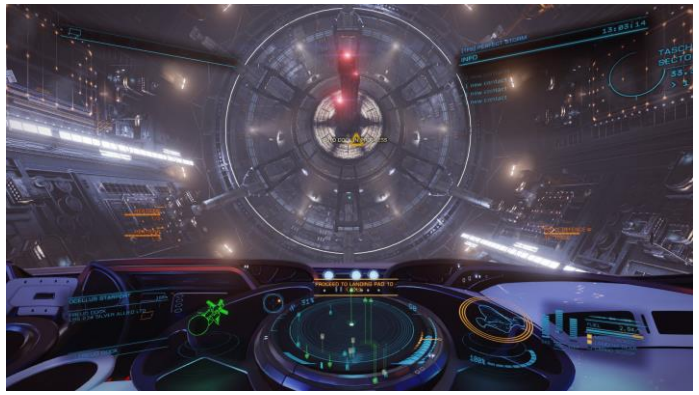
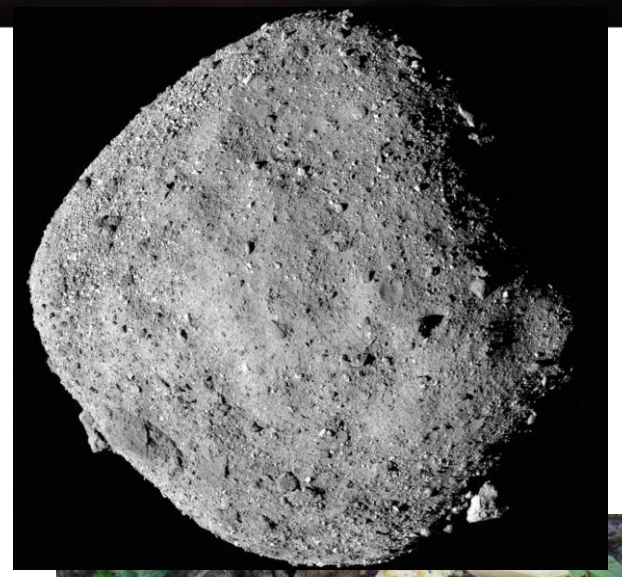


NASA HUNCH
Design and Prototype Projects
2021 to 2022



NASA Links for Educators and Students

- www.nasahunch.com
- General information for students on NASA.gov site:
  - http://www.nasa.gov/audience/forstudents/9-12/index.html

A-Z Topic on nasa.gov
http://www.nasa.gov/topics/

Space Station Tours
http://www.nasa.gov/mission_pages/station/main/suni_iss_tour.html

Information about International Space Station
http://www.nasa.gov/mission_pages/station/main/index.html

Living in Space-Multiple resources listed
http://nasasearch.nasa.gov/search?query=living+in+space&affiliate=nasa&utf8=%E2%9C%93

Working in Space
http://nasasearch.nasa.gov/search?query=working+in+space&affiliate=nasa&utf8=%E2%9C%93

Space Station Layout
http://www.space.com/3-international-space-station.html

Space Station air circulation
http://en.wikipedia.org/wiki/Life_support_system

Station Tour (there are lots of others)
https://www.youtube.com/watch?v=bGvA8kS-_5M

Physics of Microgravity
http://nasasearch.nasa.gov/search?utf8=%E2%9C%93&affiliate=nasa&query=Physics+of+Microgravity

- Design and Prototyping gives Students the opportunity to help develop important hardware and features that could help the astronauts live more functionally and aid in the scientific and engineering capability on the International Space Station.
- The Following slides have different project ideas that students could work toward for the 2018-2019 school year.
- Talk with your mentor to determine the dates for your Preliminary Design Review (October to November time frame), Critical Design Review (February to March time frame) and the Final Review will be April 16, 2019 at Johnson Space Center.

More Resources

Life in Space
http://www.esa.int/Our_Activities/Human_Spaceflight/Astronauts/Living_in_space

Explanation of the Soyuz--Russian space craft and the mechanics of docking to the ISS—
https://www.youtube.com/watch?v=24Bz5Ra5RgE

General Information for Students
https://www.nasa.gov/audience/forstudents/9-12/index.html

Google Maps of ISS

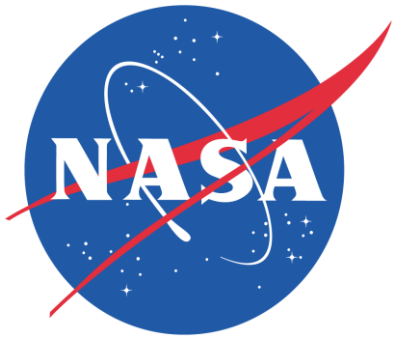
https://www.google.com/maps/@29.5604733,-95.0855252,3a,75y,116.77h,82.07t/data=!3m6!1e1!3m4!1sSEfknbwn4K4AAAQvxgbyJQ!2e0!7i10000!8i5000

Understanding Fluid Dynamics in Space

https://www.youtube.com/watch?v=jn5KuSHguUE

Where to get Mars, Moon and asteroid simulated soil

https://www.ucf.edu/news/ucf-experimental-martian-dirt/



Zero-g Bulk Transfer System

Problem:

The current solution to controlling the many little nuts, bolts, almonds, M&Ms, Leggos, … is to wrap them in small plastic bags but all of these small packages add to a very large amount of trash. Is it possible to control the many, many particles that can be inhaled, float into eyes, clog up electrical connectors, obstruct air vents and cause many other problems in zero-g without sending more trash to the ISS or other space craft? Because of the lack of gravity, we end up having to send up many plastic packages to control the small particles. If we could come up with a system that would allow the transfer of small particulate from a large, flexible, bulk bag to a smaller container we could save NASA from sending up a lot of packing material that turns into trash and adds to other trash issues on the International Space Station.

Objective:

Design a systems that would allow the transfer of the contents of a large flexible bag of almonds to a smaller container in a controlled fashion in zero gravity.

Requirements:

- Need to be able to control the amount of particles being brought into the new container
- Needs to be easy to clean
- Helpful if the new container is transparent
- Could be hand powered or battery powered
- The easier it is to operate, the more likely someone will want it.

Tips:

- This sounds easy but is complicated because most people have a hard time envisioning lots of particles floating around in space and controlling them.
- This will be difficult to demonstrate on Earth since we have gravity-----maybe try small Styrofoam balls or packing peanuts?
- Could small, low volume fans be used to pull materials into the smaller containers.
- Could this be done with centrifugal force with rotation pulling the particles in a controlled fashion?
- Its easy to make something complicated (may not work), its hard to keep it simple

For more detailed information
http://www.hunchdesign.com/uploads/2/2/0/9/22093000/zero-g_bulk_transfer_system.pdf

Lunar Supply Pod Airlock

Problem:

- HUNCH needs a safe place where the crew can unload the Lunar Supply Pods. If the crew unloads them outside in the vacuum of the lunar surface, the space suits are going to be too big and bulky to be able to crawl into and out of the supply pods and dust would probably get on all of the supplies. The supply pod needs to be brought into a controlled environment to make it easy for the crew to unload the supplies and bring them into the habitat where they can be used.

Objective:

- Build a scaled model (will fit on top of a desk)of an airlock big enough that can be used for emptying the contents of a supply pod. Use a softball as the dimension of a spherical supply pod (3.8in). Find a similar sized soup can to represent a cylindrical supply pod.
    - Suggest construction materials. Show how these or similar materials will be put together.
    - Provide ideas of how it will be delivered to the moon and attached to the smaller airlock
    - What kind of hatches or sealing 'doors' would be used?
    - How will it handle the lunar dust without leaking?
    - What does the Lunar Supply Pod Mover need to be able to do for your airlock? You can impose requirements on both the supply pod and the mover (within reason).
    - What kind of tools may be needed for unloading the supply pods?

Tips:

- Be prepared to explain how the Supply Pod Mover gets the Supply Pod inside the airlock. (you can choose which mover from last year fits your need)
- Is there an orientation that could minimize the amount of dust that gets on the hatch or gets inside?
- Does the airlock have to be at 14.7 psi? Could it be at 10.2 psi or 4.0 psi to minimize stress on the airlock and air that might be lost to leaks? Can people breath at those lower pressures?
- Could there be air filled support beams to keep the roof up when the airlock doesn't have air in it?
- Are there specific shapes that would make it easier for the pod to be placed inside?
- Are there specific shapes that make the volume easier to work in?
- Are there specific shapes that are easy to construct with the materials you are choosing?

For more detailed information
http://www.hunchdesign.com/uploads/2/2/0/9/22093000/supply_pod_airlock.pdf

Crystal Growth NanoLab

Problem:

Research has shown that growing crystals in zero-g produces a higher quality of crystals than those grown on Earth. The reason is not well known but it is believed that the crystals are able to grow over a longer period of time without bumping into the sides of the containers that can cause imperfections. There are many materials that could be improved if larger more perfect crystals could be made— organic compounds like proteins for drugs, semi-conductors for computer chips, and metallic crystals for high quality metals. Researchers may have great questions that need to be answered but may not have the background or the time for putting together the equipment needed to fly their experiment to space.

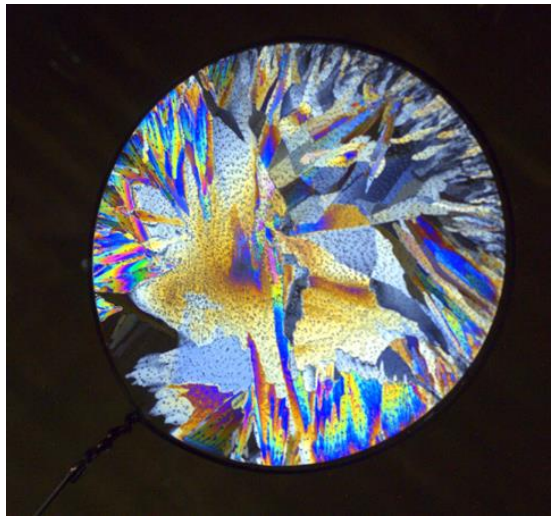
Objective:

Develop the box that could house a variety of different experiments and how to make the interior of the box so the person doing the experiment can arrange the components in the box to fit their needs.

Requirements:

- Must fit into 10cm x 10cm x 20cm NanoLab
- The type of containers for good evaporation or electrolysis—this could be very complicated. As soon as you open the container so the liquid can evaporate and allow crystallization to occur, the surface tension of the liquid may allow the liquid out of the container and get all over the inside of your box.
- Methods for electrolysis.
- How should the containers be held so cameras can still see the formation of the crystals
- How **big** do the containers need to be? Can you find different sizes and options?
- Can there be different methods for how the reaction might be started once in zero-g
- Plan How cables for sensors and probes will be held in place
- If containers are rectangular would the corners become a nucleation site for the crystallization? Do the containers need to be cylindrical or some other shape?
- Find a good location for the control electronics that won't get wet but will allow good options for cable routing for the sensors and camera(s)—may need contact with aluminum NanoLab wall for conducting heat from electronics.
- Some of these methods for crystallization may not be possible because of the constraints in zero-g.

For more detailed information
http://www.hunchdesign.com/uploads/2/2/0/9/22093000/crystal_growth_nano_lab.pdf



Fungus NanoLab

Problem:

Scientists and Researchers are wanting to send up experiments to the ISS but they don't have enough experience designing labs. HUNCH wants to make it easier for Researchers to do their science without having to do all of the engineering by making a generic lab that is easier for them to work with. Molds and fungus are found growing on the ISS and the crew cleans the station often to keep them from proliferating but few have tried to grow mushrooms yet. As people expand into the solar system, fungus will come with us whether by design or accident. Studying how it does and does not grow in zero-g and the spacecraft environment may be important to the health and safety of the space craft and crew.

Objective:

Design a generic lab for growing fungus that can be arranged by different researchers to fit different fungus experiments

Requirements:

- Must fit within a 10cm x 10cm x 20cm NanoLab.
- Accurately Account for the volume and a variety of locations for the hardware (cabling, camera, sensors, raspberry pi,…) to be installed in the box. Each item may not have a specific location but can be shifted to where the researcher wants them. (think of it like designing a doll house so that a child could arrange the furniture and accessories where they want them to play they want)
- Determine materials for holding the substrate—plastic bag, cloth, rigid container, size, shape—cylinder, rectangular
- Determine methods for injecting water to start the growth after the lab arrives on orbit and turned on.
- The researchers want to be able to arrange and place their substrate in a specific location relative to the camera(s), the water injection, and sensors. It is important that your team makes the NanoLab variable enough that the researchers can locate what they want where they want and be assured that nothing will shift or move during vibrations of launch or while on orbit.
- Find a good location for the control electronics that won't get wet but will allow good options for cable routing for the sensors and camera(s)--may need contact with aluminum NanoLab wall for conducting heat from electronics.
- Design a method of stopping a mushroom from releasing spores—this could mean preventing the cap from opening to prevent spores from being released—not too early, not too late. There may be other options for preventing spores from releasing.

Pointers:

- This will have some similarities to growing a plant but the lighting may only be for photography.
- Is infrared lighting of any value for the mushroom? Do you need a specific camera?
- Is there value to Ultraviolet light?
- Since these experiments will only be for 30 days and the box is mostly sealed, it seems one injection of water is all that will be required—may find different with experimentation—determine by testing.
- There are many ways to cut a mushroom but what direction will it grow?
- Mushrooms seem to sprout up in the yard overnight. How will you know when to cut it?
- Will mushrooms grow bigger or smaller without gravity?
- Know the dimensions of your equipment from the website. Don't forget cabling.
- How do you keep the cables from vibrating out of sockets or getting in the way of the camera?

For more detailed information http://www.hunchdesign.com/uploads/2/2/0/9/22093000/fungus_nanolab.pdf

Fermentation NanoLab

Problem:
Scientists and Researchers are wanting to send up experiments to the ISS but they don't have enough experience designing labs and understanding the requirements of space hardware. HUNCH wants to make it easier for Researchers to do their science without having to do all of the engineering by making a generic lab that is easier for them to work with. Fermentation is a natural process used in many kinds of production of foods, beverages as well as in research and pharmaceuticals on Earth including making bread, beer, wine and gene research. Understanding what happens to yeast cells in the radiation levels of the ISS can help researchers understand what happens to human and animal cells in space. There is no doubt that yeast can grow both in liquids and squishy dough in zero-g, the difficulty is how to keep the fermentation from shutting itself down due to the yeast's waste products remaining close to the yeast cells.

Objective:

Design a generic lab for fermenting liquids and solids that can be arranged by different researchers to fit different fermentation experiments.

Requirements:

- Must fit within a 10cm 10cm x 20cm NanoLab.
- Accurately Account for the volume and a variety of locations for the hardware (cabling, camera, sensors, raspberry pi,…) to be installed in the box. Each item may not have a specific location but can be shifted to where the researcher wants them. (think of it like designing a doll house so that a child could arrange the furniture and accessories where they want them to play they want)
- Determine materials for holding the substrate—plastic bag, rigid container, size, shape—cylinder, rectangular
- Determine methods to start the yeast growth after the lab arrives on orbit and turned on.
- The researchers want to be able to arrange and place their substrate in a specific location relative to the camera(s), the water injection, and sensors. It is important that your team makes the NanoLab variable enough that the researchers can locate what they want where they want and be assured that nothing will shift or move during vibrations of launch or while on orbit.
- Find a good location for the control electronics that won't get wet but will allow good options for cable routing for the sensors and camera(s)--may need contact with aluminum NanoLab wall for conducting heat from electronics.
- Needs a simple method for circulating the fluid on a regular or continuous basis so the yeast cells are able to feed without going dormant.

Pointers:

- Is there value to seeing the yeast on a microscopic scale during the experiments or is it better to see the macroscopic picture of the whole mass?
- What kind of lighting is needed for the kind of pictures you want?
- Are there colors of light that may be helpful to growing yeast? Infrared, Ultraviolet, visible spectrum, no light?
- Is there a way to shut down the yeast growth at any particular time of the experiments?
- Does food or water needed to be added over the 30 days?
- Know the dimensions of your equipment from the website. Don't forget cabling.
- How do you keep the cables from vibrating out of sockets or getting in the way of the camera?

For more detailed information
http://www.hunchdesign.com/uploads/2/2/0/9/22093000/fermentation_nanolab.pdf

NanoLab software GUI

Problem:

Scientists and Researchers are wanting to send up experiments to the ISS but they don't have enough experience designing labs. HUNCH wants to make it easier for Researchers to do their science without having to do all of the engineering by making a generic lab that is easier for them to work with. There are 4 generic labs HUNCH is aiming for—Agriculture, Fungus growth, Fermentation and Crystal Growth. Last year we had students developing a Generic Ag Lab with good results and great ideas. We would like to expand the kinds of labs that could be made generic to include more researchers needs. We would also like to make the interface to all of them very similar so that there is a consistent style of controlling the instrumentation (potentially different sensors, cameras and equipment) that would be in each of the generic labs.

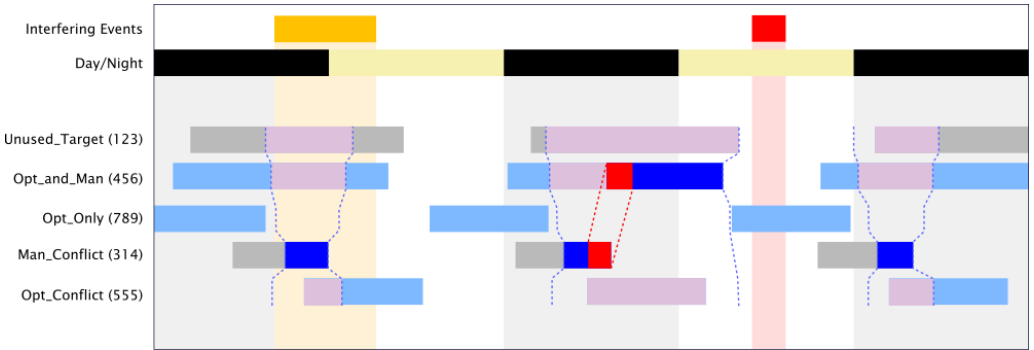
Objective:

Develop software for the Raspberry Pi or Arduino that would control a large number of Sparkfun hardware and make it easy enough that a 5th grader would be able to be able to do the setup but a college professor would be able to get the data they are looking for.

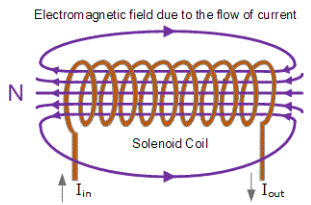
Requirements:

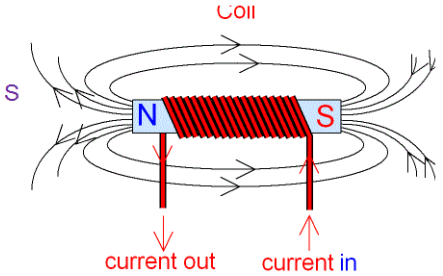
- Uses a Raspberry Pi or Arduino
- Interfaces easily with several Sparkfun sensors, motors, cameras.
- choose your coding language but likely to be python
- screens or windows that help select down to specific equipment to the desired lab.
- Consistent style throughout software between each lab.
- Interfaces with NanoRacks downlink for data retrieval
- Operate without internet connectivity
- Able to operate for a minimum of 30 days with minimal interaction with the ground
- Arrangement that will allow a compact volume for the boards, cables, connections without retaining too much heat. Contact with aluminum NanoLab shell?

For more detailed information
http://www.hunchdesign.com/uploads/2/2/0/9/22093000/nanolab_software_gui.pdf



Magnetic Boots for Space X Human Landing System





Problem: If space craft are made out of ferromagnetic materials, could we come up with a magnetic boot that would allow astronauts to walk around and work on the outside of the ship instead of floating? This would allow astronauts to maneuver with their feet and carry things with their hands similar to what they do on Earth.

Objective:

Design and build a prototype of a magnetic boot that would allow astronauts to walk and work on the outside of a steel hulled ship.

Requirements--

- Must be able to turn them on and off in some fashion to allow for walking
  - The switching mechanism is really what is going to be key to this. Its easy to get a strong magnet or electromagnet to stick to a piece of metal. The real question is can it be manipulated so some one could walk around easily.
- Turn on extra strength when working at a work site
- Turn them off when getting back inside or when the job is over
- Realistically, in zero-g the magnetic boots don't really need to hold your weight except when you are at a work site and pulling or pushing on something.
- Should hold at least 20 lbs. on 301 stainless
- Where do the batteries go if they are needed?
- Are the switches in the boots or do they need to be in the hands?
  - Can the switching mechanism be done with toes or with ankle motion? Maybe motion of the arms so that you are still able to 'carry' things in your hands and arms?
  - If you adapt a specific type of walk, can your motions activate and deactivate—even if it looks funny?

Pointers—

- It seems like it would be valuable to have at least 2 magnets per shoe both for safety (redundancy) and also for mobility—one in the toe and one in the heal.
- It would be valuable if they aren't too big and bulky but operational is more important than size at the moment.
- They may be shaped different from normal shoes.
- Could be something that fits onto a regular shoe.
- There are at least 3 options—
  - solid magnetics—mechanical method of switching magnets to be "on/off"
  - Electromagnets—able to turn on and off by switches, uses batteries.
  - Hybrid—solid magnetics and electromagnets combination—solid magnets for walking and electro magnets for clamping on hard at the worksite—just thoughts for you to consider.

For more detailed information
http://www.hunchdesign.com/uploads/2/2/0/9/22093000/magnetic_boots.pdf

Lunar Habitat Shoes

Problem:

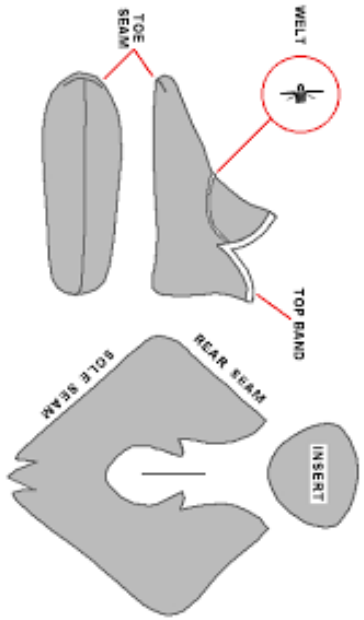
The Lunar habitat will be a fairly unique location where NASA may need a specialized shoe to aid the astronauts in this new environment. Because of the 1/6th gravity you will also have 1/6th friction for walking around. Static electricity sparks can cause fires. Because the lunar dust is sharp like shards of glass, the floor needs to be easy to clean.

Objective:

Develop the shoes the astronauts will wear in the lunar habitat and the inside surface of the habitat they will walk on.

Shoes for the inside of the lunar habitat

- good traction
- light weight
- No spikes or sharp edges that could damage the walking surface or puncture the inflated habitat
- nonflammable materials
- must have some kind of arch support
- easy to put on and take off
- must not build up static electricity
- good insulation from the floor but minimizes sweaty feet
- arch support
- less padding so that bones are able to receive more shock despite low weight
- Choose a flexible, cleanable material for the floor of the habitats
- While these shoes may have many similarities to many existing shoes, I'm certain that no current shoe would fit all of the astronauts' Lunar habitat needs.

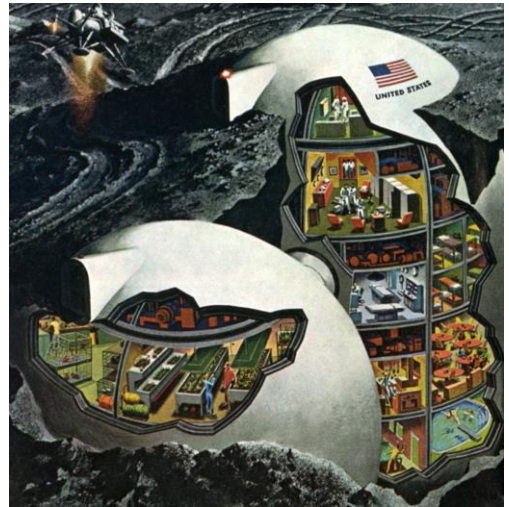


Options to consider

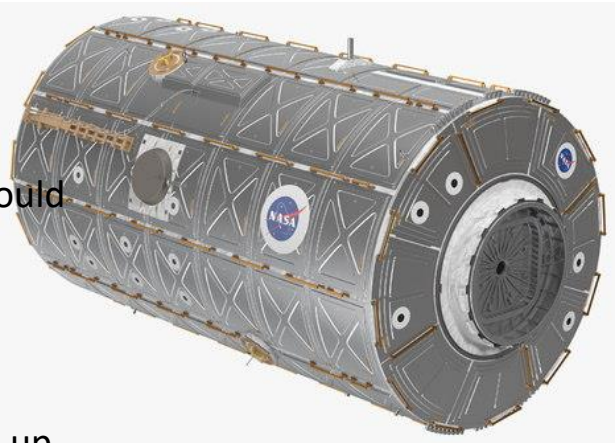
- zippers, Velcro, laces, elastic, buttons???
- like a scuba booty/ wrestling shoe, aqua sock, slippers, more than a sandal
- Leather, Nomex, beta cloth

If your school has a fashion design class or sewing classes, this would be a great project for collaboration.

For more detailed information
http://www.hunchdesign.com/uploads/2/2/0/9/22093000/lunar_habitat_shoes.pdf



Destiny mockup



Problem:
HUNCH is interested in building a full scale mockup of the Destiny module that could be placed in an airport waiting area

Objective:
Build a 1 to 33 scale model of a Destiny module to demonstrate how a full sized module would be built and transported from one venue to another.

Structure

- We are looking for something that is easy to transport on a flat bed trailer, set up and take down.
- How much needs to be made of steel, aluminum, wood?
- Should be modular sections that assemble
- Individual modules may have wheels for moving on concrete floors
- Individual modules could be picked up by fork lift to get it on and off a truck if necessary
- Enter through bay 1 starboard and exit through bay 6 port. Make the endcones so graphics or photos can show the interior of other modules
- Ramps for entry and exit to module
- Will allow for handicapped entrance
- What kind of structure is needed for the floor to support many people walking through? What kind of structure is needed for the walls and ceiling to hold TV screens
- Exterior surface could be inflated or flexible covering with graphics to make it look like the outside of the module.
- We do not want it on a trailer since that would limit the outer dimensions of the mock up to what is legal on the road.

Interior

- Interior walls and ceilings could be large touch screens to allow interaction with the experiments?
- What kind of TV screens do you recommend?
- How big of doors are needed for handicapped entry?

For more Detailed information
http://www.hunchdesign.com/uploads/2/2/0/9/22093000/destiny_mockup.pdf

Asteroid AR/VR Simulator

Problem:

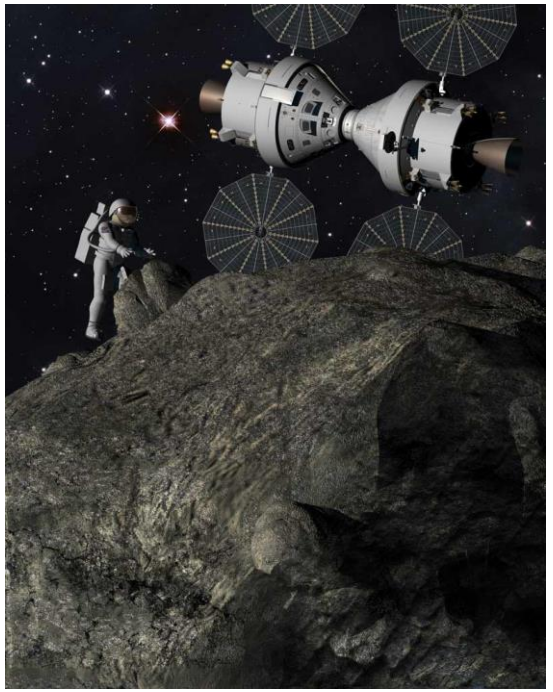
- If people are to visit and explore asteroids and eventually develop methods of mining an asteroid, we will need to come up with technologies for getting close to, setting down on and removing material without creating big dust clouds or pushing ourselves off the asteroid. Zero-g or micro-g can be very difficult to work in when there are many small particulates that need to be controlled. We will need a method of testing ideas that can't really be done with solid objects on Earth.

Objective:

- Develop a VR/AR program that simulates the what it would be like for an astronaut to bump into Bennu and what methods could be used to minimize an expanding dust cloud that has been stirred up by small manuvering thrusters.
  - How long will it take for different sized particles (1mm, 5mm, 10mm, 20mm, 40mm, 100mm) to be pulled back to the surface after being dislodged by force of 10N. What kind of path with the particles take?
  - Assume the astronaut hits the asteroid with their fist with 10 N of force.
  - Assume density of rocks to be 1.190±0.013 g/cm^3
  - How much debris will be scattered by a xxx thruster that is 10m from the surface?
  - How much gravity does a Bennu have? Will it be the same everywhere since it isn't spherical?
  - How might people move around on the surface?
  - What kind of software do you want to use--Unity, Unreal engine, other?
    - Are there some that are better for this application than others?
  - How do we capture an asteroid without being in a cloud of dust?

Pointers:

- A key question is how to represent this problem in a virtual reality program? Trying to model billions of small and large particles would quickly crash your computer to do all the calculations for their collisions and paths as the weak gravity slowly pulls them back toward the bigger body of the asteroid.
- It may be helpful to start with an asteroid made with several bigger rocks and see how they behave. Then once you have something that is working well, add more rocks that are smaller and see how they behave. As you add smaller and more rocks to the collection, your computer will work harder and harder to model the particle paths and this means it will get slower and slower. However, you will also begin to see patterns where you can simplify the calculations.
  - The bigger rocks are not really moving all that much. Is there a need to do calculations on them?
  - If the asteroid is 1000 m across, do I need to do calculations for anything beyond 2 m away from my astronaut?
  - Maybe at first we don't need to do calculations on dust particles as much as we could do everything with baseball sized rocks.
  - https://www.youtube.com/watch?v=M9NrzyTKaCE



For more detailed information
http://www.hunchdesign.com/uploads/2/2/0/9/22093000/asteroid_ar-vr_simulator.pdf