Engineering Consultant Challenge

Theme: Science and Engineering in Society

Introduction

Youth become engineering consultants and work as a team to help their clients make materials decisions for an upcoming project.

Time needed:

- 40-45 minutes to DO the activity and discuss what you did

Do & Learn Goal:

- Youth will develop a plan to make intentional consumer choices that positively impact the environment.

Materials:

- Scenario Cards (see included cards)

Background Information

The decisions we make about the materials we use for everyday activities have a lasting impact on the world around us. Designers interested in **sustainability** use a technique called life cycle assessment to analyze the environmental impacts of products. **Life cycle assessment** takes into account all stages of a product's life including extracting raw materials, processing, manufacturing, distribution, use, repair, and disposal (often called "cradle to grave"). This broad focus allows designers to consider systematic environmental concerns such as energy use, the impact of extracting raw materials and related potential pollutants, and how the flow of materials affects the environment.

The life cycle assessment includes four main stages:

- Goal Definition: describe the product and the environmental considerations under review for the assessment.
- Life Cycle Inventory: identify and determine the amounts of energy, water, and raw materials used as well as any environmental emissions (air, waste, etc.) in the product life cycle.
- Life Cycle Impact: analyze the potential human and ecological effects of the energy, water, raw material usage and emissions.
- Interpretation: Evaluate the results of the Life Cycle Inventory and Life Cycle Impact analyses to select the preferred product

Choosing materials that are **biodegradable** (such as **bioplastics**) or from **renewable** sources have a different impact on sustainability than those made from **non-renewable** materials. In this activity, youth become engineering consultants and work as a team to help their clients make materials decisions for an upcoming project.

Do!

Questions:

Think about a time a friend asked your advice on a big purchase they were about to make. How did you help them decide? What kinds of questions did you ask? What information was helpful to know?

Procedure:

1. Tell the group that they will work in teams as engineering consultants.
2. Tell the group their team's task is to help their client choose a material for their project. They will need to weigh the pros and cons of a variety of criteria in their decision, including how to save energy and reduce waste, what products and related technologies are available in their community, the cost, and other specifics noted in the scenario description. They should also reflect on what is missing from the scenario description - what other questions do they have and what further research would they do to make the best recommendation?
3. Remind each team that they will present their solution, reasons, and suggestions for further research to the group. Invite groups to create a visual to help present their solution. You many also want to provide a variety of craft or other materials for teams to use to build possible solutions.
4. Split the group into teams of 3 -4 youth. You may want to suggest each team use defined group roles (see list at end of document for suggestions). Give each team one scenario card. Give teams time to analyze their scenario and prototype solutions.

Reflect

- Bring all teams back together to share with the whole group.
- Teams take turns presenting and sharing feedback.
    - First, share with the whole group what their task/challenge was.

- The presenting team, acting as engineering consultants, will share their solutions, reasons, and suggestions for further research.
- Everyone else, acting as the client, will ask questions and provide feedback about the presented solutions. - promoting the idea of consulting and teamwork.
- As a facilitator, make sure the group reflects on questions around material suitability for the task, costs, and environmental impact in their solutions.

Learn More

- Take action on one of the Engineering Consultant scenarios or a related community issue.
- Visit a local makerspace or school technology program to see what kinds of materials they use in fabricating designs. How many are from renewable and how many from non-renewable sources? If 3D printing is available, try designing an object(s) from plant-based or recycled plastics that would be useful in the home or community.

Tell someone why **you are a scientist** or **teach them a new word** you learned:

- **Sustainability**: able to be maintained at a certain rate or level
- **Renewable**: a material made from naturally occurring resources that can be replenished, often within one person's lifetime
- **Non-renewable:** a material made from resources that are only available in limited quantities and take a long time to be replenished (i.e. millions of years)
- **Polylactic acid (PLA):** material made from cornstarch which is a renewable resource and compostable. Used to make plant-based plastics
- **Biodegradable**: a substance or object capable of being decomposed by bacteria or other living organisms
- **Repurpose**: use of an item for a new purpose (e.g., using a yogurt container to hold crayons).
- **Life Cycle Assessment:** takes into account all stages of a product's life including extracting raw materials, processing, manufacturing, distribution, use, repair, and disposal (often called "cradle to grave") that allows designers to consider systematic environmental concerns in design decisions.

This activity is part of **Sustainable Polymers: Taking Action to Solve the Challenge of Plastics,** a 4-H STEM curriculum for grades 6-8. Please visit 4hpolymers.org to download the full curriculum.

School Playground

Situation: The Parent-Teacher Organization (PTO) of your local elementary school is looking to make their playground better. They are looking at lots of different kinds of materials to put on the ground under the swing, slides, and other equipment. Right now it's mostly covered with sand. Some parents are very excited about environmentally friendly options like recycled plastic chips or tires. Others are worried about the costs and think that sand or grass would be better. In the end, the PTO would like a something that is strong, non-toxic, affordable, and most of all provides a soft and safe surface for kids to play.

Your team has been chosen to help design and build part of the new playground outside your school. The PTO wants you to tell them what material would be best to cover the ground in the main play area.

Your Challenge:

Define the problem: What materials could be used to cover the playground ground? What are the environmental considerations?

Prototype solutions: Explore the pros and cons of different designs.

- What kinds of playground surfaces have you seen? What materials were used?
- How much do they cost to purchase and install?
- Where do the materials come from? What kinds of raw materials are involved?
- How can you make sustainable decisions? For example, how might you reduce waste or transportation costs?
- What products and related technologies are available in your community related to this?

Further research: What else would you like to know to be able to design the best solution for this challenge? What can you find out on your own? What would you ask the Parent-Teacher Organization? Others?

Your Proposal:

Considering the practical and environmental aspects of this situation, what does your team suggest is the best thing to do?

Group Field Trip Fundraiser

Situation: Your group has just been invited to go on an exciting field trip to an amusement park. But now you have to start raising money for travel and admission costs for everyone! Your group leaders and parent advisors have told you they will help you with a sales project. They have asked you to create an item that is environmentally friendly. It should also be something people and families in the community would want and be able to use. There is a local makerspace where your team could use 3D printers and other manufacturing tools to design and build these items. Your group brainstormed a bunch of ideas at their last meeting, (things like 3D printed cell phone cases, using venetian blinds as repurposed garden stakes, or birdhouses) that your group could consider or you could suggest new ideas.

What do you think your group should make and sell?

Your Challenge

Define the problem: What kind of item would sell well and be environmentally friendly?

Prototype solutions: Explore the pros and cons of a variety of designs.

- What materials will you use? How are they suited to the purpose of the item (for example, do they need to be water or drop resistant?) Where do the materials come from?
- How much time would it take to build the items?
- How much does each item cost to build and how much could you expect to sell them for?
- How can you make sustainable decisions? For example, how might you reduce waste or transportation costs?
- What products and related technologies are available in your community related to this?

Further research: What else would you like to know to be able to choose the best item? What can you find out on your own? What would you ask your group? Others?

Your Proposal:

Considering the practical and environmental aspects of this situation, what does your team suggest is the best thing to do?

Club Swag

The Situation

Your club is getting ready to participate in the annual summer festival parade. Everyone wants to get t-shirts so they can show their club spirit. You've created a beautiful graphic to go on the shirt; now you just need to decide what kind of shirts to get. Since your club just did a project about protecting the environment, some members suggested getting shirts made from recycled materials. Your club treasurer reminds everyone that building the float for the parade already used a huge chunk of your budget and the group should be careful about spending too much on shirts, too.

What kind of shirts do you order?

Your Challenge

Define the problem: What kind of shirt material would you need? In what conditions (weather, work, etc.) do you anticipate the group would wear their shirts? What are the environmental considerations?

Prototype solutions: Explore the pros and cons of a variety of designs.

- What materials will you use? Where do they come from? How much do they cost?
- How can you make sustainable decisions? For example, how might you reduce waste or transportation costs?
- What products and related technologies are available in your community related to this? Could you contact a local graphic design business and get information"

Further research: What else would you like to know to be able to choose the best material for your shirts? What can you find out on your own? What would you ask your club? Others?

Your Proposal:

Considering the practical and environmental aspects of this situation, what does your team suggest is the best thing to do?

Let the Dogs Out

The Situation

Your local animal shelter wants to build an exercise pen for their dogs. They have space outside of their building, but will need a way to fence in the area so the dogs can play safely. One of the animal shelter board members is very excited about this project, suggesting a lot of top-of-the-line fencing choices and even a roof! However, it's been a tough year for donations so the shelter is working with a small budget. They do have other resources. One supporter has recently donated a big load of wooden pallets. Others have volunteered to help with construction when the project gets to the building stage.

The animal shelter owners have heard that your team has had great ideas finding solutions to design problems like theirs and ask for your advice. How do you think they should build their pen?

Your Challenge

Define the problem: What does the animal shelter need? What resources do they have? What materials could be used to build a dog pen? What are the environmental considerations?

Prototype solutions: Explore the pros and cons of a variety of designs.

- What materials will you use? Where do they come from? How much do they cost?
- How can you make sustainable decisions? For example, how might you reduce waste or transportation costs?
- What products and related technologies are available in your community related to this?

Further research: What else would you like to know to be able to design the best solution for this challenge? What can you find out on your own? What would you ask the animal shelter staff? Others?

Your Proposal:

Considering the practical and environmental aspects of this situation, what does your team suggest is the best thing to do?

Example of Team Roles:

Student teams often function most effectively when members have designated roles. These can be instructor-determined or established by the groups themselves, e.g., by giving teams a list such as the one below and asking them to decide on and delegate appropriate roles within their group.

The roles you – or your students – assign will depend on the goals of the assignment, the size of the team, etc. They can be fixed or rotating. Here are some possible group roles, but the list is not exhaustive. Think creatively and come up with your own!

Facilitator: Moderates team discussion, keeps the group on task, and distributes work.

Recorder: Takes notes summarizing team discussions and decisions, and keeps all necessary records.

Reporter: Serves as group spokesperson to the class or instructor, summarizing the group's activities and/or conclusions.

Timekeeper: Keeps the group aware of time constraints and deadlines and makes sure meetings start on time.

Devil's Advocate: Raises counter-arguments and (constructive) objections, introduces alternative explanations and solutions.

Harmonizer: Strives to create a harmonious and positive team atmosphere and reach consensus (while allowing a full expression of ideas.)

Prioritizer: Makes sure group focuses on most important issues and does not get caught up in details.

Explorer: Seeks to uncover new potential in situations and people (fellow team members but also clients) and explore new areas of inquiry.

Innovator: Encourages imagination and contributes new and alternative perspectives and ideas.

Checker: Checks to make sure all group members understand the concepts and the group's conclusions.

Runner: Gets needed materials and is the liaison between groups and between their group and the instructor.

Wildcard: Assumes the role of any missing member and fills in wherever needed.