

# Projects for Capstone Design (ME4182/GT4823)

Fall 2019

Sponsored Projects

<http://projects.gatech.edu>



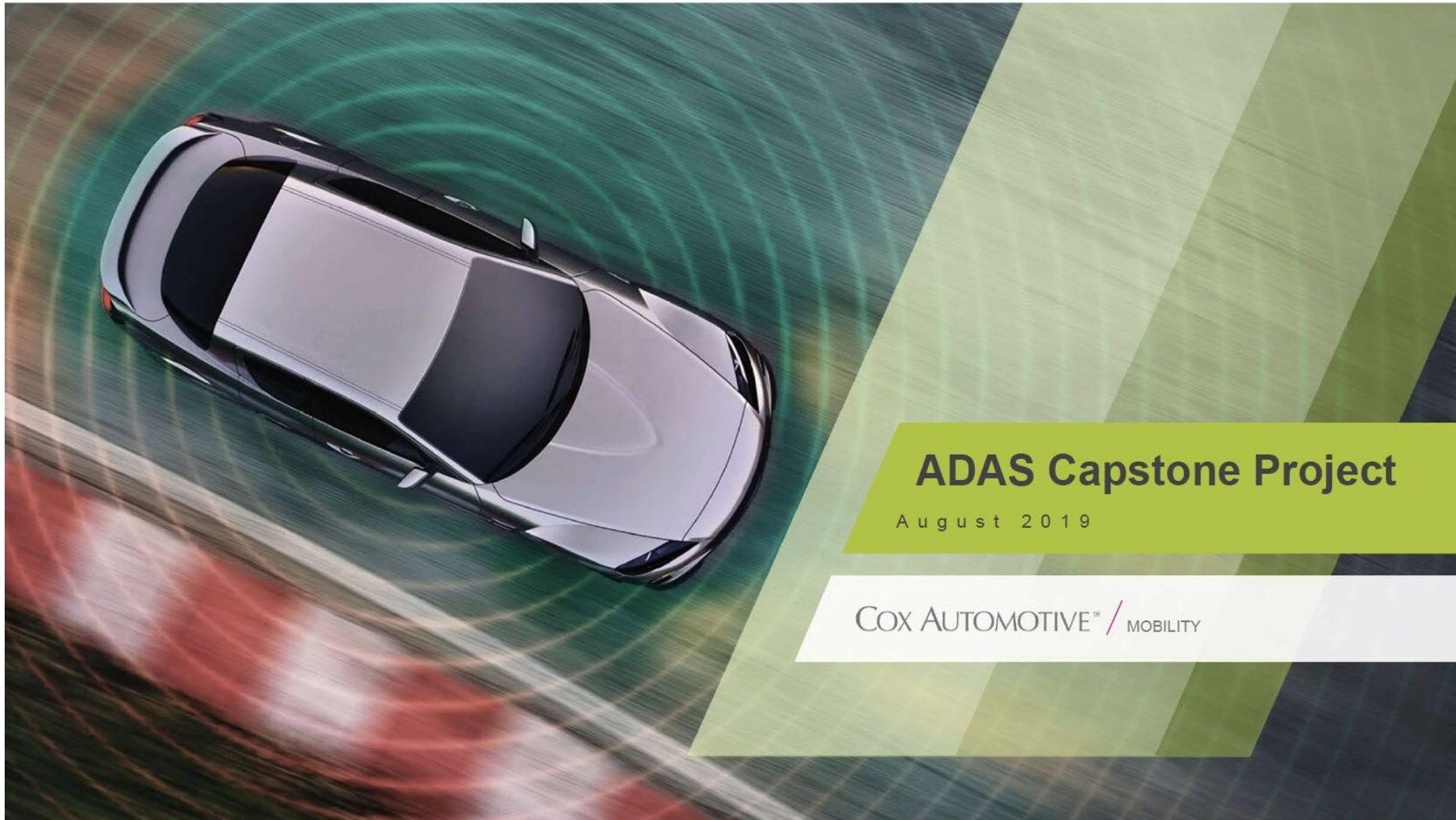
# ANNOUNCEMENTS

- Social “Mixer” with sponsors today (8/19) between 3-4pm in IC #215
- For ME4182-A, C, GT4823-MEB, ECE and MSE
  - Today’s studio (8/19) will begin at 4pm in IC #103
  - Wednesday’s studio (8/21) will begin at 3pm in Howey Physics L2

# Sponsor Pitches

- C02-Advanced Driver Assistance Systems (ADAS) Optimization Plan Project
- C04-Canine Dental Disk Prototyping
- C06-NM Jacket Line Paper Feed
- C07-Deployment Offload System for Deployable Boom Ground Test and Calibration
- C08-Small Spacecraft Modular Monopropellant Propulsion
- C09-Tri-axial Test Stand to Validate Additive Manufacturing (metal 3D printing) Components
- C10-Smart Water Management System Via Connected Manifold
- C11-Manipulation and Transportation of Gas Turbine Discs
- C13-PET Wheelchair Design
- C15-ChockBot™
- C16-Mechanical Tree Pruning Apparatus To replace Traditional Climbers
- F01-Design of Biomechanical Testing Load Frame for Orthopaedic Surgery Application
- F02-Deployable Piezoelectric Crosswalk Electro-Mechanical Packaging

# C02-Advanced Driver Assistance Systems (ADAS) Optimization Plan Project



## ADAS Capstone Project

August 2019

COX AUTOMOTIVE™ / MOBILITY

COX AUTOMOTIVE™

**MOBILITY**

**Cox Automotive  
exists to transform  
how the world  
buys, sells, owns,  
and uses cars.**

COX AUTOMOTIVE™



COX AUTOMOTIVE™

# MOBILITY

The **Cox Automotive Mobility** group takes on the *biggest changes* that are disrupting the automotive industry today:

- Car ownership
- Electric vehicles
- Autonomous vehicles

and all the *underlying service and system changes* that make these emerging machines possible and safe...

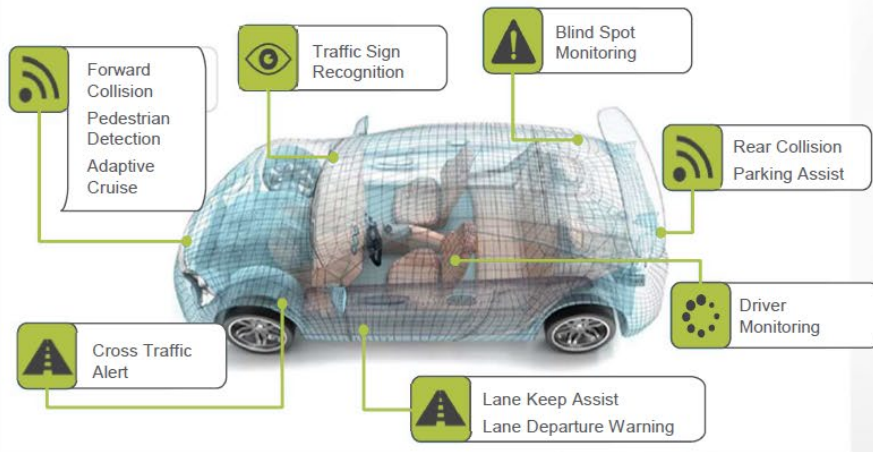
Which brings us to the  
**Cox Automotive ADAS  
Capstone Project**

COX AUTOMOTIVE™



**What is ADAS? Advanced driver-assistance systems (ADAS) are electronic systems that aid a vehicle driver while driving. They are designed for a safe human-machine interface, which increases car and environment safety.**

### ADAS Applications Technology Today



### Service Market Growth

Expected to grow from **2.49B** in 2018 to **3.98B** in 2024

OEMs showing an increase in their ADAS offering driven by IIHS requirements for “Top Safety Pick Plus” award

Technology advancement - cost effective sensors with improved functionality

Increasing consumer awareness about the benefit of these technologies



# OEMs are legally required to repair these safety systems when damaged... but it's not easy to do.

American Honda Position Statement

**HONDA**

Issued: May 2019

## SUBJECT: POST-COLLISION DIAGNOSTIC SCAN AND CALIBRATION REQUIREMENTS FOR HONDA AND ACURA VEHICLES

It is the position of American Honda that **all vehicles**\* involved in a collision<sup>†</sup> **must** have the following minimum diagnostic scans, inspections, and/or calibrations done to avoid improper repair:

- A preliminary diagnostic scan during the repair estimation phase to determine what diagnostic trouble codes (DTCs) may be present, so proper repairs may be included. (See "Background on Scan Requirements" below for more information.)
- A post-repair diagnostic scan to confirm that no DTCs remain.
  - Any repair that requires disconnection of electrical components in order to perform the repair will require a post-repair diagnostic scan to confirm if the component is reconnected properly and functioning.
  - Damage that requires the replacement of body parts will always require a post-repair diagnostic scan.
- Some safety and driver assistive systems will require inspections, calibration, and/or aiming after collision or other body repairs. See "Inspection/Calibration/Aiming Requirements" on page 2 for additional information.

### Background on Scan Requirements

Honda and Acura vehicles include numerous electronic control systems, including those that operate safety and driver assistive systems. Most of these systems include onboard self-diagnostics that monitor the state of health and/or rationality of input and output circuits.

When monitored circuit values fall outside predetermined thresholds, DTCs may be set in one or more electronic control units (ECUs).

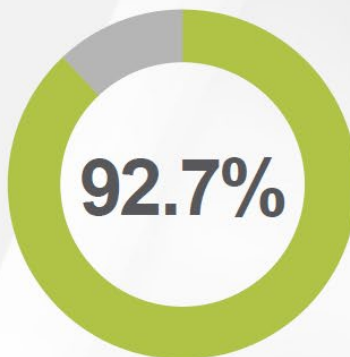
The mechanical forces encountered in a collision can damage electrical circuits and components in ways that are not easily diagnosed with visual inspection methods.

Here are some other electronic control system self-diagnostic facts:

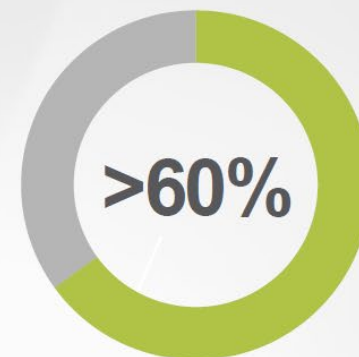
- The proliferation of electronic control systems has increased the number of potential DTCs beyond the point where a dashboard indicator can be installed and/or illuminated for every DTC. Dashboard indicators are intended for driver notification, not vehicle diagnostics.

\* Refers to any model year Honda or Acura vehicle that is equipped with a diagnostic port from which DTCs can be retrieved with a physically connected tool. This includes: all 1996 to current model year vehicles, certain 1994 to 1995 model year vehicles that contain a 16 pin OBD2 connector, and certain 1992-1995 model year vehicles that contain a 3 pin diagnostic connector.

† A collision is defined as damage that exceeds minor outer panel cosmetic distortion.



of all new vehicle models as of May 2018 had at least one advanced driver assistance system



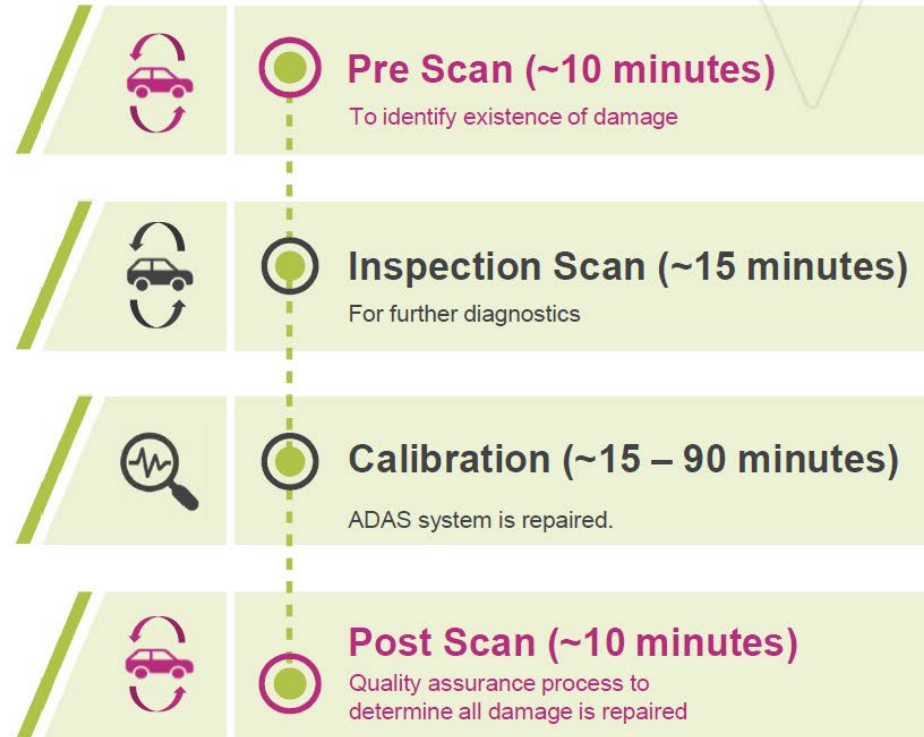
of vehicles Manheim body shops already touch are equipped with ADAS functionality

*Honda's position statement entails that there must be pre- and post repair system scanning and also provides background on scan requirements, diagnostic recommendations, inspection/calibration/aiming requirements, and how to obtain service information*

# ADAS repair is time consuming, specialized, labor intensive, and expensive.

Scanning and calibration requires:

- **Specific space requirements:**  
76x46 ft, level and matte floor, covered, lighting
- **Equipment requirements to scale:**  
frames, targets, and diagnostic devices in order to meet customer demand
- **Technician ADAS training necessary for calibration**
- **Partner relationship is critical:**  
Safelite and AirPro
- **Client demand is present and growing:**  
more requests already from Mercedes Benz, GM, Enterprise, Chase, US Bank, Santander and others



## The goal

- The purpose of this project is to design and validate that the **scanning and calibration process can be automated, compressed (shorter time for set up and execution) and become more efficient while satisfying OEM standards**. The current scanning equipment and processes involved have multiple manual (labor intensive) steps. We believe there are multiple areas of opportunity as a result.
- Pre-Scan/Health Scan (Capturing Codes)
- Post-Scan (Identifying/Clearing Codes)
- Post-Repair Calibration/Initialization (PRC/I)
- Post Repair Calibration(s) and Post Scan Processes



Scanning technology that hooks up to the car's OBD port to read the car's software and detect damage codes in the electrical systems.



Static calibration equipment (called targets) to calibrate certain cameras and sensors. Car is parked in front of equipment and very detailed steps allow a technician to calibrate the car (many steps and time consuming).

- C04-Canine Dental Disk Prototyping



# Fresh Petcare

*Reinventing Oral Care for Pets*

# Why?

- Periodontal disease is the most common clinical condition occurring in adult dogs and cats, and is *entirely preventable*.
- By three years of age, most dogs and cats have some evidence of periodontal disease.
- Only 4% of pet owners brush their dog's teeth daily.
- Good Oral Care can add 2 to 3 years to the lifespan of a dog or cat.



# Current Oral Care Solutions



# The Opportunity

- Need a team to reimagine our MVP.
- Let's create something disruptive.
  - All natural ingredients
  - Fully dissolvable
  - Can't be chewed and swallowed in a bite or two
  - Shelf stable
  - Gives the owner real-time feedback that it's working







# Fresh Petcare

*Reinventing Oral Care for Pets*

# C06-NM Jacket Line Paper Feed

- Southwire Company

- The purpose of this project is to design a new NM Paper payoff that is operator/user friendly, safe, and efficient.
- The design should have features built into alert and/or prevent failure that leads to non-conformant product.

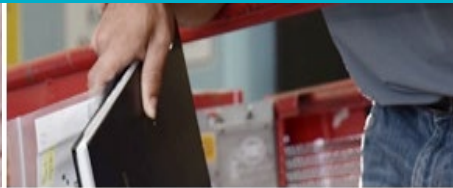


- C07-Deployment Offload System for Deployable Boom Ground Test and Calibration



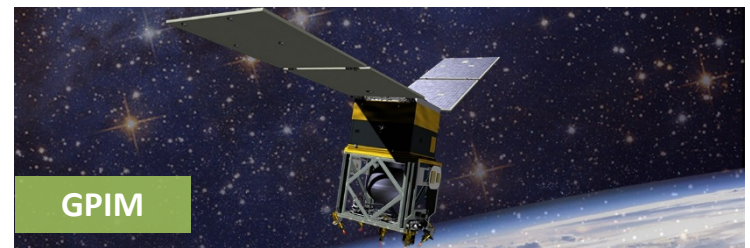
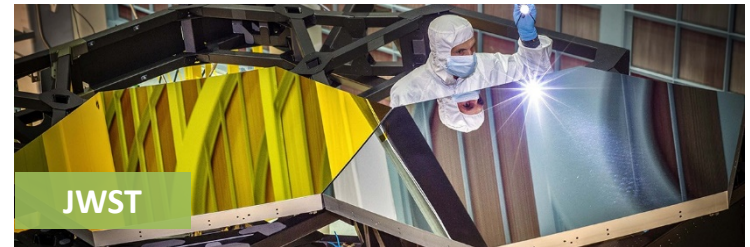
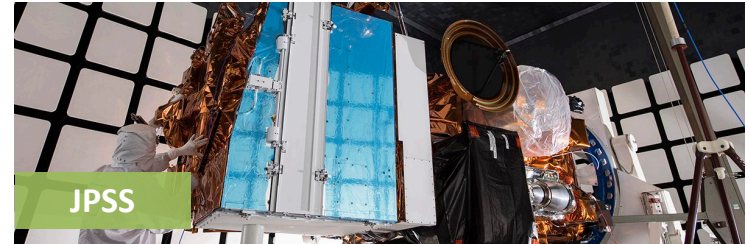
# DEPLOYABLE BOOM OFFLOAD FIXTURE

**BALL AEROSPACE**  
*BOULDER, CO*

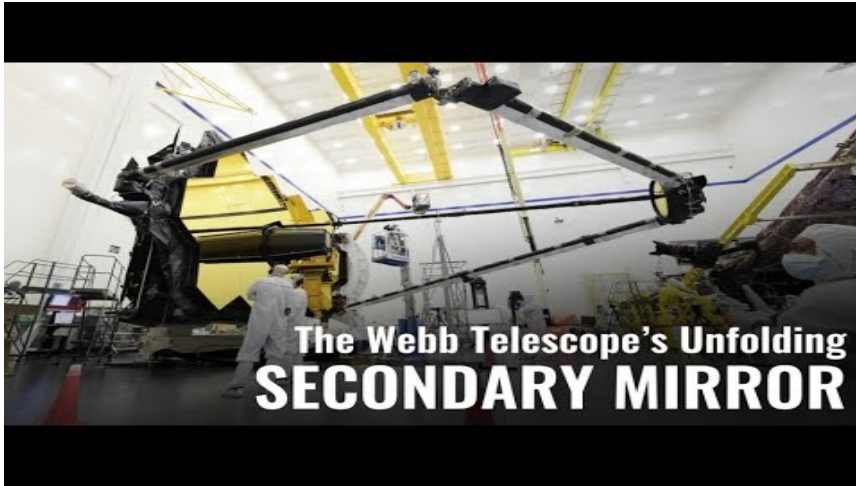


# BALL AEROSPACE

- Civil
  - JWST, NOAA 20, Hubble, Kepler, WFIRST, GPIM, GEMS/TEMPO...
- Commercial
  - Quickbird, Methane Monitor, Phased Array Antennas, LaserCom...
- Defense
  - WSFM, OPIR, F-35, SBSS...
- More At: [ball.com/aerospace](http://ball.com/aerospace)



# DEPLOYABLE BOOM OFFLOAD FIXTURE



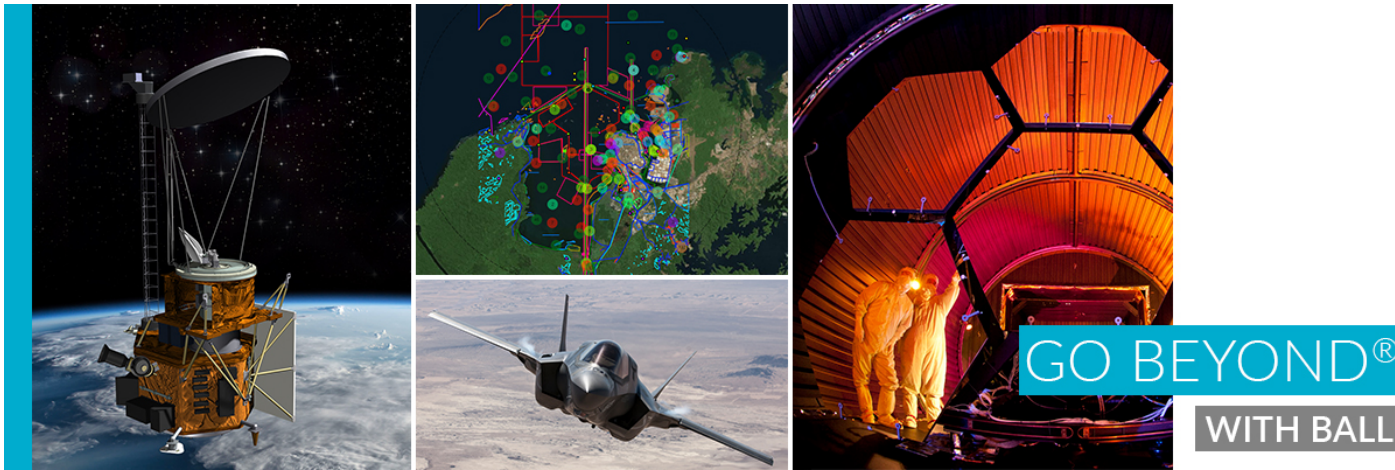
JWST Secondary Mirror Deployment:  
Credit: NASA, youtube.com



GOES-R Boom Deployment:  
Credit: NGIS/Orbital ATK, youtube.com

# WHY THIS PROJECT

- Aerospace Industry Experience
- A Large Mentor Team
- Impact NextGen Space Flight Systems



Only US Citizens may apply.

- C08-Small Spacecraft Modular Monopropellant Propulsion





# SCOUT

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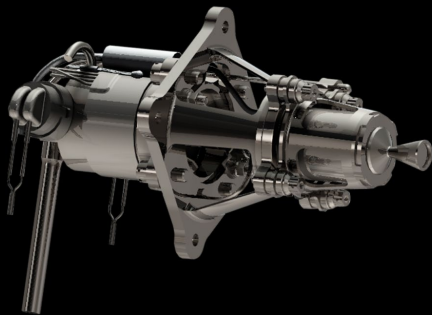
## AEROSPACE



**GEORGIA**  
Space Grant Consortium



JPL engineers working on the  
ASTERIA probe



GR-1 artist rendition Photo:  
Aerojet Rocketdyne

## Background

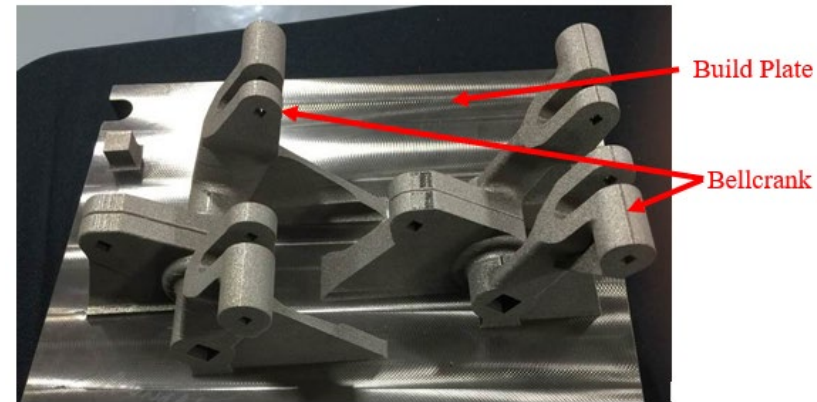
- Scout Aerospace LLC is an orbital transfer vehicle and spacecraft manufacturing company.
- The space industry is going through a renaissance where 3D printing, component miniaturization, and privatization have created new business opportunities.
- NASA has been looking for a Hydrazine replacement for the past several years.
- AF-M315E is a promising fuel with higher performance.
- Engineering barriers exist that prevent wide adoption of AF-M315E
- Scout Aerospace has received funding through the Georgia Space Grant Consortium to find solutions to use AF-M315E

## Concept

- Scout Aerospace is requesting R&D for an AF-M315E reaction chamber and nozzle compatible with modular CubeSat propulsion concepts
- Design parameters:
  - >230 sec ISP
  - 2-30 N Thrust
  - < 1 kg dry mass
  - Fits inside a 6×6×8 cm envelope
- Designs that incorporate metal SLS construction and photolysis ignition are encouraged.
- Project heavily centered on heat transfer, fluids dynamics, photochemistry, and material sciences.

# C09-Tri-axial Test Stand to Validate Additive Manufacturing (metal 3D printing) Components

- The purpose of this project is to design, build, and validate a triaxial test stand that is capable of testing AM produced parts and ensure that they meet the desired performance requirements.
- Design must be modular so as to simulate loading conditions for different components like aircraft brackets, bellcranks, A-frames, ASTM test bars, etc.
- **Only US Citizens may apply.**



Bell Cranks



A-Frame

- C10-Smart Water Management System Via Connected Manifold



# Smart Water System

Georgia Tech Capstone Fall 2019

Ferguson Ventures Innovation Lab @ GT

Jones Stephens

# SMART WATER SYSTEM – OVERVIEW



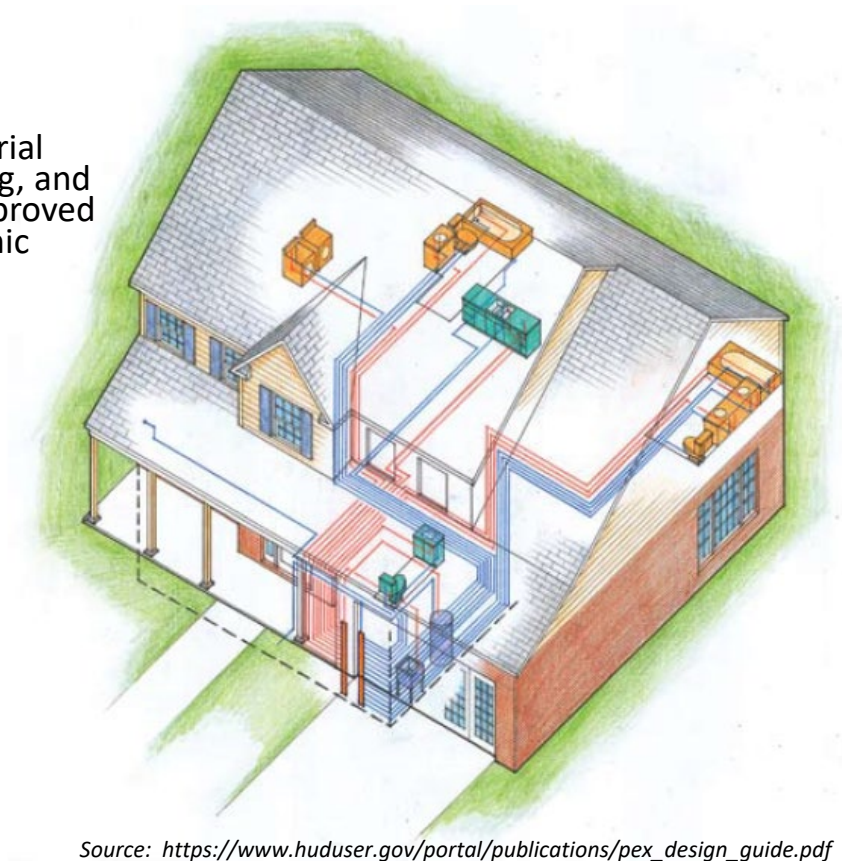
## What is a PEX Water System?

Cross-linked polyethylene (PEX) is a high-temperature, flexible, polymer pipe. PEX has a 30-year history of successful use in the European market with extensive testing for durability and material performance. It has been primarily used for radiant floor heating, and more recently, for **domestic water distribution systems**. It is approved for potable hot and cold-water supply systems as well as hydronic heating systems.

**Sizes** - 3/8", 1/2", 3/4", 1", 1 1/4", 1 1/2", 2"

## Advantages

- Ease of Installation
- Durability - 30 yr life
- Cost Effectiveness
- Energy Efficiency
- Noise Reduction
- Water Conservation
- Environmentally Sound



Source: [https://www.huduser.gov/portal/publications/pex\\_design\\_guide.pdf](https://www.huduser.gov/portal/publications/pex_design_guide.pdf)

# SMART WATER SYSTEM – CAPSTONE CHALLENGE



Develop a low-cost sensor/control valve device which can

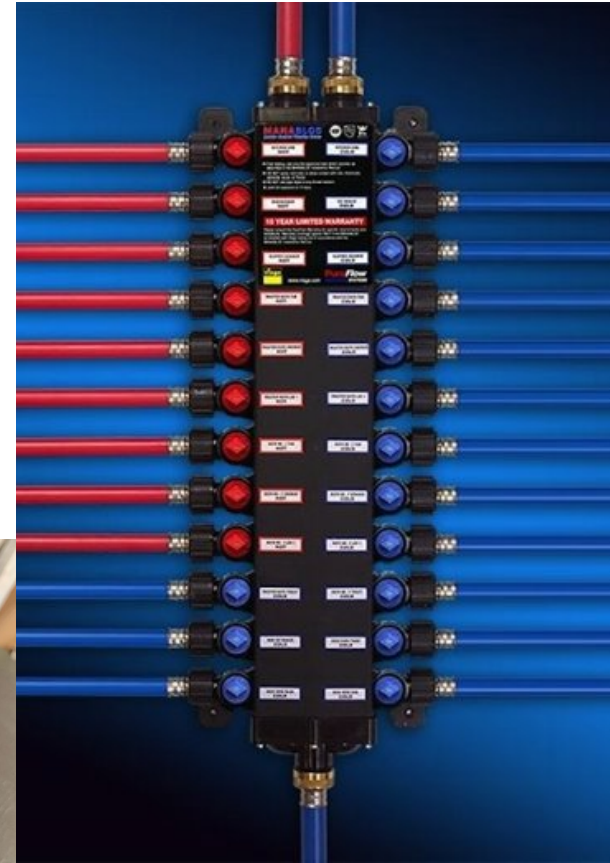
- Monitor and control each individual water supply at the manifold
- Provide flow and pressure data to a separate controller
- Stop flow when the controller identifies a leak

## Out of Scope

- The controller will be designed in the future

## Key Features

- Individual home-runs to each fixture
- Centrally located
- Non-proprietary connections









# SMART WATER SYSTEM – WHY DO IT?

Smart home trends & climate volatility are driving more sustainable resource efficiencies

- **Climate volatility driving increased cost of water**
  - 10% of homes have leaks that waste 90 gallons or more per day
  - Minor leaks account for 1 trillion gallons of wasted water (*Source: EPA WaterSense*)
- **Smart homes empower the consumer – Project increase 23% from 2018 to 2019**
  - Amazon Alexa, Google Assistant, Samsung Bixby are leading this watershed moment
  - Platforms are maturing now to see home use, but we can do better
  - Wi-fi is everywhere; the connected home is here
- **The Smart home is becoming more data driven at a micro level**

*Our access to the rough plumbing market opens a unique opportunity to change the game and control individual fixtures*



# SMART WATER SYSTEM – MARKET ANALYSIS

Current Leading Solutions Have Limitations

- Single monitoring point
  - They cannot identify the leaking fixture
- Algorithms still alert false positives
- Single control valve
  - They shut off the entire house when a leak is detected





# C11-Manipulation and Transportation of Gas Turbine Discs



**Problem...** *MHPS turbine disc movement is inefficient. Waiting for forklifts and cranes to become available often causes delays.*

**Mission...**

- *Move discs without forklifts and pallets*
- *Flip discs without cranes*

# C13-PET Wheelchair Design



# C15-ChockBot™

## Sonitech Enterprises ChockBot®

Jay Tison

[jaytsn05@gmail.com](mailto:jaytsn05@gmail.com)

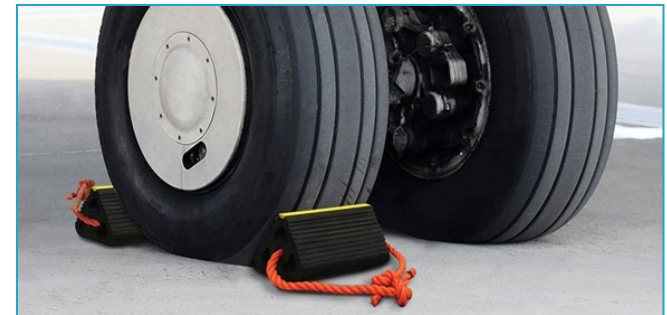
404-312-4326



# Problem



- ▶ Commercial aircraft operations worldwide require wheel chocks for boarding, de-boarding, and parking
  - Ground personnel currently place and remove chocks as part of normal operation
  
- ▶ Automating the chocking process provides key benefits to airport operations
  - Time and motion / efficiency of ground personnel – focus on other duties
  - Boarding / de-boarding during lightning activity, when tarmac closed to ground personnel
  - Brake reliability and time-on-wing extension – no extensive parking brake use after landing
  - Safety: De-conflict already bustling tarmac and prevent head / neck injuries or lacerations
  
- ▶ Team Goal
  - Develop working vehicle prototype by end of semester
    - Company membership and intellectual property (patents, non-disclosure agreements) considerations
  
- ▶ Desired Candidates
  - Mechanical, electrical, and computer engineering design or manufacturing
  - Programming experience, preferably with autonomy or robotics
  - Great Attitude!





# C16-Mechanical Tree Pruning Apparatus To replace Traditional Climbers

- The goal of the project would be to create a drone or mechanical cutter that can reach areas that cannot be pruned by traditional equipment and can replace all or some of the need for manual climbers.



# F01-Design of Biomechanical Testing Load Frame for Orthopaedic Surgery Application



Department of Orthopaedics

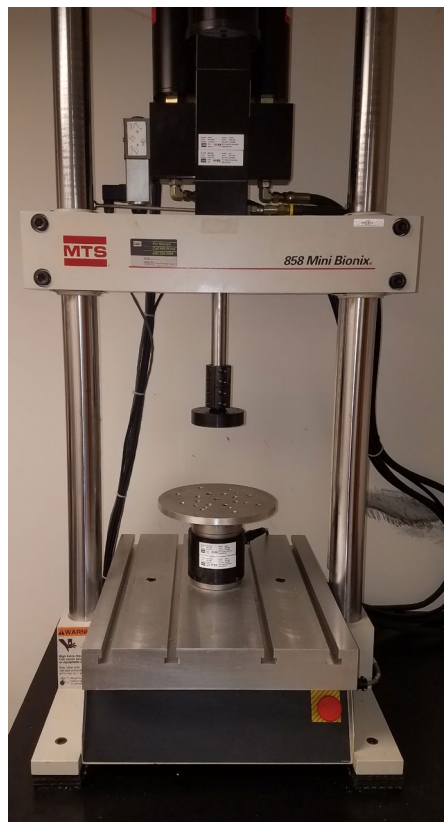
Official Sports Medicine Provider for:



Braves



THE ORIGINAL  
\* HARLEM \*  
GLOBETROTTERS.



- Biomechanics Test Lab focused on upper extremity research.
- Conduct studies to help develop new surgical procedures and biomechanical devices.
- Data is published in orthopaedic journals and the findings are implemented by orthopaedic surgeons across the country rapidly.

Emory Orthopaedics & Spine Center - Atlanta

59 Executive Park South

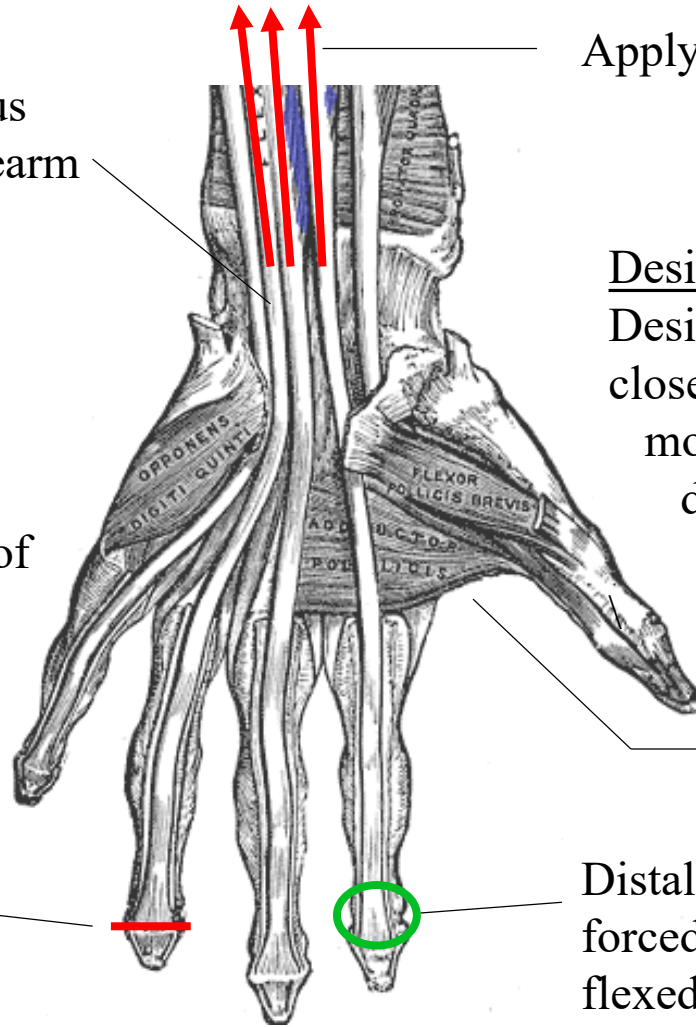
Atlanta, GA 30329



Flexor Tendons:  
Flexor Digitorum Profundus  
(FDP) extend from the forearm  
to each fingertip.

Research Goal:  
Conduct a biomechanical  
study to quantify and  
compare the effectiveness of  
6 different Jersey Finger  
repairs.

The Jersey Finger  
injury occurs when  
the tip of the FDP  
becomes detached.



Apply cyclic loads in tension.

Design Project Goal:  
Design a table top system utilizing  
closed loop force control to drive  
movement. Record force and  
displacement data in real time.  
Powered with electric motors  
or pneumatics.

Secure hand specimen.

Distal Interphalangeal (DIP) joint,  
forced hyperextension when finger is  
flexed causes injury.

# F02-Deployable Piezoelectric Crosswalk Electro-Mechanical Packaging

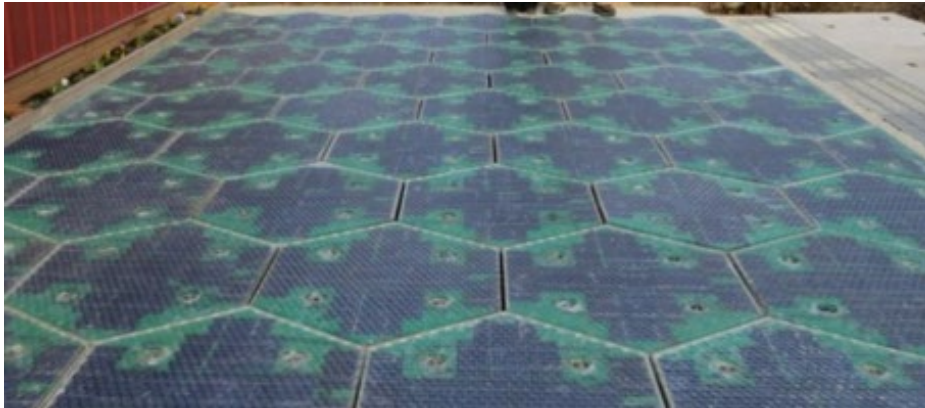
## Crosswalk PZ

August 19<sup>th</sup>, 2019

Matthew Swarts, GTRI-ATAS  
Energy and Sustainability Group



# Energy Harvesting from Ground Surfaces



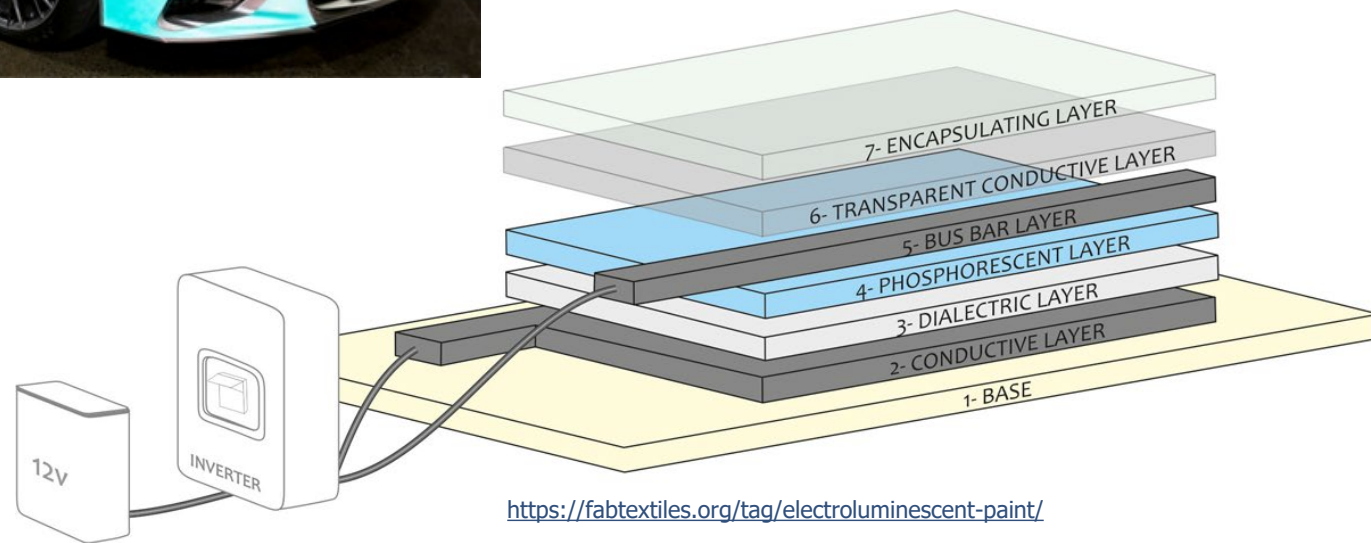
<https://wattsupwiththat.com/2018/04/04/the-road-to-hell-is-paved-with-solar-panels/>

<https://www.kennedyspacecenter.com/blog/new-to-kscvc>

# Electroluminescent Paint and Conductive Inks



<https://www.lumilor.com/>



# Due Dates (NOW!)

- Saturday, 8/24, 08:00 pm – deadline for submitting bids for sponsored projects on [projects.gatech.edu](https://projects.gatech.edu)
- For your own idea:
  - Get approval from instructor;
  - Register your team on [projects.gatech.edu](https://projects.gatech.edu)
- **Make sure all team members are listed in your team on [projects.gatech.edu](https://projects.gatech.edu)**

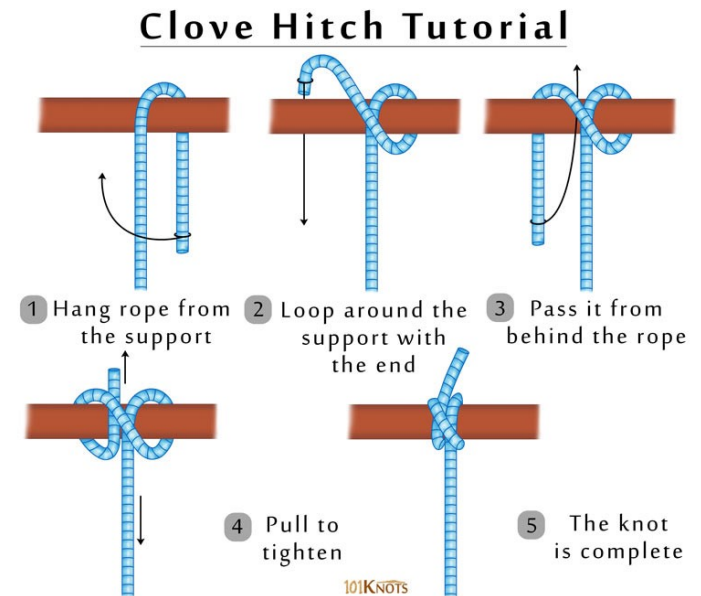
# Additional Project Pitches



# C01-Aircraft Wire Harness String Tie Tool Development

- Lockheed Martin

- The purpose of this project is to design and validate a tool to be used to tie the knot (Clove Hitch) shown below, followed by looping the ends as shown in the second diagram.



C03-Low cost simple manual/electrical machine for washing/rinsing Bitter Leaf

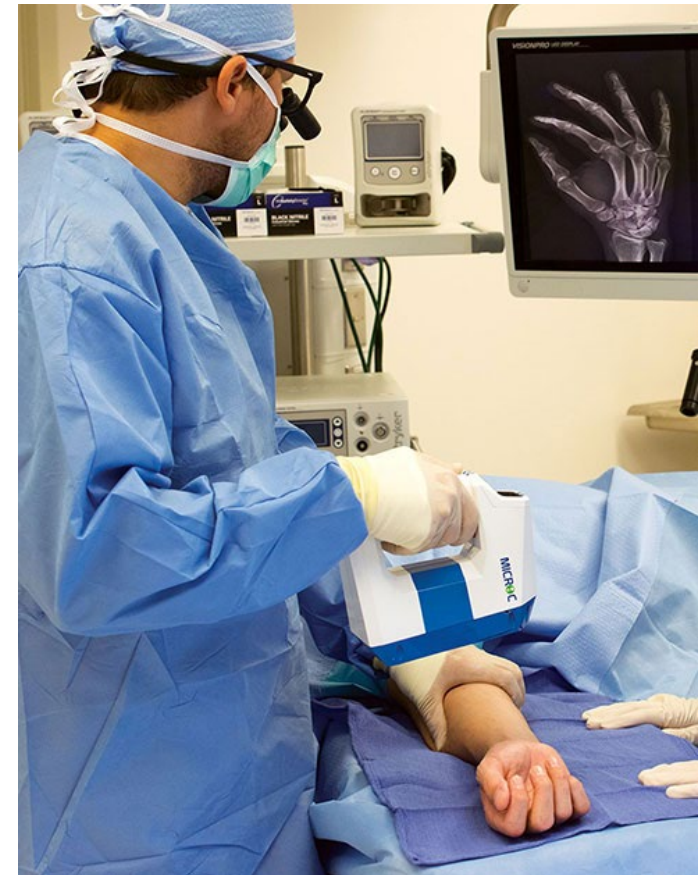
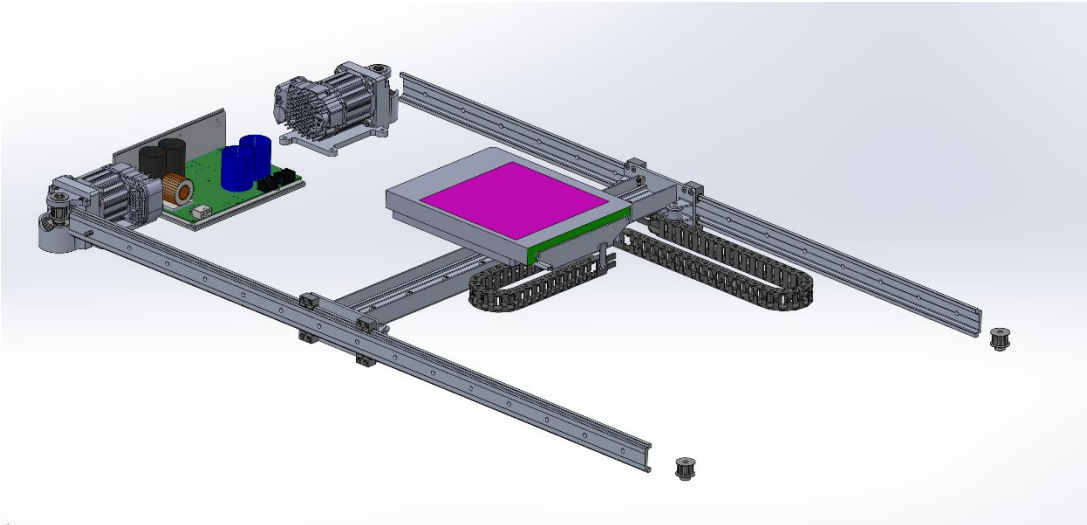
- Dr. Zama

[https://www.dropbox.com/s/18uobiiygj88vtc/Pitch%20Bitter%20Leaf\\_PITCH.MOV?dl=0](https://www.dropbox.com/s/18uobiiygj88vtc/Pitch%20Bitter%20Leaf_PITCH.MOV?dl=0)

# C05-X-Ray Enabled Battlefield Platform

- By OXOS Medical

- Design a composite based monocoque structure to house the X-ray capturing cassette



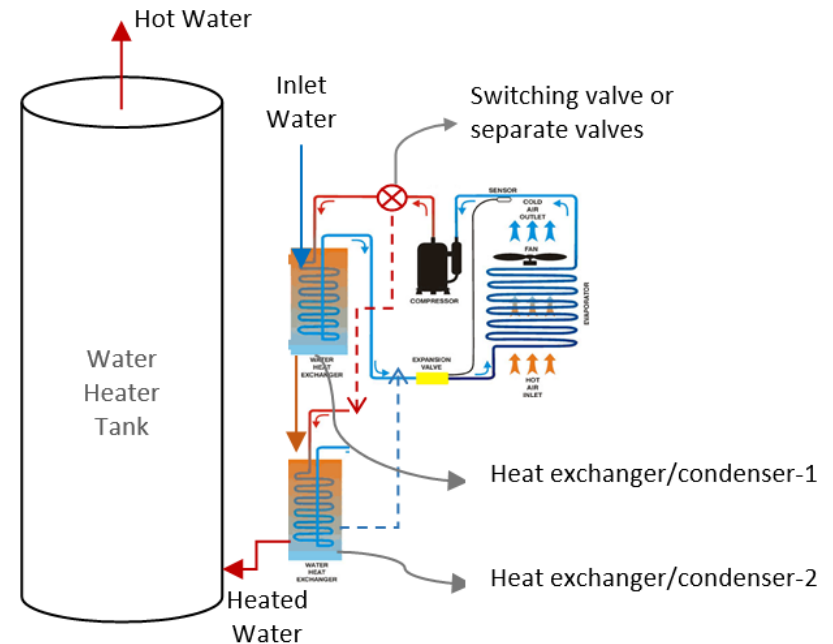
C12-Low cost simple manual/electric system for rolling/rapping processed raw Cocoyam in leaves and Aluminum foil

- Dr. Zama

<https://www.dropbox.com/s/7ylf5icfilig01g/C12-Pitch.MOV?dl=0>

# C14-Heat Pump Water Heater with Increased Efficiency - Rinnai

- The project will focus on developing alternative ideas, concepts, technologies, and mathematical models that can be used in HPWH systems to increase energy efficiency.



Example HPWH concept design - simplified sketch of HPWH with increased efficiency



GENERATION II  
Reinvented Toilet

# F03 - Generation II Reinvented Toilet (G2RT)

*A Research and Engineering Collaborative designing solutions for On-Site Sanitation*

>2.5 Billion people need Fecal Sludge Management

By 2030, 74 % of the population will live in regions with extreme water scarcity

The overarching aim is the rendering of the bodily wastes of an adult human into water, CO<sub>2</sub>, and mineral ash; **at a per capita daily total cost not to exceed \$0.15**; in a **safe, enduring, environmentally satisfactory manner** that is adequately human-engineered; in a way that it will be widely **acceptable by the world's poorest people.**

## Six Culturally Acceptable Use Cases:

Washers vs. Wipers

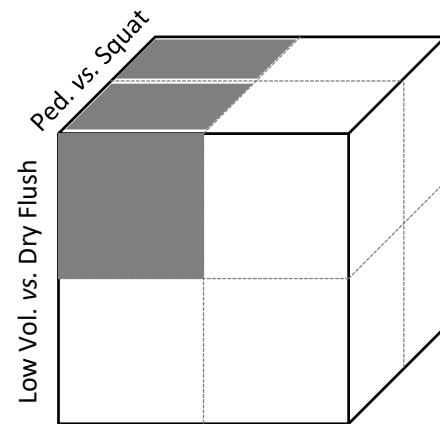
Low-Volume Flush vs. Dry Flush

Pedestal vs. Squat Plate

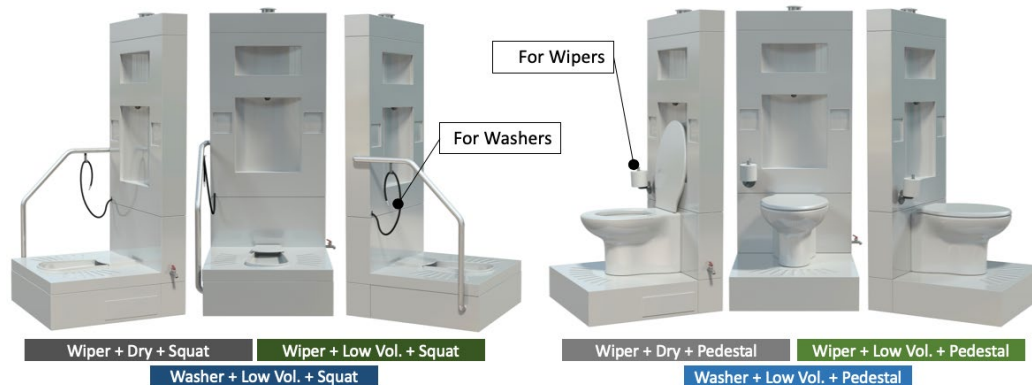
8 - 2 = 6 culturally acceptable use cases

- o No use case for Dry Flush - Washers

Therefore, 6 prototypes need to be developed:



Washers vs. Wipers

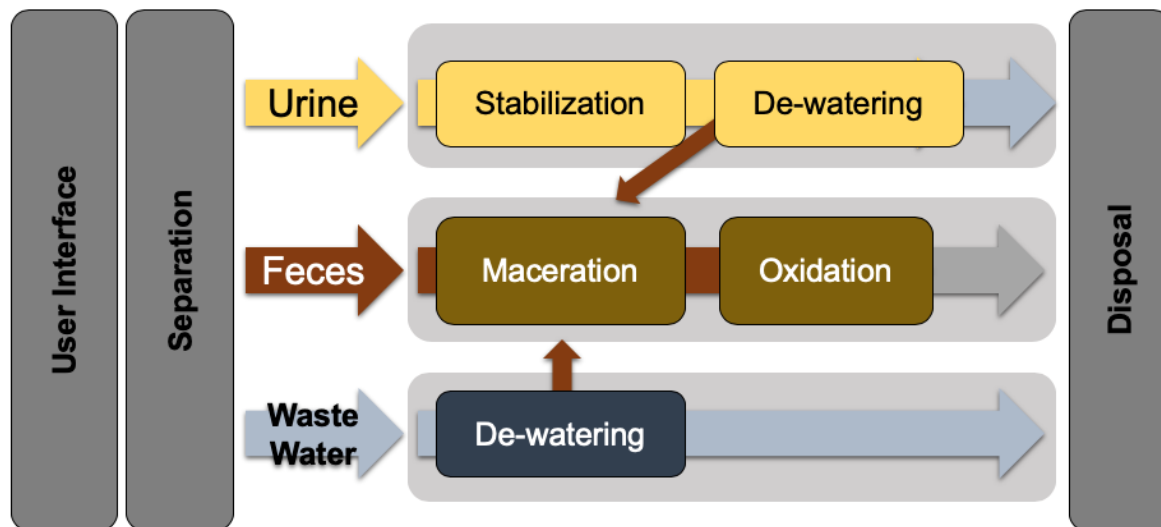




GENERATION II  
Reinvented Toilet

# Generation II Reinvented Toilet (G2RT)

*A Research and Engineering Collaborative designing solutions for On-Site Sanitation*



## Metrics

- **Cost \$450 CapEx, \$0.15/day OpEx**
- Energy efficiency over energy neutrality
  - **<1 kWh/day, <15 A, <1.8 kW**
- Post-source separations
- ISO (30500) standards

## Desires and Goals

Provision of a toilet/lavatory facility suitable for hygienic deposition of human bodily wastes that is well-lit and self-maintaining in all critical respects, including freedom from insects, odors, stains, and unhygienic surfaces.

Scalability down to a single residence scale without loss of developing world practicality

Conversion of recovered water into consumable water, e.g., via polishing, to address considerations of color, odor, and achieve assured sterility.

Production (e.g., via electrolysis) of modest quantities solutions for general-purpose sterilization.

Robustness of operations.

## How can you be involved?

The G2RT teams is designing, assessing and prototyping modular components that will separate, transport and sanitize human waste.

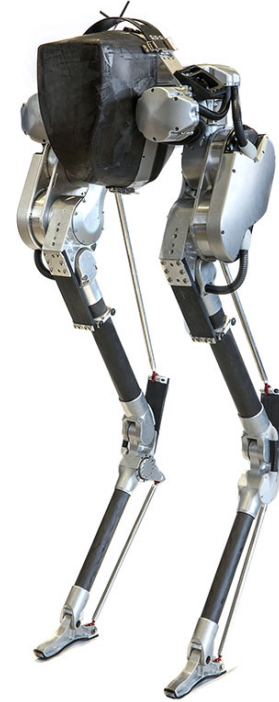
The resulting machines will not only need to deal with a wide range of materials, but also operate in some of the most challenging environments and locations. The designs will need to be robust, effective and efficient.

**Can your team help us address these challenges?**

# F04 - Whole-body coordination motion generation and control of an upper body robot Athena

- Dr. Ye

- *The purpose of this project is to design and validate the mechanical design, control, and trajectory generation of a light-weight upper body robot.*





THANK YOU