COE CST Tenth Annual Technical Meeting

Human Input Systems for Commercial Space Transportation

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Agenda

- Team Members
- Task Description
- Schedule
- Goals
- Future Work

Team Members

Thomas C Eskridge
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Daniel Kirk
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Don Platt
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Kazuhiko Momose
HCD PhD Student

Anna Wojdecka
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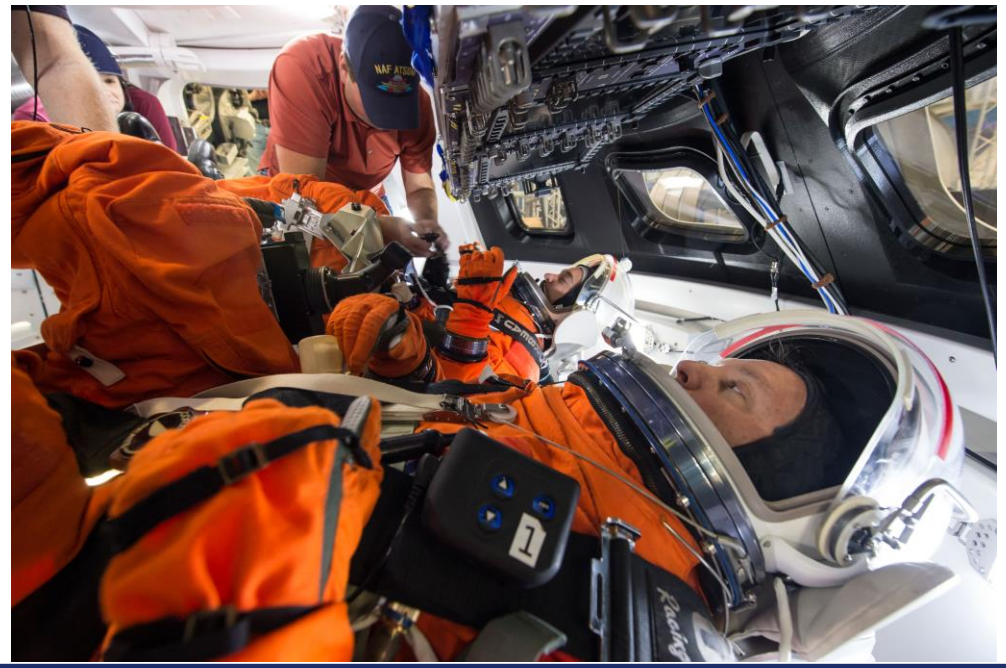
Team Members: Consultants

- Specialist in aerospace medicine: **Esther Beltran**, MD, Ph.D., (University of Central Florida)
- Specialist in Human-System Integration: **Anil Raj**, MD, Ph.D. (Institute for Human and Machine Cognition)
- Specialist in motion base integration: **Rick McLean** (Servos and Simulations)
- Matching funds provided by **FIT Human Spaceflight Lab**

Task Description

- This project will develop guides for the CST industry in the area of definition and engineering of CST control input devices and systems usable in variable gravity with or without spacesuit.



Control in Variable Gravity

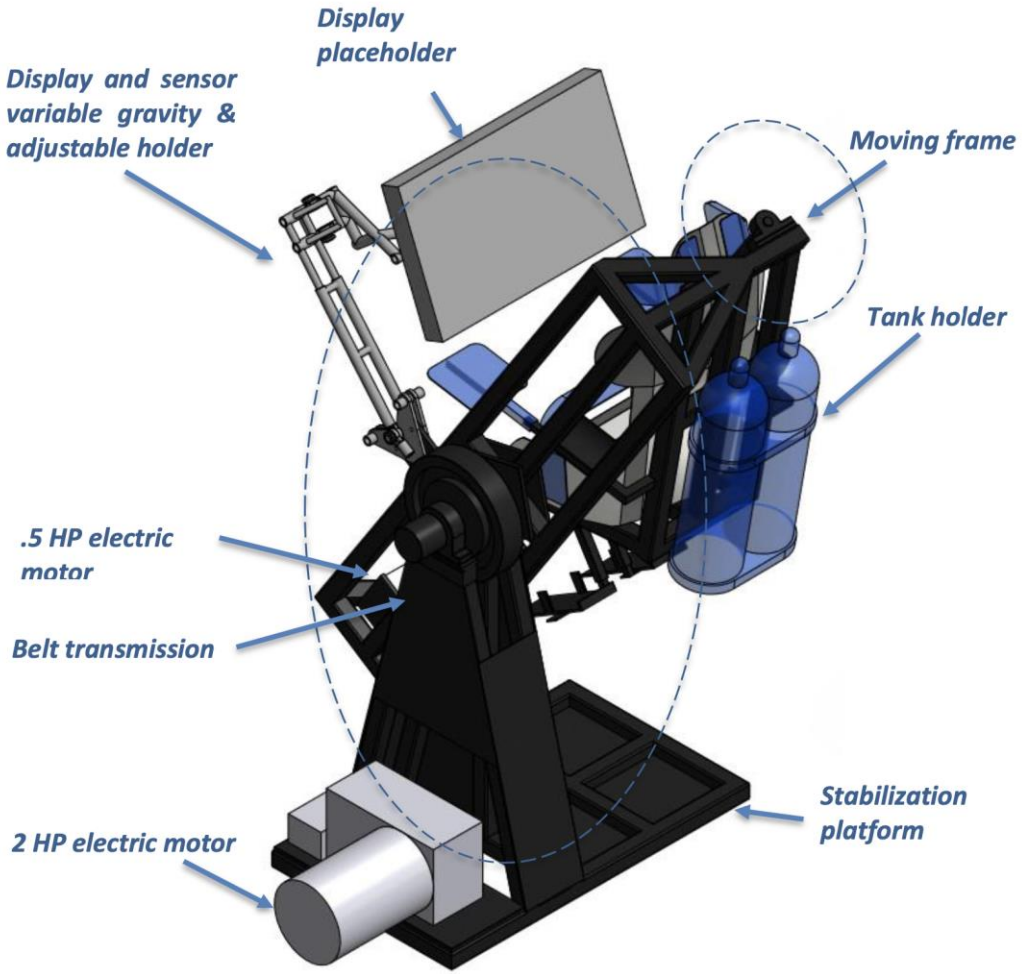
- Control of vehicles require
  - good visual acuity,
  - eye-hand coordination,
  - spatial and geographic orientation perception, and
  - cognitive function.
- Space flight research has demonstrated the effects of variable gravity on each of these requirements

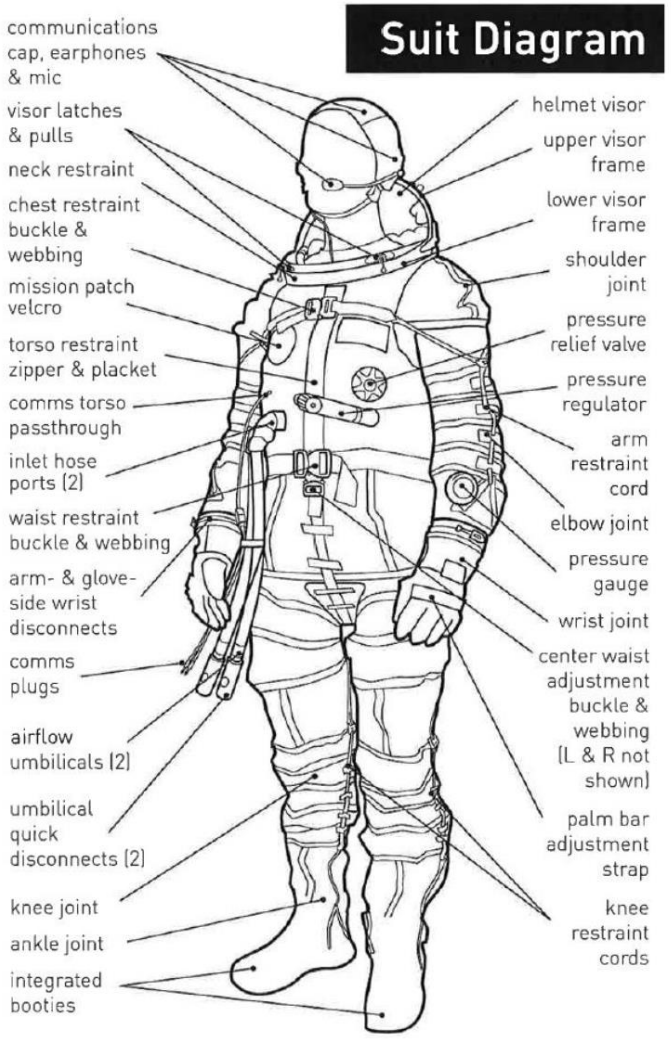
Bloomberg JJ, Reschke MF, Clément GR, Mulavara AP, Taylor LC. NASA evidence report: Risk of impaired control of spacecraft/associated systems and decreased mobility due to vestibular/sensorimotor alterations associated with space flight. 2016. [September 12, 2016]. https://humanresearchroadmap.nasa.gov/Evidence/reports/SM.pdf. [Reference list]

Control in variable gravity

- Experiments show occasional **directional confusion** when using joystick with typical aviation logic
  - pull towards the operator's body means up
- Occasional confusion of direction left and right happened as well
- Suggestion from former astronaut to "*avoid use of aviation flight control logic in microgravity or hypergravity*"
- Control and display systems should *reflect phases of spaceflight*

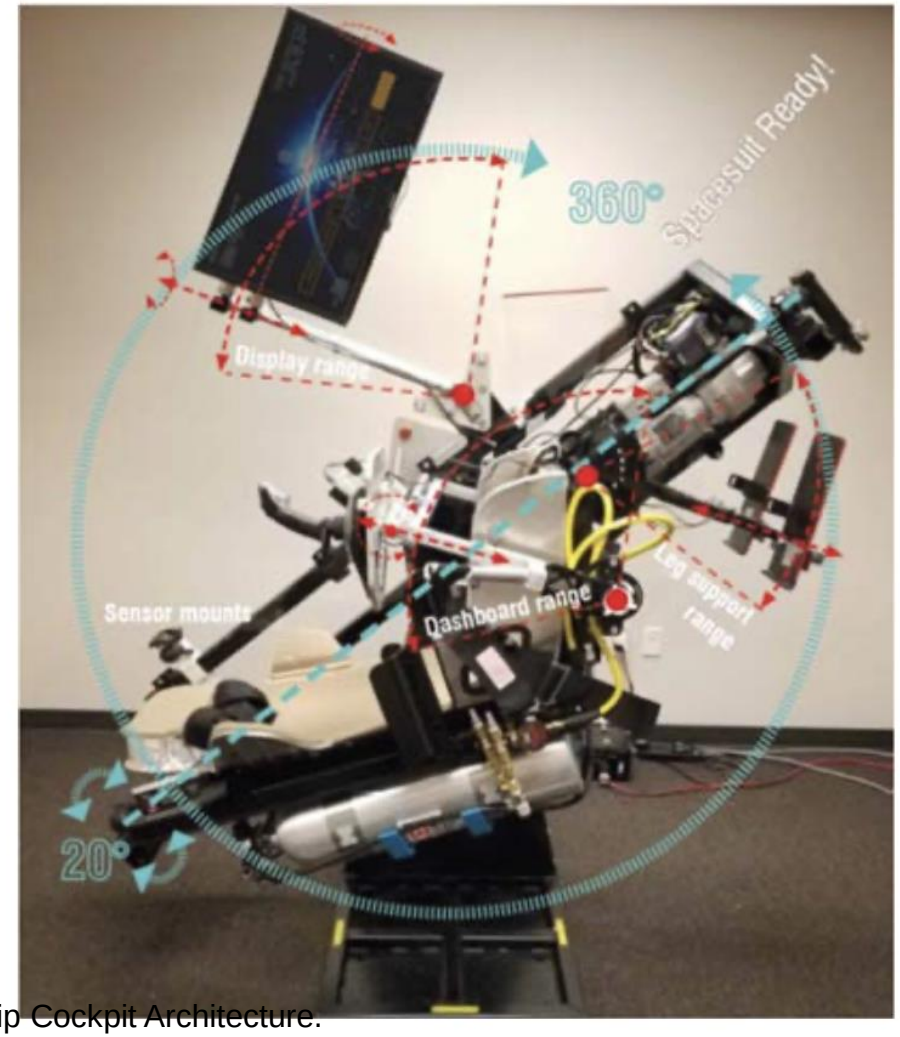
Adaptive Spaceship Cockpit Simulator (ASCS)

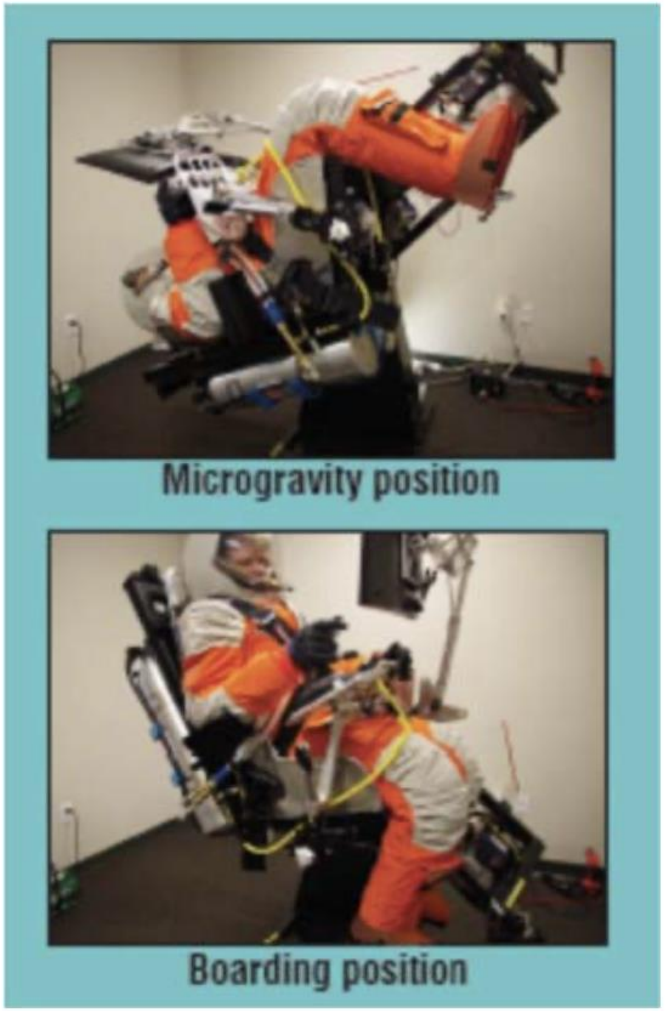




Doule (2018) Adaptive Spaceship Cockpit Architecture. PhD Dissertation, Florida Institute of Technology

FIT ASCS





Doule (2018) Adaptive Spaceship Cockpit Architecture.
PhD Dissertation, Florida Institute of Technology

Goals

1. identify the best human-input physio-cognitive control logic and mechanisms for human operators in variable gravity environment
   - Including normative and emergency scenarios when automated system cannot perform the control function
   - Avoiding orientation misinterpretation of aviation control paradigm
   - Control systems for pilots and tourists

Goals

2. Identify satisfactory multimodal feedback for confirmation of actions in hyperbaric, variable gravity environment.
3. A homing function for input devices can be misinterpreted when using spacesuit and/or operating the vehicle in variable gravity environment. Determine whether an input device should have a homing function and, if so, how it should be communicated to the user.
4. Identify the personal physical and cognitive ergonomic features of vehicle occupants that should be driving the cockpit cognitive and physical ergonomics adaptation.

Goals

5. Determine fundamental rules of how to secure optimal performance of the mission and safety of astronauts in interactions with adaptive automation
   - How should artificial agents communicate with humans and distribute function authority if the human is incapacitated in some sensory areas such as haptic or hearing senses.

Schedule

SEC CST	2020				2021								2022												
Work Package	*Sep*	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*
1 - Project Management																								
2 - State of the Art																								
3 - Selection/design of IS and Exp Design																								
4 - Simulation HW and SW update																								
5 - Simulation Execution - HITL													SIMULATIONS											
6 - Data analysis and guides definition																								
Final Report							DR1										DR2							FINAL
IAC,CHAI publication																								
NewSpace publication																								

Future Work

- We are one month into the project
- Focused on collecting state of the art control methodologies and evidence of variable gravity induced control issues
- Tuning and maintenance on ASCS
- Evaluating interface toolkits for rapid prototyping