International Space Station (ISS)

Overview
for
HUNCH

High School Students United with NASA to Create Hardware

This packet is full of helpful information about the ISS that you can use to fabricate real-world products for NASA while applying science, technology, engineering and mathematics skills and learn to work in teams and think creatively.

This packet has general information about the ISS including, the modules of the ISS and what life on ISS is like.

In the Design and Safety Factors section you will find important concepts to incorporate into your creations; these factors that have been pulled directly off NASA safety guidelines and documents.

The Interviews with Astronauts section contains questions about ISS, answered by real men and women who have been on ISS. They offer great insight on things that could make life easier on ISS.

Use the information in this packet to help start your research, but be sure to check out the Helpful Resources section. It's crammed with links for more information.

As you start the design process, Good luck and Have Fun!

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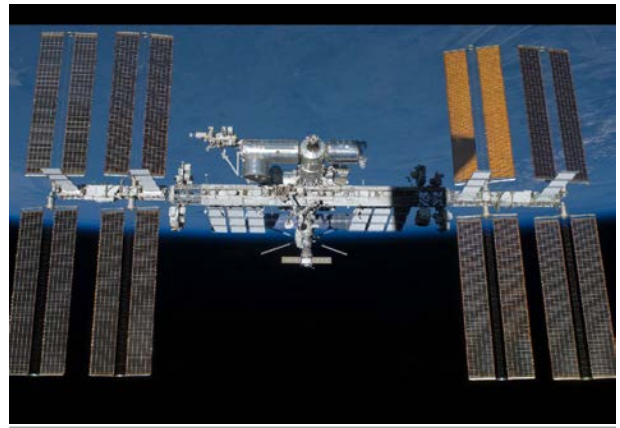
"I cannot say in words how much that I appreciate the opportunities and experiences provided by HUNCH. I am very happy and excited for my future as I believe that HUNCH has opened many doors for me." - **Rachel, Cypress Woods High School**

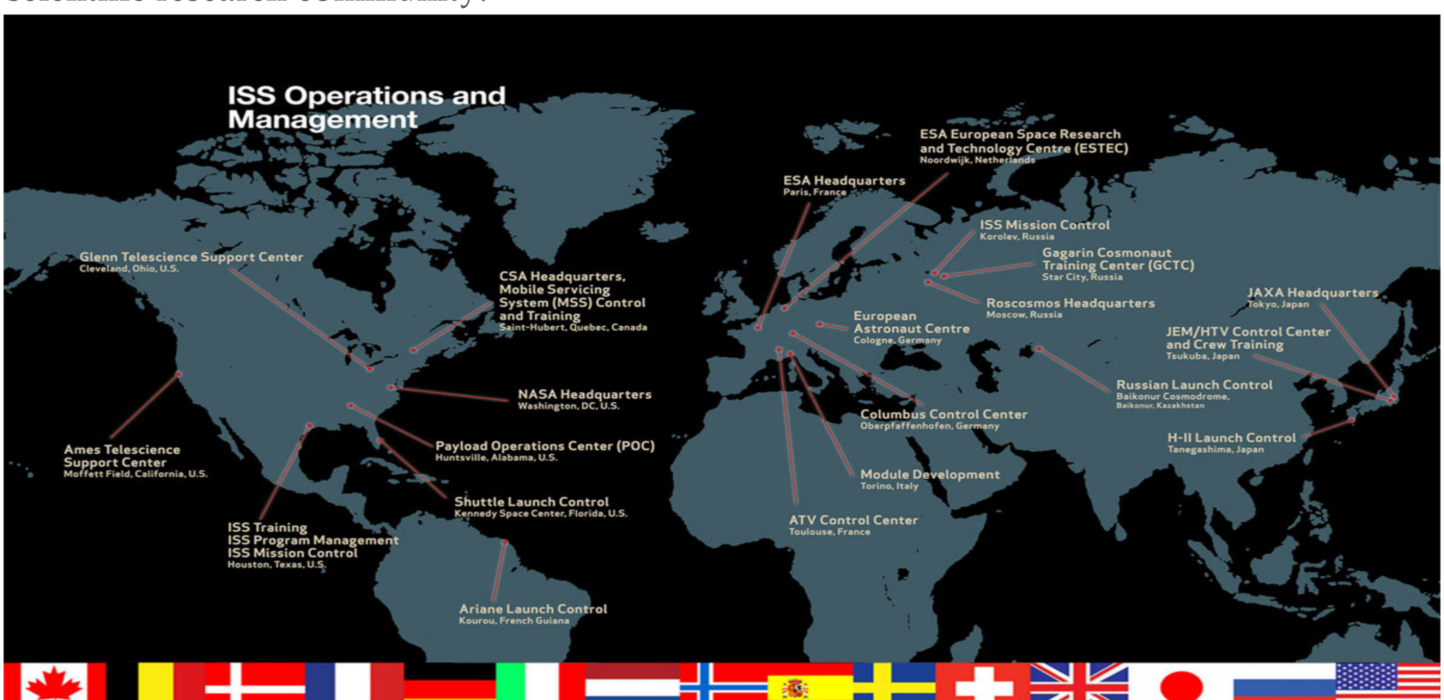
What is the ISS?



The space station is a working laboratory orbiting 240 miles above the Earth and is home to an international crew. The station provides a laboratory complex where gravity, a fundamental force on Earth, is virtually eliminated for extended periods. The ability to control the variable of gravity in experiments creates unimaginable research possibilities.

Launched in 1998 and involving the U.S. (NASA), Russia (ROSCOSMOS), Canada (CSA), Japan (JAXA), and the participating countries of the European Space Agency—the International Space Station is one of the most ambitious international, engineering, and scientific collaborations ever attempted. The largest space station ever constructed, the ISS has been visited by astronauts from 14 countries—and counting.

The ISS has been the most politically complex space exploration program ever undertaken. The International Space Station Program brings together international flight crews, multiple launch vehicles, globally distributed launch, operations, training, engineering, and development facilities; communications networks, and the international scientific research community.



Why is there an ISS?

The station is vital to human exploration. It is where we are learning how to combat the physiological effects of being in space for long periods. The space station is our test bed for technologies and our decision-making processes when things go as planned and when they don't. It is important to learn and test these things 240 miles up rather than encountering them 240,000 miles away while on the way to Mars or beyond.

Almost as soon as the ISS was habitable, it was used to study the impact of microgravity and other space effects on several aspects of our daily lives. ISS astronauts conduct science daily across a wide variety of fields, including human life sciences, biological science, human physiology, physical and materials science, and Earth and space science. Over 400 experiments have been conducted on the ISS as so far, over 9 years of continuous research. Experiments on ISS include research on:

- Purification
- Fluid Flow Models
- Duchene's Muscular Dystrophy
- Durability of Materials
- Planetary Contamination Monitoring
- Cancer Treatment Delivery
- Vaccine Development

Design Factors to Consider

❖ **Efficiency**

Look to create a design that will make life on ISS easier, more efficient, or enjoyable. Find a task that is not currently optimized, and help optimize it. Use this packet to help get an idea of what astronauts could use. Here are some things to consider in your design process:

Strength - Although it's easy to move heavy objects, any force that an astronaut applies in Space also pushes them in the opposite direction unless they're holding on to something stable. Sometimes astronauts have long work days or exhausting tasks and are tired from all the required work. Keep this in mind, and design your project so that it doesn't require too much force to operate.

Microgravity – The biggest thing you need to consider is that ISS exists in a microgravity environment. If you drop something on ISS, it doesn't go to the floor. If you touch something, even lightly, it might spin away into the wall. Liquids don't stay inside of cups, and particles like crumbs simply float around and make a mess.

Labeling – Labels on Earth use directions like, "This side up." However, because of microgravity, determining the top of a floating object can be difficult. To compensate for this, ISS follows a convention of port/starboard, zenith/nadir, which you will need to consider if your project will interact with other parts of the station. You need to think carefully about how to label your project. Consider color-coding matching parts as well as, diagrams and instructions that can go with your design.

Previous Designs

Microgravity Science Glovebox

Many experiments take place on the International Space Station, either on one of the racks or in the Microgravity Science Glovebox (MSG). Astronauts train for MSG use on-Earth by using a model MSG produced by a previous HUNCH group.

Exercise Suit

Due to less gravity astronauts' bodies, tend to lose muscle mass and bone density when in Space. To prevent this, astronauts spend a considerable amount of time exercising in Space. By wearing a resistance based exercise suit, the physical exertion for daily activities and exercises will be intensified leading to, in theory, less total time exercising.

Design Factors To Consider

❖ **Utility**

Make sure that your project is something that will be useful. When you're designing hardware for Space you should remember that astronauts have a lot of demands, so you want to make your project something that has a purpose and does not overly complicate tasks. Here are some things to consider in your design process:

Size Range – Since the Space Program accepts people of many different heights, it's important that all the equipment on board the ISS can be used comfortably by all crew members. Make sure to design your project so that it can be used by a small woman but won't constrict a large man.

Coverings – Free-floating objects might hit your project by accident, so make sure to protect it. Consider an overall cover and also covers for any parts that might be not work if small things get inside. If connection points are delicate, make sure to have covers to protect them from damage. Design a built-in storage location for coverings, or attach them permanently to the project.

Connection Points – Since the arrangement within the ISS changes a lot, astronauts might have to install, take apart, and move your project multiple times. Try to make the assembly and removal a quick and easy process. Take into consideration how long it might take to screw or unscrew a joint, and design your project so that taking one piece apart doesn't require taking the whole thing apart.

Power Sources – If your project requires electricity, recognize that plugging anything into the ISS is a big deal. There are rechargeable batteries already on ISS that you should consider using as a power source instead of a plug.

Expendable Resources – On the ISS, astronauts have a limited supply of materials to work with. It costs a lot of time and money to send up replacements and the used resources take up valuable space. A project that burns through expendable resources is not likely to be used.

Safety Factors to Consider

❖ Safety

The environment in Space is harsh and unforgiving, and there's not doctor or hospital nearby. Safety is an important issue, and hazards may disqualify an item from going into Space. Here are some safety concerns to keep in mind:

Floating Debris – If your project deals with liquids or particulate matter, you need to make sure that it stays contained. In Space, when there's a spill the material doesn't just fall to the floor – it could go all over and damage the Space Station. If there are any filters, make sure that replacing them doesn't let all the captured debris float free!

Temperature Constraints – Make sure that your project doesn't pose a burning or freezing hazard. If any parts get hot or very cold (Less than – 18C or greater than +49C), make sure that they can't be touched.

Noise – Since the astronauts have to live continually in the presence of all the machinery in the ISS, there are limits imposed on noise so that their hearing isn't damaged and it doesn't affect their ability to hold conversations, sleep, or hear safety alarms. Sudden loud noises are to be avoided, since they could cause alarm amongst the crew. Think about how loud your project is, and if you would want to spend 6 months living in a small Space listening to it.

Lighting and Reflectivity – Make sure that any lights on your project can be dimmed if they're bright. It's also important to make sure that major surfaces of your equipment don't reflect too much light. Extremely reflective surfaces can tire out astronauts' eyes, distract astronauts, or prevent them from seeing something critical.

Accidental Actuation Protection – In Space, dexterity might become less precise. It's important to protect buttons and other controls like switches so that they won't be hit by accident. They should also be large enough and have enough space between them so that astronauts won't accidentally hit two controls at once.

Sharp Items – Sharp screws, bolts, cotter pins, wires, edges, corners, and handles all pose potential hazards that could injure a crew member or damage other hardware. Suits and other crucial items are inspected carefully, but if your project causes an unnoticed rip or hole in an important item onboard ISS, lives could be at risk in the unforgiving vacuum of Space. Cover, file, grind down, or de-burr sharp or rough surfaces.

Safety Factors to Consider Continued

Materials Durability and Failure – Vibrations and forces experienced during launch, re-entry, and other operations can subject your project to heavy loads. Make sure your project is sturdy enough not to fall apart! If there are any spaces in your project that trap gas that cannot escape, how will it fare against the vacuum of Space? This is important to consider because in the case of a station depressurization emergency your project could make a bad situation worse if it explodes.

Materials Properties – When you craft your project, be sure to consider flammability, shattering, and off-gassing concerns. Flammability is highly dangerous on ISS because there are a lot of flammable gasses around. Shatterable materials could be harmful to the astronauts and equipment, especially when all the shards are floating around in the air. Sharp pieces of glass wouldn't fall to the ground in space! Off-gassing is when materials release small particles into the air. "New car smell" is one example of off-gassing. Here on Earth, the atmosphere dilutes off-gassing fumes and they rarely pose a threat. On the ISS, however, an off-gassing item could make the air toxic or clog the air purification system.

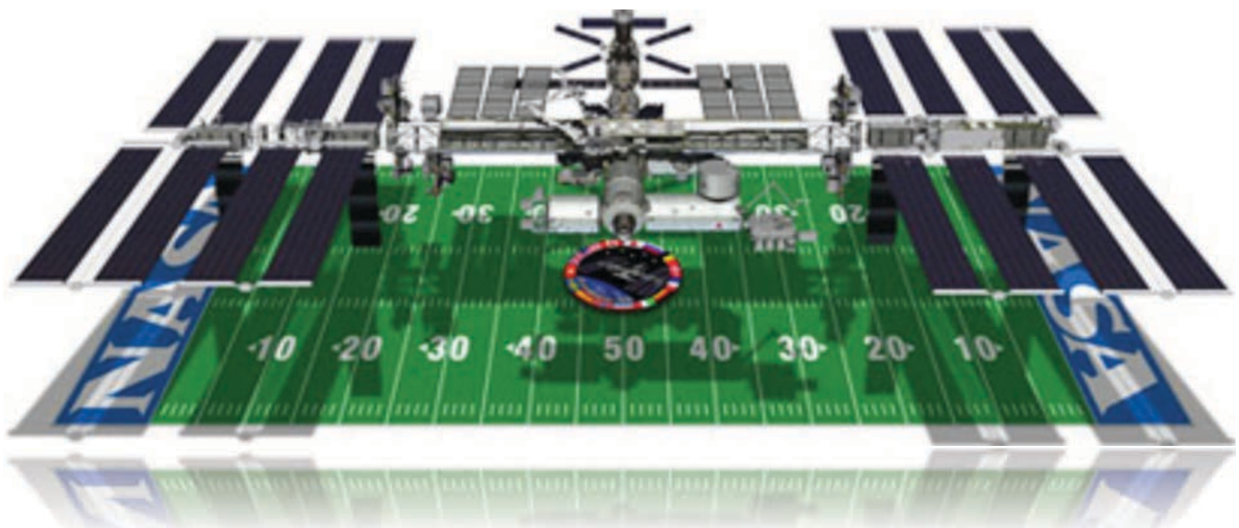
Electricity – Shocks and sparks from electrical systems are unacceptable on station. All systems must be grounded, the wires must be able to handle the current, and there must be protection from shocks. If any connections must be assembled, there should be a way to turn power off to that connection. All batteries must be tested and approved, even small ones like watch batteries!

Safety Stop – In the case of an emergency, your project needs to be out of the way and not pose any threats. Make it easy to stow so it won't get in the way of an evacuation, and make it simple to stop any electrical or mechanical systems.

Explore the ISS

The space station, including its large solar arrays, spans the area of a U.S. football field, including the end zones, and weighs 924,739 pounds. The complex now has more livable room than a conventional five-bedroom house, and has two bathrooms, exercise equipment, and a 360-degree Earth-viewing window.

- Module Length: 167.3 feet (51 meters)
- Truss Length: 357.5 feet (109 meters)
- Solar Array Length: 239.4 feet (73 meters)
- Mass: 924,739 pounds (419,455 kilograms)
- Habitable Volume: 13,696 cubic feet (388 cubic meters)
- Pressurized Volume: 32,333 cubic feet (916 cubic meters)
- Power Generation: 8 solar arrays = 84 kilowatts
- Lines of Computer Code: approximately 2.3 million



The International Space Station marked its 10th anniversary of continuous human occupation on Nov. 2, 2010. Since Expedition 1, which launched Oct. 31, 2000, and docked Nov. 2, the space station has been visited by 204 individuals.

At the time of the anniversary, the station's odometer read more than 1.5 billion statute miles (the equivalent of eight round trips to the Sun), over the course of 57,361 orbits around the Earth.

A total of 168 spacewalks have been conducted in support of space station assembly totaling more than 1,061 hours, or more than 44 days.

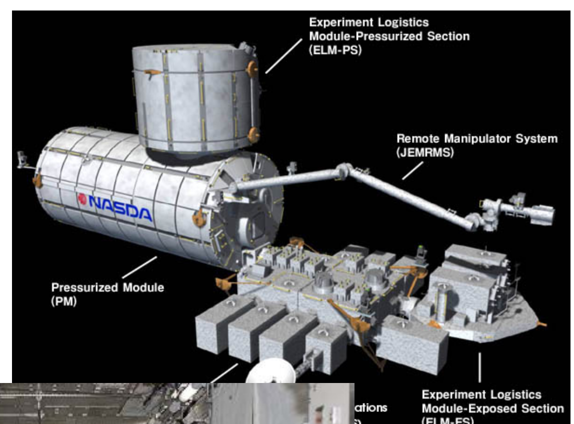
Modules and Laboratories of ISS

Destiny Laboratory

Destiny is the primary research laboratory for U.S. payloads, supporting a wide range of experiments that contribute to health, safety and quality of life for people all over the world. Science conducted on the Station offers researchers an unparalleled opportunity to test physical processes in the absence of gravity. The results of these experiments will allow scientists to better understand our world and ourselves and prepare us for future missions, perhaps to the Moon and Mars.

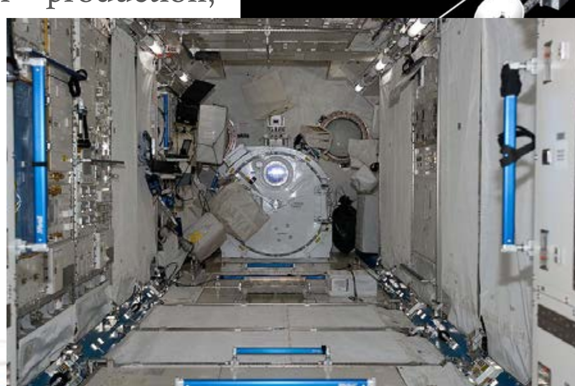
The aluminum module is 28 feet long and 14 feet in diameter. The lab consists of three cylindrical sections and two endcones with hatches that can be mated to other station components. A 20-inch-diameter window is located on one side of the center module segment.

Kibo Laboratory



The Japanese Experiment Module, or JEM, called Kibo -- which means "hope" in Japanese -- is Japan's first human space facility and enhances the unique research capabilities of the International Space Station.

Experiments in Kibo focus on space medicine, biology, Earth observations, material production, biotechnology and communications research. Kibo consists of several components: two research facilities -- the Pressurized Module and Exposed Facility; a Logistics Module; a Remote Manipulator System; and an Inter-Orbit Communication System unit. Kibo also has a scientific airlock through which experiments are transferred and exposed



Modules and Laboratories of ISS

Columbus Laboratory

As the European Space Agency's largest single contribution to the station, the Columbus laboratory supports scientific and technological research. Columbus is about 23 feet long and 15 feet wide, allowing it to hold 10 "racks" of experiments, each approximately the size of a phone booth.

The Columbus laboratory's flexibility provides room for the researchers on the ground, aided by the station's crew, to conduct thousands of experiments in life sciences, materials sciences, fluid physics and other research in a weightless environment not possible on Earth.

The control center for the work conducted in the Columbus laboratory is located in Oberpfaffenhofen, Germany. From there, ground controllers can communicate with the module as the space station orbits the Earth, as well as with researchers across Europe and their partners in the United States and Russia.

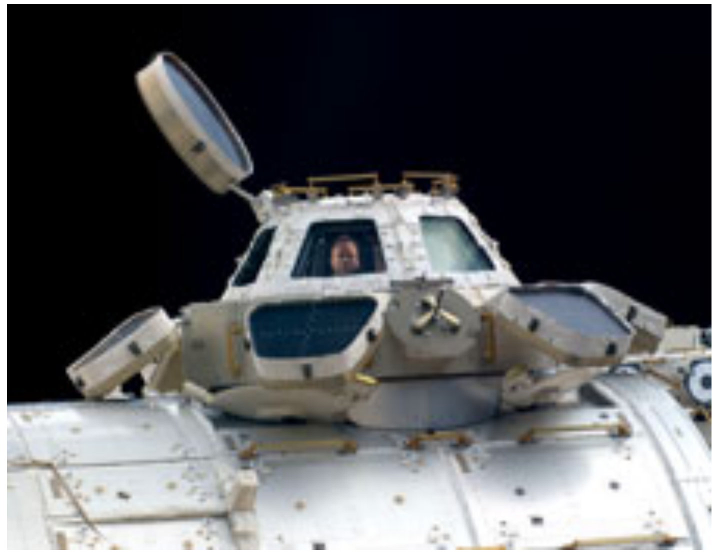
Zarya

The Zarya Module, also known by the technical term Functional Cargo Block and the Russian acronym FGB, was the first component launched for the International Space Station. This module was designed to provide the station's initial propulsion and power. The 42,600 pound pressurized module was launched on a Russian Proton rocket in November 1998.

The Service Module enhanced or replaced many functions of Zarya. The Zarya module is now used primarily for its storage capacity and external fuel tanks. The Zarya Module is 41.2 feet long and 13.5 feet wide at its widest point. Its solar arrays and six nickel-cadmium batteries can provide an average of three kilowatts of electrical power.

Modules and Laboratories of ISS

Cupola Observational Module



The Cupola is a panoramic control tower for the International Space Station, a dome-shaped module with windows through which operations on the outside of the station can be observed and guided. It is a pressurized observation and work area that accommodates command and control workstations and other hardware.

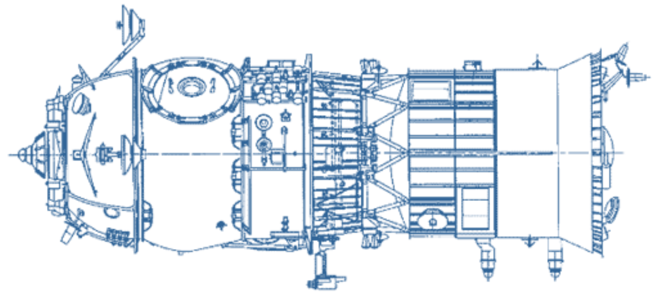
Spacewalking activities can be observed from the Cupola along with visiting spacecraft and external areas of the station with the Cupola offering a viewing spectrum of 360

Permanent Multipurpose Module

Derived from the Leonardo Multipurpose Logistics Module (MPLM), the Italian-built Permanent Multipurpose Module (PMM) is attached to the Earth-facing side of the Unity node. The PMM is a large, reusable pressurized element that was originally used to ferry cargo back and forth to the station. It added 2,472 additional cubic feet of pressurized volume for storage and for scientific use, and it can hold up to 16 racks of equipment, experiments and supplies. It also has an end-cone that has additional storage space for cargo bags and other items.

Modules and Laboratories of ISS

Pirs



Pirs is a docking port on the Russian segment of the space station for Soyuz crew vehicles and Progress cargo vehicles. It also has an airlock for Russian spacewalks. The 16-foot-long, 8,000-pound Pirs Docking Compartment is attached to the bottom, Earth-facing port of the Zvezda Service Module. It docked to the International Space Station on Sept. 16, 2001, and was configured during three spacewalks by

Poisk

Poisk is another docking port on the Russian segment of the space station for Soyuz and Progress vehicles. It provides spacewalk capability and extra space for science experiments.

Quest Airlock

The Quest Airlock is a pressurized space station module consisting of two cylindrical chambers attached end-to-end by a connecting bulkhead and hatch. The airlock is the primary path for International Space Station spacewalk entry and departure for U.S. spacesuits, which are known as Extravehicular Mobility Units, or EMUs. Quest can also support the Russian Orlan spacesuit for spacewalks.

The Joint Airlock acts as a stowage area for spacewalk hardware as well as a staging area for crewmembers preparing to conduct a spacewalk. A combination of the depress pump and pressure equalization valves located within the hatches accommodate the depressurization/pressurization capability of the airlock.

Modules and Laboratories of ISS

Rassvet

Rassvet (Russian, for "dawn") was delivered by space shuttle Atlantis on the STS-132 mission. It is used primarily for cargo storage and some payload operations. Rassvet also provides a fourth docking port on the Russian segment of the station for the docking of Soyuz and Progress vehicles. It is 19.7 feet long, has a maximum exterior diameter of 7.7 feet and weighs 11,188 pounds.

Tranquility Node

Tranquility was one of the last U.S. components added to the International Space Station. The pressurized section provides additional room for crew members and many of the space station's life support and environmental control systems on board. These systems include air revitalization, oxygen generation and water recycling. A waste and hygiene compartment and a treadmill also are located there.

Unity Node

Unity was the first piece of the International Space Station provided by the United States. It was the first of the three connecting nodes (Harmony and Tranquility would become the other two). The Unity Node contains more than 50,000 mechanical items, 216 lines to carry fluids and gases, and 121 internal and external electrical cables using six miles of wire.

Modules and Laboratories of ISS

Harmony Node

Harmony is a node on the station that is used to connect Kibo, Columbus and Destiny. It is also the docking port for the Cygnus, Dragon and HTV cargo vehicles.

The module acts as an internal connecting port and passageway to international science labs and cargo spacecraft. Harmony is a utility hub, providing air, electrical power, water, and other systems essential to support life on the station. It distributes resources from the station's truss to the Destiny lab, to the European Space Agency's Columbus Laboratory, and to the Japanese Kibo Laboratory. In addition to increasing the living and working space inside the station, its exterior also serves as a work platform for the station's robotic arm, Canadarm2.

Zvezda

The Zvezda Service Module was the first fully Russian contribution to the International Space Station and served as the early cornerstone for the first human habitation of the station.

The module provides station living quarters, life support systems, electrical power distribution, data processing systems, flight control systems and propulsion systems. It also provides a communications system that includes remote command capabilities from ground flight controllers. It also provides a docking port for Russian Soyuz and Progress spacecraft as well as the European Automated Transfer Vehicle.

Life on Station

Take a look at the journal entry of Astronaut Sandra Magnus …

"I am going to try to describe a typical day of life on the ISS. Many people have asked this question, I imagine wondering what everyday life is like in such an unusual place and environment. First and foremost I need to point out that our days, all of them, are planned by a huge, world-wide group of people on the ground… The end result is that before I even launched I had a big picture view of what I would be doing every week while I was up here as well as what the major objectives of the mission were.

How does this relate to a typical day? Well we have a scheduling program on board that has in it all of the details that we need to know in order to do the day's work. It tells us when we should go to sleep, when we should get up, when we should exercise, when to eat our meals, when and what information we need to do our tasks. This program is our main way of communicating and coordinating our day with the ground.

With that background, I can begin to describe a typical day. We use Universal Time as the clock we work to. This allows everyone in the world to synch up to one standard time zone. So the schedule typically shows us getting up at 0600 GMT. There is a period right after we get up called "post-sleep" and is about an hour and a half. Think of this as being the same as the time you have in the morning when you get up to take a shower, eat breakfast, get yourself ready for work, and get to work. Different crew members use this time in different ways. Some like to sleep late, others will gather all of the tools they need for the day, some like to start exercise early, some will actually start working. Or you may do different things on different days. My preference is to get up and start my workouts.

At the end of this time period we have a morning planning conference which includes every control center. This gives us all a chance to tag up and talk about the day's plan, including any changes that have occurred since the previous evening. It also is the time to get answers to questions (in both directions) or ask new questions about outstanding issues (a lot of the questions/answers revolve around stowage). After the conference, which is usually 15 minutes long or so, we hit the ground running. We have already looked at the plan for the day and know what is expected. I will usually look at what they have for me and make sure I understand what constraints there are… Once I have figured out all of these questions I re-arrange my day to make it as efficient as I can.

Journal Entry of Astronaut Sandra Magnus Continued

Usually after the DPC (Daily Planning Conference) I do my cardio exercise, as I mentioned I asked to have exercise scheduled first thing in the morning. I try and alternate each day between the treadmill and the bike; each offers something different and both are useful. I have been doing a lot of water sampling as we have just put the new water system in and the ground wants lots of samples taken at certain time intervals to make sure the system is working well in a steady-state manner. Another thing I have been doing a lot of since I got here is all of the unpacking from both the shuttle and the Progress, which arrived shortly after the shuttle left. Basically both vehicles brought tons of stuff to the ISS and it all has to be neatly put away (after you find where it was temporarily stowed in the first place!). … In addition there are always science tasks to do in all three laboratory modules as well as small "housekeeping" chores. A typical day is a mix of all of this.

Unlike shuttle missions, where you easily work through lunch because things are so hectic, we do stop for lunch, scheduled for an hour, and we do try to eat together. This is also a good time to take pictures out of the Service Module windows while you wait for your food to warm up. Lunch is not rushed but we do not dally either. It is a useful pause in the day to take a breath, see how your crew mates are holding up that day, and then get back to it.

The afternoon continues on the same as the morning. We usually have more interaction with MCC-Houston (Mission Control Center) in the afternoons because our afternoons correspond to Houston's main office hours. Any tasks that require lots of ground support usually show up on our schedules in these time slots, and are indicated that they should be done at the scheduled times. For example, Mike activated the new toilet system last week and I am currently working on getting the new crew quarters activated. Both of these tasks involve coordination with people in Houston. At the end of the working day, which is typically around 1730 or 1800, we have another planning conference to discuss any open items from the day and also the upcoming schedule for the next day. Again it is with every control center and about 15 minutes long. Sometimes you are finished with your work by the evening daily planning conference, and sometimes, if there were some problems that occurred during the day, you are behind and there are things still incomplete.

After the planning conference we are officially done with work. If there is a task that is still unfinished, though, we will typically finish it before heading to dinner. We do eat dinner together, and it is usually around 2000. Dinner is not rushed and we use this time to unwind. It is also a good time for photos out the window and all three of us will huddle near the windows with our cameras watching the world go by. The pre-sleep period is about 2 hours and along with dinner and winding down we can look ahead to tomorrow's plan and get ready for the morning. There is also email, phone calls, news, photos to review, and other activities which occupy this time. Friday is movie night and sometimes Saturday too. Bed is officially at 2130 (but not everyone makes it to bed that early!).

The next day the whole cycle starts again…"

Life on Station

Check out what the ESA has to say about ISS…

The concept of a "day" aboard an orbiting spacecraft is a little abstract: every 24 hours, astronauts on board the ISS will experience 15 sunrise/sunset as the station speeds around the world. But human beings have been conditioned by millions of years of evolution to a 24-hour daily cycle, and so-called circadian rhythms of waking and sleeping are hard-wired into our brains and bodies.

Each crewmember is designated 8 hours for sleep on mission days. The crew are awoken by an alarm each "morning." Crewmembers sleep in sleeping bags tethered to the wall in their respective crew sleep stations or "crew cabins" (pictured top right). Most crew cabins also include a spot to attach a laptop for a workstation. The crew cabins are spacious but only large enough for one crewmember. Additionally, airflow is very important when sleeping. If an astronaut sleeps in a poorly ventilated area, he or she can end up surrounded by a bubble of his or her own exhaled carbon dioxide. The result is oxygen starvation: at best, they will wake up with a splitting headache.

The crew dress as quickly as they can: no easy task when your limbs float out at odd angles. They wear disposable clothes, replacing them once every three days: there are no washing machines in space. Astronauts wash with wet towels, there is no shower on the International Space Station.

Then comes the day's first of three meals. Space food has vastly improved in taste and variety since the purely freeze-dried days of the Apollo missions. But space meals are prepared and eaten under the same basic restrictions: food and drink has to be somehow confined, or else it will wander off around the station. This is obviously messy and unhygienic; but if free-falling food gets into station equipment, it can also be dangerous. So drinks and soup are served in plastic bags and sipped with straws. But with a little care, astronauts can eat more solid dishes with a knife and fork - magnets keep the utensils from floating away from the dining table. Prolonged microgravity dulls taste buds, so spicy food is usually a crew favorite.

What the ESA has to say about ISS Continued

To minimize on resupply needs, the ISS life-support systems are designed to recycle as much as possible. Waste water from urine and moisture condensed from the air is either purified and reused direct, or broken down by electrolysis to provide fresh oxygen. Carbon dioxide 'scrubbers' chemically remove that toxic gas from the air.

One substance that is not recycled on ISS is solid human waste: it is collected, compressed and stored for disposal. Space toilets do not use water. Instead, astronauts must first fasten themselves to the toilet seat, which is equipped with spring-loaded restraining bars to ensure a good seal. A lever operates a powerful fan and a suction hole slides open: the air stream carries the waste neatly away.

A less stressful daily routine involves exercise. The human body loses muscle and bone in weightlessness; a few hours of daily exercise helps to keep some tone in muscles that would otherwise see little use. Exercise also helps relieve the so-called "space sniffles", caused when body fluids, no longer tugged downward by gravity, accumulate in the head

Generally, days in orbit are busy - and when heavy equipment has to be moved, they can be exhausting, too. Just because a crate of scientific gear is weightless doesn't mean that it has lost its mass. Astronauts have to pull and push against inertia, and they are often working in strange positions for which human muscles are not well adapted.

The crew will normally have some free time before bed. These hours are precious: this is when they might write emails home, watch DVDs, or transmit just for fun on ham radio.

Interviews with Astronauts

Use the below interview questions to help identify issues with hardware on the ISS, and

What tasks are inefficient, annoying, or do you wish would change on Station?

"We are required to fill out a food log once a week. It was difficult for me to remember what I had eaten throughout the week, so I made a spreadsheet and kept track of everything I ate as I ate. It would be nice to have an easier way to track food that was eaten.

Dust on the ISS is an issue. We have to regularly clean ventilation filters in the various modules and our crew quarters. It is time consuming and a messy job.

Having to go to an audio terminal unit to talk is inefficient. Hands free would be great.

It would be nice to have a good way to stretch (the body) in space.

When transferring water from a bag into the water system, air bubbles in the water stop the flow of water. The gas trap that we currently use is not very effective. A simple task like water transfer, takes a lot of time by the crew.

Things floating away and getting lost." *–Joe Acaba*

"I don't know that anything was ever really annoying to me. My perspective was that this was all part of the adventure, and that things were going to be different in space. But yes, some of it is inefficient in the way you do things. I think that comes more from the way procedures are written or the way the description of what you're supposed to do is communicated to you…

Additionally, cleaning is inefficient on Station. Dust, just like it does down here, collects on surfaces and in crevices. But when you want to vacuum in Space it doesn't want to leave the Surface. There's some attraction the dust has; it's like static but I don't think that's it. On ground and in Space people shed dead skin and then the skin becomes dust, but down here it just falls to the ground. On Station you want to be able to clean up dust because otherwise you're breathing in your crewmates on a fairly routine basis. So it would be nice if there were a way to efficiently clean surfaces. There are a lot of uneven services and you would want to do it in a way that doesn't generate a lot of waste. I remember that being a difficult problem for myself and other crews." *–Nicole Stott*

Interviews with Astronauts

What tasks are inefficient, annoying, or do you wish would change on Station?

"We've tried to be as efficient as possible but what's difficult is our stowage of hardware and our transfer of items. We've run out of space and we're stowing in areas that don't have designed racks or ways of stowing items. Instead we use bungees cords, we call them bungee jails. One of the things we've talked about is to look at bags that would stow things more efficiently, like near hatches. A way to hold items in place without bungees would be a good innovation because bungees are useful but you have to adjust them and they only hold so well as to the volume behind them. Meaning that things can float out from the bungees and float around within the space they're constrained. If you could make a large bag that fits near hatches, that has multiple openings and entry points and can stow other bags within in it that would be really useful.

Now the bad part about having things in one bag is being able to find them. So it's helpful to have dividers or Velcro to keep things in place or having multiple entries rather than having one big opening. So that'd be really useful." *–Dorothy "Dottie" Metcalf-Lindenburger*

What are some activities you perform daily when on Station?

"We do everyday operations, the same ones that you have to do at your house, like eating, taking care of your body, exercising, bathing and all of those things. One thing is with exercise is: astronauts have to keep track of all their shoes and exercise equipment and then have it dry out. They use clips, but if there was a handy way to stow all of your exercise equipment together that might make life easier." *–Dorothy "Dottie" Metcalf-Lindenburger*

"Well, it's pretty much like it is down here. On ISSLive! you can look at the astronauts' daily timeline and you'll see that every day there's standard things that are set up during the workday. Stuff like post-sleep activities and a daily planning conference. And then at the end of the workday you'll have pre-sleep and another daily planning conference and those kind of things.

There's also daily hygiene aspects to it, there's "how do I wake myself up" aspects to it, there's eating breakfast, and those kind of things. There's an independent review of the timeline to see what you're doing and your crewmates are doing that day, and then you talk with the ground to see how they envision the day turning out. And then there's how do I get ready for the day. And how do I get ready for bed timeframe. There's exercise every day and a mix of maintenance and research activities. And scattered in between there, usually in the pre-sleep timeline there's your free time. Time when you can look out the window, take pictures, check email or make videos for your family." *–Nicole Stott*

Interviews with Astronauts

What is well designed and needs little to no improvement on Station?

"I think bathroom operations has improved to as good as it's going to be. Eating has a few nuances but people have been doing it for a long time; it's pretty streamlined but there a way that that can be done better. EVA operations are pretty streamlined. We know how to get people in and out and maintain the equipment." *– Dorothy "Dottie" Metcalf-Lindenburger*

"The toilet is well designed. Work is currently being done to improve the water dispenser, the heating of food, and the kitchen' table. These do not need further improvement.

Sleeping bag is well designed." *–Joe Acaba*

What are some issues involving Space that you did not consider when on Earth?

"I think there's certain things you just can't train for: how your body's going to move around and how you're going to position yourself. But in the bigger picture there are just organizational skills. If you've gone and collected a bunch of tools in your Zip-Lock bag and you want to get a tool out it's going to be very difficult. You have got be very organized in how you do things. And as much as I had thought about organization with procedure reviews and mockups in the 1-g lab, until you're actually doing it, it's not real to you. I think every person develops his or her own methods for staying organized. It's not just important for your own work but if you lose that one Allen wrench that three other people have to use for their tasks, they're not going to be very happy. You have to be diligent about keeping track of tools in Space because it impacts the overall operation up there. That's all the way from the vitamins you have in a bag, it's simple stuff like that. Packaging for items in Space has evolved because of how it's going to behave in Space. I remember a crewmate of mine opening his bag of vitamins without even thinking about it opened the bag. All he wanted was just one pill, but because he wasn't thinking the whole bag of pills dispersed. And you're laughing at first, but as you laugh the entire bag is spreading out across the whole Station. It's those little reality checks that make you think it's a completely different environment that we work in. And keeping track of your stuff is a huge deal." *–Nicole Stott*

Interviews with Astronauts

What are some issues involving Space that you did not consider when on Earth?

"Contacts. You know, people had actually warned me but it's a little more cumbersome to take care of contacts, especially disposable ones. For short durations, like shuttle missions, we just used daily contacts. But on Station to deal with contacts you have to roll out a piece of tape, then you put them on there so that you can close them and throw them away. In the meantime you have to temporarily stow your other contacts so they don't float away. And then you don't want the contact solution getting released all over, so it's useful to have a washcloth nearby. It's kind of the same thing with any operations… hair ops, food ops. For food operations you didn't want to cut everything open that you wanted to eat. When I was making tortillas, it was like: I'm going to float the tortillas here. Then I've got to get the eggs, then what else do I want? Anything with trash took a little extra effort because the trash bag doesn't stay shut. And trash does not remain down in the bag. You've got to tape things up if it needs to stay in the bag. Duct tape became really handy in Space." *–Dorothy "Dottie" Metcalf-Lindenburger*

What was the most rewarding part of being in Space?

"I think there's the aspect, and it'll probably sound hokey, but there's the aspect of working as a team. And that the whole team thinks what we're all working on is important—that is really very rewarding. I think of the team in many different ways. There's your crew for sure. But there's also the team as a whole. It's the team that got you ready to fly; it's the team that you worked with on side-projects; the team that worked on things other than getting ready to fly in space; it's the team in mission control when you're taking off or landing or in orbit. It's everyone in Space and on the ground working together to get the job done.

Everyone working is excited and passionate and thinks that it's worthwhile. And the team isn't just us in the US. I mean, when I look at the *International* Space Station Program, the thing that makes it so unique and so valuable is that we have established relationships with our international partners that I don't think we would've developed through any other form on the ground. I really think the stuff we've done in Space on the Space Station has helped to bring countries together. Somebody's building something in Italy and someone's building something here and you work together to get it up to space and stick it together. And if it doesn't fit, you work collaboratively to figure out how to make it work. I think those relationships have had a positive effect on politics and things of that nature on the ground. I think that's a big part of the reward, and what I think is so valuable. I'll probably get shot for saying this, but if not even an ounce of science came out of the ISS, I think the relationships that have been forged are equally, if not more, valuable than the science aspect." *–Nicole Stott*

Interviews with Astronauts

What was the hardest part about being in Space?

"The hardest part of being in space is the process required to get there. Training is long and there is a lot of information we have to learn. Once you get there, the hardest part for me is the first couple of days as the body adjusts to being in space; not feeling physically great." *–Joe Acaba*

"Not much. I think they trained us pretty well. Keeping track of your items, because you have many more places to lose them. If you set something down and floated it into a place that you thought was stable it really isn't because of air currents. Just like if you drop something small is doesn't just go to the ground so you have more possibilities of where to find it. We helped each other out a lot on Station trying to find things. A small portion of each day was trying to find stray floating objects. Sometimes you find it in the weirdest places. One time we were looking for a CD in the middle of a module and we found it way tucked away in a random corner. How it got there, who knows? Must have been an air current." *–Dorothy "Dottie" Metcalf-Lindenburger*

"The hardest part about being in Space was being away from my family. All of the other things, keeping track of your stuff, how do you go to the bathroom, how to sleep, the best position to get to work a task—is doable stuff, it's just different. But the one thing that's just not going to happen is having your family up there." *–Nicole Stott*

Interviews with Astronauts

What are some recent innovations that have made life easier in Space?

"The iPad has been great in Space. It makes it so that you can take your procedures with you. Before they used green cards for emergency drills and it seemed more fake. But now they use software that's more interactive and more like in a real emergency and it's all just on the iPad. Just having the conveniences of Earth being able to be placed in space more easily is nice because the certification process can be so long that by the time a piece of technology is certified it can become obsolete. So for common items that we find useful on Earth, they probably have a useful purpose in Space but it's a lengthy process to get items certified. With the iPad you can have your procedures nearby and you can take a photo or video of an issue and get it to the ground, before you would need a camera and it would take much longer.

Exercise equipment is a good example of equipment that has improved. We had IRED which was the first resistive exercise device now we have ARED which is the advanced exercise device. The old TVIS treadmill worked, but now we have the advanced T2. We still have the same CEVIS cycle. But those are things that have improved." *–Dorothy "Dottie" Metcalf-Lindenburger*

"One of the things that's been done recently is an upgrade to the toolbox. We have toolboxes with drawers that pull out. The drawers have foam cutouts where the tools go and they're labeled. They just did a revamp of the labeling and foam design of the drawers, because they found that the way the drawers were initially made had issues. After a while the foam cutouts wore out and the tools would float out, or the way the labels were placed on the foam caused them to peel off eventually. So they did a total revamp of the overlay and the cutout for the toolbox. Here on the ground the toolbox is there and the tools just sit in it. And you're not going to have any problems unless you put the drawer in upside down. But over time in space stuff is just going to float out. That's a simple example of something that helps.

I think there has also been a better understanding of the systems of Station. We understand more about how the systems work and what the limits of their abilities are now after we've been operating with them for 11-12 years. Because of this there's a little more flexibility with the kinds of things you can take up with you now. Things like hair products, or how you can package materials and store them on orbit has been given more leeway.

Crew Quarters was a big deal for crewmembers on station. I think having that personal space for crewmembers was important and it's the perfect amount of personal space.

In terms of the overall station the Cupola. You can look at it from psychological standpoint and from an operational standpoint too. Psychologically its' huge, to be able to go from a flat window to a horizon-to-horizon view and look at Earth from that perspective it's a very spiritual, psychological thing for me. But then you can look at it operationally as a robotic workstation where you fly the arm from and actually have a 3-d visual, a crystal clear visual of what you're moving around. As compared to having a 2-d version and having 5 screens in front of you to see if you have clearance. Now you can just float up in the Cupola to see if there's clearance The Cupola has been huge psychologically and operationally." *–Nicole Stott*

Interviews with Astronauts

What are some medical and health concerns in Space?

"Bone/muscle loss, radiation exposure, intracranial pressure and papilledema are the major concerns. Something else to consider are concerns with the nutritional content of the food. There is so much emphasis for preservation and a long shelf life that the food ends up getting loaded with preservatives and sodium. And when you have to put that much of anything in food, it counteracts any nutritional benefit that you might get from with. When calories are the baseline measure for how well you are maintaining your body mass, you want them to be good calories not bad calories. There's a lot of room for improvement concerning food in Space." *–Nicole Stott*

"The immune system is suppressed when you're in space. Within 60 hours your immune system is not as robust as on Earth. For this reason there is a much higher awareness of the goods that are sent into Space. They must test materials for bacteria or viruses because they don't want any hazardous materials sent to space.

The reason we do all the exercise is for our bones. It's like getting osteoporosis when you go to Space.

Crewmembers have to do a lot of blood sampling, and urine sampling and things like that. Having all of that equipment together and easily usable would be a nice change. Right now sometimes people ship it in different bags and have different ways of shipping it. So if it was more uniform and things were shipped together that would be more useful. Human research has become more streamlined but it can still use a little work." *–Dorothy "Dottie" Metcalf-Lindenburger*

What issues do material properties have when in Space?

"A simple example is your clothing. On Earth, you fold stuff up in a drawer and it stays in place; but on orbit everything seems like it wants to billow and bulge out and you can't really keep anything in place. You also can't get anything perfectly back the way it was. You have to be much more careful with fluids. One time I thought I had shut a drink bag, but I had not closed it as tightly as I thought. So all of a sudden I've got this orange juice bubble and I don't want it to get onto any switches or make a big mess. That's something you don't' have to worry about on Earth because "my coffee stays in its cup".

The safety teams think about the flammability of items. You do have to consider the mixing of air. There was one time when we had 13 people taking a picture all in one confined space. All of us were breathing out CO_2 and we made this concentration of CO_2. Well, we all got really sleepy and we were all talking on a television show. But up there when we were on television we were just thinking "just stay awake" and end the presentation as soon as possible so that no one gets a CO_2 headache." *–Dorothy "Dottie" Metcalf-Lindenburger*

Interviews with Astronauts

What issues do material properties have when in Space?

"On the exterior there's exposure issues to radiation and atomic oxygen; all the kinds of things that are going to degrade things faster than what we see down here. But inside I don't think there's much difference working inside space station than down here, except that it's very restrictive on the types of materials you can use on station. There's everything from flammability concerns to off-gassing concerns. That comes down to two kinds aspects: safety and systems. For safety, you don't want anything spontaneously combusting or causing a bigger fire if something does catch on fire. But there's also the fact that our system that cleans the air can only handle removal of certain components out of the atmosphere. So even though I wanted to take up my Chanel Coco lotion, because I knew it would smell really nice, I couldn't. It can't clean alcohol out of the atmosphere so our payloads had to change and our medical equipment had to change because we couldn't use alcohol swabs anymore. So it's not that certain materials can't withstand the interior of space station, it's the limitations because of the systems and safety aspects that are there.

Having said that the internal components of electronics will experience different things due to the radiation, that's why the same computer that may cost $1000 on Earth, costs at least several thousand because it has to be enhanced to take to Space." *–Nicole Stott*

Do you have anything you would like to tell the High School students?

"The International Space Station is an amazing and complicated orbiting laboratory. It truly is an international endeavor and is an example of what can be accomplished when people and nations work together towards a common goal. In order for humanity to continue exploring space, we will need this cooperation to continue along with the imagination, intelligence and support of the next generation of explorers, scientists, engineers, etc. With programs like HUNCH, we hope that today's students find a way to connect with the work we are doing today in order to inspire them to do even greater things." *–Joe Acaba*

Interviews with Astronauts

Do you have a message for the High School Students?

"**Simpler is better when designing**. When you think about improving life whether that be in Space on Station or here on Earth I think you need to take the simpler is better approach. I think you can be very creative in that as well.

Hopefully, through this program, when the students are learning about what is going on with the ISS they can see the complexity of what's going on up there and how multiple countries have come together to do that and how it really is a masterpiece. I think it should inspire them that the opportunities are out there and if you can think creatively about this stuff and generate ideas and learn how to work as a team with other people to implement your ideas, you have big things to look forward to." *–Nicole Stott*

"I think it's really important to utilize their creativity. High School students look at this from a whole different perspective. They are learning about Space and that may give them ideas to put into the realm of what we are currently doing in Space. I think it's exciting that they are doing this and that they are a part of future space exploration. This is what we want: for high school students to be motivated to go into science, technology, engineering, and math. So to have this experience that they are helping to improve life on ISS is pretty cool!" *–Dorothy "Dottie" Metcalf-Lindenburger*

Helpful Resources

To learn more about the ISS, take a look at…

ISSLive! - Live data from the ISS:
http://spacestationlive.nasa.gov/

NASA ISS Page:
http://www.nasa.gov/mission_pages/station/main/index.html#.UdQk9NI3u84

ISS Module Info:
http://www.nasa.gov/mission_pages/station/structure/assembly_elements.html

European Space Agency (ESA) ISS page:
http://www.esa.int/Our_Activities/Human_Spaceflight/International_Space_Station

Japanese Aerospace Exploration Agency (JAXA) ISS page:
http://iss.jaxa.jp/en/

NASA ISS Multimedia Page:
http://www.nasa.gov/mission_pages/station/multimedia/index.html#.UdRE49I3u84

NASA's Youtube Channel (especially check out their A Day in the Life playlists):
http://www.youtube.com/user/NASAgovVideo?feature=watch

Astronaut Sunita Williams' ISS Tour:
http://www.nasa.gov/mission_pages/station/main/suni_iss_tour.html

Astronaut Nicole Stott's Article about Life on ISS:
http://www.dwell.com/interviews/article/life-space-email-iss

What Kind of World Do You Want?
http://www.youtube.com/watch?v=dmOmYNzIK5c

See an acronym you don't recognize? Check out NASA Acronyms:
http://spaceflight.nasa.gov/cgi-bin/acronyms.cgi

To learn about HUNCH, take a look at…

HUNCH homepage:
http://www.nasahunch.com/

HUNCH Youtube:
https://www.youtube.com/channel/UCgTIg2XXSnXFvMh1HrfikEA?feature=watch

To see some past HUNCH projects, watch…

Drosophila and Chlorella experiment:
https://www.youtube.com/watch?v=bidFs4C6drc

Cargo Bags:
https://www.youtube.com/watch?v=tC-RVoRK7Gk

Thank You!
And
Good Luck!

"HUNCH gave me the opportunity to learn from others, and to be able to meet new people, great people who share their passion for knowledge like I do. But most importantly I was able to find my calling in life. I decided to become an Aerospace Engineer, and in time I would like to be what I would call a hero, an astronaut."- **Julio, Conroe High School** (Pictured to the Left)

"In the time that I have been with HUNCH it has not only taught me how to overcome all of the strict quality control standards of NASA, but several other life skills. I think the biggest life skill that I have taken from this experience is problem solving, over the last four years I have learned to overcome almost any obstacle."- **Zach, Cypress Woods High School** (Pictured Above)

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