

# SHARING

- We presented our innovative solution to Professor Terry Sachlos from Lassonde School of Engineering, York University



- We presented our innovative solution to Professor Regina Lee from Lassonde School of Engineering, York University



- We discussed our INTO ORBIT challenge with Astronomer, Ryan Marciniak



- We presented our innovative solution and skit to over 200 middle school students at Bayview Glen.

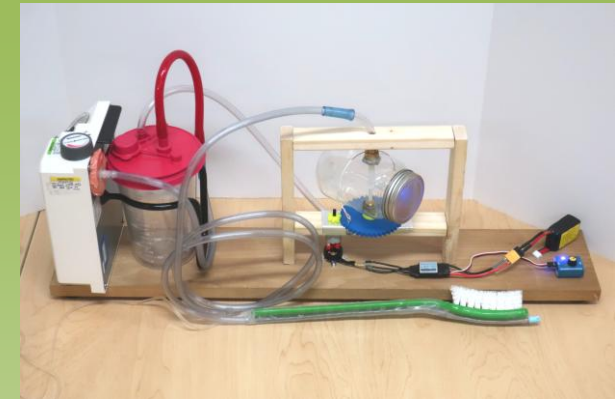


**Saving astronauts' lives  
one brush at a time**

**Ctrl-Z Bayview Glen  
FLL Team #5831**

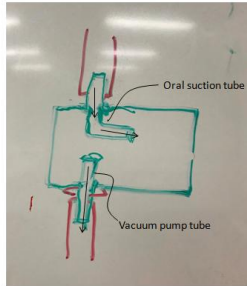
Visit:

- (a) our website at <https://fllctrlz.github.io/ctrlz/>
- (b) our video at <https://youtu.be/xA40-mpaxVU>

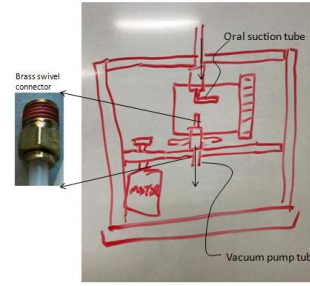


## Whiteboard Design of our Solution

Preliminary Idea for the Astrobrush Centrifuge

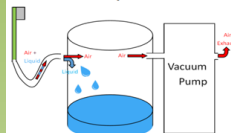


Refinement of our Astrobrush Centrifuge



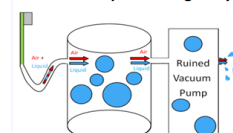
## Why Does the Astrobrush Use a Centrifuge to Create Artificial Gravity?

Vacuum Pump on Earth



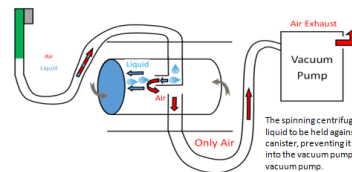
When liquid is suctioned into the canister, gravity separates the liquid from the air and only air is suctioned into the vacuum pump.

Vacuum Pump In Microgravity



When liquid is suctioned into the canister, it floats around and will be suctioned into the vacuum pump, contaminating and ruining it.

Astrobrush Centrifuge in Microgravity



The spinning centrifuge causes the suctioned liquid to be held against the wall of the canister, preventing it from being suctioned into the vacuum pump. Only air enters the vacuum pump.



## PROBLEM IDENTIFICATION

According to NASA, a dental abscess, which can lead to sepsis and eventual death, is the medical condition most likely to result in a spacecraft evacuation. Astronauts need to brush their teeth to prevent this. Currently, there are two ways of getting rid of toothpaste and oral fluids after brushing. One is to swallow it, which can result in harmful fluoride toxicity in the long run. Another is to spit it into a towel which requires costly towel supplies and creates unnecessary trash. We need a way to make brushing teeth safer and more pleasant to encourage proper oral hygiene during long duration space travel.

### Sources of Information

- We have consulted with experts and referred to articles and websites

### EXPERTS

- **Mr. Bill Kowalczyk**, Houston-based NASA Senior Flight Control Officer, provided us with technical considerations, like the importance of minimizing power consumption for the heating element in the centrifuge so that critical science, the main mission of the ISS, can continue without interruption.
- **Ms. Andrea Kowalczyk**, Dental Hygiene Mentor and author of "Hygiene in Orbit" published in Registered Dental Hygienist Magazine outlined the benefits of fluoride for tooth enamel, and said that she "liked the idea of giving the astronauts an effective way of delivering fluoride while they are in orbit."
- **Prof. Regina Lee**, Associate Dean of the Earth, Space Science and Engineering Department at York University, informed us that in advancing our invention, we must conduct a risk analysis to determine what part of our Astrobrush is most likely to fail.
- **Prof. Terry Sachlos**, Mechanical Engineering Department at York University, encouraged us to consider some possible non-space uses of the Astrobrush.
- **Dr. Vinay Bhide**, periodontist advised us as to the potential impact of long-term poor dental hygiene on one's physical health.
- **Mr. Ryan Marciniak**, astronomer and public speaker from the Ontario Science Centre shared his insights on the various issues around space travel and exploration.

### SELECTED REFERENCES

- BBC: Philippa Roxby, "How to Deal with a Medical Emergency on the Space Station", 10 Jan 2016
- Toronto Dental Office: Is it bad to swallow toothpaste?, Erin Van Der Meer
- NASA: Review of Spaceflight Dental Emergencies, Anil Menon, MD, MS, MPH
- The Sciences: How does fluoride in toothpaste affect cavities? Is there any kind of "natural" fluoride protection or is it only in artificial compounds?, Scientific American
- Centers for Disease Control and Prevention: "Recommendations for Using Fluoride to Prevent and Control Dental Caries in the United States"
- Andrea Kowalczyk, RDS, BS, RDH, "Hygiene in Orbit", 10 Jul 2015
- Surgeon General's Perspectives, Vivek H. Murthy, Surgeon General of the United States, Community Water Fluoridation.

## EXISTING SOLUTIONS

These suction toothbrush systems require gravity to work and cannot be used space.



## INNOVATIVE SOLUTION

### OUR TEAM'S SOLUTION

The Astrobrush is an irrigating toothbrush that suctions toothpaste and oral fluids from the astronaut's mouth. This is done by connecting it to a centrifuge that leads to a vacuum pump. The centrifuge prevents solid and liquid contents from being suctioned into the vacuum pump in microgravity. The centrifuge is heated to vaporize the water which is vented into the spacecraft cabin for reclamation in the spacecraft's water condensation system ("CCAA"). The solid waste in the centrifuge is then disposed of. This will help prevent tooth decay and problems related to long-term ingestion of fluoride by encouraging convenient and frequent tooth brushing by space travelers, while minimizing waste. Brushing is particularly critical in space since drinking water from the CCAA contains no fluoride.

### PROTOTYPE COSTS

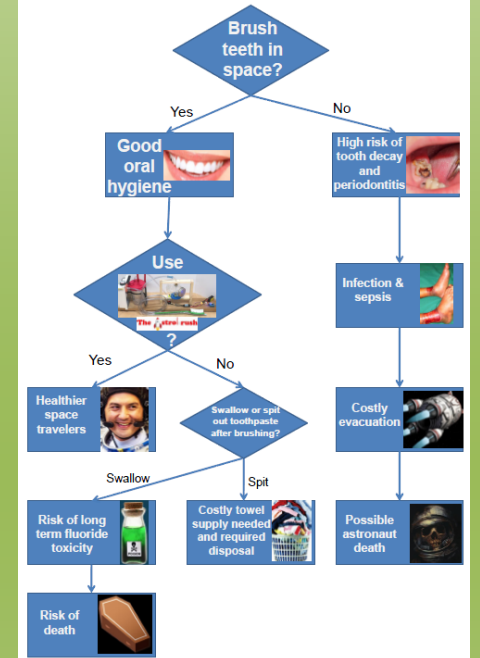
Astrobrush Prototype Costs	
Easy Go Vac Aspirator	\$254.99
Drone motor	26.25
Lithium polymer battery charger	18.75
Lithium polymer battery (3-cell)	18.75
Infu-Stat Pressure Infuser	18.49
CCPM Servo Driver	15.00
Electric speed controller	11.25
Oversized toothbrush	9.75
Brass swivel connector (x2)	5.99
Lumber	5.92
Silicone caulking	4.68
Flexible tubing 3/8" OD	4.50
Wood screws	2.99
LEGO axle, half-beams and pins	2.25
Plastic Mason jar	1.75
Ball bearing	0.75
Sheet metal	0.74
Filament for 3D printed gears	0.68
	<b>\$403.47</b>

## INNOVATION

- It is an irrigating toothbrush, making it easier for astronauts to add and remove water to and from their mouths
- Connects to the astronaut's **personal toothbrush** so multiple astronauts can use our product
- Centrifuge prevents damage to the vacuum pump in low gravity

## IMPORTANCE OF THE ASTROBRUSH

The Astrobrush Can Be the Difference Between Life and Death on Long Duration Space Journeys



## SCHEMATIC OF OUR PROTOTYPE

