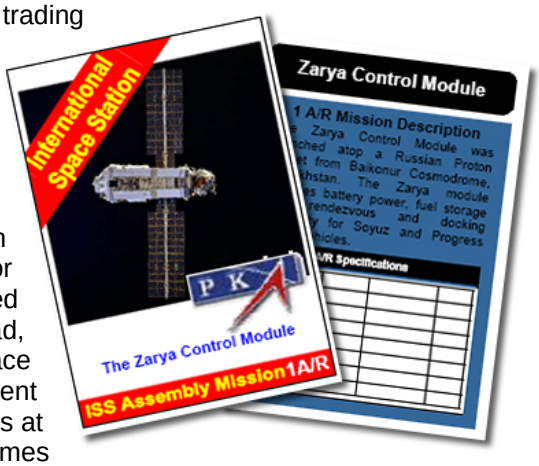
Principles of Engineering

Space Technology

MISSION – 1

Space Station - Specifications

Objective: Your mission is to research and design a series of trading cards used to describe space station specifications on the Salyut, Almaz, Skylab, Mir, and International Space Stations (ISS).



Briefing: Mankind's long-term exploration of space begins with a permanent manned space station in earth orbit. Space stations are manmade structures designed for people to live in space. To this point, space stations have been placed in low earth orbit (LEO). For the most part, space stations lack the equipment for propulsion. In fact, early stations could not maintain the speed necessary to stay in orbit. Space stations cannot land either. Instead, other spacecraft transport people and materials to and from the space station. Although the space station may be considered a permanent fixture in space, it is not intended for long term habitation. Most stays at a space station may last weeks, perhaps months, and sometimes years. Space stations are used to study the effects of long-term space flight on the human body as well as provide a platform for long term scientific studies in microgravity. Since the disaster aboard Soyuz 11 and the mechanical diffulties with the Salyut 1 and Salyut 2 attempts, all manned spaceflight duration records have been set aboard space stations. To date, the duration record is 438 days set by Valeriy Polyakov aboard Mir from 1994 to 1995. As of 2006, 3 astronauts have completed single missions of over a year… all aboard Mir. Following the reentry and crash of Mir in 2001, the International Space Station (ISS) is the only space station currently in orbit. The ISS has been continuously manned since October 30th, 2000.

Essentially, there are two types of space stations. Stations like Salyut and Skylab, were ready for habitation as soon as they hit orbit. They were designed to be expendable machines that would fall to earth once they became obsolete. The Russion Salyut 6 and 7, brought about a transistion in space station design. These space station components included docking ports, which allowed another space craft and crew to visit. This allowed for a fresh crew to continuously man the station. The second docking port also allowed supply vehicles to dock with the station, meaning that fresh supplies could be transported for long-duration missions. These inovations served as the proof-of-concept for the use of modular space station design.

The current type of space station design is launched as separate modules which are later assembled in space. Mir and the International Space Station are examples of this type of design. This method allows for greater flexibility in operation, as well as removing the need for a single powerful launch vehicle. This type of space station receives it's supplies through periodic transport missions which dramatically adds to a station's lifespan.

All space stations have various issues that limit long-term habitation. Very low oxygen recycling rates, high radiation levels, and the lack of gravity may not only cause discomfort, but long-term health effects as well. Solar flares, and the resulting cosmic radiation, endanger astronauts with radiation poisoning. All proff that space station life, by its very nature, is a dangerous adventure.

Research Resources:

Web Site	Description
http://heasarc.gsfc.nasa.gov/docs/heasarc/missions/skylab.html	NASA Skylab Project
http://liftoff.msfc.nasa.gov/rsa/mir.html	Mir Project
http://www.nasa.gov/mission_pages/station/expeditions/index.html	NASA ISS Webpage
http://spaceflight.nasa.gov/station/	NASA HSF International Space Station
http://www.geocities.com/i_s_s_alpha/iss_alpha.htm	Space Station History

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Nomenclature:

Salyut	Zarya	Z1 Truss	Canadarm 2	S0 Truss
Almaz	Unity	P6 Integrated Truss	Joint Airlock	S1 Truss
Skylab	Zwezda	Destiny	Pirs	P3/P4 Truss
Mir				

Questions:

1. What was the name of the first space station in orbit?
2. How did the Cosmonauts aboard Soyuz 11 die?
3. Why were the Salyut 1 and Salyut 2 missions unsuccessful?
4. Why did the U.S. Skylab space station's orbit decay earlier than expected?
5. What were the launch and re-entry dates for Mir? Why was Mir abandoned?
6. To this point, there have been two types of space station design. How are the two design concepts different?
7. What are the names of the countries contributing to the International Space Station?
8. Which ISS modules were constructed by the USA?
9. When is the ISS scheduled for completion?
10. How are the Soyuz and Progress spacecraft functions different?
11. Once complete… How many watts of power will be provided by the ISS solar arrays?
12. How many minutes is the length of one ISS orbit?
13. Thrusters are used to position the ISS or adjust its orbit. Where are the thrusters attached to?
14. What was the name of the first component of the ISS placed in orbit?
15. What is the current weight and dimensions of the ISS?

Required Materials:

Computer Workstation with Microsoft Word Installed
Color Printer
White Full-Sheet Label, Card Stock, or Heavy Paper
MS Word Trading Card Template

Procedure:

Research:

1. Use Microsoft Word to open the Trading Card template file.
2. You will be assigned 2 space stations or space station components from the Nomenclature list. Use the Research Resources listed above to collect the following information for the Mission Overview section of the Trading Card:
   - Sequence
   - Launch Vehicle
   - Launch Pad
   - Launch Date
   - Docking Date
   - Undocking Date
   - Landing/Re-entry
   - Crew List
   - Origin
   - Payload
   - Weight
   - Dimensions
3. Cut and paste the appropriate Mission Patch and Photographs into your trading cards.
4. Develop a paragraph detailing the mission objective for each space station or station component you have been assigned. Insert this paragraph in the appropriate section of the trading card.
5. Edit the remaining information on the card. Be sure the information is accurate and error free.
6. Print out and process your trading card design.

Detailed Procedures:

How to Insert Photos:

A. On your toolbar, enable the drawing toolbar by clicking *View, Toolbars* and then *Drawing*. The Drawing toolbar will then appear on the left or bottom of your screen, depending on the version of MS Word you are using.

B. To insert a photo, highlight and click where indicated.

C. On your toolbar, click *Insert*, select *Picture*, and click *From File*. Select your photo file and then click *Insert*.

D. To resize the photo, click on the image and then click and drag on the drag boxes located in the corners and on the center of each line framing the photo.

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E. To move the photo, click on the image and then click on one of the framing lines, your cursor will transform into a hand icon. Drag the photo to its new location and release.

F. When you have the photo the size and position you want, click on the photo, and then click the up arrow on your keyboard. A gray frame will appear around the image. On the drawing toolbar, click the Draw button, and then click *Order* or *Arrange* (depending on your version of MS Word). Click *Send to Back*. This will insert your photo behind the template.

How to Edit the Card:

Front

A. To change text background colors: double-click on the color, the Format Object window will appear. Select the *Colors and Lines* tab and under *Fill, Color*: select a color. Click *OK*.

B. For International Space Station: Click on the text, a WordArt box will appear. Type in the name and change the font, size and style if you wish, and then click *OK*.

C. The sample information is in a text boxes. Highlight and type over the samples to type in your information.

D. Open the any NASA website and then copy and paste the selected clip art into the text box you just created.

Back

A. Highlight and type over the sample text to enter your own text. You may also change font, font size and color, just as you would in any Word document.

B. To change background color: double-click on the color background, the Format Object window will appear. Select the *Colors and Lines* tab and under *Fill, Color*: select a color for the border. Click *OK*.

C. To replace any clipart, click and delete. Then, using the Text Box icon on your Drawing toolbar, create a new text box in that area.

D. Double-click inside the box. The Format Text Box window will appear. Under Fill, Color: select *No Fill*. Click *OK*.

How to Print the Card:

A. If you want to duplicate your card to make more, first click on the arrow icon in your Drawing toolbar, and then click in an area in the upper left corner of the page, making sure you are above and to the left of the crop marks there. Then pull down toward the lower right corner until the entire card is framed by the outline, and release. Next hold the Ctrl-Alt-Shift keys, a "+" will appear inside the grabber hand icon. While holding these keys, drag down past the next group of crop marks to duplicate the card and release, your completed card will appear. Repeat to get as many cards as you like.

B. Set your print quality to *Best*, and then print this document on White Full-Sheet Labels, Card Stock or Hard Paper. Cards will print four fronts and four backs to a page. Let cards dry thoroughly.

C. Carefully cut out the card fronts and backs.

D. Cut 2 1/2" x 3 1/2" pieces of card stock for each card you want to make.

E. If you're using White Full-sheet Labels, peel the backs and affix to the piece of card stock to complete your card. If you're using Premium Plus Photo Paper, affix to the card stock with spray adhesive, or a glue stick.

F. On your toolbar, click *File*, and then *Save as…,* to save your cards for future use.

Note: Always make a test print on plain paper before printing on specialty paper. These instructions are written for a front-loading inkjet or laser jet printer.

Conclusion:

During this exercise, you researched various space stations and space station engineering. You also designed a couple of trading cards used to describe space station specifications or the various components of the International Space Station. The Salyut, Almaz, Skylab, Mir, and ISS space stations span over 30 years of space engineering. Examining the history of space station design and engineering specifications provide broad knowledge of space station design and operation.

Principles of Engineering

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MISSION – 2

Space Station – ISS Simulation

Objective: Your mission is to research, design, and build a computer simulation of the International Space Station (ISS) as it orbits today. You'll use the simulation software to configure modules for launch and recruit astronauts to operate the station and conduct experiments.

Briefing: The International Space Station (ISS) is recognized as the greatest construction project ever attempted by the mankind. Using the Space Station Simulator ® software, you can create and manage the International Space Station and its crew. You'll construct the ISS using modules and components from NASA and its four exploration partners, RSA, ESA, JAXA and CSA. You'll also recruit astronauts to board the ISS. Your mission is to keep your astronauts happy and healthy, and your station in top shape.

Research Resources:

Web Site	Description
http://www.vision-play.com/products/game1/ISS_Manual.pdf	International Space Station Familiarization Manual
http://www.vision-play.com/products/game1/manual/index.html	Space Station Simulator User Manual
http://www.nasa.gov/mission_pages/station/expeditions/index.html	NASA ISS Webpage
http://spaceflight.nasa.gov/station/	NASA HSF International Space Station
http://spaceflight.nasa.gov/station/isstodate.html	Latest ISS Statistics

Simulation Assembly Sequence:

Seq.	Module	Seq.	Module	Seq.	Module
1.	Zwezda (Service Module)	7.	Joint Airlock (Quest)	13.	P6 Truss
2.	Zarya	8.	Pirs (RSA Docking or Docking and Stowage Module)		
3.	Unity (Node 1)	9.	S0 Truss		
4.	Z1 Truss	10.	S1 Truss		
5.	Destiny (US Lab)	11.	P1 Truss	2 Ea	Soyuz
6.	Canadarm 2 (Not Simulated)	12.	P3/P4 Truss		Progress

Questions:

1. What is an O_2 Candle (Oxygen Candle) and how does it work?
2. What are the functional differences between the ISS's O2 Candles, Elektron, and O2 Generators?
3. What does the Contaminant component do?
4. Why is it necessary to have a dehumidifier on board the ISS?
5. What does the Water Component do?
6. Which spacecraft deliver supplies to the ISS?
7. Which spacecraft deliver personnel to the ISS?
8. Ultimately… What single module limits the number of personnel that can be aboard the ISS at any time?
9. Why does the ISS require C02 Scrubbers and how do they work?
10. The assembly sequence listed above is incorrect, but necessary to run the simulation. What is the correct sequence?

Required Materials:

Computer Workstation
Space Station Simulator ® Software
Latest ISS Statistics Sheet
ISS Exploded View Sheet

Assignment:

Use the Latest ISS Statistics and the ISS Exploded View drawing to build a simulation of the current configuration of the International Space Station (ISS). Supply and manage the space station and crew to successfully operate the station and conduct an experiment.

Detailed Procedures:

A. Launch the software and complete the Tutorial. You will need a key disk to start a game.

B. Exit the Tutorial and Build New Station.

C. Add modules, crew, and components as necessary to match the Latest ISS Statistics.

D. Continually supply and manage the crew and space station equipment keeping them in top working order.

E. Conduct at least one experiment using the Plant Growth or Small Animal Facility component.

F. Once successfully completed… Save your game and demonstrate your simulation to your instructor.

G. Answer the Questions listed above. Once complete, show them to your instructor.

- Hints:
    - Use the links listed above to review the Space Station Simulator ® software instructions and ISS Familiarization Manual.
    - Launch the modules in the Assembly Sequence listed above.
    - Use the ISS Exploded View to help determine module placement, configuration, and cost distribution.
    - Most modules can only be launched on specific vehicles. You'll have to wait for that vehicle to be ready to launch modules in a certain order.
    - Be sure to click on the Info button to get technical information on modules and components.
    - Save different versions of the game so you can restore a game if a catastrophe occurs.
    - The maximum number of crew-members is determined by the number of docked Soyuz escape spacecraft.
    - You will not be able to configure the P6 Truss and solar array as the ISS is currently configured. You'll need to place it at the end of the P3/P4 Truss.

Conclusion:

Simulators can help us realize the impact of performing difficult or even dangerous tasks. The Space Station Simulator used in this mission has introduced the various modules, components, and configurations of the International Space Station. You've also learned about the crew qualifications necessary to operate and maintain an orbiting space platform, as well as, conduct micro-gravity experiments. Managing the operations of the ISS is daunting. Emerging technologies, launch schedules, supply needs, personalities, and just the bare essentials of providing breathable air, edible food, and potable water make the ISS project the most significant construction project in human history.