ROBOCIST
MOBILITY & ROBOTIC CONSULTING

Autonomous Shuttle Technology Review
Fort Bragg, NC and Greenville, SC Deployments

Strategic Transportation Planning Committee
August 06, 2018

Jeff Barghout
CEO, Robocist, Inc.

Agenda

Interactive dialog about Autonomous Shuttles:

- Who is Robocist
- Background
- Autonomous Shuttle Deployment - Approach
- Fort Bragg Deployment
- Greenville, SC Deployment

About Robocist

Bridging the gap between current and emerging transportation technologies

- Technology Scouting & Feasibility
- Demonstration, Evaluation & Implementation
- Driver Safety Technology Development
- Transportation Data Analytics

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US Transportation Statistics

40,000+ Fatalities
4.5 + Million Injuries
6+ Million Accidents

7 Billion Lost Hours in Traffic

3 Billion Gal. Wasted Fuel

$400 - $900 Billion Annual Price Tag

Source: U.S. DOT

Who's at Fault?

- **94% +** of accidents are human error
- **1%** of drivers applied the brakes at full force
- **1/3** of drivers didn't apply the brakes at all

Source: National Highway Traffic and Safety Administration (NHTSA)

Fully Autonomous Vehicles

- Drive themselves without human input
- GPS, LiDAR, radar, cameras, odometry, simulation, artificial intelligence, computer vision
- Interpret the driven environment
  - Self location, position, speed and trajectory
  - Object recognition, location, trajectory and intercept
  - Traffic signs and road markings
  - Accurately assess potential hazards

High Speed *verses* Low Speed

NHTSA: Identify Threat ¾ s + Reaction Time ¾ sec = 1.5 sec
Low beam headlights project about 160 feet

	 **Highway Capable Vehicle**	 **Low Speed Vehicle (LSV)**
Stopping Distance	265 Feet @ 55 mph	44 Feet @ 20 mph
Fatality Rate	87% @ 55 mph 60% @ 45 mph	7% @ 20 mph 2% @ 10 mph

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US Army: Autonomous Vehicle Evaluation Plan

Automated Vehicle Evaluation Plan

- US Army - Tank Automotive Research, Development and Engineering Center (TARDEC)
- US Army Fort Bragg

ARIBO: Applied Robotics for Installations and Base Operations


ARIBO

DRAFT-v3.1

Fort Bragg
Autonomous Warrior Transport On-Base
Automated Vehicle Evaluation Plan

March 27, 2017

Prepared by:

ROBOCIST
MOBILITY & ROBOTIC CONSULTING

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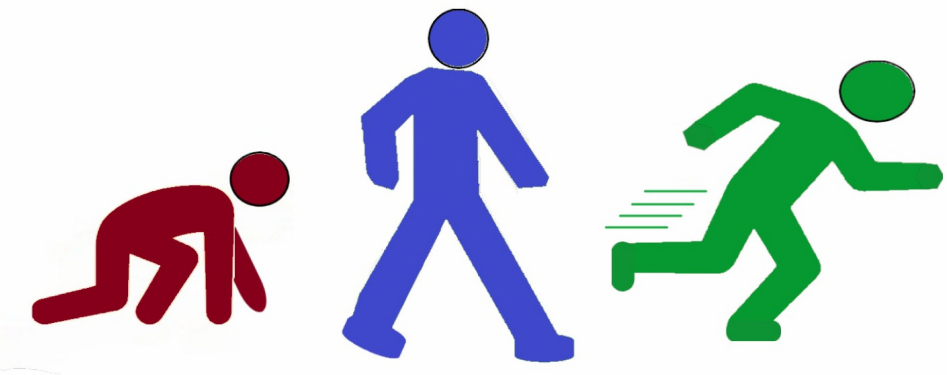
Evaluation Criteria Examples

- Mechanical Evaluation
- Rules of the Road
- Obstacle(s) Detection, Identification and Response
- Object(s) Recognition, Trajectory Prediction and Response
- Pedestrian Reaction
- Traffic and Intersection Negotiation
- Critical Path Planning and Selection
- Driver, User and Observer Subjective Input
- And many more …

Cautious Phased Deployment Approach



Crawl **Walk** **Run**

Phased Approach To Autonomy

Phase 1: Chauffeured

- Trained driver - 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

- Driver/operator removed from vehicle
- Lessons learned and findings applied

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Fort Bragg Deployment: ARIBO

Applied Robotics for Installations and Base Operations (ARIBO)

U.S. ARMY RDECOM
TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

U.S.ARMY

Fort Bragg
Home Of
The Airborne
And
Special Operations
Forces

TARDEC

ROBOTIC RESEARCH

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ARIBO at Fort Bragg

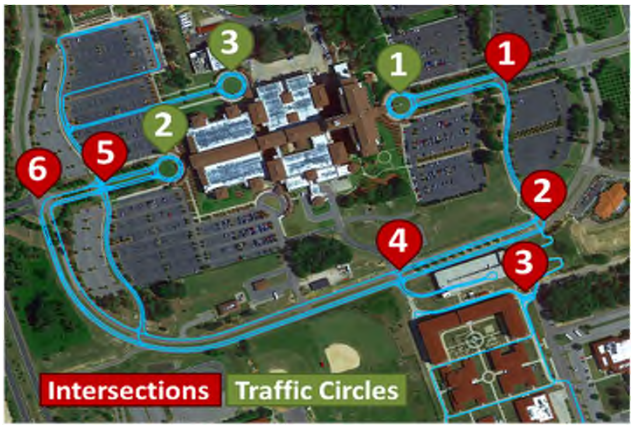
- Autonomous Warrior Transport On-base (AWTO)
- Address real-world needs of the Warrior Transition Battalion (WTB) at Fort Bragg.

- Support soldier transport between the Barracks and the Womack Army Medical Center (WAMC).

Autonomous Shuttles

Modified Cushman Shuttle Electric Golf Cart

Fort Bragg Traffic Circles and Intersections



- 6 intersections (red numbers)
- 3 traffic circles (green numbers)

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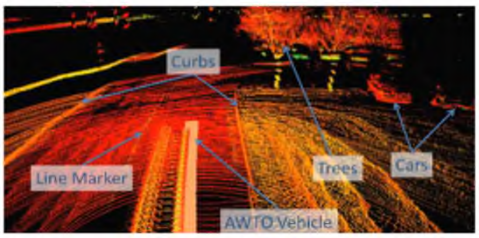
Greenville, SC: FHWA Driverless Shuttle Initiative

Modified Cushman Golf Cart

Olli



Route Assessment & Data Acquisition

Sign on CU-ICAR Campus

Greenville, SC: FHWA Driverless Shuttle Initiative

- Greenville County Council and Greenville City Council
- Carolinas Alliance 4 Innovation (CA4I)
- Robotic Research, LLC (RR)
- Local Motors (LM)
- Robocist, Inc.
- Clemson University's International Center for Automotive Research (CU-ICAR)
- Verdae Development, Inc
- Global Autonomous Vehicles Partnership (GAVP)
- National Renewable Energy Laboratory (NREL)

U.S Department of Transportation
Federal Highway Administration

Key Objectives

- **Equitable Transportation**: Democratize for the elderly, disabled, and poor
- **Vision Zero**: Reduce traffic fatalities and injuries
- **Improve Environment**: Reduce pollution and congestion
- **Livable and Walkable**: First-mile / last-mile - live, work, shop and play
- **Economical**: Develop and demonstrate self-sustaining business models

Local Motors – *Olli* Autonomous Shuttle

- 8 passengers
- IBM's Watson
- 33 miles range
- 4 hours charge time
- 25 mph maximum speed
- Robotic Research autonomy system
- Local Motors vehicle manufacturer
- Being deployed in cities around the world

University and Planned Community Deployment

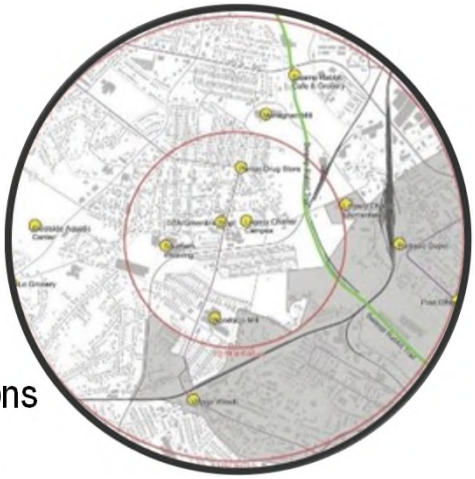
CU-ICAR And Verdae Planned Community

- Multi-modal first / last mile solution
- Reduced parking requirements
- Increased access to work, shop play
- Increased property value
- Community 'premium' differentiator

Economically Disadvantaged Deployment

Parker District

- Multi-jurisdictional
- 10th poorest census tract in US, 2010
- 41% of residents don't have personal cars
- Improved public transit options
- Reduce Greenville County Expenses



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Thank You

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