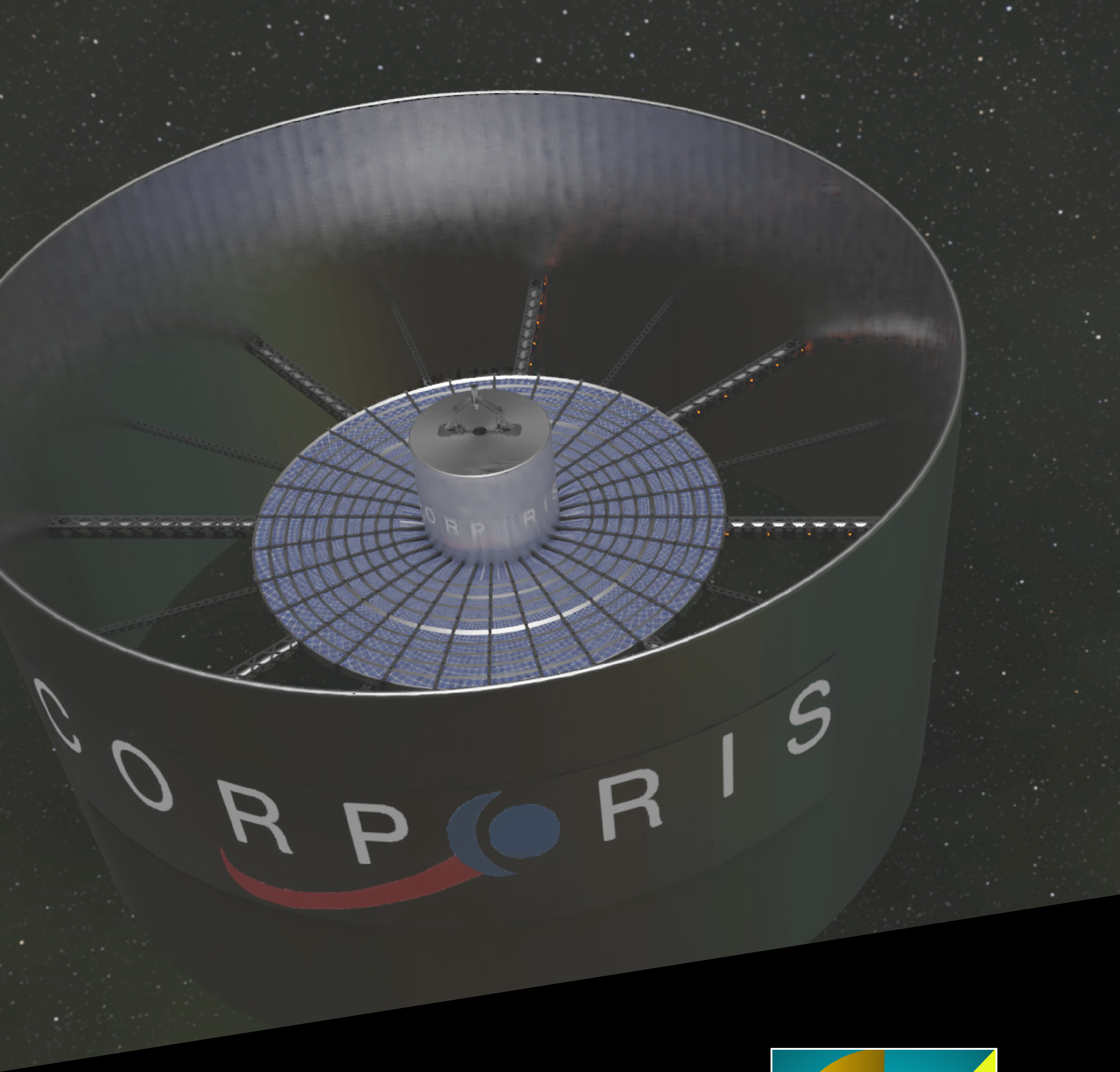


THE ASM CORPORIS

AEROSPACE
MERIDIAN

EXECUTIVE SUMMARY

The ASM Corporis is a space ring to be located at 1.416 AU in the vicinity of Mars. The Corporis is designed to facilitate the mining of the asteroid belt in order to provide resources for the Earth and generate an economy; it will also operate as an outpost for Mars exploration. This venture is presented in three phases: Moon supply base; design, construction, and orbital placement; and colonial life.

In Phase I we discuss the construction of a Moon supply base which will provide the Corporis construction team with food, water, and fuel. Food plants will be grown on the Moon using the lunar regolith. Though lunar regolith is normally dangerous, we discovered by experiment that lunar regolith can be sintered and rebroken to be used as growing soil. For agricultural water, we will acquire water from the Moon reservoirs located near the South Pole. In addition, lunar water will also be transformed into rocket fuel (LOX) via the process of electrolysis. Our experiments show that the water does not have to be purified because water soiled with lunar regolith simulant undergoes the process of electrolysis at a higher rate than purified water. In addition, the lunar water will be used for agriculture and drinking water.

Phase II consists of the design, construction, and orbital transfer. In the design stage, we have calculated the dimensions of the ASM Corporis required for the living and agricultural areas of the space ring. Our shielding designs are based on our radiation and high velocity particle field tests. In the construction stage, our plan is to send rockets with payloads of AI robots and AR telerobots to Ryugu. Mining and refining operations will take place on Ryugu, essentially transforming the asteroid into the ASM Corporis. The orbital transfer stage involves the transfer from Ryugu's elliptical orbit to a circular orbit of its apogee; the Corporis will be positioned close to, but outside of, Mars' sphere of influence.

Phase III presents an overview of life on the ASM Corporis. This phase features originally-designed houses based on Japanese architecture. We incorporate an original musical anthem written to unify our colonists through song. The ASM Corporis will be a permanent home for thousands and function as a food supply base and gravity rest stop for asteroid belt miners and Mars explorers.

Josiah DeLuz, Team Leader

PHASE I
MOON SUPPLY BASE

Phase I of the ASM Corporis project will be the construction of Shackleton Crater base, a lunar supply base. The Moon will be used to supply the engineers at Ryugu with food and fuel. Based on the research conducted by Madeleina Wolcott, we have determined that lunar regolith can be converted into an arable soil. Thus, the lunar supply base will incorporate a farming process. In Nolan Pries' electrolysis experiment, we learned that lunar regolith simulant mixed with water speeds up the process of electrolysis. Our plan is to use the Moon's reservoirs of water to create LOX/LH2 rocket fuel via electrolysis.

Even though the Moon is beneficial, we did not choose the Moon for other resources for many reasons. Obtaining metals on the Moon is expensive. This is due to the high energy needed to separate metal from regolith [Spudis 2014]. We also decided to go against extracting Helium-3. An estimated $25 billion is needed to start production on Helium-3 extraction [*PM* 2004]. Helium-3 requires hundreds of millions of tons of lunar regolith in order to extract only 1 ton of Helium-3 [Steinhaus 2018]. Helium-3 also requires a temperature of 700 degrees Celsius during the extraction process [Olson 2015]. Since this is too much lunar regolith to gather and too much money to spend, we decided that mass production of Helium-3 would dampen the Corporis project. These are the reasons why we decided not to use the Moon to build the Corporis.

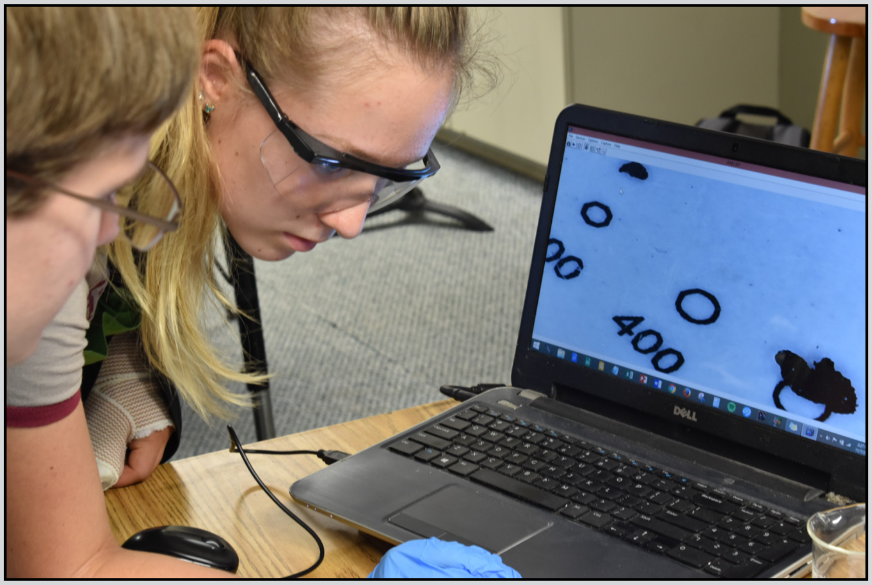
LUNAR REGOLITH

Madeleina Wolcott

Austin Pham

Hana Husek

The engineers of the ASM Corporis need an annual food supply. We propose the construction of the Shackleton Crater Base for this (and other) reasons. In order for agriculture to commence, local soil is needed to create farmland. Last year, we proposed the concept of using lunar regolith for farming; this year, AeroSpace Meridian has conducted observations and found evidence regarding the safety and arability of lunar regolith. These observations demonstrate how regolith can be used for farming.



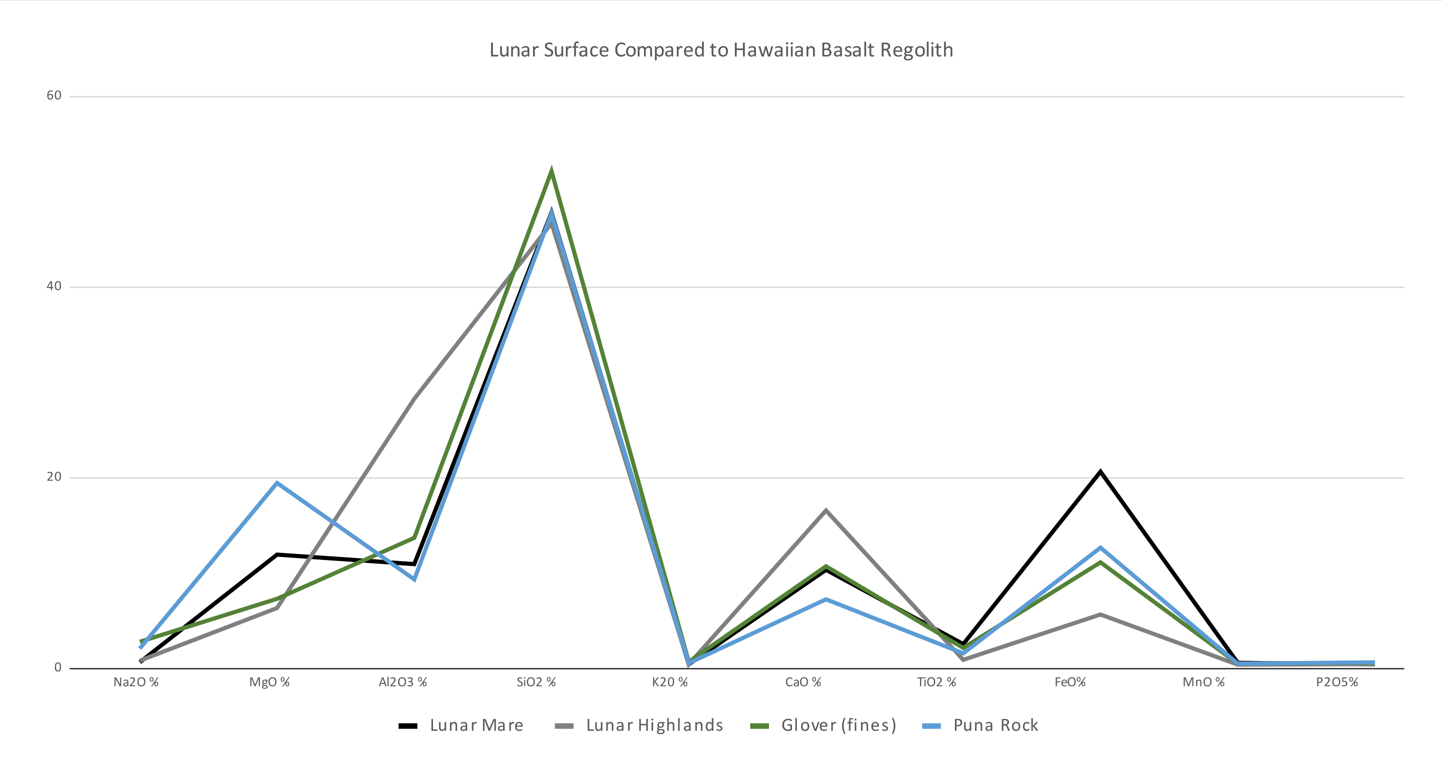
Grains of lunar regolith simulant, sintered and fragmented, are examined by ASM members under a microscope.

Complications of Regolith

Lunar regolith is associated with a variety of health issues. These issues are what ASM aims to overcome. Lunar regolith is very sharp and fine because the Moon does not undergo erosion as Earth does. Lunar regolith is a hazard to the respiratory system, the cardiovascular system, the integumentary system, and the visual system.

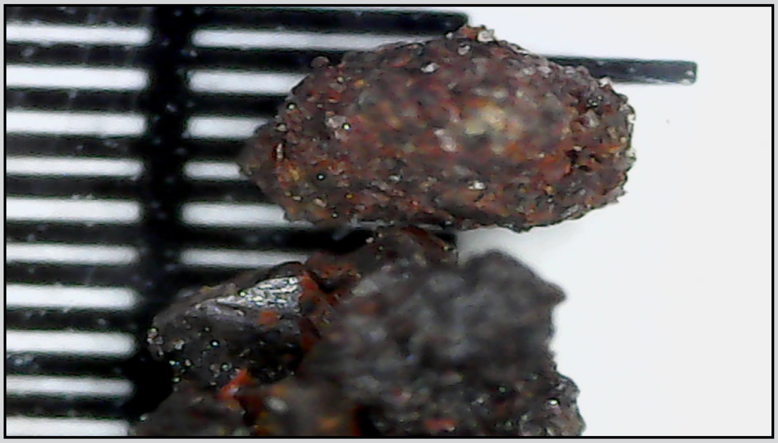
To begin, inhalation of lunar dust can cause great harm to the internal body. Inhaling lunar regolith has been compared to inhaling asbestos or volcanic ash. When the dust particles enter the body through inhalation, they enter the respiratory system. This leads to breathing problems due to inflammation. Because lunar regolith is electrostatic, it has the tendency to attach itself. Furthermore, the dust can affect the cardiovascular system, causing numerous types of cancer [Major 2012].

Second, contact with the lunar dust can affect the skin and eyes. Along with being razor-sharp, lunar regolith may also have a glassy shell from the vapor of meteor impacts. Contact with this sharp substance will create intense irritation to the skin by small and painful cuts [Major 2012]. Eyes can also be damaged from the regolith through airborne contact. Irritation to the skin and eyes can greatly harm productivity and will delay the achievements of the Corporis.

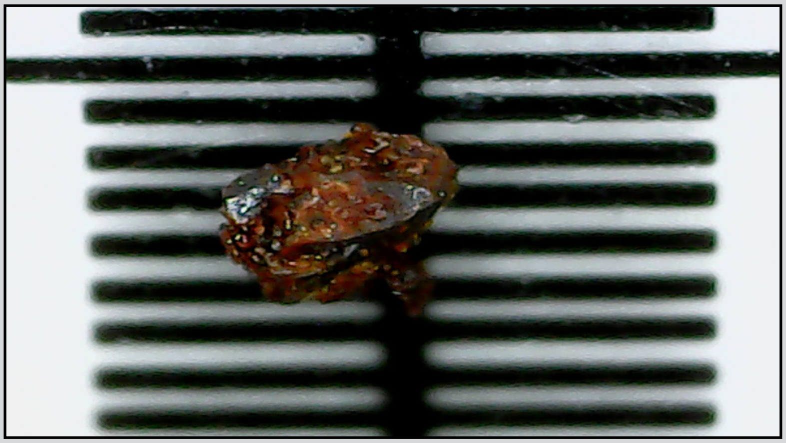


Lunar regolith and Hawaii Island simulant differ only marginally in composition. Graph courtesy PISCES/Kyla Defore.

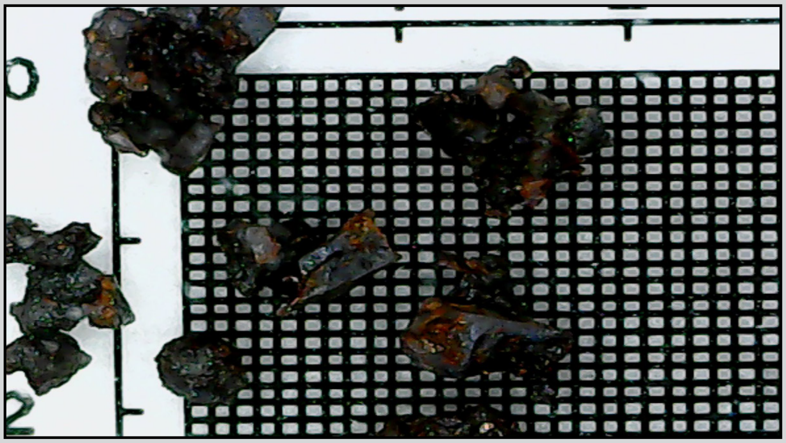
Unsintered lunar regolith simulant is powdery and has fine grains that are as small as 10 microns or less.



Coarse grains of simulant measured from 100 to 500 microns.



A minority of grains that were round had moderate sizes.



Many smaller grains were angular and had more distinct edges.

Observations

Hawaii Island resides on five volcanoes. Due to this, Hawaiian lava soil and lunar regolith share approximately 90% of chemical components [Rogers 2018]. As a result of living on the Big Island of Hawaii, we were able to obtain materials for lunar studies. Kyla Defore, a geologist from PISCES, graciously provided ASM with both sintered and unsintered regolith simulant to use for our research. (See graph for the comparison of lunar regolith with Glover and Puna simulant samples.) We were able to research our inquiry: Can regolith be used for farming?

I (Madeleina) examined the Glover sample of unsintered regolith simulant and found it to be a fine dust. Larger grains ranged in size between 100 and 10 microns; many were smaller. When working with the unsintered simulant, I was required to wear protective goggles, gloves, and a facemask because the small size of its grains can easily damage the skin and lungs. Though these grains were not sharp, the lunar equivalent is.

We utilized a sintered regolith block of Puna basalt and scraped grains from the surface to examine. Although smaller than a millimeter, the grains of sintered regolith did not require face masks to manage. It was deemed not to be harmful to the skin or lungs due to the relatively large size: grains ranged from 100 microns to 500 microns. The grains were considerably larger than the unsintered by a factor of ten or more. They varied from those that were coarse and oblong of an average size of 500 microns, to those measuring 500 microns or less that were rounder, to those that were angular in shape and 100 microns in size.

Conclusion

Lunar regolith can be sintered into small blocks; these in turn can be granulated to remove sharp edges. By the mechanical process of attrition (using a ball mill and screener), jaggedness can be further reduced [Heck 2018]. Thus, we determine that lunar regolith is arable once it is sintered, granulated, and attritted; this system results in a vast reduction in the jaggedness of the regolith. Processed grains are also dense and compact enough to allow regolith to absorb and hold the water.

ELECTROLYSIS

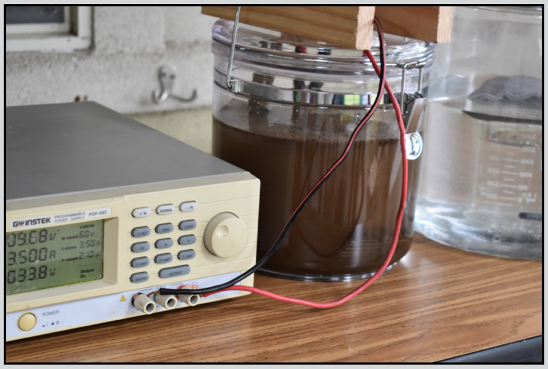
Nolan
Pries

One particular issue that has always existed when involving space development is the cost, efficiency, eco-sustainability, and shipment of fuel. This is a valid concern because it currently costs $10,000 per pound of material shipped to space [NASA 2008]. Due to the expenses of numerous shipments per year, ASM has been exploring a more competent way to produce and ship fuel that is efficient and eco-friendly by the means of LOX/LH2 fuel production through the process of electrolysis.

Electrolysis is the method of splitting water molecules into hydrogen and oxygen molecules by directing an electrical current through a quantity of water. During this process, rising gas molecules rapidly release. In the experiment we conducted, the hydrogen was captured and measured in an mL bottle and the seconds were recorded at every 50 mL of production. We experimented with three variations: distilled water, tap water, and water mixed with lunar regolith simulant. Volts were applied in two different ways: "Relative volts" in which the voltage was allowed to fluctuate with a constant power, and "Absolute volts" in which a constant 10 volts was maintained.

In the distilled water, the results were not optimal due to the lack of mineralization. The results obtained through the production rate gave an Absolute Average of 115.0 seconds per 50 mL and the Relative Average of 77.5 seconds per 50 mL. Not only was distilled water the lowest in production rate, but tap water outproduced distilled by a vast amount. Tap water electrolysis flourished because of its mineralization and low concentrations of the collection of diverse elements, such as calcium, magnesium, and nitrate. In averaging the production rate, we found an Absolute Average of 91.0 seconds per 50 mL and a Relative Average of about 74.2 seconds per 50 mL. This confirms that tap water is more efficient in the production of hydrogen and oxygen gas than distilled water, but it did not produce as well as the lunar regolith infused water.

Designed by Nolan and Ryan Pries, the electrolysis device captures hydrogen in a submerged flask.

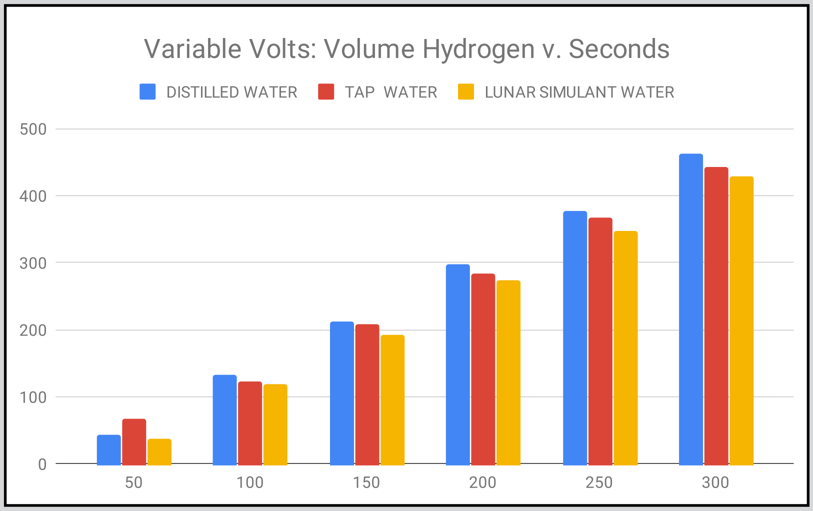


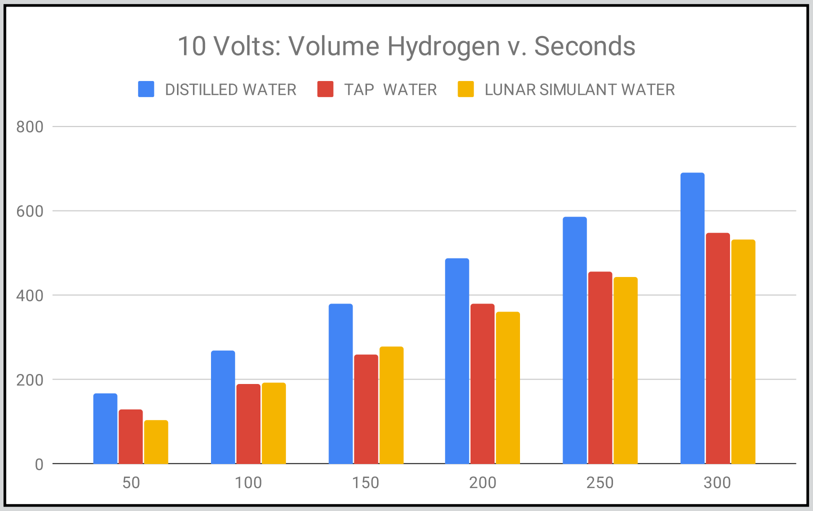
H2O with lunar regolith simulant was observed to produce the highest rate of electrolysis.

We mixed a coarse lunar regolith simulant to the water in the final experiment. We discovered a significant difference due to its elemental status. The rate of hydrogen production resulted in an Absolute Average of 88.8 seconds per 50 mL and a Relative Average of 71.7 seconds per 50 mL. We obtained the lunar regolith simulant from Pōhakuloa Training Area at Mauna Loa with permission from Deputy Garrison Commander Greg Fleming. The lunar regolith simulant shares 90% of similarities to lunar regolith [Rogers 2018], which is composed of oxygen, silicon, and iron which are key factors in these drastic results. The lunar regolith simulant was not pure and contained some measure of organic matter.

This experiment produced a stable and genuine outcome through three different types of distilled, tap, and simulant Moon water under both types of voltage applications. Therefore, the presence of lunar regolith will vastly improve the outcome and efficiency of hydrogen and oxygen gas production. The process of electrolysis will help with our idea of creating rocket fuel on the Moon. Through our research, we have discovered that the lunar regolith mixed with water reservoirs on the Moon will actually speed up the process of the hydrogen and oxygen gas production. As a result of this conducted research, we have decided that this is the best means of LOX/LH2 fuel production.

Electrolysis is the best means of production because it is eco-friendly, efficient, and has an unmeasurable capacity to produce the fuel needed. Electrolysis is eco-friendly because the fuel is obtained as hydrogen, which is not only a natural element, but also the most abundant atoms on earth. Unlike fossil fuels, the hydrogen will not contribute to the debris. While it will be very expensive to bring the equipment and essential materials to the reservoirs for building electrolysis production facilities, the outcome will be cheaper in the end result. Once production facilities are set up on the Moon, the shipments will take advantage of the Moon's low gravity (and therefore a lower delta-v) for more trips.





In both tests, Moon water produced free hydrogen and oxygen in fewer seconds than pure or tap water.

MOON BASE

Logan Russell

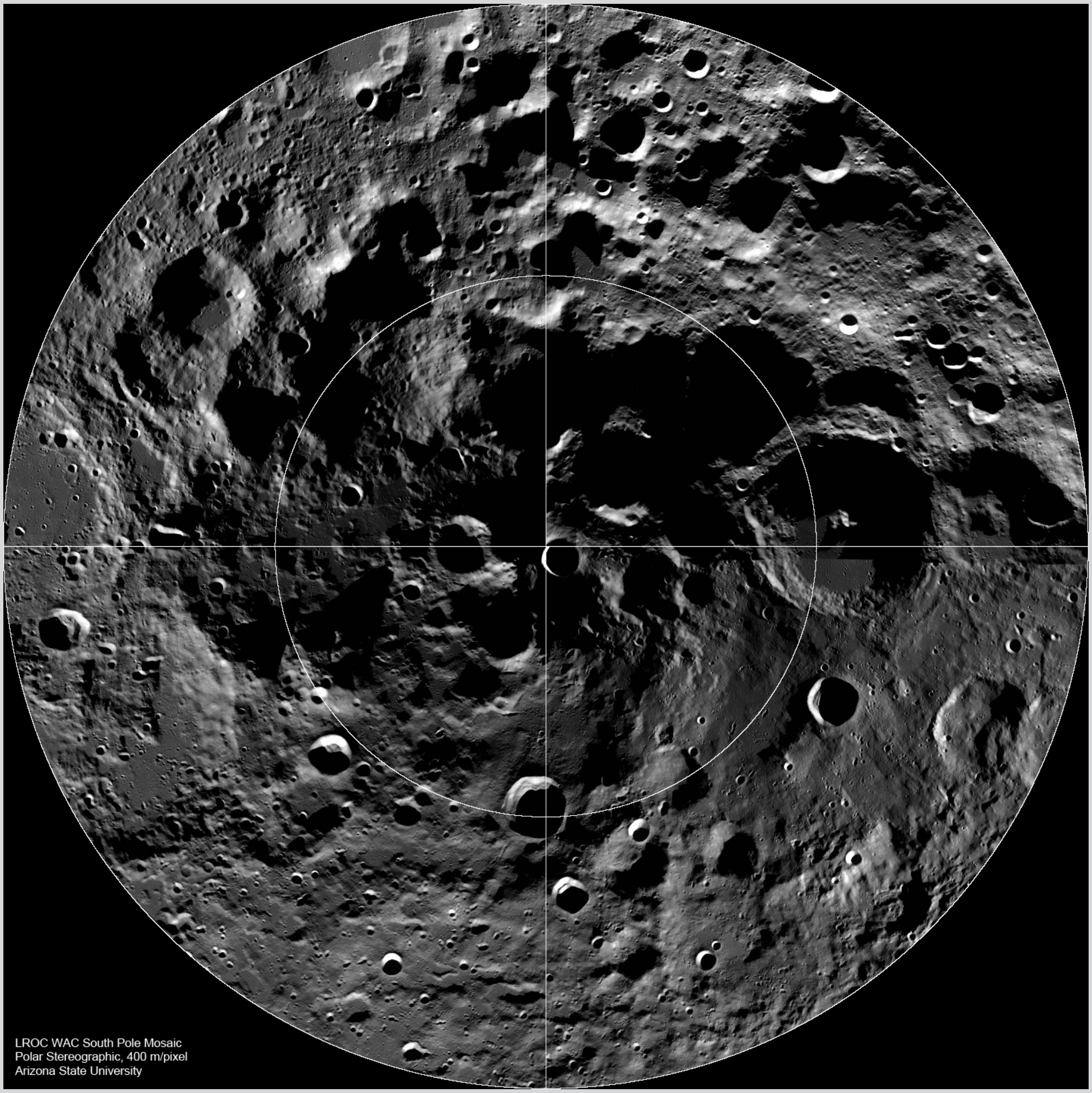
The construction of the ASM Corporis will require an excessive amount of fuel for the construction transports and for the orbital transfer once construction is completed. Shipping fuel to the Corporis construction from Earth will be a major waste of money and resources. Instead, the AeroSpace Meridian team decided that it is best to build a lunar polar base supported by two solar arrays.

We determined that building our Moon base on the near edge of Shackleton Crater will be most beneficial. Shackleton is located nearly in the direct center of the lunar south pole. The Moon is tilted at the perfect angle such that the bottom of the crater has not seen the sun in eons, which means it will be protected by the radiation of the sun. Moreover, it is believed to have large stores of water, its primary resource.

The concentration of lunar ice is much more abundant on the south pole of the Moon, where Shackleton Crater is located, in comparison to the more barren north pole. The more lunar ice, the more water can be harvested for future use. Constructing a supply base on the edge of the crater will help cut the costs of transportation and technology. Considering the ice is underground, the deeper we build, the easier the materials will be to harvest.

Fully powering the Shackleton base through chemical energy from Earth would be an impossible task. That is where the solar arrays come in. The solar arrays will basically be a lifelines to the Shackleton base. They will be positioned 500 kilometers north of the base—one on the Earth near side, the other on the Earth far side—in order to collect more solar energy than that which is incident at Shackleton base. The solar arrays will solely be for energy purposes; there will not be any residential sections or farming areas. Each solar array of 1 km x 2 km collects energy during its solar periods. The energy will be transmitted to Shackleton through microwave beams [Dance 2008]. There is minimal power loss during transmission due to the lack of atmosphere on the Moon.

The Shackleton Crater is 21 km in diameter and 4.2 km deep, which leaves an adequate amount of room to expand and modify. The physical base itself is designed



Shackleton Crater is located just skew of the lunar south pole.
Image: NASA/SER/ASU

to be approximately one half of a square kilometer. Most of it will be sunken 10 meters underground to protect against solar radiation. Interconnecting tunnels will be strategically placed between the domes.

One of the many reasons for building this base is to make transportation efficient between Earth and the Corporis. Due to the Moon's relatively low gravity, it will take significantly less fuel because of the lower delta-v.

Regolith, also known as lunar soil, is one of the main reasons why we are building the Shackleton base. Regolith is not like Earth soil in physical consistency; it is very powdery and loose and can be highly fatal if projected at high velocities. We have observed in our experiments that regolith can be sintered and rebroken to form an arable substrate. Crops can easily grow in this regolith. Regolith is going to be for the purpose of farming at Shackleton to provide food for the construction workers building the ASM Corporis.

The lunar ice will be extremely valuable. Lunar ice is essentially frozen water located in underground pockets. We will refine it mainly for potable water and water for the Shackleton farm. Additionally, the best part about lunar ice is that you can separate the oxygen from the hydrogen to create rocket fuel. This will be another major advantage being able to make fuel so close to the Corporis.

There is going to be a constant flow of rockets landing and launching nearby Shackleton. Normally on Earth, we have the luxury of building large, expensive, technologically advanced launchpads to get our rockets into space. The problem on the Moon, however, is the regolith. Because of how grainy regolith is, plus the low gravity, the excess force from a rocket landing will spray regolith for many kilometers, destroying anything in its path. Placing our solar arrays 500 kilometers away eliminates this problem. Shackleton base itself is underground, so regolith exhaust spray will not be a problem. To take extra precautions, the launchpad will be constructed with 35-degree upward slopes to deflect the lunar regolith up and away from exposed components of the base.

This lunar base will be beneficial for many reasons: regolith for crop growth, water for rocket fuel, a pit stop for commuter ships, a constant supply of energy, and a safe place for various research projects. With the Shackleton Crater Base, along with the ASM Corporis, AeroSpace Meridian will be the most successful enterprise in space.

PHASE II
a -ASM Corporis Design
b - Construction
c - Orbital Transfer

Phase II is divided into three stages: design, construction, and orbital transfer.

The design of the ASM Corporis concerns its structure, energy source, and shielding. The ASM Corporis is a space ring; the design was chosen to minimize mass. Solar panels are arranged in arrays between the “spokes” of the ring. The solar arrays face a single direction. This is functional because the space station will have a synchronous orbit about the sun that is maintained by attitude control. The space station is equipped with radiation and high velocity particle shielding both of which are based on data from our field tests.

Construction of the Corporis takes place on Ryugu. Transport is by the Big Falcon Rocket-Construction (BFR-C) based on SpaceX’s BFR Starship design. Various dilemmas of deployment and construction are resolved, and both telerobots and AI robots are employed.

After construction, orbital transfer will place the ASM Corporis into circular orbit. This will permit easier attitude control and allow constant radiative temperature. This positioning of the Corporis at 1.416 AU will benefit both Mars and asteroid belt missions.

PHASE I a
ASM Corporis Design

SOLAR POWER

Christian Williams

Population	kW per Person per Year	Total Annual	Watts at 1 AU	Distance from Sun
10,000	5,000	50,000,000	1,365	1.416 AU
Watts from Sun per square meter	**PV Cell Efficiency**	**Electric Charge Daily Production**	**Electic Charge Annual Production**	**Required Panel Area**
680.88	40%	6.54 kWh/day	2385.79 kWh/year	20,957 square meters

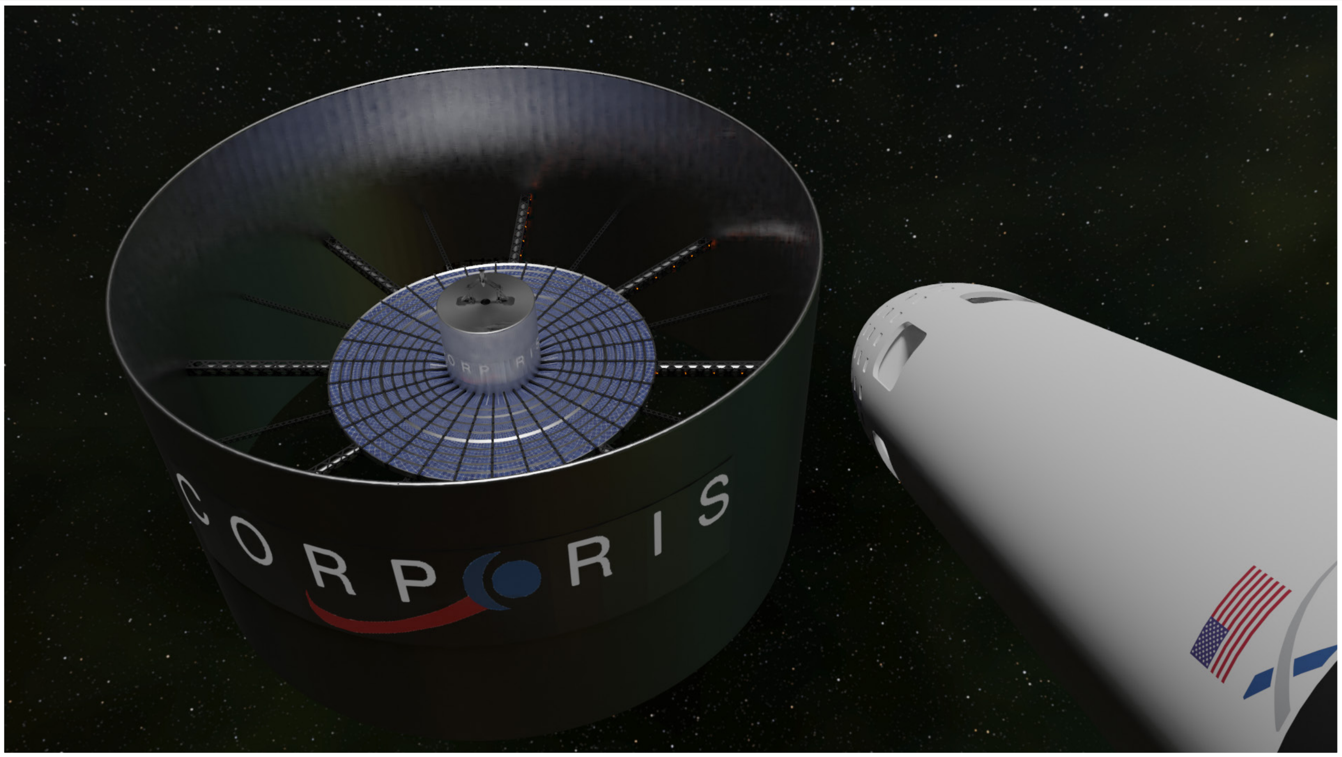
Calculated energy requirements for the ASM Corporis population.

Virtually any space station requires a source of power to function properly, and the two main options for clean energy in space are solar power and fusion power. (Fission power is not clean energy and is relatively dangerous.) Although fusion is arguably better for deep space travel, since our space station is at a reasonable distance from the Sun, it would be significantly less expensive to use solar power. Solar panels cost less to manufacture, to ship to space, and to operate than a fusion reactor would. Fusion power also requires expensive fuel extraction.

Collecting enough solar radiation from the Sun to provide power to an entire space station would require a large surface area; we have accounted for that in our design. Solar panels are on the side of the space station that always faces the Sun. This design lowers cost. Overall, solar power is the best option for energy production in our situation.

STATION DESIGN

Austin Pham



ASM Corporis images by Austin Pham. Corporis logo by Jayde Whiting.

The shape and size of a space station affects the design of every single system aboard the spacecraft. Therefore, it is imperative that a cost-effective and functional design is utilized, so that the success of the Corporis is guaranteed. The shape and size also must be able to accommodate human life on the Corporis. The members of AeroSpace Meridian have decided that the use of a space ring is the best design.

The “space ring” design can offer an ideal living area to surface area ratios. Surface area is the area that is exposed to the vacuum of space. The total living area of the Corporis will be 479,536 sq. m with a radius of 263 m and height of 289 m. The members of AeroSpace Meridian have deemed it necessary that 225,675 sq. m will be dedicated to housing for the colonists. The agricultural area is estimated to take up approximately 200,000 sq. m. An additional 53,851 sq. m is added to the total to account for yards, walkways, and other infrastructure.

Key: Corporis	$L = 2\pi R(1.1R)$
L = Total Living Area	$L = 2.2\pi R^2$
H = Cylindrical Height	$R = (L/2.2\pi)^{1/2}$
R = Radius to Living Area	$R = (479526/2.2\pi)^{1/2}$
$H = 1.1R$	$R = 263$; $H = 289$

The ratio between the height and the radius is 1.1. We chose this ratio, first, to maintain the stability of the space station. It is imperative that the rotation of the space station remains stable to minimize the risk of the Corporis from losing control and harming the inhabitants because of the "wobble." According to Al Globus [2010], in order to preserve a stable spin, the space station's height to radius ratio must be 1.3 or less. By using the height to radius ratio of 1.1, further rotational stability can be achieved. Second, by reducing the height to radius ratio, we are required to increase the radius to maintain the same living area; doing so lowers the head-to-foot gravitational difference.

Due to the size and mass of Earth, there is a minuscule gravitational differential between the feet and head; however, when placed inside a much smaller space station with an even shorter radius, the gravitational differential between the feet and head can be much higher. To reduce the differential, the radius must be increased. According to a study titled Artificial Gravity by Centrifuge [Prado, 2019, the minimum radius required to generate artificial gravity is 20 meters. This is well below the Corporis' own radius of 263 meters. The same study noted that 4 rpm is the maximum safe rotational speed for humans when using centrifugal gravity, which is well above the 1.84 rpm that will be employed on the Corporis. Thanks to the dimension and rotational speed of the Corporis, it is able to achieve earth gravity at ground level and a 0.76% difference from head height to feet height (assuming an average human height of 2 meters).

Attitude Control

Attitude control is very important since it dictates whether or not the Corporis will receive any solar energy. Solar panels are dependent on the position of the sun relative to the space station. Since the solar panels are placed on a single face of the Corporis (to save on materials), it is necessary that there is a stable way to maintain a slow rotation facing the sun. In order to achieve this, a single thruster will be used to provide orthogonal vector components to maintain the correct rotation. First, the Corporis will be moved into a circular orbit around the sun to allow for a more efficient attitude control because for a circular orbit, the attitude control does not need to vary as it would for an elliptical orbit. Second, the Corporis will be oriented with a rotation to face the sun. Last, the space station will be sent into its spin of 1.84 rpm. Even with the spin, the attitude control thruster can still be used where the horizontal thrust will keep the ship facing the sun, while the vertical thrust vectors will cancel out. In addition to that, the ASM Corporis has a 615-day year, requiring it to only rotate 0.585 degrees per day. This makes maintaining the attitude of the ASM Corporis very manageable.

Nutation Control

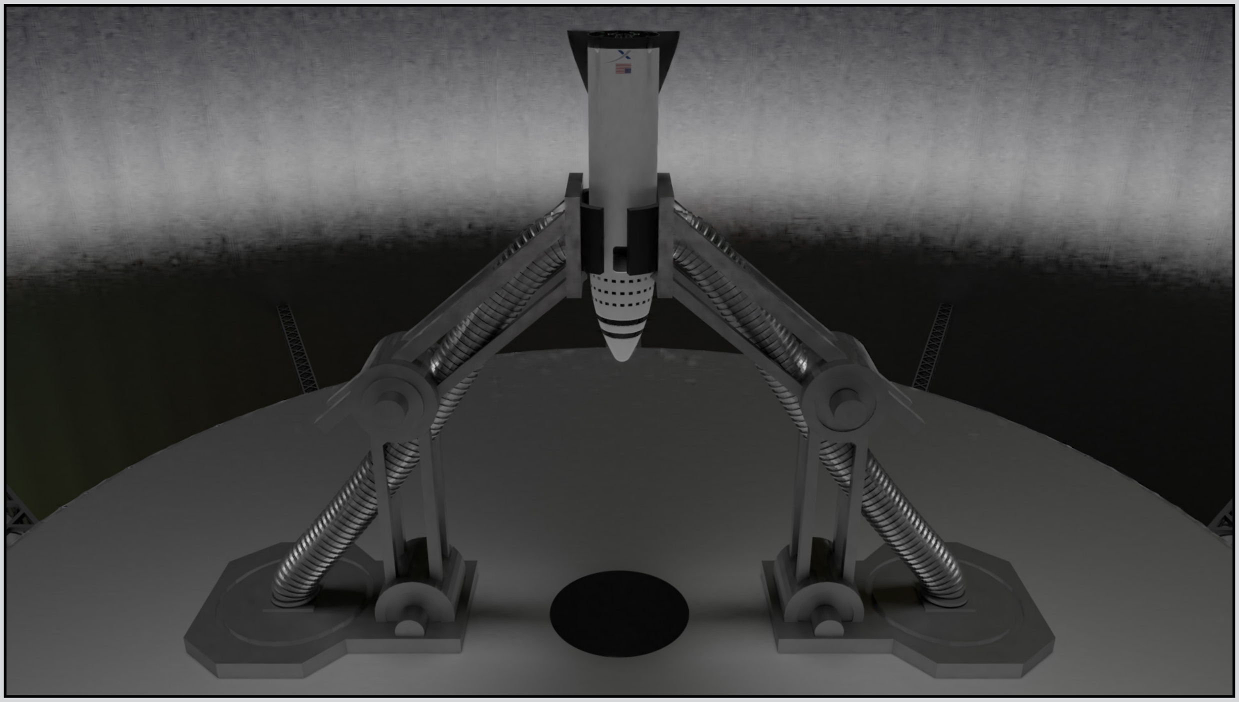
Any swaying in the spinning of the Corporis could result in a total loss of control of the space station. The Corporis will feature the use of a series of pumps as a way to circulate water and counteract any nutation. If any nutation occurs, the water will be circulated throughout the space station to eliminate the effects of the wobble.

Docking

The space station must have the ability to allow spacecraft to dock with it to allow for the transfer of supplies and other materials. However, there is a special problem that arises with the use of artificial gravity through centrifugal forces. There is no stationary point in the space station. The Corporis is not immune to this problem.

Instead of a conventional docking procedure, which requires a stationary point on the space station relative to a spacecraft, any incoming spaceships must match the spin of the Corporis. By matching the Corporis' spin, the spaceship will perceive the Corporis as stationary. Once spin is matched, the spaceship may enter the dock at the radial center of the Corporis. A bridge will connect to the oncoming spaceship where the exchange of supplies can occur.

The use of this method of docking is far superior to counter-rotating the dock. Counter-rotation brings a host of its own problems. First, it requires a tremendous amount of energy when compared to rotating the spaceship. It is a given that the docking platform will be more massive than the spaceship itself, thus requiring more energy to rotate. Second, there is a higher risk that the spin of the Corporis will be affected by the counter-rotation of the core, and as a result, it could generate wobble.



A BFR Starship docks with the ASM Corporis. BFR Starship by SpaceX.

Instead, the proposed method of rolling the spaceship will have less potential to affect the Corporis since the spaceship is less massive. Third, when the dock is countering the spin of the Corporis, transfer of cargo or people between the docking platform and the hull of the space station will be restricted as the counter-rotation will make movement between the docking area and the hull of the Corporis impossible. Matching spin eliminates this problem.

Storage

Storing materials and supplies throughout the space station is crucial. To keep the space station functioning correctly, the members of Aerospace Meridian have concluded that placing the storage around the docking area is the preferred design. Positioning the storage section of the Corporis towards the midline of the cylinder has a number of benefits.

First, thanks to the properties of centrifugal artificial gravity, by placing the storage area near the core of the Corporis, there is reduced gravity and weight. Owing to the reduced gravity, the effect that massive cargo has on the spin of the Corporis is reduced. Placed elsewhere, heavy cargo may have a greater impact on the spin of the Corporis and cause unwanted wobbling. Furthermore, thanks to the decreased gravity, storage of cargo will require considerably less energy, since said cargo will weigh less.

Second, by having the storage area wrapped around the center of the Corporis, space can be reduced. If the storage area were to be positioned on the same level as the living area of the Corporis, it would result in a higher lateral surface area or radius. As a result of the increased surface area, more materials would need to be diverted to the construction of shielding and other support structures. This will increase both the cost and decrease the efficiency of the Corporis' design.

Transit

Transporting both humans and supplies between the center (docking area) and the outer area (living area) is essential for the survival of the inhabitants. A reliable method of moving things between the two sections of the Corporis is a must-have. Stairs, ramps, and other conventional methods of moving cargo and people would require too much energy and space over the distance 263 meters (the inner radius of the space station). Therefore, a great solution is the use of elevators to move both people and cargo between different gravities and sections of the space station.

It is imperative to recognize that space flight can have its toll on the human body, and even more importantly, that readjusting to prolonged periods in space can be difficult. As people move further away from the center hub of the Corporis, they will experience an increase in gravity. Passengers on board the elevator are not required to exert themselves while they adjust to the gravity, aiding the process of acclimating themselves to the gravity on the Corporis. Though elevators can be costly in their energy consumption, it is more important to preserve the health and well-being of the colonists inside of the Corporis.

Even though the Corporis is in Space, space is at a premium on the Corporis. The use of vehicular transport requires additional infrastructure that would expand the size of the Corporis. Elevators, on the other hand, act on a vertical axis; therefore, requiring much less space. Thanks to the use of elevators, the Corporis' size can be decreased dramatically.

In addition to that, the total circumference of the Corporis is only 1.65 kilometers, which can be easily traversed by foot; however, if someone were unable to make the trek to the nearest elevator, whether it be due to health problems or a need to transport heavy cargo, bicycles may be used instead. Bicycles can be fitted with carriages to aid with transporting additional passengers or cargo. They also produce no pollution that could seriously harm the inhabitants of the Corporis due to its enclosed nature. Just be sure to ride against the gravity! All in all, thanks to bicycle efficiency, ease of use, and the size of the space station, bicycles shall be included onboard the Corporis.

SHIELDING

Austin Pham

Josiah Richards

High Velocity Particles

Life has existed on Earth for eons under the protection of the Earth's atmosphere. The Earth's atmosphere is necessary for human life and acts as a shield from meteorites that could destroy the human race. There is no doubt that a similar system must be employed that can protect humans from the dangers of space. This shield must have the ability to stop incoming high velocity particles (HVPs) and larger projectiles. Through a series of field tests comparing different shielding designs and the effectiveness of bullet resistant materials akin to kevlar, the members of AeroSpace Meridian have discovered that the two most effective designs are those that implement diamond-shaped shielding and the bullet-resistant material, Dyneema.

During the field tests, we experimented with seven different designs against an AR-15. The AR used a 223 Remington round with 1,738 joules of energy. In comparison, an HVP that is only 10-9 g and traveling at 35,406 km/h can achieve an astounding 4,838 joules of energy, nearly 3 times the energy of the bullet. However, compared to typical cosmic dust particles, which are often porous in nature, the bullet is solid. We have found our data is useful in determining the most effective shielding type. In the control test, the bullet was capable of penetrating an average of 11.4 cm of substrate before coming to a stop.

The diamond-shaped shielding is our second best design. It uses 2 pieces of double-layered corrugated galvanized steel to form the shape of a diamond with a 20-degree angle at each of the bends. Each piece of galvanized steel is 2 mm thick.

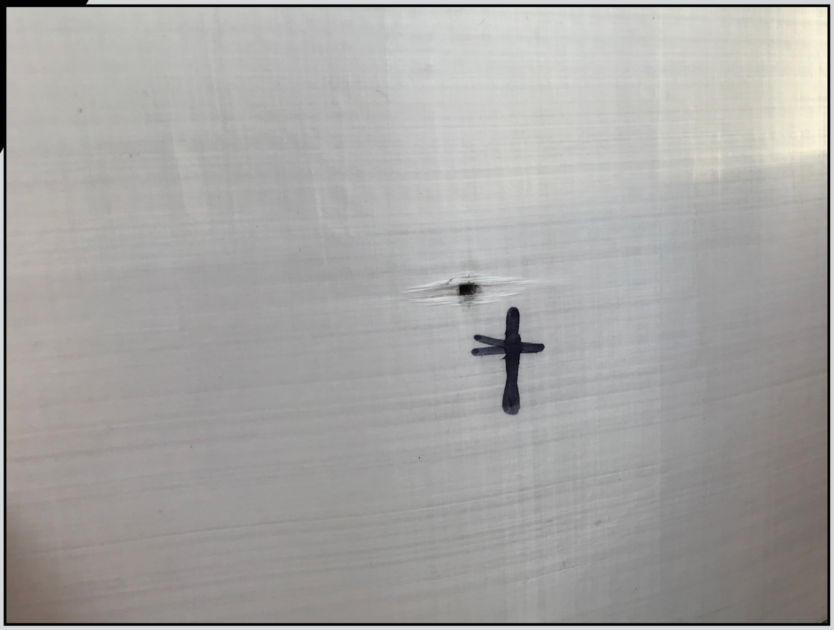
Diamond shielding provided the second-best protection among test designs by deflecting kinetic energy in multiple directions.

Slowed by the diamond shielding, the bullet penetration is reduced by 27%. The bullet is stopped by the substrate.

During the field test, the bullet was only capable of penetrating 8.3 cm into the Lunar regolith simulant backing. Additionally, a small portion of the bullet fragmented inside of the diamond shape. This proves that the diamond shape is effective in absorbing a substantial amount of energy. The angled metal has the ability of deflecting the particle energy in multiple directions.

In the Dyneema shielding test, 3 mm of material was used. The reason behind this choice is because Dyneema is 15 times stronger than steel, making it the strongest fiber in the world. The Dyneema is also 8 times lighter than steel. Simultaneously, it was able to absorb more of the bullet's energy, which only penetrated 7.95 cm into the substrate, the lowest amount of penetration of all of the tests.

For the purposes of keeping the inhabitants of the Corporis safe and keeping shielding weight down, the best high-velocity particle shielding design would be a combination of both of these designs. The outermost layer of the shielding will consist of the aforementioned diamond shaped shielding. Instead of only 4 mm of steel, 1 cm of an alloy of Ryugu's metals (iron, cobalt, nickel) will be employed. Its original sloping of 20 degrees will remain in the design to reduce the amount of metals required to build the shielding as compared to a steeper slope. Behind that, a 3 cm deep layer of Ryugu substrate will be placed in order to absorb energy of the HVP. A 6 mm thick layer of Dyneema will be positioned directly behind the substrate to prevent any openings that may form after the metal shielding is hit by an HVP. Additionally,



Projectile penetration of Dyneema. Though the penetration seemed to do minimal damage to the structure of the Dyneema, the material proved to have the best stopping power.

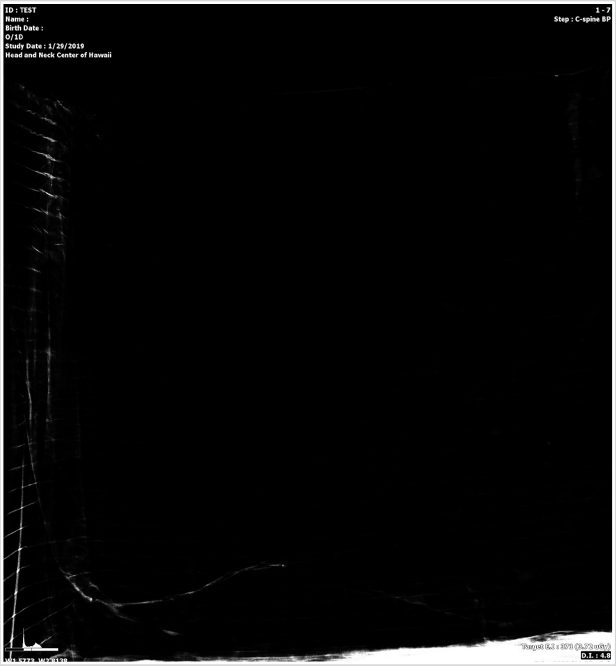
behind the Dyneema, a final layer of 10 cm deep substrate will be placed as a redundancy measure if all the layers before it have been breached. The total HVP shielding layer will be 0.154 meters deep. Finally, to ensure that any breach of the shielding will not result in all of the shielding materials being released into space—therefore making it useless—steel bulkheads will be employed and divide the entire shielding structure into many 1x1 square meter blocks.

	Shield Description	Penetration cm
1	**Control No shields**	**20 11.43 12.70**
2	**Two corrugated metal positioned at 45° angles**	**10.16**
3	**Two sheet metal positioned at 45° angles**	**12.07**
4	**Test sheet metal flat against substrate**	**24.77 Anomaly**
5	**Corrugated sheet metal in diamond-shape contact**	**8.26**
6	**Spaced corrugated sheet metal**	**12.40**
7	**Dyneema flat against substrate**	**7.95**

Radiation

One of the primary hazards that the Corporis faces is solar radiation. Fortunately, our team has developed a form of shielding that is both economical and efficient. To predict dependability, our team conducted an experiment in which

Control tests proved that the container did not interfere with radiation penetration.

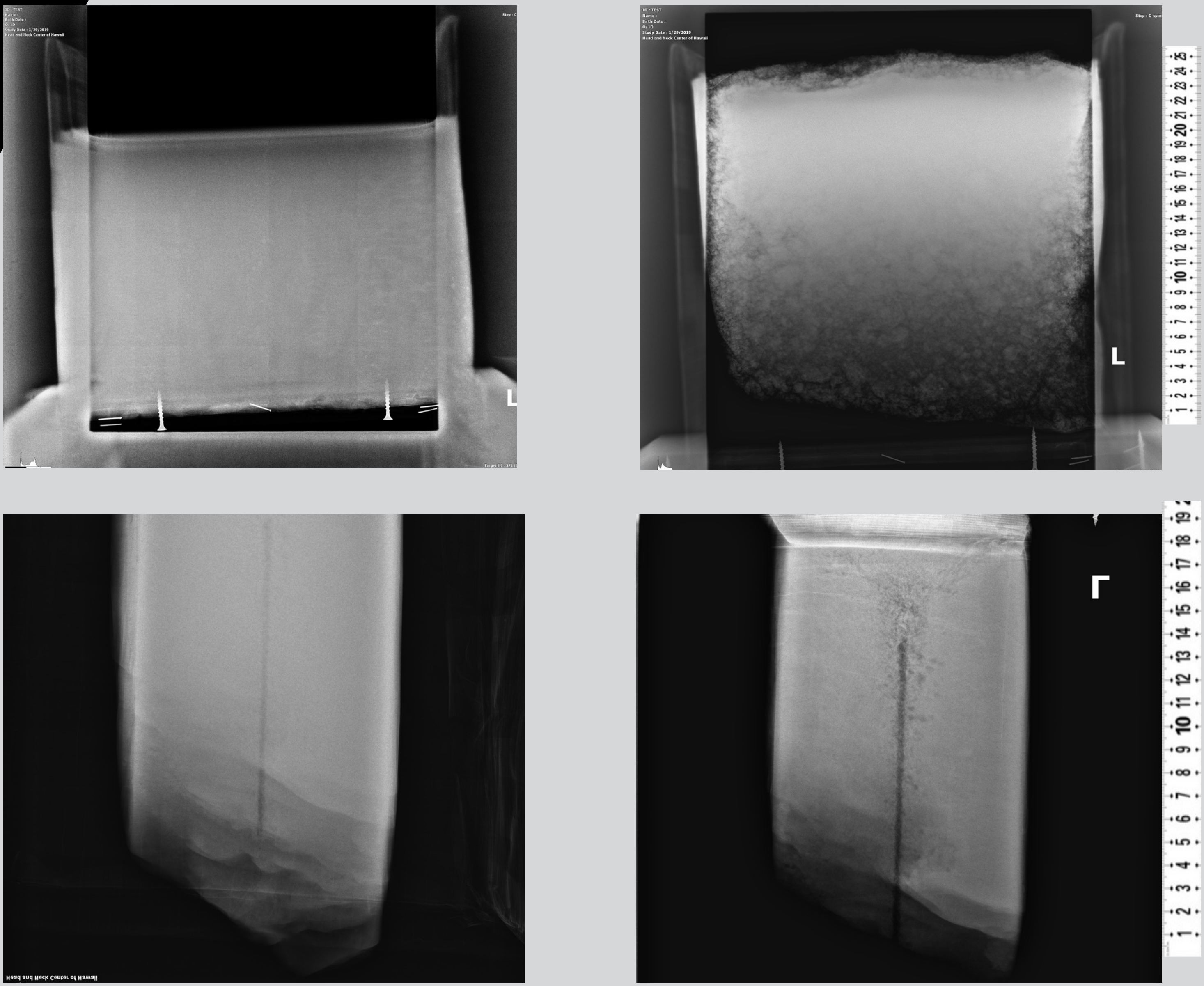


we measured the penetration level of X-ray radiation through our shielding. During this process, we designed a cube-shaped container that is diagonally divided in the middle, creating a 45° angle inside. One side is sealed closed, while the other side is left open so that it can be filled with substrate.

Before the container was filled with substrate, our team performed a control test to ensure that misleading results would not be taken into account. The intensity of the X-ray machine was set to 44 kVp (peak kilovoltage) and 88 kVp; once the empty container was scanned, it displayed full radiation penetration without any interference.

Following the control test, we observed the effects of radiation through two materials: substrate and ice. Our team considered the use of substrate because of it is the excess material of Ryugu. Similarly, ice was also considered a viable material seeing that it would be low maintenance. With each test, the level of radiation penetration correlated to the blackened areas depicted in each photo: The darker the color, the greater the penetration. Going into the experiment, our goal was to find a material that withstood greater amounts of radiation.

The setup for the substrate test began by filling the container with dirt substrate to a maximum depth of 25 cm. After infusing the substrate with X-rays, there were no indications of radioactive permeation



At 44 kVp (left) and 88 kVp (right), substrate (above) and ice (below).

within roughly 22-25 cm of depth at 88 kVp. No effective penetration occurred at 44 kVp. For the ice experiment, we used an angled block of ice with a maximum depth at 19 cm. The ice received X-rays at 88 and 44 kVp.

Comparing the results, we found that ice at lower kVp made for a better shielding; however, at high kVp, substrate was found to provide better protection at depths of 19 cm and above.

Combined Shielding

It is convenient and efficient to combine the HVP and radiation shielding. Taking our initial use of 13 cm of substrate for HVP shielding, we believe that extending this by 7 cm of depth would provide sufficient radiation shielding; this will be an additional 3.5 cm on either side of the Dyneema layer.

ARCHITECTURE

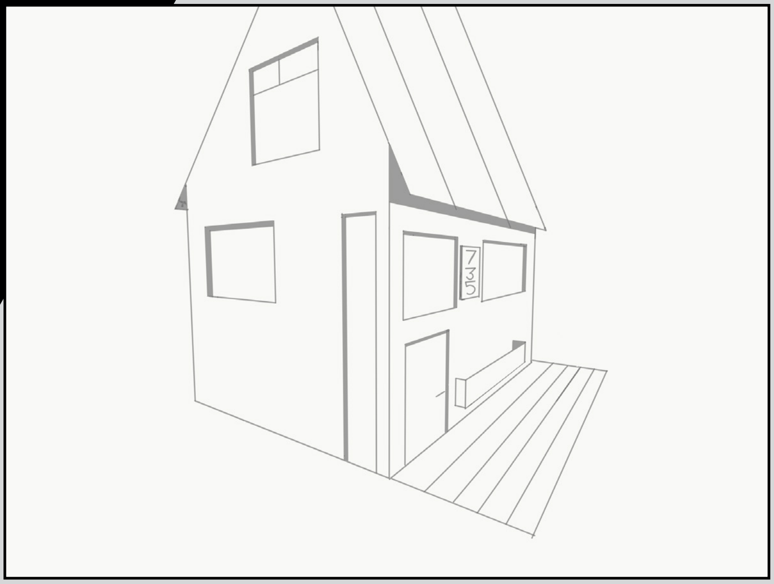
Hana
Husek

On the ASM Corporis, the main goal is to minimize space used on the architectural deck, thus decreasing the size and construction costs of the ASM Corporis. The average house size in 2015 for an American home is approximately 819 square meters, while the average living space per person is approximately 322.48 square meters (Mark J. Perry). For the ASM Corporis, the average house size is disregarded and house sizes are based on family sizes and/or average living space per person. A single person's home will require 335.28 square meters, closely matching the average living space per person in 2015. A couple's home would be the same size (335.28 square meters) because couples do not require an increased amount of space due to sharing the same facilities. A house of three (one child) will have 381 square meters with 45.72 extra square meters compared to a single or couple's home. A house of four (two children) will have 457.2 square meters with 121.92 extra square meters. Last, a house of five (three children) will have 609.6 square meters with 274.32 extra square meters.

To create a suitable population for the ASM Corporis, the family sizes are distributed. Single residents will constitute 10% of the population with 1,000 people and 1,000 homes. Couple residents will take up 15% of the population with 1,500 people and 750 homes. Families of three will take up 20% of the population with 2,000 homes and 667 homes. The family of four will take up 40% of the population with 4,000 people and 1,000 homes. Families of four are ideal because they have a large number of people and a small requirement for housing. The final family size, families of five, will take up 15% of the population with 1,500 people and 300 houses.

Original architectural designs by Hana Husek.

To conserve additive space, houses will be two-story and decrease the total footprint of the architectural deck. Single-



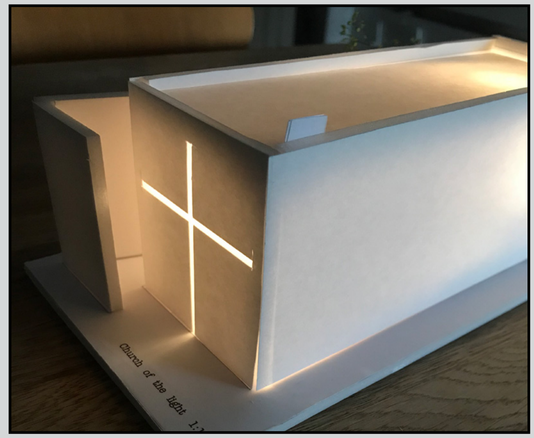
family homes will have a footprint of 167.64 square meters per home totaling a footprint of 167,640 square meters. Couple homes will also have a footprint of 167.64 square meters per house, but have a total footprint of 125,730 square meters. Families of three will have a footprint of 190.5 square meters per house with a total footprint of 127,000 square meters. Families of four will have a footprint of 228.6 square meters per house totaling a footprint of 228,600 square meters. Finally, families of five will have a footprint of 304.8 square meters per house and a total footprint of 91440 square meters. The total footprint of the entire architectural deck will be 511,810 square meters. Adjusting housing sizes in relation to the family sizes will decrease the space required on the ASM Corporis and create a sustainable environment for the population.

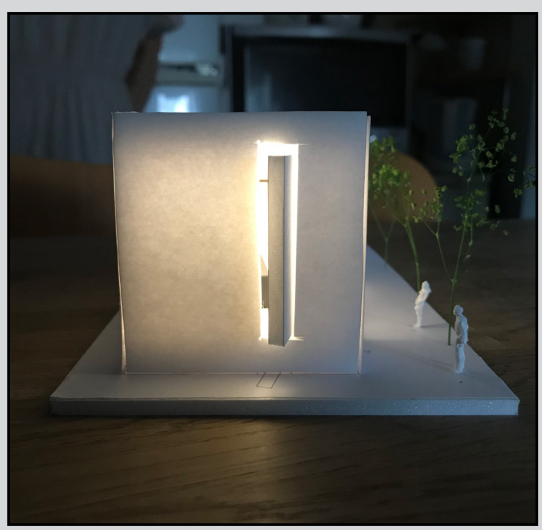
Minimalist Design on the ASM Corporis

To make the houses comfortable and convenient, the interior and exterior designs are based on the minimalist style and effective use of space of Japanese modern and traditional homes. Minimalism is a fast-growing style for it is a clean-cut, "less is more" style (Marc Schenker). The purpose of minimalism is to reduce space with simplicity, so it is ideal to utilize the style for our housing. Japanese values of Taoism, embracing emptiness, leads to minimalism shown in the architecture (Marc Schenker). With this simplicity, Japanese designs require effective use of space. The ASM Corporis will use these methods to essentially make a comfortable living space.

Virtual images by Hana Husek.

The exterior design is fashioned to create a comfortable space. The large windows make space seem lighter and larger. An interesting addition to the exterior is the thin window added to the door. This window is based on The Church of Light in Iribaki, Osaka, Japan by Tadao Ando. The Church of Light has a thin window in the shape of a cross as its main source of light in the church. The cross is accompanied by a few slits in the wall to allow an additional wall to enter and exit the building. The intention of the small windows and the simplistic design is to represent a duality of space (Andrew Kroll) which is an intention of the home designs on the ASM Corporis. Tadao Ando said, “In all my works, light is a controlling factor” (Andrew Kroll). Ando’s use of light and space is used in the exterior of the ASM Corporis homes to create efficient use of space.





Original 3D models by Hana Husek.

PHASE II b
Construction

Construction

Christian Williams

Since machinery would be required to extract resources from Ryugu, we needed to examine the teleoperation of robots via augmented reality and artificially intelligent robots. Both augmented reality (AR) and artificial intelligence (AI) are reasonable solutions for asteroid resource extraction as they can operate in "real time." Both have their pros and cons.

With AI there are no lives at risk; however, using AR requires people to be in the vicinity, and people require costly resources and protection. To control, AI requires operational field testing and AR requires human training. Because of AI being safer and more cost effective, I have concluded that the majority of resource extraction should be done using AI.

AR will also be used, however only in certain conditions when AI would be unreliable, such as in emergency situations or for navigating rough and unexpected terrain. Therefore, our plan is to supply BFR-Cs with a payload of autonomous robots that would be monitored by humans aboard the BFR-Cs.

Augmented Reality (AR)	Artificial Intelligence (AI)
+ "Real time" communication from BFR-C AR user interface to Ryugu mining unit.	+ "Real time" on-board computing to control mining unit.
- Personnel must be in the vicinity, requiring expensive resources and protection.	+ No lives at risk from the dangers of the asteroid surface or being aboard BFR.
- Personnel require training to use user interface.	+ AI mining units are autonomous, reducing the need for personnel aboard.
+ Haptic feedback gives users sensory reception for precise control of humanoid mining units.	+ Does not require biological or psychological resources.
+ Humanoid mining units have human structure including hands.	- Extensive AI operational field testing would be required to maximize reliability.
+ Users have full operational freedom as they are not confined to automated operations.	+ AI mining units are more efficient under optimal conditions than user-operated units.*
+ Users are more reliable in rough and unexpected terrain and emergency situations.	- AI code is susceptible to glitches and bugs which may cause undesired operation.

The BFR Starship

Dry ship mass: 85 t
Propellant mass: 1,100 t
Height: 48 m (157 ft)
Diameter: 9 m (30 ft)

Data: SpaceX

Supplies and personnel will be transported to Ryugu by a modified Big Falcon Rocket (BFR-C) Starship specifically suited for the construction phase of the Corporis. The BFR was decided upon as the ideal method of transportation to Ryugu, since it is the only spaceship already designed for modern interplanetary travel.

Deployment

The BFR-C will approach Ryugu without landing directly on the unstable, rocky surface. Instead, it will orbit the asteroid and begin scanning the surface to generate a map of resource concentration. Then the BFR-C will move into a stationary orbit 0.4 km above the best surface mining location. Several robotic AI mining units will be lowered one at a time by a 5 mm wide, 400-meter long tether composed of braided Dyneema (HMPE) fibers. A spool of such material at that length and width would only need to be 30 cm in diameter, 20 cm long, and weigh 6 kg, yet still withstand nearly 26.7 kN of force. The momentum from deployment will be enough to allow the slight gravitational force of Ryugu to take over and pull the tether to the asteroid surface.

The AI units will then disconnect themselves from the tether and navigate to the nearby predesignated mining location. Once the mining units are at the proper location, they will clear a surface for a solar array that will be lowered in segments from the BFR-C. The solar cells will be used to charge small interchangeable batteries for when the mining units start to run low on their battery power so that they can be switched out for the fully-charged batteries. A smelter, powered by the solar array, will also be lowered from the BFR-C. Several large, high-capacity batteries will provide power for the smelter while the solar array is facing away from the Sun.

Operations

To make use of the resources from Ryugu, they must be mined and collected by the on-surface mining units. The raw ores are then refined by separating the valuable metals and minerals from the asteroid rock. Once the metals are refined and smelted, they can be cast into useful construction components. Additional BFR-Cs may be used

A SpaceX BFR Spaceship rendezvous with Ryugu.

to speed up the entire construction process. At an advanced stage of manufacturing, additional solar cells can be created using refined materials. If at any point there is an emergency situation on the surface, telerobotic units controlled remotely by human operators aboard the BFR-C can be sent to resolve the situation.

PHASE II c
Orbital Transfer

ORBITAL TRANSFER

Josiah DeLuz

Once the ASM Corporis is completed, team AeroSpace Meridian has decided to change the ellipticity of its orbit from that of the Ryugu asteroid to a circular orbit. We will do this at apogee to save on fuel cost and to minimize the needs of attitude control. The latter is necessary to keep the Corporis' solar panels faced towards the sun.

For the following equations, we divide μ (GM) by 1 AU to convert units for use in Equations 1, 2, and 3. Equations 1 and 2 provide the estimated velocity of Ryugu when it is at its apogee (aphelion) and its perigee (perihelion).

Key: Ryugu

Semi-Major Axis = 1.1895 AU

Semi-Minor Axis = 1.1678 AU

Apogee = 1.4159 AU

Perigee = 0.9632 AU

$V^2 = \mu(2/r - 1/a)$

$r =$ Apogee

$a =$ Semi-Major Axis

$\mu =$ Standard Gravitational Parameter

Equation 1 - Apogee Formula

$$V^2 = 8.8711 \times 10^8\ (2/1.4159 - 1/1.1895)$$

$$V^2 = 8.8711 \times 10^8\ (0.5718)$$

$$V = (507249498)^{1/2}$$

$$V = 22522.20\ \mathrm{m/s}$$

$$V = 22.522\ \mathrm{km/s}$$

Equation 2 - Perigee Formula

$$V^2 = 8.8711 \times 10^8 \,(2/0.9632 - 1/1.1895)$$

$$V^2 = 8.8711 \times 10^8 \,(1.2357)$$

$$V = (1096201827)^{1/2}$$

$$V = 33108.94 \text{ m/s}$$

$$V = 33.109 \text{ km/s}$$

Equation 3 describes the orbital velocity the Corporis must achieve in order to transfer to a circular orbit. This orbit will be the apogee of Ryugu which is between the apogee and perigee of Mars. However, the Corporis will be placed outside of Mars' sphere of influence (SOI).

Equation 3 - ASM Corporis Required Velocity for Circular Orbit

$$M_R V^2/R = G M_R M_S/R^2$$

$$V^2 = G M_S/R$$

$$V^2 = 8.8711 \times 10^8/1.4159$$

$$V = 25030.67 \text{ m/s}$$

$$V = 25.031 \text{ km/s}$$

Equation 4 gives the required Delta-V for the orbital transfer.

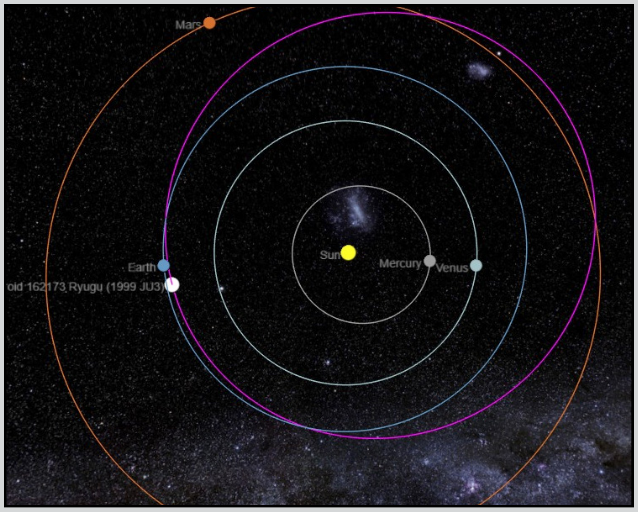
Equation 4 - Required Change in Velocity

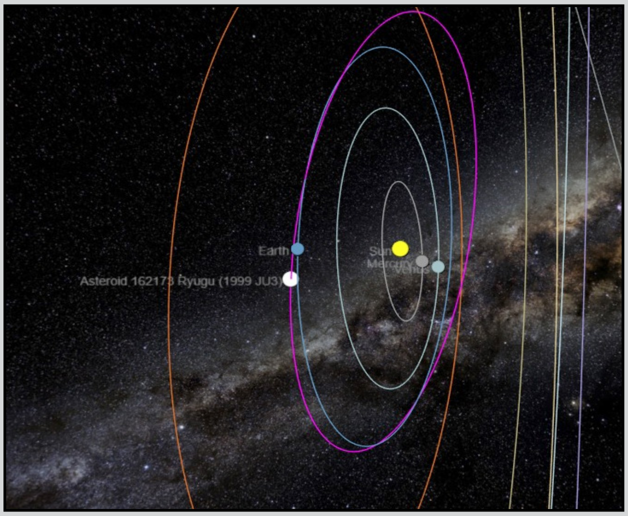
$$\Delta V = 25.031 - 22.522$$

$$\Delta V = 2.509 \text{ km/s}$$

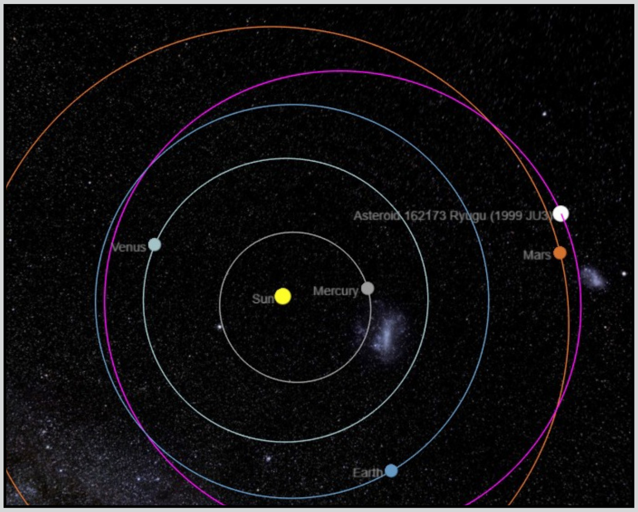
Ryugu's apogee is a desired position for two reasons: first, it gives us a proximity advantage to asteroids which are 1000 times more valuable than near-Earth asteroids (NEAs). Second, placing the Corporis at the perigee would require a Delta-V of 2.75 km/s, which is not that different from the apogee Delta-V of 2.51. However, a perigee burn will require as much as 10% more fuel. Third, apogee benefits attitude control because the ASM Corporis will be moving at a lower velocity, such that the space station needs less than 1° of change per Earth day to keep its solar panels facing the sun.

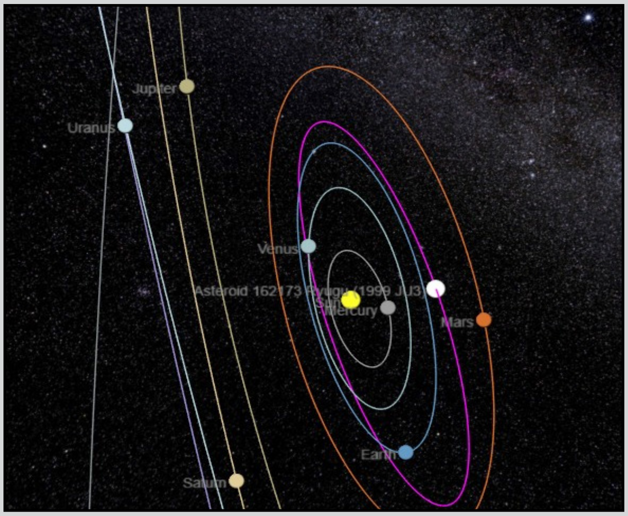
We have decided that the ASM Corporis will maintain Ryugu's 5.9° of inclination. We decided not to fix the inclination of the space station for two reasons: First, the adjustment would require an large quantity of fuel. Second, the 5.9° of inclination may even be advantageous in reaching many asteroids in the asteroid belt.





THE ASM CORPORIS RECEIVES FUEL FOR TRANSFER FROM THE SHACKLETON LUNAR SUPPLY BASE IN DECEMBER 2033.





THE ASM CORPORIS TRANSFERS ORBITS IN MAY 2037.

Images produced with theskylive.com.

PHASE III LIFE ON THE ASM CORPORIS

Once the ASM Corporis reaches circular orbit, the people of the colony begin their normal lives. Many facets of their personalities have been anticipated through our psychological surveys. The Corporis will act as a hub to Mars and a base for asteroid miners. Asteroid mining will grow economy on the Corporis as it will gather rare resources to send to Earth for a profit; the asteroid economy will maintain everyday life.

As these many nations come together to create a harmonious new colony, unity will be promoted through the ASM Corporis national anthem, “Chosen Amongst the Stars.” Music is a crucial key to finding a sense of solidarity on the Corporis and helps prevent social isolation. Children will also be educated in music so that they may develop the minds and gain critical skills that can be used on the Corporis.

The Corporis needs effective management of domestic affairs to operate. The ASM Corporis will minimize crime by keeping the Gini Coefficient low; revolution and chaos will be avoided through representative government. The merit system will allow incentive for workers but avert the Gini Coefficient by not parading wealth. Simultaneously, the use of Montesquieu’s separation of powers and Locke’s representative government will manage big ideas on the ASM Corporis.

GOVERNMENT

Hana
Husek

In 1830 Charles X was king of France. The elections for Councillors of State did not go favorably for him. The conservative king became frustrated and enacted the Four Ordinances. The ordinances consisted of adjourning the liberty of the press, reducing the electors from the middle class, reducing the number of deputies, and holding a new election under the new laws. Although Charles X had the intention of sheltering the people of France from the new ideas, the Four Ordinances angered them. The July Revolution began. Charles X abdicated, leaving France without a king.

Luckily, Marquis de Lafayette found a relative of the Bourbon family, Louise Philippe, with whom to he would restore the monarchy. Louis Philippe was a conservative king; however, his father had fought for the Republic in the French Revolution, which appealed to all people of France. Unfortunately for Louis Philippe, by 1848 the people of France were dissatisfied by his conservative ruling as only 1% of the French people could vote. The February Revolution began. Louis Philippe also abdicated, leaving France to the Second French Republic and—not longer afterwards—to Napoleon III.

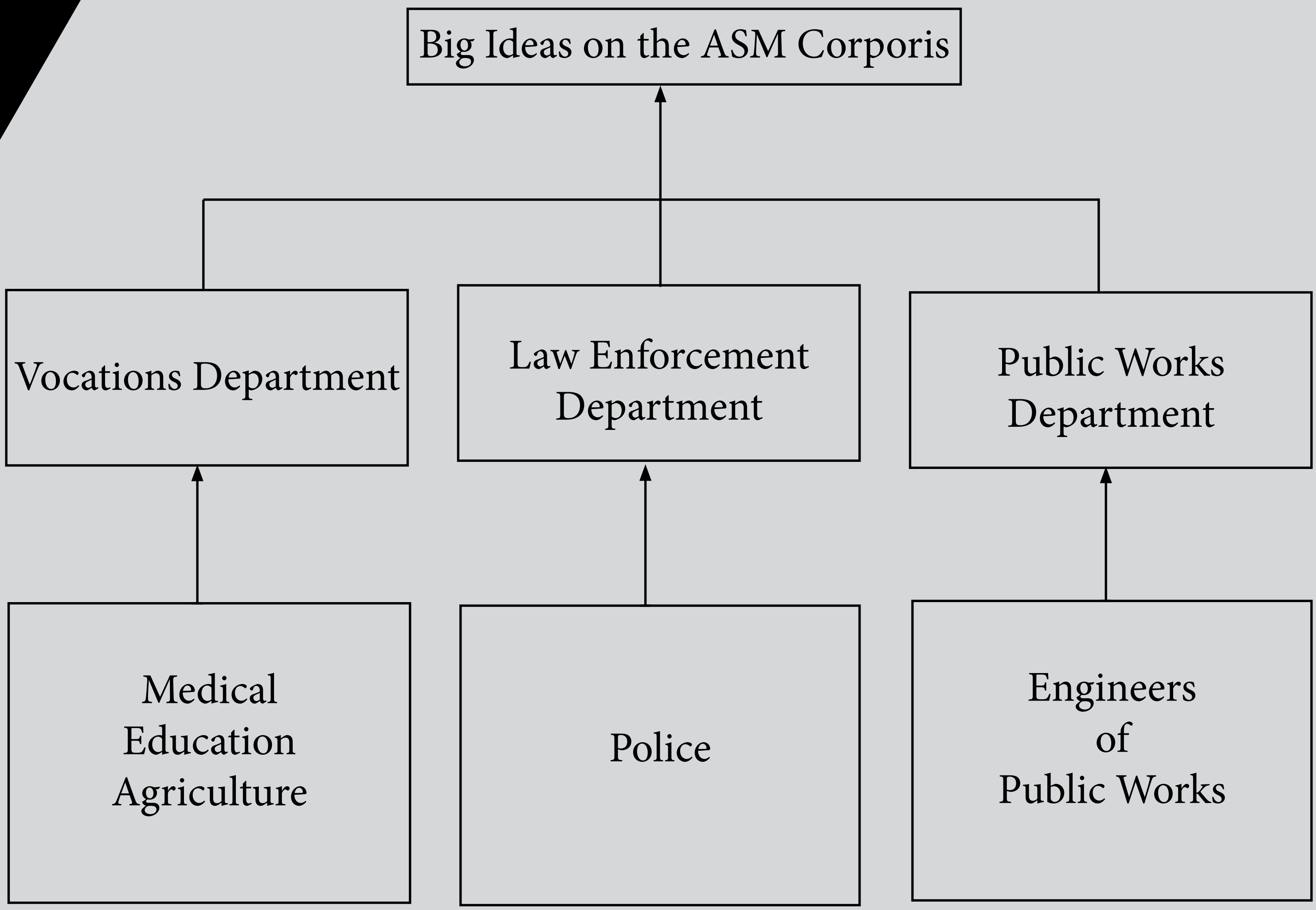
Representative Government and Voting

Classical Liberal and Enlightenment ideas contend that expressing the equality of all people through representation is essential for a community. On the ASM Corporis, this idea will be utilized to prevent revolutions.

The root of ASM's representative government is John Locke's concept of all people being equal. John Locke believed that natural rights should be protected and that the people have a voice within the government to maintain their rights. In the ASM Corporis, government officials will be elected by all people of the age 18 and over, allowing everyone to have a voice.

Separation of Powers

The Enlightenment idea of separation of powers will be applied; Montesquieu conveyed that a balanced government is a powerful government. Three branches of administrators will oversee the ASM Corporis. One department will oversee vocations, another will oversee law enforcement, and the third branch will oversee public works and systems. The three departments will collaborate for major decisions.



Administrators are chosen by election by those working in their departments. The administration board for vocations will be operated by workers in medical, education, and agriculture. Law enforcement will be operated by the police; the elected administrators will also be chiefs of police. Engineers of public works will have their own department heads to monitor their operations as well.

The number of administrators per department will be determined by the size of workers electing the candidates. The vocation department will have 4 administrators with the most workers within it. The public works department will have 3 administrators; public works have their own, separate department, however, it has many workers in it. Law enforcement will have 2 administrators because of its small department. In order to keep the law enforcement department from becoming a mob, judges must be in place. The ASM Corporis will employ trial by jury. These methods make sure that one part of the government is not all-powerful and elections are held for all workers.

CRIME PREVENTION

Hana Husek

The Gini Coefficient

The Gini Coefficient is a measurement of wealth inequality in a populace. It correlates positively with crime. The Gini Coefficient can be decreased to near zero if citizens have the same income (Kenton). The Strain Theory shows that when inequality is perceived through luxury items, the poor feel detached from social expectations, thus making crime more acceptable (Pinsker). Therefore, by reducing the Gini Coefficient on the ASM Corporis, there will be virtually no crime on the ASM Corporis. Citizens on the Corporis must be incentivized to receive a higher education without expressing the inequality that causes a high Gini Coefficient.

Source: Luther, Zippia

The Merit System

To create an incentive to work while avoiding luxury and currency, work is incentivized through merits which are tranferable to shortened work days and days off from work. Because some citizens who decide to work long hours through higher education, such as the medical staff, such persons will be allowed more merits to spend on days off. These citizens can choose reasonably ahead of time for additional days off. Through this merit system, every person will have equal luxury items, similar houses, and the idea of being rich or poor is not perceived. This equality will reduce the Gini Coefficient and virtually eliminate crime.

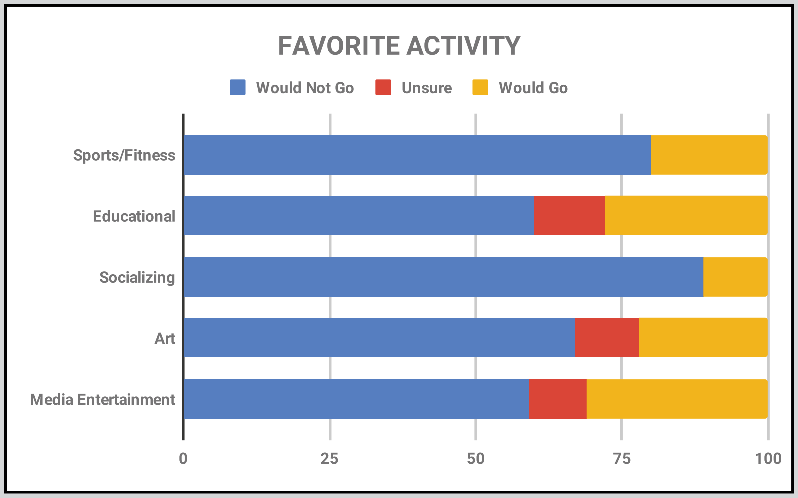
PSYCHOLOGY

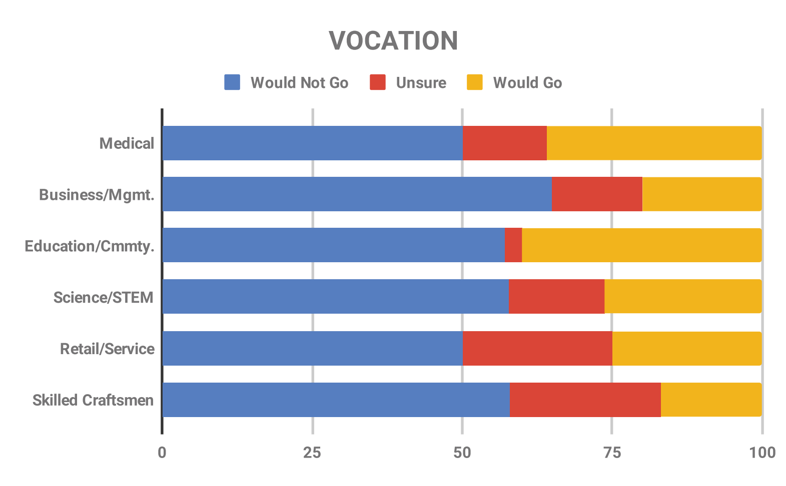
Raychelle Lorenzo

Psychological research allows us to determine the ideal party that would like to live on the ASM Corporis. My hypothesis was that socialites and those working in the medical and engineering fields, between the ages 25 to 35, would be the most interested. Results refuted the hypothesis. For this project, two surveys were conducted. Each survey asked the question: “Realistically, how would you be affected by living in a Space Station? Keep in mind loss of family and friends, reduced privacy and living space, and adapting to persons from other cultures. Would you live in space for a long term?”

Coming up with ideas on how I was going to accumulate data was simple. People prefer very simple questions that do not take too long to answer. So in 2017 and 2018, I conducted surveys on men and women of different age groups primarily from America and Japan. After 100 people answered each survey, I was ready to analyze the information and learn.

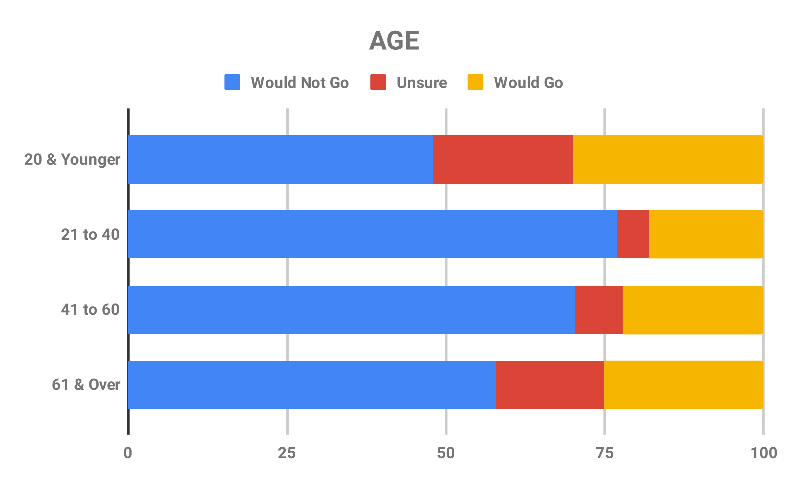
I wanted to learn how people with different interests are affected by the question of wanting to live in space. Are physically active people more interested in living in space than artists? Those more interested in media entertainment than educational pastimes? I highlighted people’s interests, including sports, education, socializing, art, and media (music, video games, television). Those interested in media were most willing, saying yes to living in space at an immense 31%. My hypothesis was correct. The second highest group included those invested in educational pastimes at 28%. On the other hand, 89% of socialites answered no.

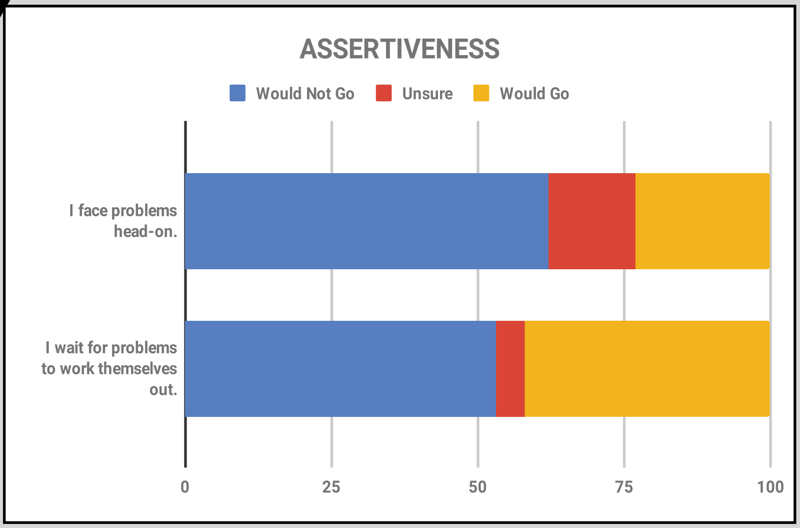


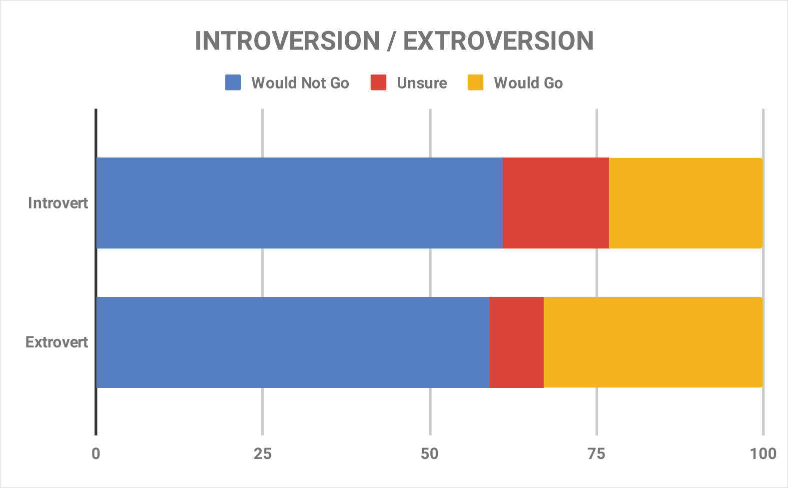


Data was correlated to see whether or not people in a variety of occupational categories would have different opinions about living in space. The question asked which vocation they worked in or were hoping to work in. I hypothesized that more people in the medical field and financial field would be interested in partaking in an experience in space. Why? Perhaps being in a space station miles away from Earth would be a great way for doctors and nurses to join together in helping citizens who will not have access to an array of medical institutions. Workers in finance typically have the mind to work out mathematical issues which will be helpful on the Aerospace Meridian Corporis. Other than strategic knowledge in mathematics, those working in finance are negotiable, making them ideal to live with thousands of other citizens in space. Results showed that only 20% of those working in finance were willing. My hypothesis was proven incorrect. The end result showed that those working in the community and education (teachers, aides, etc.) were most interested in living in space at 40%. Yet 36% of those working in the medical field answered yes to living in space.

I wondered which age group would be most willing to live in a space station. I hypothesized that more young people would to be willing to live in space than any other category. Why? Well, millennials nowadays are always looking for new opportunities and spontaneous activity. What could be more spontaneous than living in the AeroSpace Meridian Corporis? The survey concluded that 30% of those who are twenty-years-old or younger answered yes to living in space, while 25% of those in retirement (age 60+) also answered yes. Surprisingly, only







18% of those ages 21 to 40 and 22.2% of those ages 41 to 60 were willing. All in all, my hypothesis in this experiment was partially refuted.

The next survey asked the question of whether or not those who face problems head-on are more interested in living in space than those who allow their problems to work out on their own. I expected those who are more assertive to be willing to live in a space station rather than those who are not. However, the results show that those who allowed their problems to be solved on their own answered yes at an astounding 42%! This proved my hypothesis wrong as only 23% of assertive people answered yes.

The question reflected the answers of introverts and extroverts. As said before, our ideal party would include extroverts. I hypothesized that those who are more outgoing and extroverted would be more willing than those who are introverts. The survey proves that 33% of extroverts were willing to live in a space station, while only 23% of introverts answered yes.

All of this data can be applied in deciding who would be ideal to live in space. These surveys simply outline the type of people we want on Aerospace Meridian Corporis, those who want to be there and those we want to learn more about. Combining all our data, the ideal willing participant is a non-assertive extrovert who enjoys media entertainment, is 20 years old or younger, and works or hopes to have a career in education!

MUSIC

Maya
Calilao

Because the inhabitants of our permanent space colony will originate from many different nations around the world, it is crucial that this mass diversity of cultures and minds are able to effectively and efficiently cooperate with each other. Music is the key.

Over the many years of mankind's existence, music has played a prominent role in continuously developing cultures and traditions of the world. It is an extraordinary art form which enhances the mind and is too often taken for granted. Music is a crucial factor in uniting societies, maintaining a peaceful well-being, and shaping the future minds aboard the ASM Corporis.

Music and Social Cohesion

Our goal is to establish a sense of unity for the inhabitants of our space colony. It is crucial that our colonists feel a psychological affiliation to each other. Otherwise, they could fall into a state of depression or emotional disconnection, gradually impairing the performance of the individual and our permanent space settlement as a whole. Music is a medium which allows people to not only express themselves as individuals, but to facilitate the effectiveness of group action. Potentially, it has the power to sustain an integrated society, such as the one that would live on the ASM Corporis.

Musical endeavors have been displayed all throughout history, in every known culture on Earth. Before the breakthroughs of modern recordings, the only way to create music was to sing and play istruments with others. Coordinating movement with another person is linked to the release of endorphins in the brain, a hormone that triggers a sense of euphoria. Oxytocin is a hormone affiliated with the act of creating music as it is known to play an important role in increasing one's positive evaluation of others [Freeman 2000]. Arguably, the amount of cooperation that is involved with creating music together increases trust between individuals—crucial factors in maintaining societal stability. Music holds an extraordinary power to aid social relations; it enables a level of communication that is understood beyond just words. The more music is embraced to unite our inhabitants together, the more the potential increases for successful social cohesion and group action.

The Significance of an Anthem

An anthem is a musical composition, commonly serving as a symbol for a distinct group. Particularly, national anthems are written to distinguish nations, suggesting the traditions, beliefs, and challenges of its people. In a way, these anthems are used to unite and define the underlying theme of a nation. They are presented in a large array of contexts, generally in the midst of diplomatic or traditional situations. Ultimately, national anthems can serve a way of drawing citizens of a country together by encouraging a sense of safety and obligation towards each other.

I have composed an original 'national anthem' to represent the ASM Corporis. Titled "Chosen Amongst the Stars," its inspiring lyrics are intended to depict the sole purpose of the individuals chosen for our space colony and the importance of their teamwork.

Music and Mental Health Well-Being

Scholars have suggested numerous functions that listening to and engaging in music might fulfill for the individual. One of these functions is contributing to mental health, for it is essential that the individuals on board the ASM Corporis maintain a stable psychological state. Mental health is defined as "a state of well-being in which every individual realizes his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to her or his community" [WHO 2014]. Each one of these points is essential to a space station community. Ultimately, music is part of our basic human needs; humankind and music cannot function without one another.

Music Education on the ASM Corporis

However, there are even wider benefits that music teaching provides. Future students of the Corporis–regardless of grade level–can further enhance their creative and critical minds through studies in music. Active engagement with various musical activities over long periods of time eventually produces significant changes in the brain. Learning to read music is deciphering a vastly different language. The comprehension and execution of unique symbols on a page challenges one's neural and cognitive mechanisms of the brain. Training in music also strengthens the brain's executive functions, including processing and retaining information, behavior control, and critical problem-solving. Overall, music can contribute to a student's areas of self-discipline, self-expression, technical motor skills, problem-solving skills, and cooperation with others [NCME 1991]. Though everyone's occupational interests may not be rooted in music, their studies in it will provide them these skills which can be applied in their everyday lives on the ASM Corporis.

Chosen Amongst The Stars

The ASM *Corporis* Anthem

Written by Maya Calilao


14
Verse A2
El. Pno.
St.
D. Set
pa - ssion our pa - ssion how it burns For so much, so
G
Bm
G
17
Verse B2
much for us to learn Through - out the years As long as we are here, our
Bm
G
D
20
Chorus
des - ti ny is bound to be ful - fi - illed (Oh) We are cho - sen 'mongst the
Em
C/E
Em
G


23
El. Pno.
stars No mat - ter where we
are to work with all our
D
Bm
St.
D. Set
25
El. Pno.
hearts in har - mon - y
We are des - tined from the
G
G
St.
D. Set
27
El. Pno.
start to cre-ate in worlds be -
yond And reach out from the
D
Bm
St.
D. Set


29
Instrumental
El. Pno.
lines from where we stand
G
St.
D. Set
34
El. Pno.
St.
D. Set
38
Chorus
El. Pno.
Fin - ding some thing so di - vine that fills our hearts with
G
D
St.
D. Set


40
El. Pno.
light an ev - er las - ting life be - yond the stars
Bm
G
St.
D. Set
42
Bridge
El. Pno.
I will keep my prom - ise tight I will fo - llow the
G
D
St.
D. Set
44
El. Pno.
signs to do what - ev - ers right for we are
Bm
G
St.
D. Set


(Acapella) Chorus
46
El. Pno.
Picked by the hands that cre ate – ed
this, the un – i – ver-se's
bliss we'll all em brace our
St.
D. Set
49
El. Pno.
gifts am – ongst the stars
St.
D. Set

Maya Calilao prepares to perform "Chosen Amongst the Stars."

Josiah Richards works on the mixdown of the ASM *Corporis* anthem.

Maya's song can be heard at
https://aerospacemeridian.yolasite.com/stuff.php

VICTORS & VANISHERS

Hana Husek

Logan Russell

In an instant, we were the only two. In an instant, my head felt like a million fireworks exploding in a broom closet. In an instant, our entire lifestyle fell apart. In an instant, everything went dark. The pain in my head attacked me as I wondered what my life had come to. I paused for what felt like forever. What has my life come to?

The Chloe I knew would not be here. Chloe, back at home, would be at the movies, doing homework, or enjoying life with the people I love ... like most normal nineteen-year-olds. Normal. What does that word even mean anymore? Nothing has been normal since Mom left. She was the light of my life and the pep in my step. Growing up, I spent most of my time with Mom. She taught me most of what I know. Dad was always too busy with work and I barely got to know him, so Mom was the person I relied on the most. Soon after she left, Dad made the executive decision to finally move to the ASM Corporis because he had been obsessing over it for years. He said it's all about human development and exploration, but I knew the true reason was Mom. He didn't know how to deal with his emotions back then so the only thing he knew to do was run: run far, far away from his problems. In our case, that meant millions of light years away from the fragile blue and green marble we called our home.

Fast forward five years later, and I find myself applying for the most coveted job in the Corporis. Yes, that spinning hub of space metal was definitely not normal. It didn’t matter, this job, asteroid mining, was all I’ve ever dreamed of doing, and I would have never imagined that it would all fall through so quickly. All of us took the oath to serve the Corporis under any circumstances or sacrifice. I didn’t think the sacrifice would be our lives. I don’t think any of us expected this to happen.

Six months ago, we knew our job was crucial to keeping the Corporis from falling apart, so we took that responsibility, without a second thought. The job I chose mainly paid the debt of the Corporis as it continued space exploration at a lower price. My job would mine from the Asteroid Belt for iron, nickel, and titanium—these things had become rare on Earth. The Corporis can then send these elements to Earth for a profit. It was a genius idea, and since we joined the Corporis, I knew immediately it was my dream job, but at that moment, I wasn’t sure.

The only thing I remember is that the ship failed. It came as a surprise; nothing appeared wrong; the ship was a masterpiece in fact. Valves, wires, panels, and untold futuristic equipment, kept us breathing day after day, but somehow, the anxiety of our first trip made us stumble. It was a miracle that Beckett had a pulse and that I was barely conscious, but I was alive, and that's all that matters. Right? As tears welled up in my eyes, I looked away from the other two bodies. We had all been so close, Axel, Emilia, Beckett, and I. Beckett took care of everything; he had more experience after all.

Multiple times I refused to continue. Axel is not a submissive man. He is painfully stubborn. Not is, he was. Was a stubborn man. He took charge and continued toward the Asteroid Belt. I never understood how he took charge as he was not a leader, but I guess he was determined. As we got closer to the asteroid, Axel incessantly ranted about the importance of constant safety and vigilance in everything we do for the Corporis. Emilia quietly sipped on her cup of black coffee, staring into nothingness. Funny, they were the ones to die first.

Two months had passed and behold, there it was, the perfect asteroid to mine, in the perfect asteroid belt. Those were Beckett’s words, not mine. After the incident happened, I did not have the willpower to continue on. Beckett kept me going with the belief that this was all for the Corporis, and reminded me of the thousands of people who would benefit from our work. So we continued on.

Soon enough we landed, ready to provide for Earth and the Corporis. The miner probes in their metallic grey shells were buzzing and whirring preparing for the long days ahead of them. By now each expedition was second nature to us; we never skipped a beat. We had practiced it so many times back on earth. While collecting the precious metals, I thought about all of the men, women, and children who would benefit off of these silvery chunks of rock, and how we would come home as heroes, Corporis heroes. Apparently, I didn't notice the large piece of rock cracking above me, but I did notice the deafening safety alarms the probes were emitting. Beckett noticed them as well, and, frantically pressing every button on his suit monitor, I felt in my stomach that another miracle would not be possible. Out of the corner of my eye, I saw Beckett eye the crate of metal. My only instinct was to survive, but he had other plans. He was going to collect the metals, why wouldn't he? It was everything we have worked for, everything we trained for. At that moment, I didn't understand his determination, so I protested.

"The Corporis is a lifeline we have been given. It is determined to provide for the human race. I am resilient because I was 'Chosen Amongst the Stars' to contribute to a dignified cause, so please ... leave me be."

As he commanded this, I pivoted on my heel and scrambled up the jagged hole while fearfully observing through one of the probe's cameras as Beckett threw his whole weight towards the pile of metal. As he turned to leap out of the void, he was violently jerked back and fell to the ground. His leg was stuck under a large piece of asteroid. He paused and looked up to me for a moment. I looked away—I knew what would happen; it was an excruciating moment, but I knew I could do nothing about it. As his oxygen slowly ran out, he whispered in the comms.

"For the Corporis." Then I knew I had to leave him.

I was alone, but something shifted. It's not about me, it's not about the team—it's not even about the precious metals. It was for the people. For humanity as a civilization. For the Corporis. We are just pawns in the big game of exploration and survival. If anything life at home and in the Corporis has taught me, it's the true meaning of selflessness in the midst of hopelessness. All three of my teammates were heroes, idols, and victors. Not were, they are. They provided, as the Corporis does. I understand how valuable my life's work is; my dream has been fulfilled. I kept these thoughts in my head as my food supply slowly dwindled and as my oxygen supply ran low. It's not about me, it's the people. Not me, the people. The people... the Corporis.

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Austin Pham, Grade 10 - Station Design, HVP Shields, 3D Graphics, LRS

Logan Russell, Grade 11 - Shackleton Crater Base, Story

"Whatever you do, work at it with all your heart as working for the Lord,
not for human masters." Colossians 3:23

MAKUA LANI CHRISTIAN ACADEMY

KONA, HAWAII