

# NECESSITY CARDS

## INTRODUCTION

This is a brainstorming activity to illustrate how engineers formulate specific problems and design solutions for them. The activity is designed to emphasize student critical thinking and diagrams. You could make this activity shorter or longer depending upon how detailed you ask for student responses to be. Depending upon how experienced your students are, you can give this with more or fewer scaffolds. If they are not at all used to this kind of problem-solving you could talk through one together, and then give group assignments.

## STANDARDS

### NGSS 3-5 ETS1-1

Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

### NGSS 3-5 ETS1-2

Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

### NGSS MS ETS1-1

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

### NGSS MS ETS1-2

Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

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*In both elementary and middle school, students need to be able to generate and evaluate designs based on criteria. This activity is an opportunity to focus on these skills. Engineers often have to work in teams to develop a design or product, so the productive talk in the group is valuable. Depending upon the particular challenge a student group gets, and how their conversation goes, they may examine the Crosscutting Concepts of Structure and Function and Cause and Effect. They will certainly gain experience using the Science and Engineering Practices of Defining Problems, Designing Solutions and Engaging in Argument from Evidence.*

NAME:

DATE:

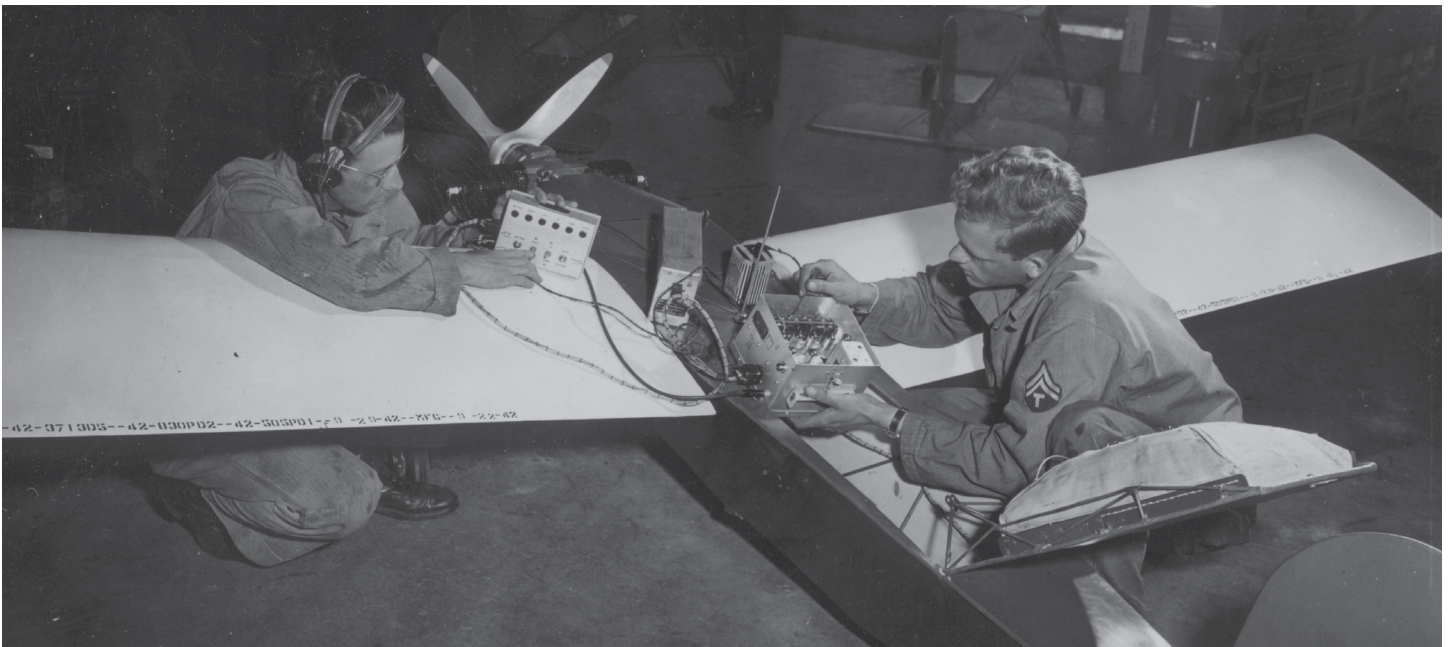
## NECESSITY CARDS

It doesn't take just smarts and creativity to make an invention work. It also takes necessity.

Unless there is a really strong need for change, a new idea won't be adopted. A new idea needs people to invest time and money, and so there has to be some sort of problem that forces them to make the change.

World War II was a time when there was a lot of need for change. The United States had to get ready really fast to make a lot of stuff, to prepare its people, and to send many of them around the world. The country had to do all that without some of the resources its citizenry were used to having because those resources were now under the control of the enemy.

Your team will get a card with a problem and a need for a solution. These all represent challenges the United States faced in World War II. Your assignment is to develop a detailed plan using what you know to create a solution to the problem.



Soldiers making adjustments to a radio transmitter and receiver on a radio-controlled target plane.  
(*The National WWII Museum, 2011.065.1176*)

### Make a plan

- + Making a list of what you know about the ideas in the problem.
- + Brainstorm a list of ways to solve the problem.
- + Evaluate that list for the ways that are best, easiest, cheapest etc.
- + Pick one of the solutions to develop.

Work with your teacher and your peers to figure out the details about how your invention will be developed and presented. Your results will certainly involve diagrams and some written explanation.

### REMOTE CONTROL

Sometimes air missions were very dangerous, and risking a crew was not a good idea.

It would be great if there were a way to send aircraft on missions and control them from the ground with no crew on board.

### PORTABLE RATIONS

There was an abundance of rations for soldiers in the field, but they took up space and were heavy and needed heating up.

It would be great if there was a packaged food that could be eaten without heating and that had ample energy and vitamins and nutrients.

### ALTERNATIVE FUEL

Fuel, which was in short supply, was necessary to use gasoline for tanks, planes, cars, and generators. Rationing helped, but areas of conflict prevented exploration and development of new oil wells.

It would be great to have a way to make fuel from alternate resources that were readily available.

### STOPPING INFECTIONS

All through history more soldiers died of infections than anything else. Infections are caused by bacteria that reproduce exponentially and make people sick.

It would be great to stop infections somehow, either by removing bacteria, killing bacteria, or treating wounds differently.

### PORTABLE POWER

There were often power outages on bases that depended on generators or in cities occupied by troops.

It would be great to have lights, radios, and other equipment that had a way for their users to generate electricity.

### PORTABLE PENS

Pilots had to make notes on maps, but the pens they used were fountain pens that spilled ink and got clogged and smeared.

It would be great to have an easier way to record information in the field and write on maps.

### TREATING TRAUMA

When someone gets injured badly, he or she often loses a lot of blood. This loss of blood has serious effects on the body—causing a condition called shock. Blood transfusions can be used to treat shock, but it is hard to get enough blood, to preserve it, to make sure it's the right type, and to get it to wounded soldiers.

It would be great to have a way to treat trauma from shock by either giving more fluid to the body, by finding a way to treat symptoms of shock, or by preserving blood more effectively.

### HIGH ALTITUDE FLIGHT

Planes are vulnerable to being shot down when they fly at low altitude. But flying at high altitude is difficult because the air is thin. At high altitude, the air pressure is so low that fight crews get very cold and have trouble getting enough oxygen. They can bundle up and use oxygen tanks, but that limits how long they can stay up in the air.

It would be great to have a way to fly at high altitude and have planes with higher air pressure.

### MALARIA

Mosquitoes were prevalent and were biting troops, especially in the Pacific Theater. Many of these mosquitoes carried malaria. Malaria is a disease caused by single-celled parasites. The drugs used for malaria were not that effective and caused many side effects.

It would be great to have a way to prevent mosquito bites, get rid of mosquitos, or cure malaria.

### INSULATING CIRCUITS

Almost all the equipment in World War II used electrical circuits. Airplanes, tanks, ships, trucks, radios, radar—all depended on electrical circuits. Those circuits used wires that needed to be insulated. Insulation of wires needs a material that doesn't carry electricity and that can be easily and cheaply wrapped around a wire.

It would be great to have a material that could insulate wire and that could be produced with existing material.

### AMPHIBIOUS VEHICLES

Though our ships, trucks, and tanks were numerous, it was a demanding job to go from one to the other. Also, getting trucks, tanks, and soldiers from transport boats to shore was difficult. It was also especially hard to move people and material around on the islands in the Pacific where conditions were wet and rainy.

It would be great to have vehicles that could move from water to land more easily.

### PARACHUTE FABRIC

Parachutes were made of silk. Silk was light and strong and performed well in this function. But silk comes from caterpillar cocoons and is slow to make and is expensive. Also, silk also came from parts of Asia that the Japanese came to control.

It would be great to have a fabric that would be strong and light like silk but was easier and cheaper to make.