



Drexel-SDP GK-12 LESSON

- Lesson Title and Identifier:
Title: Modeling and Stress Test Activity: Space Station Solar Panel Truss
Identifier: 3.5
- Module: Astronomy
- Subject Area (Unit): Astronomy
- Concept: Vocabulary
Truss
Modeling
Stress
International Space Station
- Objectives:
In this activity, students will model and test a truss intended to support solar panels on the International Space Station.
- Keywords: Truss, Modeling, Stress, Space Station
- PA Academic Standards:
Science 3.1.7 Unifying Themes
3.2.7 Inquiry and Design
Math 2.3 Measurement and Estimation
2.9 Geometry
- Grade Level: 6th
- Setting/Group Size: 30 students
- Duration/Time Required: 1 class period
- Materials List (include safety equipment if applicable)
3 sheets newspaper
tape

- Methods and Procedure:

Background: This activity will be conducted after some discussion about the support structures for solar panels on the International Space Station, plus some discussion on issues of mass on forces of inertia in a weightless environment, and on the role of mechanical engineers and electrical engineers.

International Space Station (ISS): The ISS is a multi-national effort to construct a working research laboratory that orbits the earth. On it, astronauts will perform research (following the experimental process – just like students have learned) in a variety of areas. These areas include: *human biology*: the effects of the space environment on space travelers (e.g., muscle atrophy, bone loss, fluid shifts); *biotechnology*: a microgravity environment has enabled researchers to grow three-dimensional tissues that have characteristics similar to body tissues; *materials science*: in low gravity, differences in weight of liquids used to form materials do not interfere with the ability to mix these materials opening the door to a whole new world of composite materials; *combustion science*: the reduction of gravity allows scientists to simplify the study of complex combustion (burning) processes. Since combustion is used to produce 85 percent of Earth's energy, even small improvements in efficiency and reduction of soot production (a major source of pollution on earth) will have large economic and environmental benefits; *earth science*: Space scientists will use the location above the atmosphere to collect and search for cosmic rays, cosmic dust, anti-matter and "dark" matter. Earth scientists can obtain global profiles of aerosols, ozone, water vapor, and oxides in order to determine their role in climatological processes.

The role of support structures (trusses) for solar panels on the ISS: The ISS must support solar panels of considerable mass. Although the environment is virtually free from the effects of gravity, the structures having mass still resist the forces of motion. Therefore, trusses must be strong enough support solar panels during the forces of motion, but light enough so as not to contribute too much to the mass. The trusses on the ISS have open space to reduce the mass, and hexagonal prisms formed by the support bars to add strength.

Mechanical Engineering: Mechanical engineering involves the application of principles of physics for analysis, design, manufacturing, and maintenance of mechanical systems. It requires a solid understanding of key concepts including mechanics (action of forces), kinematics (motion without consideration of mass and force), thermodynamics (relations between heat and mechanical energy or work) and energy. Mechanical engineers use these principles and others in the design and analysis of automobiles, aircraft, heating & cooling systems, buildings and bridges, industrial equipment and machinery, and more.

Electrical Engineering: Electrical engineering involves the study and application of electricity, electronics and electromagnetism. There is some distinction between electrical engineers and electronics engineers: electrical engineers are usually concerned with using electricity to transmit energy, while electronics engineers are concerned with using electricity to transmit information. The entire field covers a range of sub-disciplines including those that deal with power, optoelectronics, digital

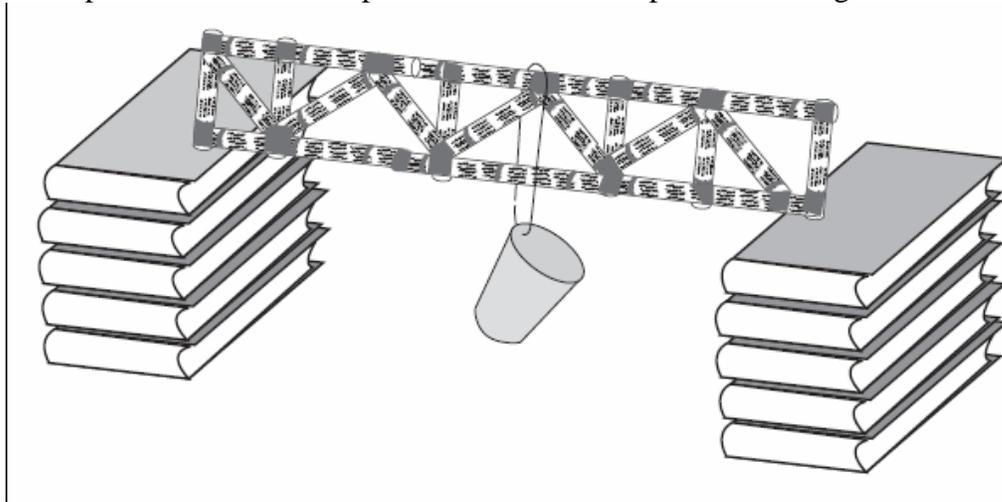
electronics, analog electronics, computer science, artificial intelligence, control systems, electronics, signal processing and telecommunications.

Procedure:

Step 1: Each team gets three sheets of newspaper and some tape.

Step 2: Each team gets 20 minutes to construct a lightweight but strong truss of **at least 1 meter in length**.

Step 3: The teams' trusses will be tested in competition to determine how many pennies can be suspended from the mid-point of the truss as depicted in the figure below.



Analysis:

Question 1: How many pennies will your truss support? What is the mass of one penny?

Calculate the mass of the number of pennies your truss supports.

Question 2: How can we improve the design? What materials could we use? Where are the weak points in your structure? What are the strong points?

Question 3: What would you do differently next time?

- Assessment

Students will be evaluated on a scale from 0 to 4 on:

_____ _____ _____
Task Completion Design meets specifications Participation in discussion

- References & Web Sites:

The reference source for this activity is the Kennedy Space Center Educator's Activity Guide for Grades 6-8: <http://www.kennedyspacecenter.com/PDF/KSCedGuide6-8.pdf>

- Authors: Connie Gomez, Dara Kusic, Donna Barreca, Pat Wilkes