

Vacuum Cleaner Scrubbing Brush Kit

Students: Angel Flores,xxxxxx

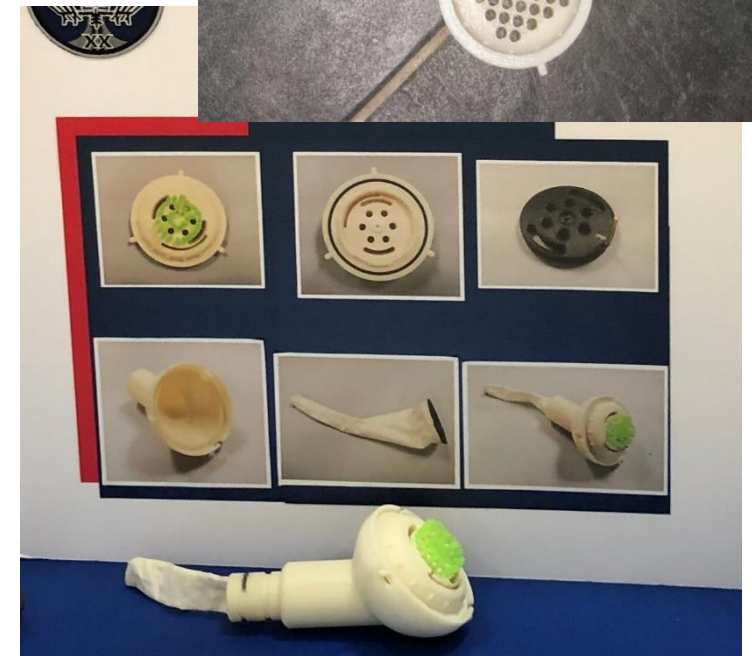
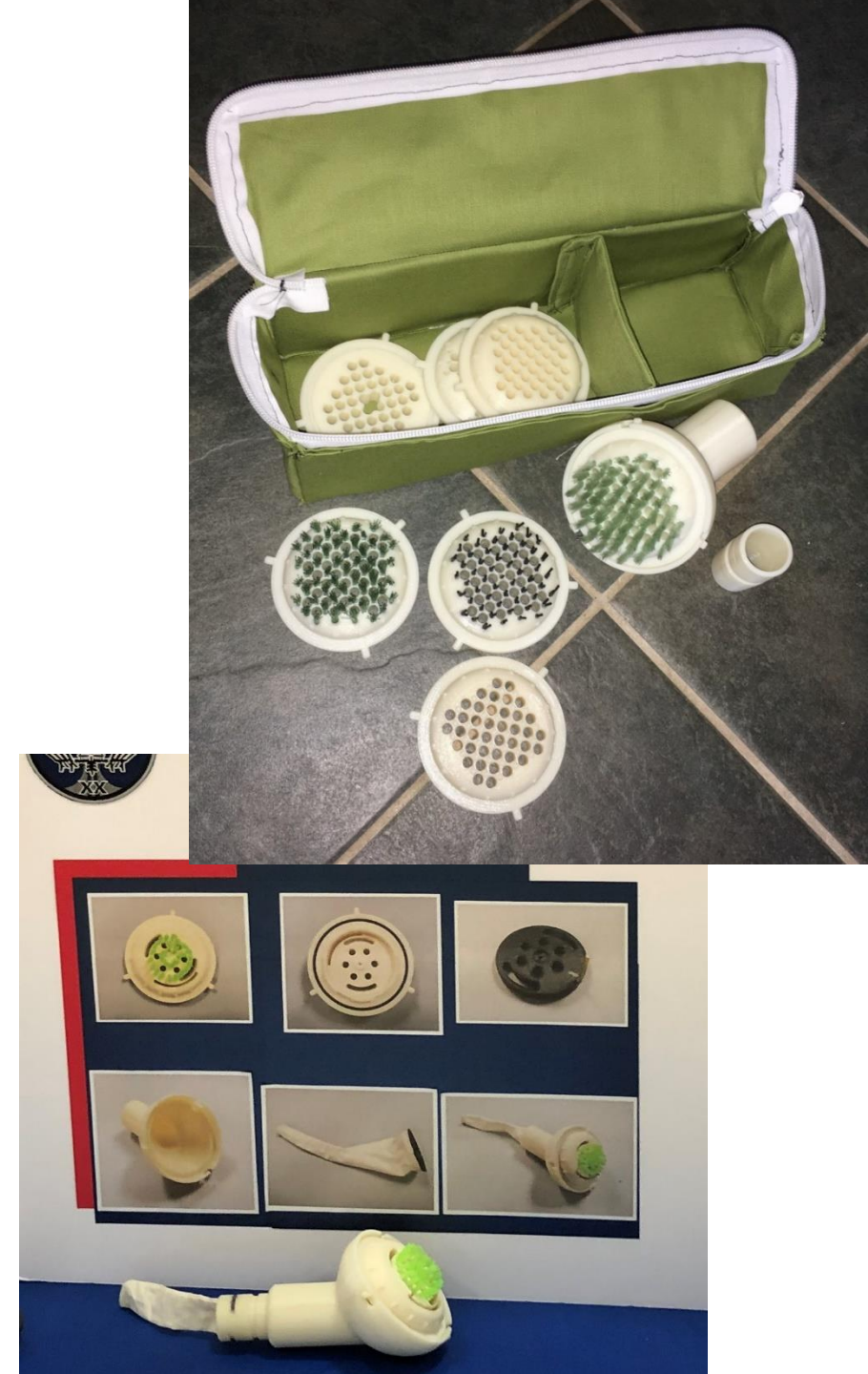
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Cleaning up equipment on the Space Station can be difficult when particles float around through the air if knocked free. Free floating particles can be inhaled or get into eyes and can be very painful. Some materials can be hazardous if inhaled or irritating to eyes. Dried food items like siriacha sauce or wasabe can be difficult to remove from cloth but still leave floating particles over time. Mold and bacteria growths need to be cleaned up to prevent spreading of the biologicals. Developing a brush that can aid in the scrubbing to remove soiling material from cloth, filters and other surfaces without liberating particles would help with general clean up. Toxic materials can be sucked into a vacuum cleaner and disposed of but if some of the materials remain in the vacuum cleaner hose, they could float free and become a hazard to the crew.

Having a disposable brush head and dust bag before the vacuum hose would allow for easier clean up of hazardous materials. By having replaceable and varying hardness of brushes, clean up could be tailored to the cleaning job.



Cleaning on ISS



The international Space Station is a mostly clean place since there aren't dogs and cats or people tracking dirt and lawn clippings and leaves into the house from the yard. However there are things that have to be cleaned up that most people don't think about. Just like houses that have filters for the air conditioning and heating that have to be cleaned or replaced on a regular basis so do the filters on the ISS.

Main job of ISS Vacuum Cleaner

- Skin particles
- Fingernail clippings
- Hair
- Lint from clothing
- Lint from cargo bags and other space station softgoods
- Food particles, crumbs
- Calluses coming off feet
- Flaking of foods and sauces that get onto cloth then dry
- Particulate from bathing
- Particulate from toilet

There are currently two different vacuum cleaners on the ISS. They are preparing to replace the black one with a battery powered vacuum cleaner to make it easier on the crew. The biggest impediment to sending up a different vacuum cleaner is the amount of noise they make.

Expected and unexpected hazardous materials

- Mouse droppings
- Mouse food flakes
- Fungus/spores that can grow on wet surfaces
- Moist biofilm in a pipe
- 'dirt' from plants
- Dead leaves and plant parts

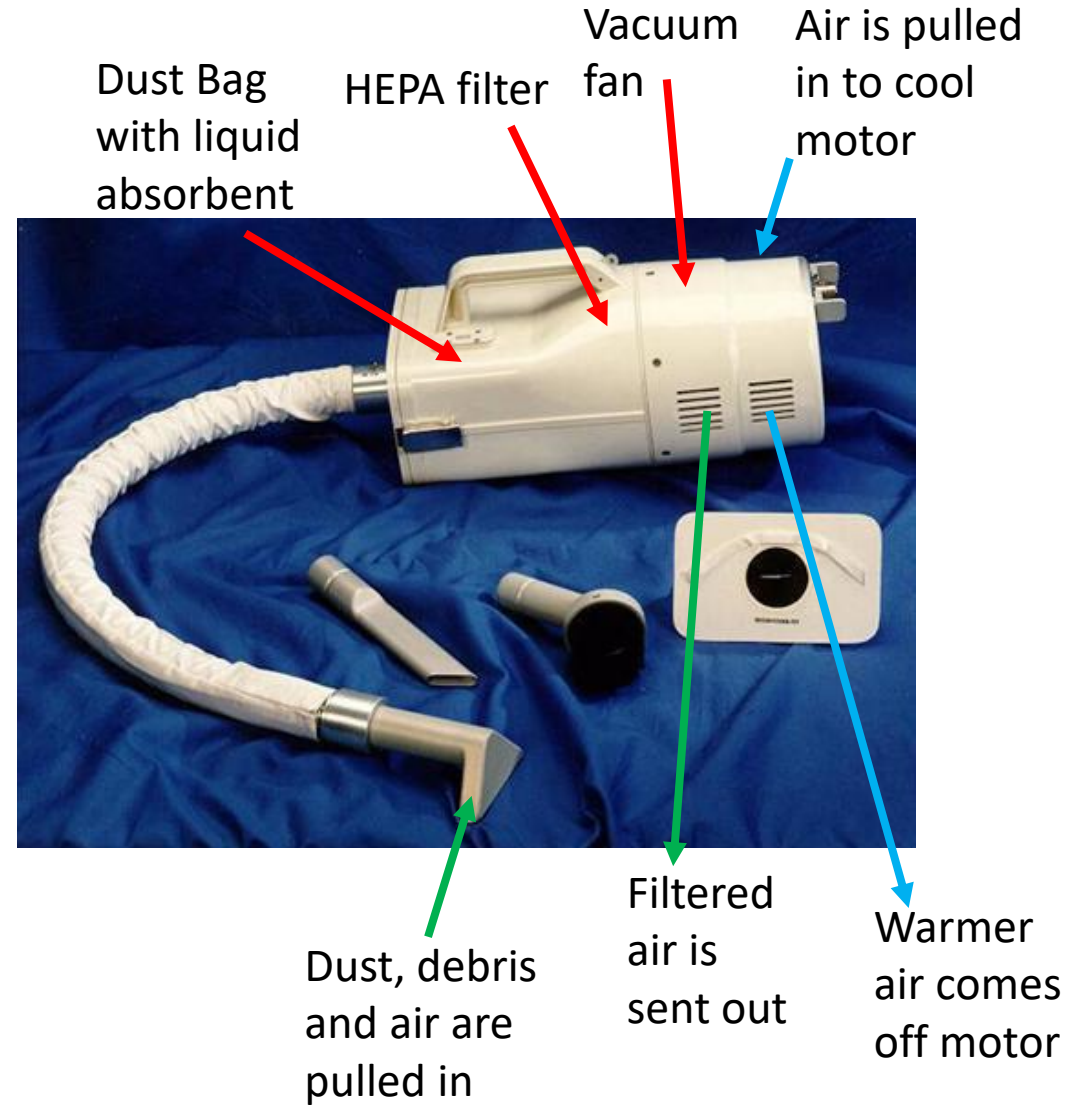
Commercial off the shelf vacuum cleaner

- There are currently two types of vacuum cleaner on the International Space Station. A small Oreck vacuum cleaner and a NASA built vacuum cleaner.
- Most vacuum cleaners pull the air in through the vacuum hose, through a vacuum bag or chamber and then past the motor to keep the motor cool. This is true for the Oreck vacuum cleaner that was sent up several years ago. For most cleaning this works fine except when there is liquid involved. This one has good suction and is preferred for most uses on the space station. If water or other liquids are pulled into the this type of vacuum cleaner, some of the liquid would go past the bag and filter and damage the motor or cause an electrical short. A shop vac, like what is used in a garage or other more industrial uses, depend on gravity to separate the liquids before the airflow continues past the motor to cool it. Shop vacs don't work in zero-gravity.



ISS vacuum cleaner

- Because cleaning a space craft in zero-g can require vacuuming up liquids (some not very pleasant), NASA needed a vacuum cleaner where there are two different air flows. One for the suction of the hose and a separate fan to cool the motor. The air flow for cleaning has a bag with a water absorbent gel in the bottom of the bag and also a secondary filter to prevent tiny particles from being sent back into the space craft. This one has less suction and is preferred for use only when liquids and toxic or hazardous materials are needed to be cleaned up.



Brushes and bristles on the two vacuum cleaners—a problem we can help with



When the vacuum cleaner is turned on, the long, **soft** bristles are pulled into the air stream and obstruct the airflow and prevent debris from getting sucked up---Self Clogging.

Because the bristles are so soft they are not very helpful in scrubbing to remove particles stuck in a woven cloth like nomex.

Since there is only one brush for each vacuum cleaner, if one gets contaminated and needs to be thrown away, there is no longer a brush option until another can be flown up.



Vacuum Cleaner On



Vacuum Cleaner Off



Vacuum Cleaner On

HUNCH Design and Prototype Project

- The Vacuum Cleaner Scrubbing Brush was initially developed specifically for helping to clean up astronaut's feet. When not walking on their feet in the ISS the calluses on the astronaut's feet fall away after about 3 to 5 weeks of being in zero-g. These calluses come off in large particles when they take off their socks or rub their feet—not a pretty sight. Because the body continues to produce a lot of skin cells for the feet, the shedding of skin from the feet continues through the whole mission. All of these dead skin particles float in the air until captured by the air filters. Crew requested assistance from HUNCH to come up with a method of minimizing the amount of skin from their feet getting into the air.

Foot Exfoliation Kit



Problem:

- After being on orbit for 3 to 4 weeks, astronauts begin to lose the calluses on the bottom of their feet due to lack of use. The excess calluses come off in small but very visible particles when removing socks. These particles float around in the space craft, get on equipment, and can be inhaled by crew members.

Task:

Come up with a method to contain the dead skin cells.

Requirements/Constraints:

- The device should be able to contain all dead skin cells to prevent inhalation or getting in eyes.
- Must be small and compact with an easy deployment method.
- Cannot have any sharp edges.
- Any scrapers or brushes must have a method of capturing removed skin cells.
- Keep it simple.

[Be watching the Reference material for more details.](#)



Coarse Brush would remove skin cells but send the particles all over.

Coarse brush (with scraper?) on a vacuum cleaner attachment might capture the particles



Pumice stone would remove skin cells but shed particles that damage hardware



Lotion Glove



Abrasive lotions have to be unscented and able to capture the abrasive material as well as skin cells

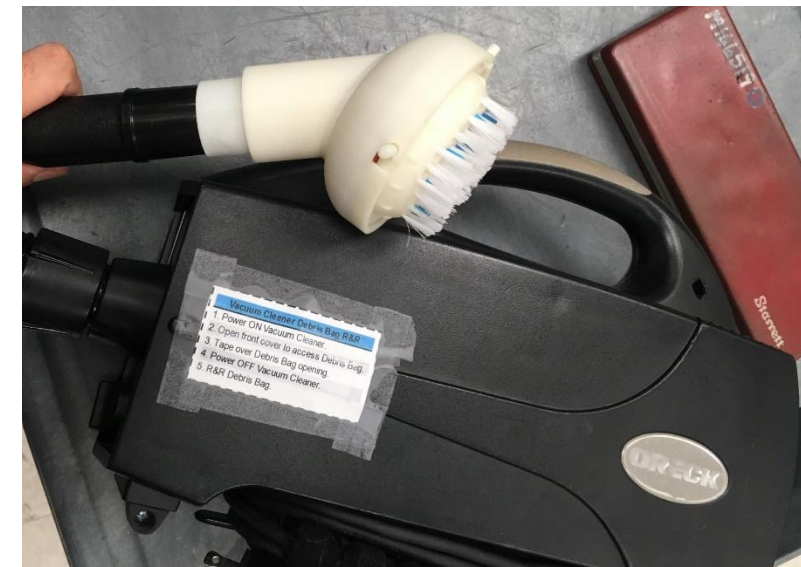
This was the students' project requirements

Student built prototype

- Comfortable shape for hand
- Short, stiffer bristles for scrubbing and also prevent self clogging from getting pulled into the airstream
- Many holes to prevent clogging by debris
- Fits DC vacuum cleaner
- Replaceable brush to allow for disposal after cleaning
- Can develop alternate replacement brushes
- Could be used for scrubbing soiled hardware or soft goods to liberate and suck up debris before getting into the air.
- Could be used for removing dead skin from feet
- Nylon bristles epoxied into holes
- O-ring for brush connection



Angel Flores Cypress Springs High School



Updated versions to include

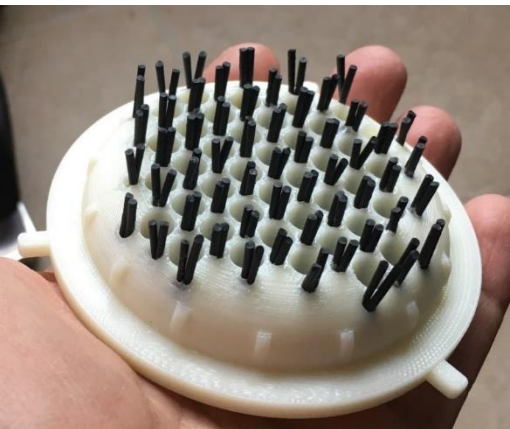
- 3D printed ULTEM body and brush
- Smoother interior for ease of clean up
- Options of hard, medium and soft bristles
- ½ in long bristles to keep good air flow
- Friction fit to AC vacuum cleaner (industry standard)
- Adapter to DC vacuum cleaner hose
- Sturdier locking clips on body
- Nylon bristles epoxied into bell shaped holes
- Viton O-ring replaces with the brush

Short bristles and closer allow for better control of liberated particles

Closer proximity to the holes allows for better control of li



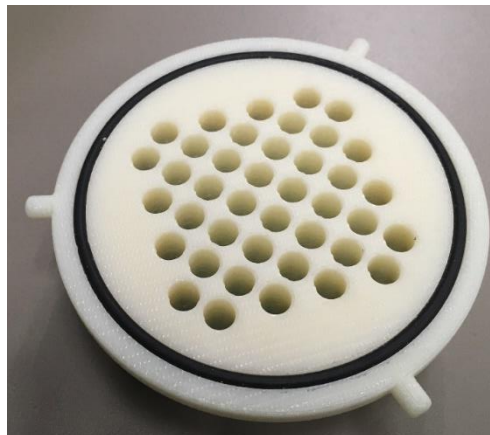
Brush heads



Viton bristles



Smooth vacuum head



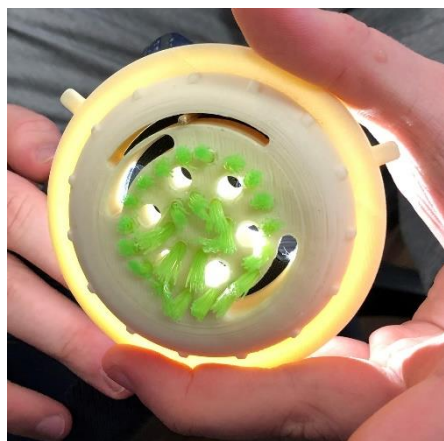
Viton o-ring on each head



Smooth vacuum head,
faster air flow



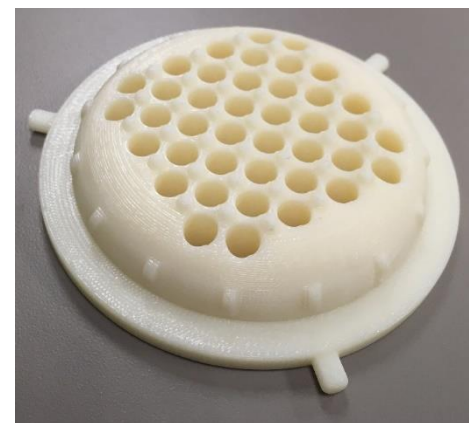
30 lbs test nylon bristles.
(stiffer)



Closable brush head
20 lbs test nylon bristles
(medium)



10 lbs test nylon bristles,
(Softer)



Bumpy vacuum head



Crevice tool
with filter bag
attachment ring

Vacuum Cleaner Scrub Brush Kit

Nomex bag



Brush body -- Fits the
Cots vacuum cleaner

Adapter to fit ISS vacuum

Multiple disposable brush
heads—bristle hardness or
material options. Different
hole options
Resupply as needed.

Discussions with Flight Crew Systems Engineering team

- HUNCH showed our student derived vacuum cleaner kit with multiple disposable brush heads to EC7. They liked it! But they asked if we could add some kind of bag to capture materials before they go down the hose.
 - When cleaning up toxic or hazardous materials, the crew is required to pull out the vacuum cleaner bag and throw it away immediately so there is no chance of it getting out or causing any other problems—even if the bag is mostly empty (we try not to waste our supplies). Unfortunately there is also the possibility that some of the toxic material is still lodged in the hose and might float out when the crew isn't using it—the station only has so many hoses and can't throw them away. (there is no good way to clean out a hose in zero-g)
- If HUNCH could outfit our disposable brush heads with a small, disposable dust bag for toxic materials, we could help minimize spreading of hazardous materials. This could also help save the program from sending up many regular vacuum cleaner bags.

Filter bag

Locking keys for attachment to brush head

Holes for sewing filter bag



Hose filter bag locking ring



Long, thin filter bag that goes down into hose allowing for continuous air flow even as the bag fills from the bottom up.

Sample Filter bag material is cotton batiste—same as used for the sleeping bag liners. HUNCH is open to any suggestions for filter bag materials.

ISS vacuum adapter—smallest diameter of hose stack up

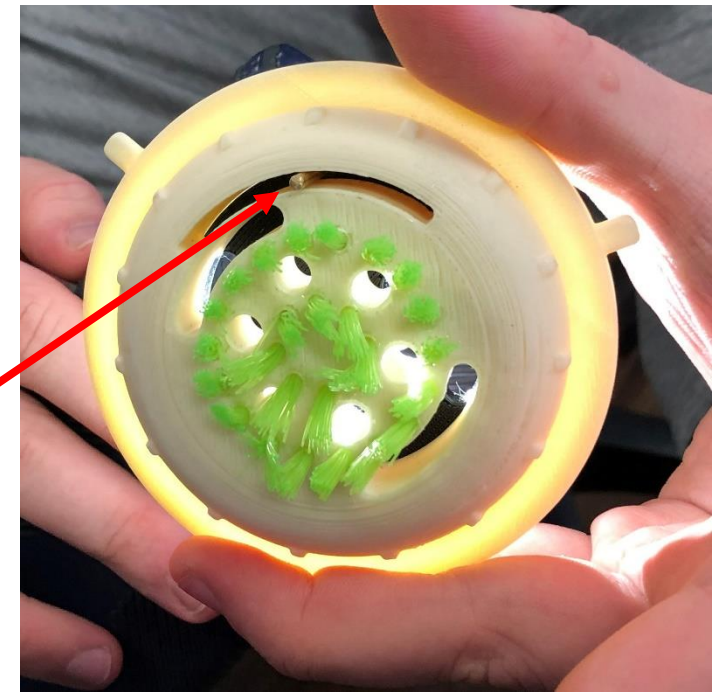


Hose filter bag with locking ring sewn

Closeable, disposable Brush Heads

Stephen Himmel-Hansen and Christian Fincher Clear Creek H.S.

Brushes can be used with or without the filter bags. Filter bags attach to the inside locking ring of the brush head. After cleaning up a hazardous material, the brush head can be closed off to trap dust inside, remove the brush head from the vacuum head. The filter bag pulls out with the brush head keeping all of the hazardous materials contained. Place the whole assembly into another bag for double containment and dispose of as needed.



Lever for closing vacuum holes to capture dust

Partially closed brush head



Hose filter bag attached to brush head

HUNCH Vacuum Cleaner Scrubbing Brush Kit

- Vacuum brush heads
 - 3D printed ULTEM body
 - Multiple cleaning bristles and configurations for stiffness and cleaning needs
 - Viton gasket for a good seal
 - Closeable to hold dust inside
 - Disposable
 - Optional disposable filter bag
 - Attaches to both vacuum cleaners
 - Comes in its own pouch
 - Can be resupplied as needed