TURNING IDEAS INTO REALITY:
ENGINEERING A BETTER WORLD
Facilitator Guide

Filtration

Prior to Facilitating Activity
● Carefully read the facilitator guide and PowerPoint presentation. Skim the full activity description
● Check kit to ensure all of materials needed for the activity are included (see material list taped to lid of kit). If not, please see Beth Hart in KL261 or call 937-229-5080.
● Contact teacher to:
   o Confirm the time and location where you will be facilitating this activity.
   o Confirm the length of time you will have to facilitate the activity.
   o Make sure you have completed all necessary training and/or background checks with the teacher(s).
   o Confirm any sign in policies, dress code requirements, etc.
   o Provide the teacher with your phone number, so she/he can reach you if needed.
   o Confirm technology available in the classroom. Many activities include YouTube videos; therefore, confirm that the school's network will not block them.
● Check the kit's memory stick for the activity's PowerPoint presentation by opening it on your personal computer.
● School technology is not always reliable, so take your personal computer for back up if needed.
● Divide materials into prepared sets for each team.

Day of Design Challenge Activity
● Arrive at school at least 15 minutes prior to your time scheduled to facilitate the activity.
● Connect projector and download PowerPoint from memory stick.
● Check that all technology is working (speakers, projection, etc.).
● Set-up as needed for the activity.
● Facilitate activity as indicated below.
● After activity, please cleanup, give the teacher feedback form to the teacher and ask him/her to fill it out (request it be completed before you leave), fill out facilitator feedback form.

- Return kit, pre/post-activity student surveys, teacher feedback, and all other forms to Beth Hart at KL261 (please note: pre and post-surveys may need to be eliminated if there is very short for facilitating the activity).

Facilitator Tips
- Always keep in mind that your first priority is to have fun with the children!
- Introduce yourself to the students (remind them you are normal!):
  o Name
  o Major
  o Where you are from
  o What you like to do for fun or a club or activity you are in at school
- As you go through the PowerPoint, be sure to engage the students in discussion by asking lots of questions rather than just presenting information.
- Make sure students know what materials they have to construct their design, any time constraints and how the design will be tested (this information should be in PowerPoint)
- Resist the temptation to let the students skip the individual and team brainstorming steps. They will most likely want to jump right in to building the design; do not let them. It is important that they experience brainstorming and designing, as they are crucial engineering elements. Before allowing teams to work with materials, require them have you approve their sketch of the team's prototype design idea.
- As the students are building their prototypes, walk around the room and ask them probing questions about their design. For example:
  o What are your reasons for selecting that material?
  o How did you combine your individual design ideas?
  o Why did you choose that design?
  o How did you create the idea for this design?
  o Suppose a company decided to use your team's prototype as a model for an actual product they plan to produce. How effective do you think it would it be in solving someone's problem?
- Encourage teams to "test" components of their prototypes as they build them.
- Point out aspects of their design that impress you.
- Whether the design works or not, ask what modifications could be made in order to improve its effectiveness.
- Be sure students understand that failure is normal in engineering, which is why engineers use readily available, cost-effective materials when initially designing and testing a prototype idea. True failure occurs only when the designer is not persistent in brainstorming ways to improve their design.
- Ask students:

- o   What do you like best about your design?
- o   What do you like least about your design?
- o   What aspects of other team designs stood out to you, and/or gave you ideas for improving your own team's design?
- o   What modifications would you make if we had time to complete the design challenge again?
- ● Do not allow students to criticize each other and try to get the "shy" or quiet students involved. This can be achieved by explaining that crazy/unachievable ideas frequently lead team members to think more creatively, which results in a better final design.

Activity Timeframe and Overview *(50 minutes)*

Activity	Time	Overview
Introduction	*2 minutes*	Introduce Yourself Provide Brief Activity Overview to Foster Excitement
Pre-Assessment	*3 minutes*	Administer Kit's Pre-Activity Survey
Design Challenge Introduction	*10 minutes*	Begin PowerPoint Presentation: ● Guide Discussion and Show Video (2m32s) ● Present the Engineering Design Challenge ● Explain the Engineering Design Process
Individual Brainstorm	*2 minutes*	Team Members Individually: ● Write Solution Ideas on Post-It Notes
Prototype Design and Construction	*15 minutes*	Teams Collaboratively: ● Discuss Individual Ideas ● Choose and Sketch Final Idea for Approval ● Gather Materials and Construct Team Prototype
Testing	*10 minutes*	Perform and Observe Prototype Testing
Conclusion	*5 minutes*	Relate to Engineering; They Did What Engineers Do Connect to Types of Engineering
Post-Assessment	*3 minutes*	Administer Kit's Post-Activity Survey

Set-Up
- ● Designate space for displaying and gathering available materials.
- ● Designate space for each team to collaborate and build their design ideas. Also, make sure all students will be able to see the presentation.
- ● Designate space for design testing. Make sure there is room for all students to observe.
- ● Optional: Distribute materials to each group.

Team Size
2-3 students per team

Design Challenge Scenario
In Africa, two out of five people do not have clean water. Because so much of Africa's water is contaminated, many people struggle to stay healthy, go to school/work, grow food, and build houses. The villagers do not have a lot of money or materials available to them, so it is a challenge for them find a low-cost, simple way to clean their water. Your team knows that a source for clean water would help solve these problems and improve the lives of thousands of people. So you decide to plan a trip to an African village and help.

Engineering Design Challenge
Before leaving for Africa, your team's challenge is to design, build, and test a filtration system that could be used for removing harmful pollutants/contaminants from water. It is important to conserve clean water, so beads and marbles will symbolize contaminated water while testing your designs.

Step-by-Step Facilitator Instructions
Note: The activity's PowerPoint presentation guides instruction and visually presents information to students. Therefore, the instructions include corresponding slide numbers.

1. Slide 1: As the pre-activity survey is distributed to students, introduce yourself and provide enough of an activity overview to gain students excitement.
2. Allow time for students to individually complete their pre-activity survey.
3. Divide group into teams of 2 or 3 students each.
4. Slides 2 and 3: Discuss engineering and what engineers do.
5. Present the engineering design problem and challenge, following the presentation:
   ● Slide 4: Show "Engineering Safer Drinking Water in Africa" video (2m32s).
   ● Slide 5: Present the real-world engineering design problem (scenario).
   ● Slide 6: Introduce the Engineering Design Challenge.
   ● Slide 7: Discuss Engineering Design Goals.
   ● Slide 8: Introduce resources (materials) available to each team.
   ● Slide 9: Explain prototype-testing procedures.
6. Slide 10: Introduce the Engineering Design Process. Explain that engineers use it as a tool to help them more effectively solve problems.
7. Slide 11: Explain how teams will use the engineering design process as they complete the challenge:
   Imagine *(10 min.)*
      ● INDIVIDUALLY: observe available materials, and brainstorm and write design ideas *(5 min.)*

- TEAM: share individual ideas *(5 min.)*

Plan *(5 min.)*
- Choose and sketch a team design plan

Create *(10 min.)*
- Gather materials
- Construct your team design plan

Improve and Test *(10 min.)*
- Teams decide on and make any last minute improvements before testing
- Each team tests their prototype while other teams observe.

8. <u>Slide 12:</u> Facilitate a whole group reflection on final prototype design and testing results by asking questions such as the following.
   - What do you like best about your design?
   - What do you like least about your design?
   - What aspects of other team designs stood out to you, and/or gave you ideas for improving your own team's design?
   - What modifications would you make if we had time to complete the design challenge again?
   - How does having the ability to filter contaminants from polluted water benefit an environment's biotic factors (living things), including humans?
   - Why is it important to protect Earth's water?

9. <u>Slide 13:</u> Conclude by discussing the following questions as post-activity surveys are distributed.
   - What ideas do you have for engineering a better world?
   - How can you turn ideas into reality?

10. Allow time for students to complete their post-activity survey.

Prototype Building - Notes
The goal is to design a filtration system that will filter out the beads from the marbles. The filter can be placed on top of the cup so that the beads collect inside the cup, while the marbles remain above the filter (assuming the marbles are larger than the beads). Thus, the design needs to be placed inside the lip of the cup. The filter should be built using toothpicks, rubber bands, string, and cardstock. Filters may be integrated into the cup (the design doesn't need to have a removable filter).

Prototype Testing - Notes
A mixture of marbles and beads are poured onto the filter.
- A successful design will:
  o Allow only beads to collect in the cup.
  o Filter (block) all marbles from entering the cup.

Follow-up / Reflection - Notes

Use this time to ask the students what they liked best about their design and what they would change about their designs. You can also relate the specific activity to a type of engineering. Ask the students if they have any ideas as to what type of engineer might design this item. If you have done something similar through co-op or a class project, share your experiences (in simple terms) with the students. Celebrate everyone's design by having the class applaud for that team after that team shares their design. Thank the students and teacher for their time, collect any post-tests or forms.

Background Information / Additional Resources

Technical Brief

"With **3.575 million people** dying each year from water-related disease, our **current water crisis** is one of epic proportions. At any given time, half of the world's hospital beds are occupied by those suffering from illness brought on by limited access to **safe drinking water**, poor hygiene and sanitation. Granted these harrowing realities plaguing our society, it's imperative that designers, inventors, engineers and visionaries do what they can to find a solution." (Paul, R. 2013. 6 water purifying devices for clean drinking water in the developing world. from http://inhabitat.com/6-water-purifying-devices-for-clean-drinking-water-in-the-developing-world)