Shubh Raval, Connor McNellis, Lily Tso, Demarcus Eagle

Team Space Cowboys

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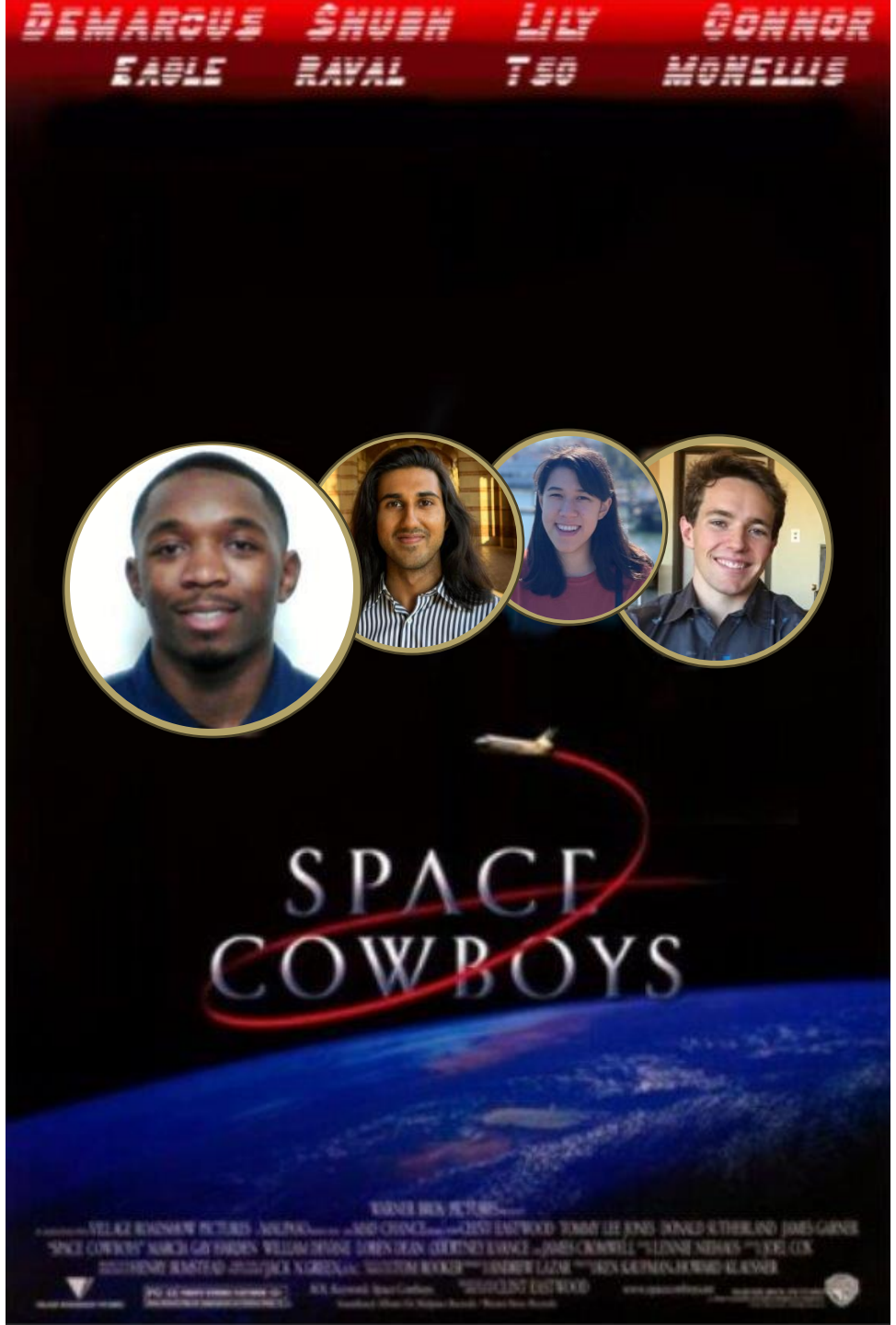

Shubh Raval

Lily Tso

Demarcus Eagle

Connor McNellis

Meet the Team!

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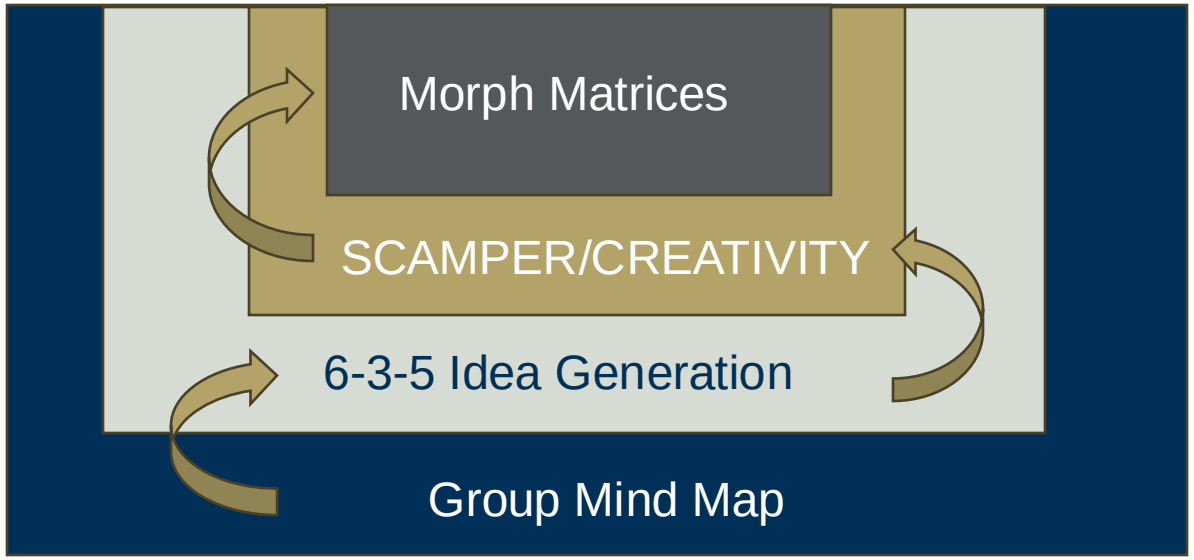
The CubeSat Launch Initiative

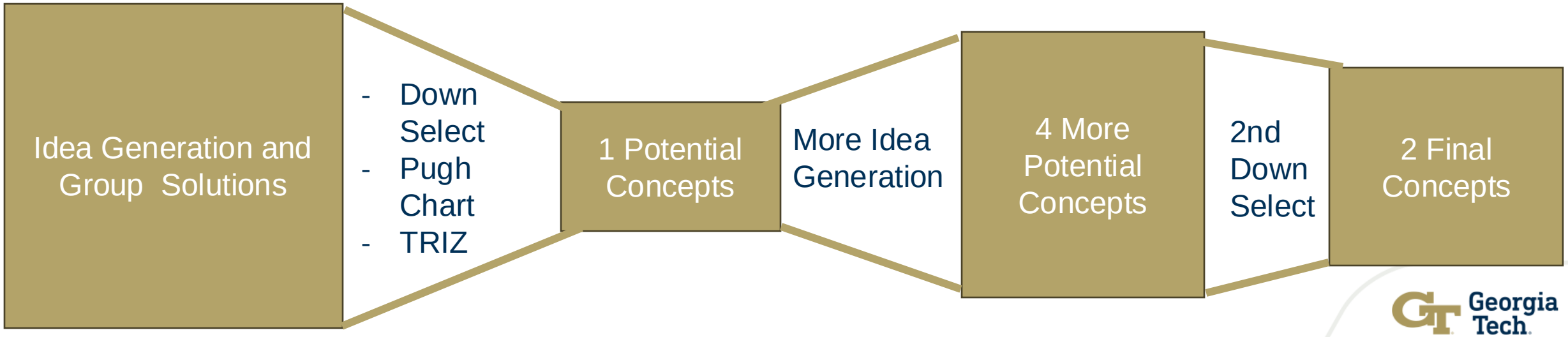
- Since 2010 Nasa CubeSat Launch Initiative has provided grants towards educational institutions, non-profits, and other research focused teams/groups

- CubeSats are small satellites usually placed in Low Earth Orbit, that are measured in CubeSat Units of 10cm by 10cm by 10cm per unit.

- Our teams mission has been to develop and prove out novel cube sat concepts that are feasible for proposing

CubeSat Concept Design Process





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Designs Down Selected From

Space Debris Removal With Expanding Foam

- Currently only theoretical hence a novel opportunity
- May be analogous tests + back-of-envelope calculations to prove concept

Prototyping Parallel Manipulator for Space

- Novel application of developed technology
- Well documented on earth

Menstrual Cup Usable in Zero Gravity

- 3D printed Molds cast with Silicon
- Necessary for Long Duration Missions
- Test systems have many dependencies (fluids, mechanical, etc)

Gravitational Wave Observation via Telescoping Antennae

- Can provide new Data that is not observed
- Difficult to prototype actual data collection

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Space Debris Removal Via Expanding Foam

- Top Level Concept
  - Expanding foam offers a lightweight, cost-effective solution to capture debris, reducing risks of further fragmentation
  - This concept leverages the foam's ability to expand and harden, allowing debris to be slowed and captured
  - This foam-based solution allows scalable missions to mitigate space debris in low earth orbit
- Risks to Prove Out
  - Foam stability under extreme conditions
  - Preventing foam fragments from becoming space debris
  - Reliable foam expansion in microgravity
  - Confirming effectiveness of both small and large debris

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Space Debris Removal Via Expanding Foam –Proof of Concept (Theoretical Research)

- Foam debris removal relies on the extremely minimal atmosphere found in low earth orbit.
- By increasing the area of the debris greater drag can be incurred, thus slowly changing the orbit of the craft.
- The force exerted by the drag effectively acts as propulsion in the direction opposite the crafts velocity, thus changing its orbit.

- The drag equation:

$$F_D = \frac{1}{2}\rho v^2 C_D A$$

F_D = drag
ρ = density of fluid
v = speed of the object relative to the fluid
C_D = drag coefficient
A = cross sectional area

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Space Debris Removal Via Expanding Foam –Proof of Concept

To prove that foam changes the aerodynamic properties of an object shaving cream was added to a paper airplane and the flight distances were observed.

The results showed a 27.5% decrease in flight distance thus proving that increased area imparted by the foam affects drag.

Test Flight	Trial 1 (ft)	Trial 2 (ft)	Trial 3 (ft)	Average
Control	11	11.25	9.3	10.52
Shaving Cream Added	7.5	7	8.25	7.60

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Menstrual Cup Usable in Zero Gravity

- Top Level Concept
- Current solutions for menstruation in space is taking hormonal birth control causing amenorrhea or using disposable period products
- As longer spaceflight is more focused on, non-consumable solutions need to be focused on
- Current research done concurrently by CNES, ESA, and ETH Zurich
    - Currently focusing on passive solutions instead of active solutions

- Risks to Prove Out
- Active solutions
- Leaking

- Note: No human-in-the-loop testing will be conducted, only focusing on the fluid mechanics

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Menstrual Cup Syringe First Test

- Menstrual Cup filled with water and corn starch mixture to increase viscosity
- With incision, no leaks were found
- After syringe was added, there was leakage

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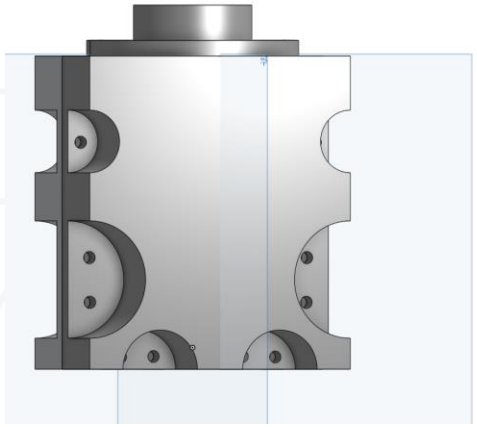
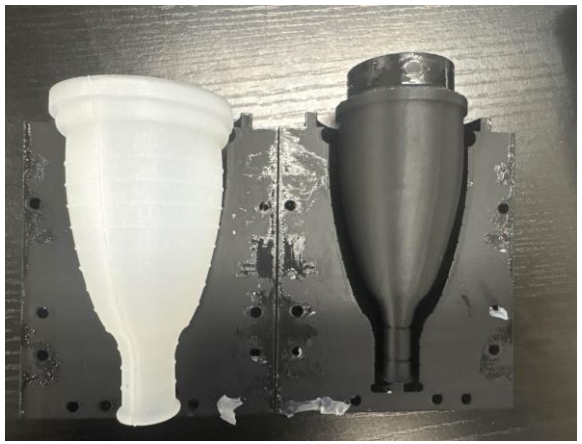
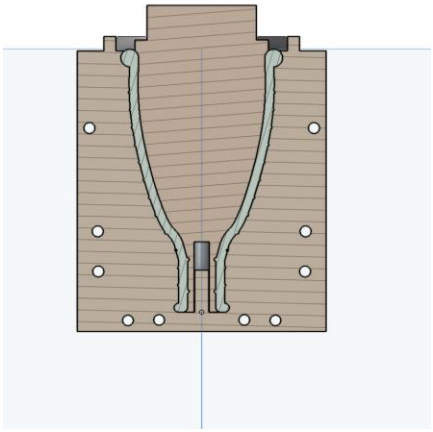
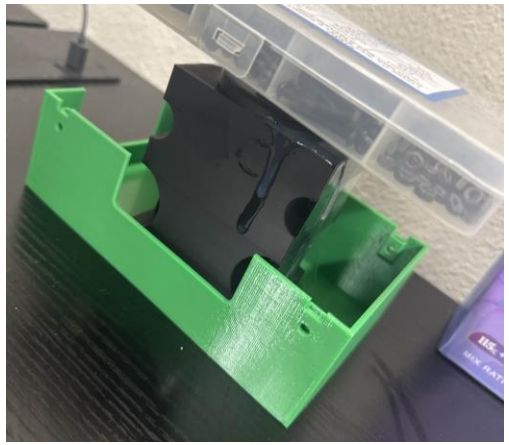
Menstrual Cup Usable in Zero Gravity – Proof of Concept

- Menstrual Cup with Opening for Syringe









- Menstrual Cup filled with water now does not leak even with inserted syringe
- Allows for now a "plug" to be used when the syringe
  is not in place preventing leakage
- Currently can only draw Fluid when enough filled liquid is inside of the cup and essentially sealed to the bottom of the container

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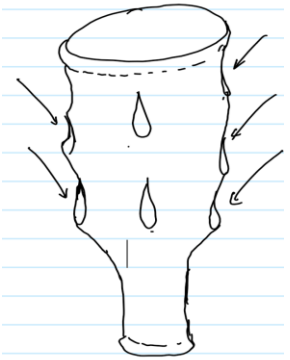
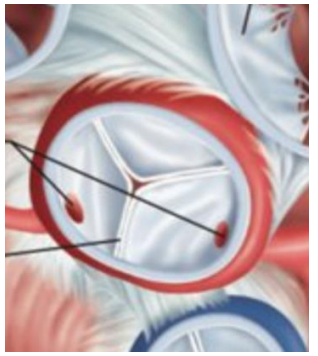
Menstrual Cup Usable in Zero Gravity – Next Steps

- Successes:
  - Opening is able to seal ensuring access via syringe only to draw out fluid
  - Sub millimeter features were maintained through the cast
  - Test Methodology works as intended and captures desired data
- Does the Menstrual Cup even have to be a cup?
  - Can we take advantages of small openings or slits to draw in fluid outside of the cup
  - Bio-Inspired Potentially from Heart Valves
- Based on the Understanding gained from the first proof of concept maybe not
  - Creating more openings in the "Cup" would allow for suction and capillary action of fluid up towards the syringe
- Next Steps:
  - Drawing fluid inverted currently has a low success rate, but the failures were due to not being able to draw up enough fluid or fluid that was outside of the cup
  - But this does show where the design needs to iterate towards



Potential New Design with Openings



Tri-Fold Heart Valve

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Next Steps For Our Team

- Additional Proof of Concepts
  - Menstrual Cup
    - Create a version with small "valve" and see if fluid can be drawn from outside of the menstrual cup as well
    - Create proposal for a more advanced test set up for further proof of concepts
  - Foam Space Debris Capture
    - Continue to Validate Analytical Results and determine supply chain availability of potential foam option
    - Research if any other analogous tests can be used like the foam on paper airplane to further eliminate risk and improve on understanding

Thank You for Watching!