DESIGNING FOR AUTONOMOUS CARGO OPERATIONS

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COMPANIES

- Perigean Technologies LLC
  - Woman Owned Small Business since 2007
  - Located in Fredericksburg, VA

- Kutta Technologies
  - Wholly Owned Subsidiary of Sierra Nevada Corporation
  - Headquartered in Phoenix, AZ

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MACROCOGNITIVE ENGINEERING

- Designing human-centered systems to enable macrocognitive work
- Usability testing
  - Formative and Summative
- Iterative Design
  - Wireframes
  - Developer guidance

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KUTTA APPROACH

- Development of mission critical solutions including:
  - UAS ground control stations
  - UAS airborne autonomy subsystems
  - Manned AV avionics systems
- Development of custom, user-centric, visualization tools that represent data in new and innovative ways.

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PROJECT

PROJECT

- Office of Naval Research
- Autonomous Aerial Cargo/Utility System (AACUS)
- Innovative Naval Prototype

retrofit perception/planning/human interface system that enables autonomous take-off, flight, and landing of a full-scale rotary-wing aircraft to and from austere, possibly-hostile landing zones, in a tactical manner, with minimal human supervision

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Paduano, J., Wissler, J., Drozeski, G., Piedmonte, M., Dadkhah, N., Francis, J., Shortlidge, C., et al. (2015). TALOS: An Unmanned Cargo Delivery System for Rotorcraft Landing to Unprepared Sites. American Helicopter Society 71st Annual Forum and Technology Display.

CAPABILITY

- Aurora Flight Sciences
- Tactical Autonomous Aerial LOgistics System (TALOS)
  - **Human-Systems Interfaces (HSIs)**
  - Planning Systems
  - Perception Systems

Aurora FLIGHT SCIENCES

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HSI CAPABILITY

- Vision
  - Request for resupply and mission monitoring should be enabled through a tablet device requiring minimal training for an operator
  - Route planning should be conducted by AACUS, using human constraints and requirements for input
  - Minimal human supervision should be necessary during mission execution
  - No operator shall have direct control of flight systems

HSI CAPABILITY

- CONOPS Challenges
  - Multiple landing consent modes (i.e., by exception and by consent) should be supported
  - AACUS-enabled aircraft should be able to land in austere environments without human intervention
  - Operators should be able to wave-off or terminate a mission

HUMAN TEAMMATES

- Air Vehicle Operator (AVO)
  - Marine at the Main Operating Base (MOB)
  - Functions include supervisory control of the aircraft – at no time does the AVO assume direct control.
  - Responsibilities include providing mission planning data, and launching and monitoring missions
  - Trained specialist
  - HSI = Ground control station (GCS)

HUMAN TEAMMATES

- Field Operator (FO)
  - Marine at Combat OutPost (COP)
  - Functions include initiate an Assault Support Request (ASR), monitor mission progress, provide consent to land – the requirement for which is determined during planning
  - Responsibilities including ensuring that conditions are safe for take-off and initiate take-off
  - No specialized training in autonomous operations
  - HSI = Tablet

PHASE I

FOCUS

- Cognitive systems engineering
- Emphasis on FO Tablet HSI

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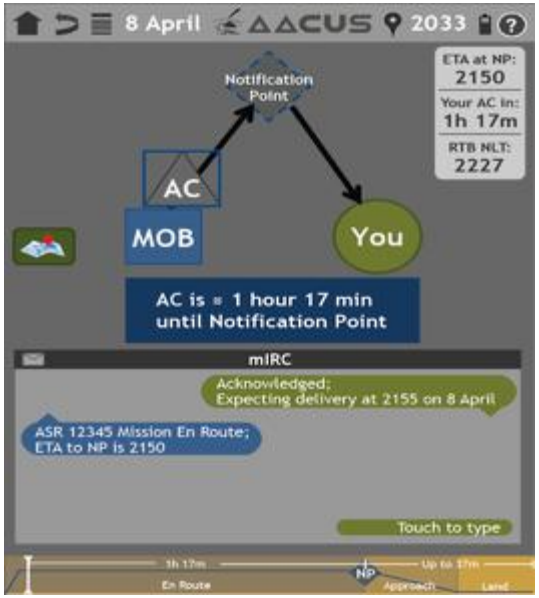
Papautsky, E. L., Dominguez, C., Strouse, R., & Moon, B. (2015). Integration of cognitive task analysis and design thinking for autonomous helicopter displays. Journal of Cognitive Engineering and Decision Making. DOI: 10.1177/1555343415602624
Dominguez, C., Strouse, R., Papautsky, L., and Moon, B. (2015). Cognitive Design of an Application Enabling Remote Bases to Receive Unmanned Helicopter Resupply. Journal of Human-Robot Interaction, Vol. 4, No. 2, 2015, Pages 50-60, DOI 10.5898/JHRI.4.2.

ACTIVITIES

- Cognitive task analysis (CTA)
  - [N=22]; Geared toward understanding and supporting the envisioned world of the FO, with participants including helicopter and UAS pilots and instructors and Marines with COP experience
- Design workshops
  - Design thinking and artifact design
- Validation studies
  - [N=13]; Focused on design reviews and an evaluation of the training time to gain working familiarity with the app

PRODUCTS



- Tablet HSI
  - COP FO
  - Working app deployed on iPad

- Tablet HSI
  - MOB AVO
  - High fidelity wireframes

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RESULTS

- Flight demonstration of TALOS
- Tablet HSI used by COP FO
- 15 minutes of training
- Observations of use and feedback from the participant demonstrated the functionality, intuitiveness, and ease-of-use
- Feedback included expressed desire for improved orientation support with regard to the FO's position, the landing zone (LZ), and the aircraft

PHASE II

FOCUS

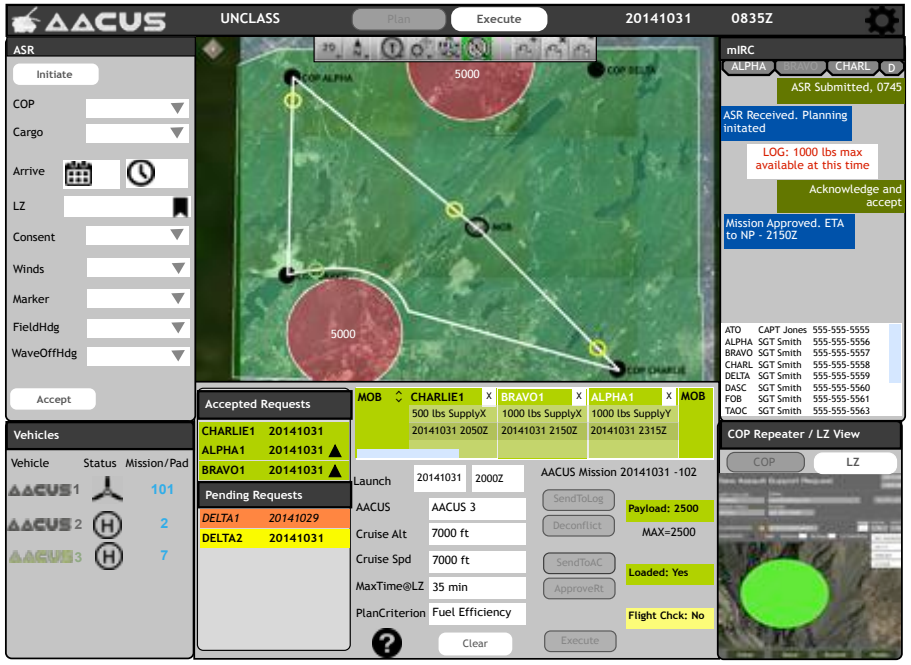
- Design and evaluation
- Focus on MOB AVO GCS HSI
- New program goals
  - Portability across platforms
- CONOP Updates
  - Serve multiple requests for any given mission
- New stakeholders
  - Logistics community

ACTIVITIES

- Design workshops
  - Design thinking and artifact and software re-design
  - Maintained design frameworks
    - MOB GCS - reconfigurable panels for central and peripheral information and action
- Design checkouts
  - Initial, N=8
  - Final, N=10

CHALLENGES, DESIGNS AND PRODUCTS

- Challenge
  - Deconflict multiple requests
- Design
  - Separate Plan/Execution
  - Planning stage gates



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CHALLENGES, DESIGNS AND PRODUCTS

- Challenge
  - Supervising mission progress
- Design
  - Birdseye and horizontal views

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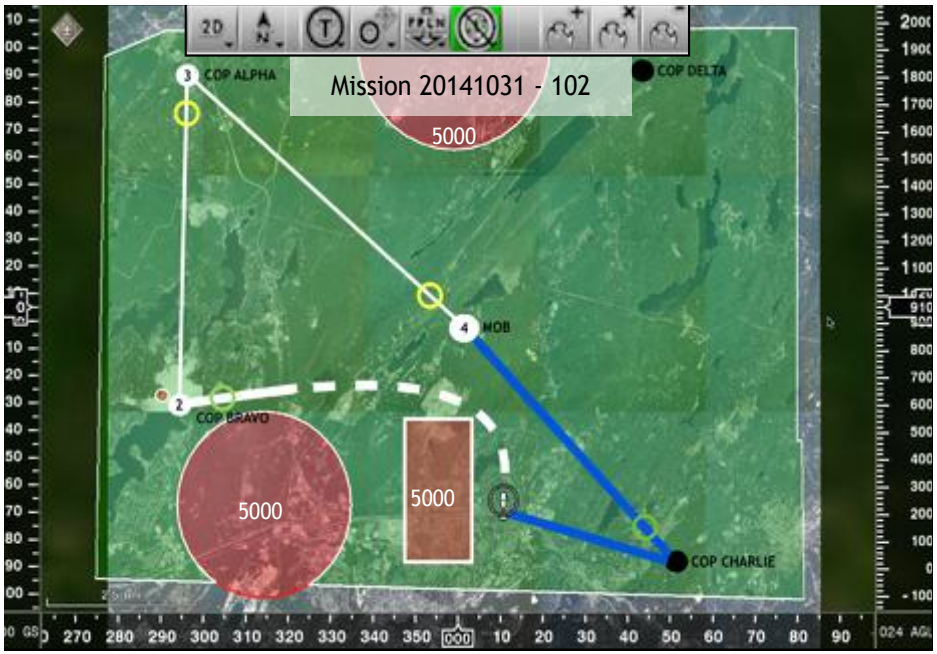
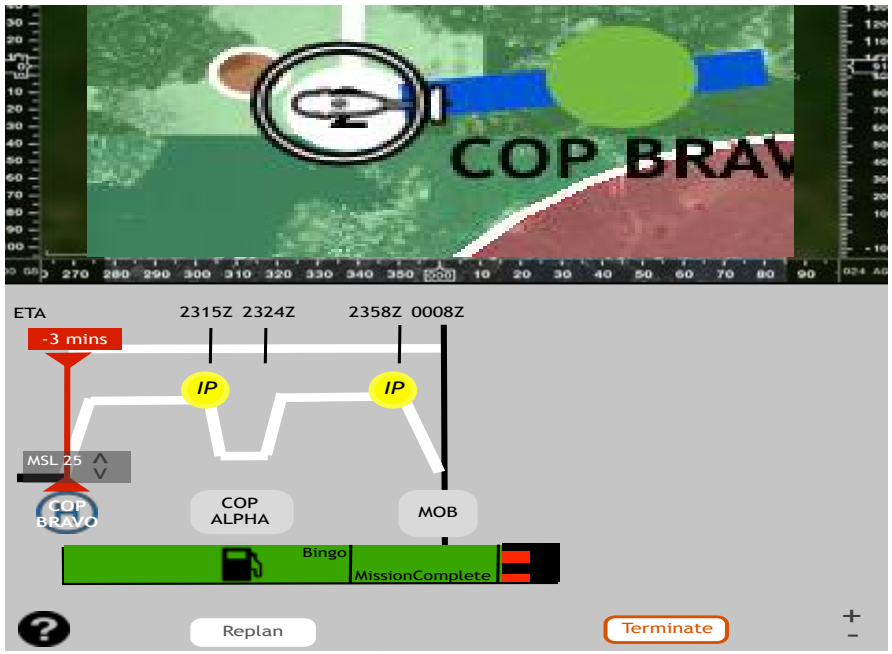
CHALLENGES, DESIGNS AND PRODUCTS

- Challenge
  - Modeling intents and actions
- Design
  - Provide known state and intended actions





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CHALLENGES, DESIGNS AND PRODUCTS

- Challenge
  - Replanning conflicts with situation awareness
- Design
  - Conduct replanning from the Execution mode

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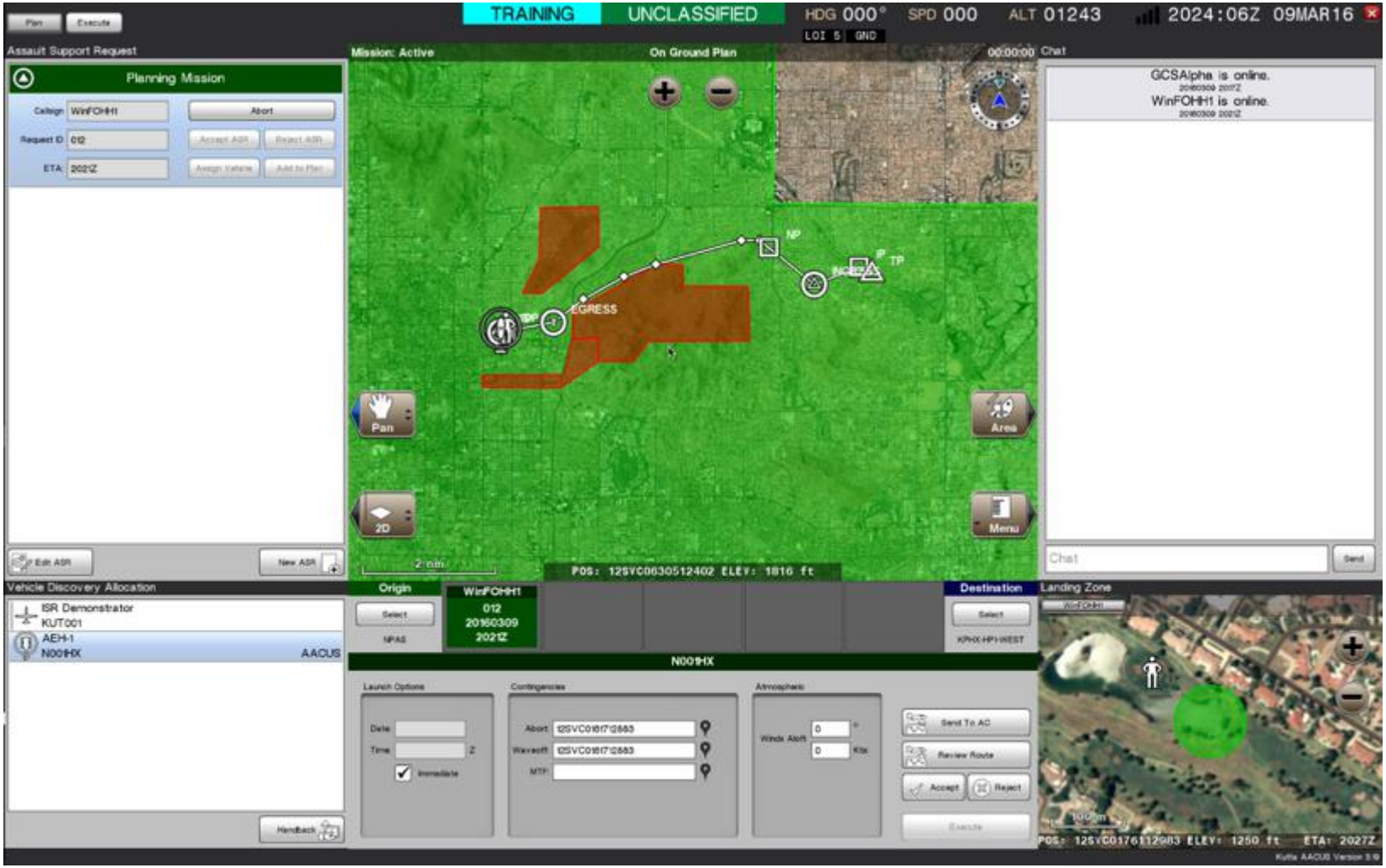
SOFTWARE: PLAN



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SOFTWARE: EXECUTE

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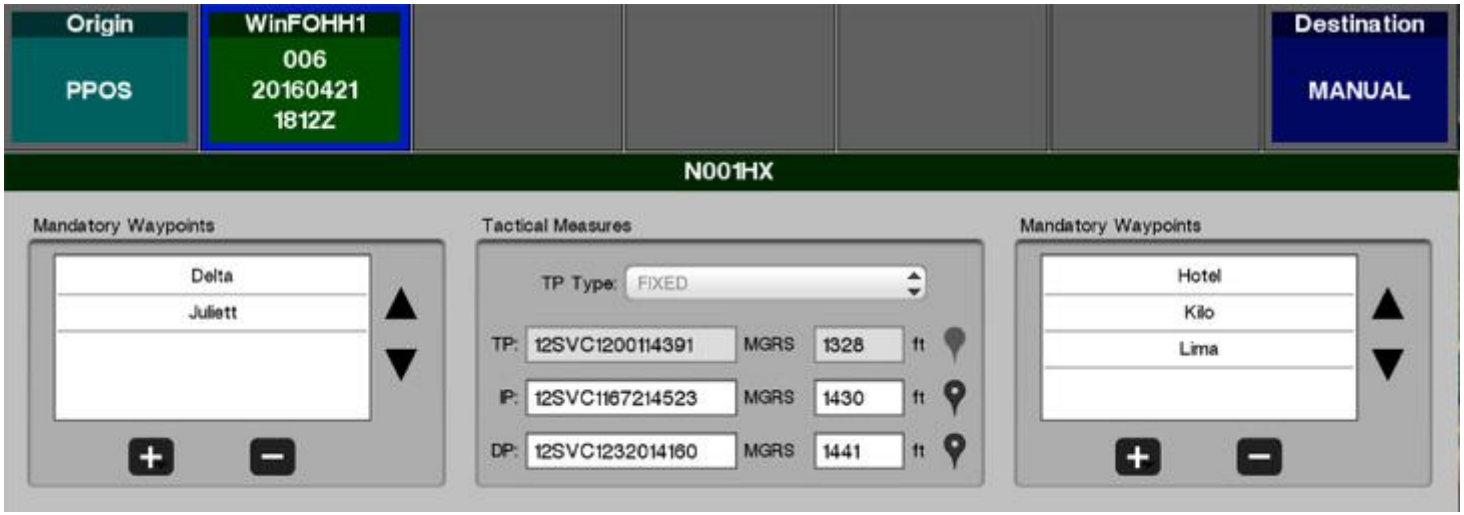
RESULTS

- Final Phase II Design Checkout
  - N=~10
  - Marines reported an overall approval of the design
  - Solicited feedback focused on determining improvements necessary to perform a resupply mission – i.e., did we miss anything
  - Biggest requested feature was tactical measures including mandatory waypoints between landing zones and manual entered initial position and departure point into/out of each LZ

INTEGRATING RESULTS

- Waypoint setting
  - Mandatory waypoints on the left are from the origin to the LZ
  - Mandatory waypoints on the right are from the LZ to the destination
  - The IP and DP are for the LZ



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FUTURE WORK

- Continuing Phase 3 work through the end of FY17 with Marine demonstrations in FY18
- Two tracks for development:
  - New functionality
    - Multiple landing zone operations
    - Contingency planning
    - Health monitoring
    - Dynamic re-planning
  - Design checkout feedback
    - Integrated help
    - Mission checklist
    - Integrated unit conversions

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THANK YOU FOR YOUR TIME!

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