operations (ARIBO)

Overview
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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
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
ARIBO Ft. Bragg
Unclassified (Distribution A)

Routes depicted are illustrative
Embracing the idea of automation (Ft. 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

Fort Bragg:

- Model installation for NTV management
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PROJECTED SAVINGS
$20M in next 7 years

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

Cost-Benefit Analysis for Fort Bragg Pilot Program

Cumulative Annual Cost Savings by Year

Cost Savings in $M

This is an additive savings
Reservation & Monitoring Tools

Android Smartphone application and PC interface for system admin
Comparing human performance to robot performance

- Chauffeured
  - Characterize vehicle performance
  - Rider surveys / Driver feedback
  - System improvements released

- Safety operator
  - Characterize vehicle performance
  - No riders until Phase 2
  - Compare performance and events

No riders until Phase 2
The Army manages almost 66,000 NTVs at a cost of over $400M

<table>
<thead>
<tr>
<th></th>
<th>Inventory</th>
<th>Cost</th>
<th>Miles driven</th>
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<tbody>
<tr>
<td>Army-owned</td>
<td>10,539</td>
<td>$72,219,872</td>
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<td>Commercial lease</td>
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<td>GSA Fleet</td>
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<td><strong>Total</strong></td>
<td><strong>65,728</strong></td>
<td><strong>$405,020,998</strong></td>
<td><strong>562,842,035</strong></td>
</tr>
</tbody>
</table>


Half of these are passenger cars

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

*ARIBO Overview*
Non-emergency Door-to-Door Wounded Warrior Transit

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
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

Impact to the Army

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

Impact to the Army

- 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
**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.*
Non-user and system impact

Unclassified (Distribution A)
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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.