Wizards of Wright

Lesson: Engineering Design Process, Building a Rescue Litter

There are several EDP lessons that present different activities, although the lesson is very similar. If students have had other EDP presentations through the WOW! program, certain sections can be shortened to a review. Please check with the teacher before beginning.

Use WOW! Lesson Intro to begin.

Background Info for Wizards:	Biomedical engineers design solutions for medical and health-related challenges. Students will practice being biomedical engineers as they design and build small-sized rescue litter prototypes. Students will also practice using the engineering design process – following the cycle, and designing within constraints.
Materials:	Each group needs: 1 WOW! potato 1 sandwich baggie 1 pencil (provided by students) Litter Design Worksheet/Packet, one per student For the store: paper towels popsicle sticks straws aluminum foil, 12" x 12" square (30 cm x 30 cm) sponges, cut into lengthwise thin sections pipe cleaners toothpicks To share with the entire class: triple beam balance digital scale 1 WOW! potato that no group has used in the design process
Lesson Time: 60-75 minutes	Introduction: 5-7 minutes (Teachers should have already done a lesson on the process, or shown our Intro video so you should be able to skip this part, or review it very quickly.) Guided Lesson: 5-7 minutes (Focus on directions for the Student Packet.) Introduction of Mission: 5-10 minutes Student Activity #1 (Planning and Building Prototype): 35 minutes Student Activity #2 (Test and Evaluate): 10-15 minutes

	Conclusion: 5 minutes
Learning Targets:	Students will be able to explain the purpose of a rescue litter. Students will be able to describe that the purpose of a rescue litter's stability. Students will apply the engineering design process to create a solution with specific requirements and constraints.
Introduction for Students: 5-7 minutes If you are worried about time, do not show the pictures of different Engineers, other life cycles, and how things have changed over time. Although, educational, these are not necessary for understanding or experiencing the Engineering Design Process. The information should still be discussed, but the extra discussion, and sharing of the pictures can be taken out.	If students have already had a WOW! EDP presentation this section can be shortened to a review. ***Ask students*** what they already know/remember about what Engineers do. ***Ask students*** if they can remember why we compared the Engineering Design Process to other kinds of Life Cycles they have learned about. Engineers are people who design, build, or maintain equipment, engines, machines, buildings, roads, bridges, parks and so much more. They work in many different fields, and are the people we depend on to know how and why things work. *(examples available)* **Ask**: Have you ever crossed a bridge, made a telephone call or flown somewhere in a plane? If so, you've experienced the work of engineers. You could be the person to design the newest and coolest skateboard or bicycle; or the highest roller coaster; or the latest and greatest video game. That's just some of what engineers can do! They put their scientific knowledge and design skills to use in many ways. Engineers work in many different fields, or disciplines. There are many kinds of Engineers because an Engineer who designs a building might not be good at designing a roller coaster, an Engineer that works on airplanes or rockets, probably wouldn't be good at designing food safety products and systems. It's just like sports or school - some kids might be good at playing soccer but are not good at basketball. Some kids are good at art, while others are good at music. **Ask** students what they already know about the Engineering Design Process. **Ask** students if they've learned about other processes or cycles. What did they learn when studying the lifecycle of a butterfly, frog, or a chicken? They should be able to tell you that the cycle repeats. Talk about the fact that one step leads into another. *(examples available)*

	Tell students that we're going to talk about the process that Engineers use.
Guided Lesson: 5-7 minutes	If students have already had a WOW! EDP presentation this section can be shortened to a review. ***Ask students*** if they remember discussing some examples of products that have changed (improved) over time, and what were some of them? Show the poster of the Engineering Design Process and ***ask students*** if they can explain the individual steps – what happens during each step, and why is each one important. Because engineers are always trying to improve things, items that we use all of the time have changed over the years. *(examples available)* An Engineers' first idea very rarely solves the whole problem. Normally, they end up brainstorming and trying several different ideas, making some mistakes, learning from them, fixing them, and trying again. All of these steps put together are called the Engineering Design Process. *(The teacher should have taught this already.)* **<u>Briefly</u> go over the steps of the EDP. Explain to the students that as they complete their mission, they will follow these steps.** 1. <u>Define the Problem</u> – This is when we ask what the problem is, what the requirements are, and what the constraints or rules are. - *a requirement is something that we need or is necessary* - *a constraint is a limitation* 2. <u>Plan Solutions</u> – <u>Brainstorming</u>! Think about how you can solve the problem. Write down several ideas…never stop at the first one. Draw a picture of what your solution might look like – it can always change later. Think about the materials that you will use. 3. <u>Make a Model</u> – <u>Build</u>! You may discover that your original plan needs to change, or that materials don't work the way you had planned. It's okay to adjust as you go. 4. <u>Test and Evaluate the Model</u> – As you're testing, pay attention to what works and what doesn't and why. Remember failures are important parts of the Process. Use it as an opportunity to make your design better. 5. <u>Reflect and Redesign</u> – Sometimes this step begins happening during testing. Make sure you are writing redesign ideas down, possibly even drawing them out.

	6. Share the Solution – By some, this is considered to be the most important part in the EDP. Every scientific discovery or success of engineering would be a waste if it weren't shared with the world, as well as stories of its failures along the way. *Students should share their designs with the class and what they learned from any failures.* Explain to the students that they will have a packet to fill out as they work. Each step must be completed before moving on to the next one. There are places along the way where they should check in with the teacher or Wizard, so we can make sure all steps are being completed.
Introduction of Mission: 5-10 minutes	**Give students all of this information**: Think about what it would be like to be in charge of rescuing an injured person. Rescuers can't always easily pick up an injured person and carry him or her. People are different shapes and sizes and adults are heavy, especially when they are unable to help support their own weight. Rescuing someone from a large open field wouldn't be too bad. But what if rescuing someone meant carrying them over steep and rocky trails? This would require several people to help, sometimes as many as six or eight. Sometimes rescues are made on water, and rescuers cannot safely land a helicopter near the injured person. When an injured person is rescued, it is very important to especially protect the head, neck, and back. If they bounce or roll the person during the evacuation, it might worsen any injury. To keep the victim safe, rescuers use a rescue litter. Think of it as a stretcher – it's flat, stiff, and easy for several people to carry at once. Think about how to safely carry an injured person. You can't throw them over your shoulder, or carry them on your back, this may injure them even more. Litters must be very light, because the rescuers may need to carry it all the way from the road to the injured person and then back again, or lower and lift it with a helicopter. Remember, the litter gets heavier with the person on board. The best litters are easy to take apart, and easy to put together. Often, multiple rescuers each carry a piece of the litter while they are headed to the victim and then put it together when they reach the accident site. This allows them to save

	their strength for when they are carrying the litter and the victim to the ambulance. With life and death injuries, every minute counts. What did we say earlier about constraints? Engineers design based on the constraints of a particular problem. There are specific constraints you need to keep in mind when designing your litter. (Lead a short group discussion and put these on the board: lightweight, stable, portable, easy to assemble, strong).
Student Activity #1: Planning and Building Prototype: 35 minutes	Make sure students are sitting in the groups the teacher has chosen for this activity. (groups of 4 are ideal) *Explain the activity to students.* The goal of this activity is for your engineering team to design a device that could be used to rescue an injured person. Given the supplies available, and the constraints set, your team will follow the Engineering Design Process and build and test a rescue litter. We'll make the prototype devices smaller than full size, using something much smaller for our litter, and for our injured victim. Engineers start this way as a way to save money and then if your litter does not work or breaks during testing, a real person won't be injured Show students the available materials, noting that each comes with a "cost" (for example, toothpicks $1 each, popsicle sticks and straws $2 each, sponges and foil $3 each, etc.). Tell students that the cost of materials is considered a *constraint*. 1. Pass out packets. 2. Students may begin working. 3. Check in with groups to make sure they are following the process. After a drawing has been approved by the teacher, teams can receive their materials. In addition, each team gets a WOW! potato and a sandwich bag to construct the litter. The WOW! potato is the model "victim." The sandwich bag is the "rescue backpack." **Important constraint!** The team needs to be able to take the litter apart, put it into the "rescue backpack", and put it back together again after moving through the testing station. They cannot build it and keep it "already put together" in the bag.

	As you give teams time to design and build their prototypes, remember there must be time for testing too. Ideally, there would be time to rebuild and retest, but that won't happen. Hopefully there's time to ask each team what they would do for a redesign if they could. 4. The Wizard or the teacher will need to be in charge of materials. As the students are working Locate an area for a testing station. Set up two chairs or desk, one representing the location of an injured person [a WOW! potato] in the backcountry, the other representing the location of the ambulance. (It doesn't have to be an easy/straight path.)
Student Activity #2: Test and Evaluate: 10-15 minutes	When it's time to Test… 1. Inform the engineering teams that during testing, their litters will be compared with other litters on the following criteria: - mass of litter - cost of litter - time of rescue - litter stability 2. Introduce the testing procedure. - At the start of a timed test, teams **begin** at the ambulance (chair/desk #1). - **Walk** with the litter in the rescue bag to the victim (chair/desk #2). - **Assemble** the litter. - **Secure** the victim to your litter. - Work together to **transport** the litter and injured person back to the ambulance (chair/desk #1). 3. Carrying the litter is **not** a 1 man/woman job. There must be at least two students carrying the device and victim. The more students involved, the better. To increase the challenge - they should only use the tips of their fingers. *Optional:* Tell groups that the litter-assembler will be randomly chosen by you at testing time; this prompts the groups to be prepared with each group member fully understanding the design and being able to assemble the litter quickly. 4. Begin testing. For testing, use the WOW! potato that was set aside. We want this to be one used when building their prototype. This is because the potatoes, like

	people, come in all shapes and sizes. The best design works for a wide range of users. Each group starts at the "ambulance" location with the rescue backpack. When timing starts, the team must walk to the victim, assemble the litter, pick up the victim, and transport it to the other chair. If the victim falls off of the rescue litter, mark the test as UNSTABLE in the "Stability" column of the worksheet. 5. After testing, have each group weigh their litter to find its mass. *(I've included a digital scale and a triple beam balance. Chances are very good that students will not know how to use the balance. I include it because it's a great opportunity to show students how to use another scientific tool. However, I recognize that there probably isn't time. In that case, feel free to use the digital scale. If there is time to demonstrate it, or use it, please do so.)* 6. As each group returns to its desks, have students fill out the table entries for the litter mass, cost, time to rescue and stability on the worksheet (Step 4). 7. After each group has tested, lead a class discussion about the data and results, and redesign ideas.
Conclusion: 5 minutes	Review the steps of the Engineering Design Process, why each one is important, and why one has to be done before the other. Do teams have an opinion on which is the most important step of the process?

activity adapted from and information credited to: https://www.teachengineering.org/activities/view/cub_human_lesson06_activity3; https://stemactivitiesforkids.com/2016/02/22/the-engineering-design-process/