Western Engineering Outreach

Moon Colony

Grade 6-8

Meet Today's ENG HERO!

Eric Johlin – Assistant Professor with Western Engineering

Dr. Johlin's group works on developing new devices, materials, and understanding of optoelectronics, particularly in relation to the creation of clean energy and photovoltaics. This work combines approaches of experiments, theory, and simulations. His work includes modeling things at the atomic scale all the way up to the macroscopic scales we are used to. To learn more about Dr. Johlin visit: https://www.eng.uwo.ca/chemical/faculty/ray_m/index.html

Learning Goal:

- Use the engineering design process to determine an appropriate solution for a problem
- Explain at least three ways that energy can be produced, along with their given strengths and weaknesses
- Recognize the complicated nature of trying to create artificial habitats, and how doing so can help us on Earth

Materials Needed:

- Computer
- Internet access
- Poster board or paper
- Construction paper
- Cardboard
- Popsicle sticks
- Recycled and cleaned pop bottles
- Pipe cleaners
- Tape

Engineering and Science Connections:

Can we ever live on the Moon? Well, to make such a project possible, engineers of all disciplines must work together to imagine, design, create and test advanced technologies and engineering solutions to enable us to live on the Moon. Learning how to sustain human life off Earth can help us solve big engineering problems here on Earth.

Humans first walked on the Earth's Moon on July 20, 1969. Now, more than 50 years later, engineers and scientists are continuing to develop the technology which would allow us to stay there for longer periods of time. As the International Space Station (ISS) has shown us, when we work together we can live in outer space for months at a time, making us a step closer to a Moon base and further human exploration of our nearest neighbor in the solar system.

How big is the Moon, compared to the Earth?

Probably the easiest comparison to make is between a tennis ball and a full-size basketball. A tennis ball is about one-quarter the size of a basketball in terms of their radii/diameters (5.5 cm vs. 23 cm). This is about the size difference between the Moon and the Earth (the radius of the Moon is about 27% of that of Earth's, 1738.1 km vs. 6378.1 km). The Moon is about 380,000 km away, the equivalent of about 60 Earths lined up end to end.

What would it feel like to stand on the Moon? Two main factors would make it feel very different than what you experience on Earth. First, since the Moon is much smaller than Earth, the force of gravity is much less. What does this mean for you? Well, if you weighed 100 lbs on Earth, you would weigh only one-sixth of that amount, or only 17 lbs, on the Moon. Take a moment to figure out exactly how much you would weigh there. This means that you need to be very careful when landing your rockets, because the exhaust from your rocket is strong enough to kick up lots of moon dust all over the place.

The second major reason that the Moon would feel quite strange to you is that it has no atmosphere. This has several consequences: no oxygen is present for you to breathe, no wind exists to blow your hair around, and the temperature ranges are far greater than on most of the Earth: from -173°C at night to 127 °C during the day, at the lunar equator. Without any atmosphere, there is no weather. And, it is sunny on the Moon for about two weeks at a time, resulting in a very intense heat because nothing exists to dim the light or move the energy away. A big consequence of not having an atmosphere is that you will need to shield not just your eyes from the sun, but also your entire body from the intense solar radiation.

A few other properties of the Moon also affect what you would experience there. For one thing, the Moon takes much longer than the Earth to spin on its axis. How long does it take the Earth to make one complete rotation? 24 hours.

So when we see the sunrise in the morning, we know it will be another 24 hours before it comes up again. How long would it be from one sunrise to the next on the Moon?
It takes 29½ earth days. On top of that, the Moon completely orbits the Earth over the course of those same 29½ days, so from the perspective of the Moon: one side always has the earth hanging in the sky and one side never sees the earth. So if we have a Moon base that is on the far side of the Moon,

In addition to longer days and nights, the Moon also has no liquid water, and not much water ice except for a small amount at the poles.

There are lots more problems that we will have to solve other than just what we've mentioned, but we will focus on one specific part of the problem today when we try to design our own Moon colony.

Engineers, Scientists, and Mathematicians made it possible for humans to take their first steps on the Moon, and it will be up to the next generation of each of those groups to design and build a way for us to live safely on the Moon for longer periods of time.

Activity:

Today we are each engineering firms responsible for designing a Moon colony and coming up with a solution to one of the most important parts of the colony: the power source. We will be using the engineering design process to plan our power source and then will finish by making a model of our designs. This activity can be done alone or in a group.

Step 1:

Recognize the Customer (5 min) - Who has hired you to design a Moon colony and create its power source? They are your customers. Briefly describe your customers, including the size of the group and where they currently live. Is it a company that wants to mine for materials? Is it the Canadian Space Agency looking to study the moon up close? What about a small group of private intrepid explorers who want to start a new life in space? After you know who will be living in the colony, you'll know better on how you design needs to work.

Start by using pencils to draw on your poster board or paper a sketch of the colony; draw it as if you are looking down on the colony from above. You have only five minutes for the sketch, so do not be overly detailed, just show what you think are the most important structures and where things will go.

Step 2:

Define the Problem (5 min) - In addition to the design of the Moon colony, you have been asked to create a power source for your colony inhabitants. An important aspect of engineering design is to define your design

requirements (rules that your product must follow). Engineers often define constraints such as how much "it" should cost, its size, and/or its weight limit.
Brainstorm five design requirements for a power generator (your power source). Here are two ideas to get you started:

- Materials must be able to be transported from the Earth to the Moon.
- Wind cannot be a source of energy since no atmosphere exists on the Moon.

Step 3:

Gather Information (15 min) - Before engineers start designing a new product, they conduct extensive background research. For your project, it is essential to learn about different energy sources. We already know of many ways to produce energy, so pick three of the ones from this list and research how effective they might be for our purpose:

- Biomass
- Coal
- Geothermal
- Hydropower
- natural gas
- petroleum
- Helium 3
- Solar
- Nuclear
- Wind

Real engineers often divide work among their teams too, so that they may save time and look at problems from more angles. If you are working with more than one person, now would be a good place to split the work between you and each of you could investigate a specific power source. Take 15-30 minutes to gather the following information about your energy source:

- Briefly describe how energy is generated. Include pictures and words to make the description clear to a potential customer for when you show it to them. Relate the energy source to your colony sketch, as appropriate (for example, if coal is one of the options you chose as a power source then perhaps show where the power plant will be and where you will store the fuel).
- Make lists of the "pros" and "cons" of this technology as it relates to the Moon. For example, a "pro" might be that it is relatively cheap, while a "con" might be that it weighs a lot and would be hard to move to the Moon or is consumable and needs to be sent regularly.

Step 4:

State of the Art Report (5 min) - One thing that engineers and researchers might make when they are going through the design process is something called a State of the Art Report (SOTA report), which is a summary of all their research on what is currently available with the technology they investigated, our SOTA Reports will summarize everything we learned about the various energy sources we looked into. One important part of SOTA Reports is that they should be as unbiased as possible, they only discuss the facts.

In our SOTA Report, we will include all the research that we did in Step 3 and we will compare them to explore how feasible they are for powering our Moon colony. Do we need to bring fuel? Can we make the fuel there from things the moon already has? Will the Moon dust get in the way of power generation?

Write your SOTA Report on either a piece of paper or poster board. Be sure to include any pictures you think would be useful for communicating your research.

Step 5:

Choose Design Options (5-10 min) - Using your list of design requirements and the information you have gathered, brainstorm ideas for which of the power sources might work on the Moon. There is no right or wrong answer, but your design must be able to work on the Moon, which does not have the same resources as the Earth. Here are some things to think about as you work on your design:

- What resources are available on the Moon that you can utilize?
- Will you have to ship materials regularly from Earth? If so, what?
- When you have chosen what to do, write a short proposal to the Canadian Space Agency that presents the design and explains why you think it will be a good design. Include some of the trade-offs that you considered. Explain why the positive features of your design outweigh the negative features.

Step 6:

Propose & Communicate Design (10 min) - Create a model of your colony using your craft supplies and what you've learned about how you will make power. For example, if your power source is solar, you could make a field of solar panels next to your base made out of squares of black paper glued onto pipe cleaners.

What Did You Learn?

- How did you gather your information?
- What was a problem that had to be designed for which you didn't expect?
- Why would we want to go to the Moon when we still have other problems to solve on Earth?

Future Learning

- Turn this research activity into a project! We've already found out how we will power our Moon colony but there are still a lot of other things we need to plan before we are ready to build it. A proper colony needs to be able to make at least some of its own food, but how could we grow food on the Moon? How are the Moon colonists going to go outside? Where are they going to sleep? What are they going to be able to do for fun? Using the method we followed in this activity, see if you can design an entire Moon colony! To finish, find a map of the moon online and figure out where your colony would go!

Share your creations!

We would love to see what you made. Email as at discover@uwo.ca or tag us on social media.

Instagram: @westernueng
Twitter: @westernueng
Facebook: @westernueng

Thanks for discovering with us!