Save the Day

Program Type: Classroom Program	***Audience Type:*** Grades 3–8

Description: Students play a card game to generate ideas for creative designs that will help different people and animals in various disaster scenarios.

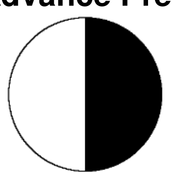
LEARNING OBJECTIVES

For Next Generation Science Standards alignment, see end of outline.

- Students will design an object for a specific person or animal in a disaster scenario.
- Students will work together to solve a problem using the engineering design process.

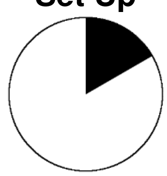
TIME REQUIRED

Advance Prep



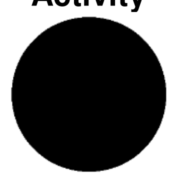
30 minutes

Set Up



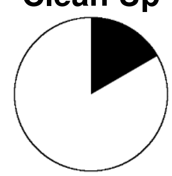
10 minutes

Activity



60 minutes

Clean Up



10 minutes

SITE REQUIREMENTS

- Tables or floor space able to accommodate groups of 3–5 students

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PROGRAM FORMAT

Segment	Format	Time
Introduction	Large group discussion	10 min
Save the Day	Group activity	40 min
Wrap-Up	Large group discussion	10 min

SUPPLIES

Permanent Supplies	Amount	Notes
Design Challenge cards	1 set	Included in the appendix; see Note 1
Design Challenge sheet	1/group	Included in the appendix
Scrap paper	2–3/person	
Pencils/markers	1/person	
Building supplies	1 set/group	See “Suggested Supplies” below

Suggested Supplies
For simplicity, students can use just paper and markers for this activity. However, there is a greater opportunity for creativity and engineering when building supplies are provided. If you choose the hands-on building option, have a selection of supplies with 4–8 of each building material assembled in a container for each group. The items below are suggested building materials, but you may use any similar items.

- Rubber bands
- Wooden craft sticks
- Tongue depressors
- Straws
- Cardboard
- Cardstock or cereal boxes
- Craft foam sheets
- Paper clips
- Binder clips
- Brads
- Pipe cleaners
- String
- Sticky tack
- Bamboo skewers

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ADVANCE PREPARATION

- Print and cut out the Design Challenge cards. (color and double sided)
- Print the Design Challenge sheet for each group (laminate if desired)
- Assemble the building supply kits for each group *(Optional)*
- Print or display the engineering design process diagram (see *background information*)

SET UP

- Set up space for partners or groups of 3–5 students to sit together
- Separate the Design Challenge cards into categories
- Place one Design Challenge sheet at each table
- Distribute supplies to each group (either just markers and paper, or the building kits along with markers and paper)

INTRODUCTION

10 minutes

Let students speculate before offering answers to any questions. The answers given are provided primarily for the instructor's benefit.

Suggested script is shaded. Important points or questions are in **bold**. Possible answers are shown in *italics*.

Today we're going to use our imaginations and creativity to design inventions for people in need.

How do people come up with inventions?
They need a new object to help them in some way. (Many examples may be given here.)

Inventions almost always begin with a problem. Engineers often design inventions to solve problems. Margaret Knight was an inventor in the early 1900s. After many friends at her workplace got hurt, she designed and built safety systems for factory machines. It took her many trials to come up with the equipment that worked just right!

The engineering design process is a cycle. Engineers make a plan of how to solve a problem. They make and test models of their inventions. Then they reflect on what they should change to make their invention better.

Show diagram in *background information*, or draw it on the board.

Starting now, you are all engineers! Soon we will be creating inventions of our own. These inventions will be used in some extraordinary situations to keep people and animals safe, comfortable, and happy.

To get our engineering creativity rolling, we'll play a card game that will give us ideas about the situations and people that our designs will help. But first, let's go through each step of the engineering design process and imagine what we will be doing as engineers.

Defining the problem: The card game will give us the problem to solve.
Plan solutions: You will work as a team to brainstorm ideas for a design that will solve this problem. We may draw pictures to show our ideas.
Make a model: We will build/draw our invention based on our plan. We may change it as we build.
Test the model: We will try our model and see if it works, keeping in mind who will use the invention.

Reflect and redesign: We will do some research, talk as a team, and make a new plan about how to make our original design better. You may be given a constraint—a restriction on your design.

Now we will use the card game to help define the problem that each group will face. When you receive your engineering challenge, be sure to follow the engineering design process and work together to create an invention. These are our "situation" cards—the extraordinary events for which we will design. Some are serious and some are silly.

Show the cards and read a few. Highlight one you think students will be interested in and will spark ideas.

What are some problems we might encounter in this situation?
(*Safety risks, technology not working, systems collapse, people being scared, etc.)*

Here are our "object" cards. These are the things we will be designing. The categories are vague, so they can include many things.

Show cards and read a few. Highlight one you think students will be interested in and will spark ideas.

What are some things that fit in this category?
Encourage and ask leading questions until you get a broad range of answers. Example: "Something to clean yourself with" might yield responses of "soap," "shower," "car wash," "scrub brush," "shampoo," "toothbrush," and "hand sanitizer."

Finally, these are our "user" cards. Engineers know that not everyone can use an object in exactly the same way because different people and animals have different needs.

Show cards and read a few. Highlight one you think students will be interested in and that fits well with the previous two cards.

Now we are going to combine all three cards! What sort of [object] could you invent for a [user] to use in a [situation]? Turn and talk with the person next to you to come up with a few ideas.

Remember to use your imagination and maybe even your sense of humor!

Let students talk for 1–2 minutes and then ask them to share some ideas. When the class appears to understand the activity, divide them into partners or teams of 3–5, introduce them to the materials, and then begin the activity.

GROUP ACTIVITY

Save the Day

40 minutes

The goal of the activity is for teams of students to design an object to suit a specific user in a disaster and then revise that design when a constraint is introduced.

Basic Gameplay

Ask each group to pull two cards from each of the “Object,” “User,” and “Disaster” categories. The group then discusses amongst themselves and chooses one of each card that they think will be a good combination. Once they have come to an agreement, they will place their chosen combination on the color-coded Design Challenge sheet and leave it where all other group members can see it. Students then return their three unused cards.

Planning (5–7 minutes)

Each group begins with several minutes of discussion and sketching. Here are some questions to pose:

- **What objects fit in this category?** (Example: “Something to wear” might yield responses of “*shirt,” “pants,” “coat,” “swimsuit,” “costume,” “armor,” and “uniform.”)*
- **What problems will come up in this disaster?** (Example: “Drought” might yield responses of “*limited water,” “heat,” “dust,” “food can’t grow,” and “habitat loss.”)*
- **What do we know about this user?** (Example: “Elephant” might yield responses of “*large,” “heavy,” and “they use their trunk for grabbing items.”)*
- **How will this disaster affect this user?** *(Example: “limited water for the elephant to drink” and “change in habitat may lead to disorientation.”)*
- **Will this user need any special adaptations to use this object?** (Example: “*babies can’t read,” “wheelchair users can’t use stairs,” and “pets don’t have thumbs.”)*

Creating/Testing (10–15 minutes)

Let groups begin to design a model by either drawing it or building it with the building supplies. Using building materials is recommended; the concrete task promotes creativity and detailed thinking, and it is easier for the entire group to participate. If the group members are not building, ask them to create a detailed drawing with labels that may include the materials used and the function of these materials.

Questions to pose:

- **What does this part do?**
- **How does this [object] help the [user] in the [disaster]?**
- **How does the [user] hold/wear/use your invention?**

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Improvement (5–10 minutes)
As each group reaches the “mostly done” stage, choose a constraint card that would be an appropriate challenge for each group and place it on their Design Challenge sheet. Look for constraint cards that would prompt new ideas for each group based on their current design. For example, giving the “portable” constraint to a group with a design too large to move. Then give students an additional 5–10 minutes to improve their design to suit the constraint.

Sharing and Discussion (10 minutes)
Gather all groups with their finished projects and have them share in a circle and explain their designs. If there is limited time, or if the group is large, pair up groups and have them present to one another.

What is your invention and what problem did you solve?

Is this model close to your original plan for the design? What did you change?

Which part of the engineering design process was the most challenging? Why?

If you went through the Engineering Design Process cycle again, how would you improve your design?

<u>Variations on Basic Gameplay</u>

1. All students create designs for the same object, user, and disaster.
2. All students create different objects for the same user and disaster.
3. Speed up the pace: Impose short time limits for each stage of play, draw instead of build, and do several rounds of designs.
4. Groups choose challenge cards for one another.
5. Use the blank card templates to create cards that are personalized and specific to the interests of your class.
6. Have groups evaluate their own designs or the design of another group. (Example categories: *Safety, Ease of Use, Reliability, Comfort, Effectiveness, Uniqueness, etc.).*

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10 minutes

CLEAN UP

- Have student disassemble their creations or choose who brings it home.

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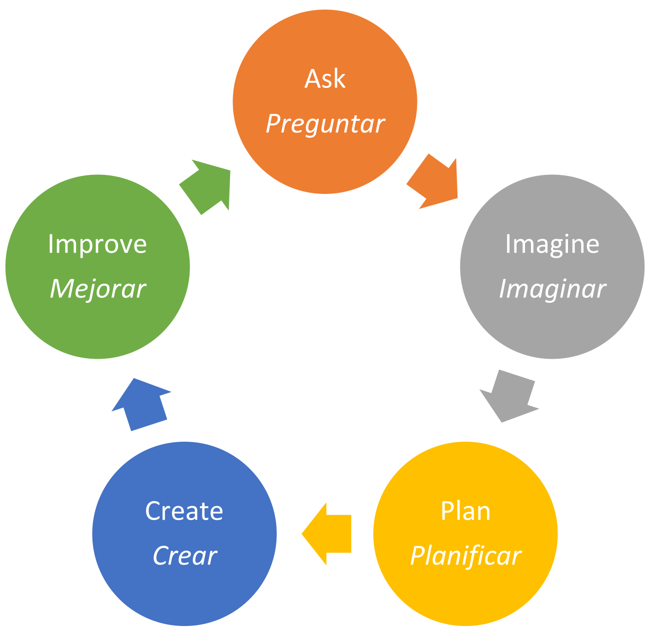
BACKGROUND INFORMATION

Engineering Design Process
Proceso de diseño de ingeniería



Engineering design cycle adapted by the *Head Start in Engineering* team, with permission from the *Engineering is Elementary* project, Museum of Science, Boston.

Ask—Ask questions to understand the problem and what you need to solve it.
Pregunta*—Haz preguntas para entender el problema y qué necesitas para resolverlo.*

Imagine—Brainstorm as many possible solutions and designs as you can.
Imagina*—Piensa en la mayor cantidad de soluciones y diseños que puedas.*

Plan—Pick a design and decide how you will use your materials.
Planifica*—Escoge un diseño y decide cómo usarás los materiales*

Create—Build and test your design to see how well it solves the problem.
Crea*—Construye y pon a prueba tu diseño para ver qué tan bien soluciona el problema.*

Improve—Make changes to your design based on what you learned.
Mejora*—Cambia tu diseño en base a lo que aprendiste.*

The **engineering design process** is a cycle that engineers follow to create and test solutions to a problem. We also use this process to solve problems every day, like figuring out a food recipe or building a bookshelf. Talking about the engineering design process with students and using the steps when you work on problems is a great way to get learners interested in engineering and help them develop problem-solving skills.

NEXT GENERATION SCIENCE STANDARDS

	Practices
✓	Asking questions and defining problems
	Developing and using models
	Planning and carrying out investigations
	Analyzing and interpreting data
	Using mathematics and computational thinking
✓	Constructing explanations and designing solutions
	Engaging in argument from evidence
✓	Obtaining, evaluating, and communicating information

	Crosscutting Concepts
	Patterns
✓	Cause and effect
	Scale, proportion, and quantity
	Systems and system models
	Energy and matter
✓	Structure and function
	Stability and change

	Disciplinary Core Idea	3	4	5	MS
	Physical Science				
PS1	Matter and Its Interaction	n/a	n/a		
PS2	Motion and Stability: Forces and Interactions		n/a		
PS3	Energy	n/a			
PS4	Waves and Their Applications in Technologies for Information Transfer	n/a		n/a	
	Life Science				
LS1	From molecules to organisms: Structures and processes				
LS2	Ecosystems: Interactions, Energy, and Dynamics		n/a		
LS3	Heredity: Inheritance and Variation of Traits		n/a	n/a	
LS4	Biological Evolution: Unity and Diversity		n/a	n/a	
	Earth & Space Science				
ESS1	Earth's Place in the Universe	n/a			
ESS2	Earth's Systems				
ESS3	Earth and Human Activity	✓	✓		
	Engineering, Technology, and Applications of Science				
ETS1	Engineering Design	✓	✓	✓	✓

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DCI Grade Band Endpoints

3-5 ETS1.A: Defining and Delimiting Engineering Problems

- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (By the end of Grade 5)

3-5 ETS1.B: Developing Possible Solutions

- Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (By the end of Grade 5)
- At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (By the end of Grade 5)
- Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (By the end of Grade 5)

3-5 ETS1.C: Optimizing the Design Solution

- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (By the end of Grade 5)

MS ETS1.A: Defining and Delimiting Engineering Problems

- The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (By the end of Grade 8)

MS ETS1.B: Developing Possible Solutions

- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (By the end of Grade 8)
- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (By the end of Grade 8)
- Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (By the end of Grade 8)
- Models of all kinds are important for testing solutions. (By the end of Grade 8)

MS ETS1.C: Optimizing the Design Solution

- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (By the end of Grade 8)
- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (By the end of Grade 8)

3-5 ESS3.B: Natural Hazards

- A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions, severe weather, floods, coastal erosion). Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (By the end of grade 5)

Performance Expectations

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.
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.
3-5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
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.
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
3-ESS3-1	Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.
4-ESS3-2	Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

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<u>Save The Day</u>
Appendix

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Design

For

Design Challenge

To use in

One More thing...

Intentionally Left Blank

A Gift

A Drink Carrier

A Form of Protection

Something to Clean

Something to Carry Things In

A Communi-cation Device

Shoes

Something to Wear

A Source of Light

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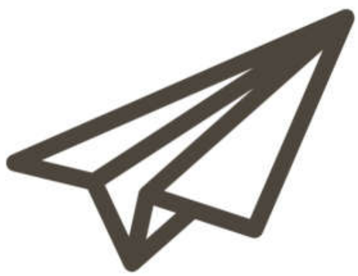
A Disguise

A Music Player

A Heat Source

A Place to Sleep



A Form of Transport

First Aid

A Time Keeper

A Cooking Utensil

Something to Sit On

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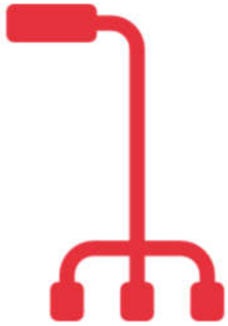


Elderly

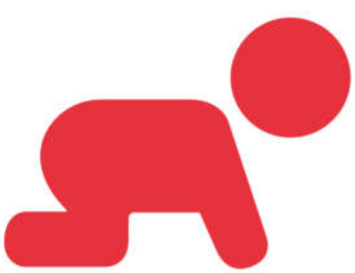
Family

Child

Doctor

Police

Pets



Baby

You

Adult

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User

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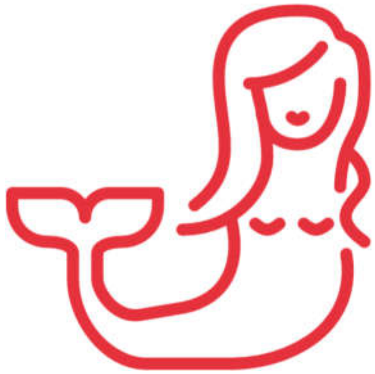
Teacher

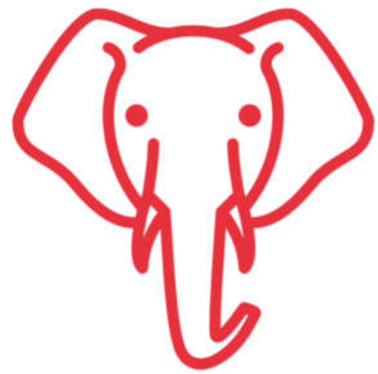


Mermaid

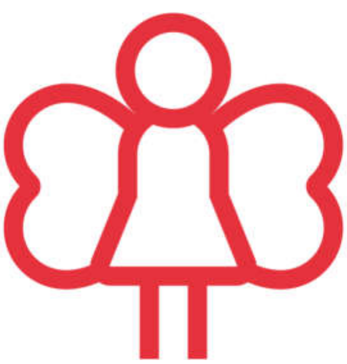
You and A Friend

President

Wheelchair User



Elephant



Fairy

Your Class

Scientist

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Earthquake

Flood

Asteroid

Drought

Blackout

Tornado

Fire

Tsunami

Epidemic

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Disaster

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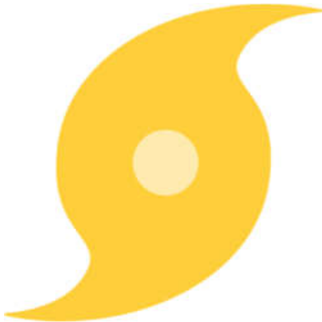
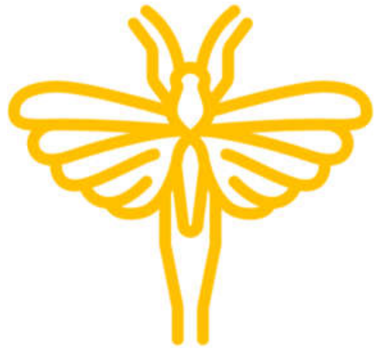
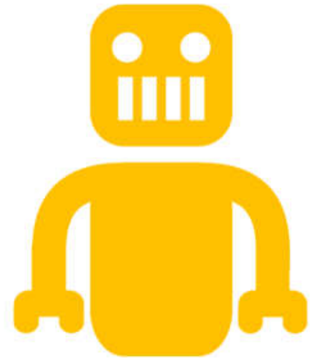
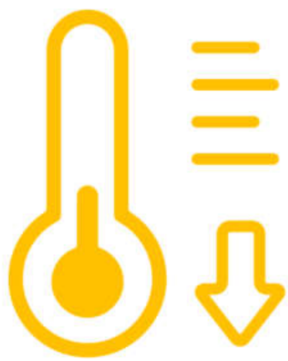


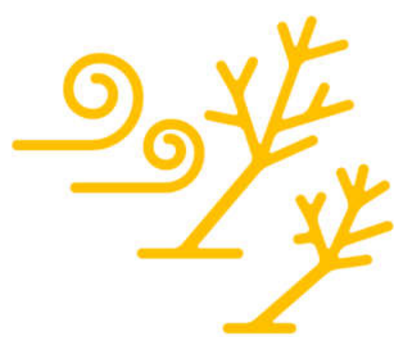




Hurricane **Plague** **Robots**



Zombies **Frozen** **Aliens**



Volcano ______ **Windstorm**

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Disaster

Second User

Second Location

Tiny Budget

Earth-Friendly

Portable

Automatic

Reusable

Does Two Things

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Constraint

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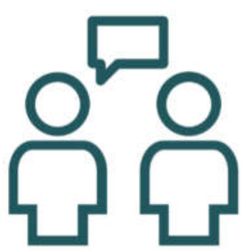

Constraint

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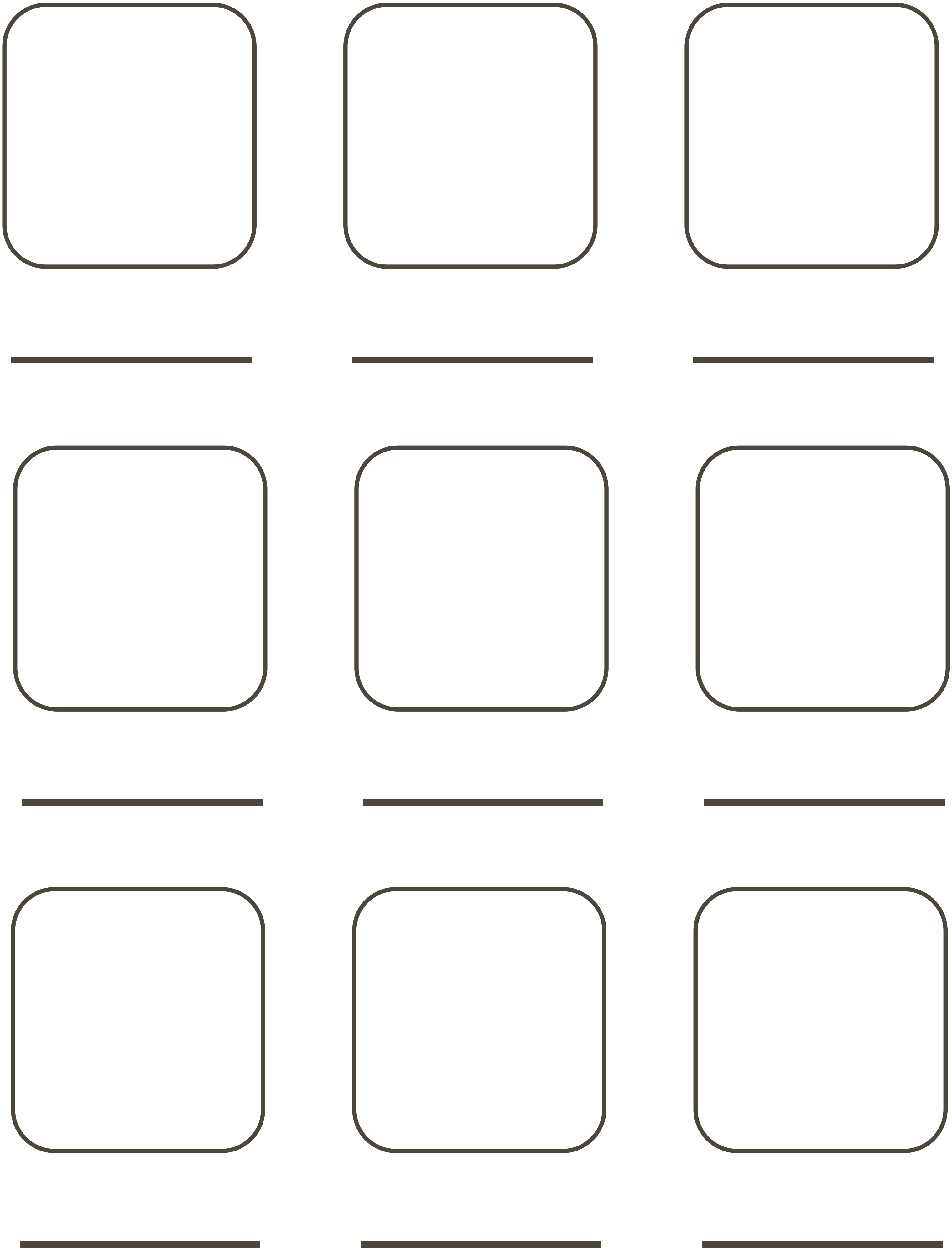

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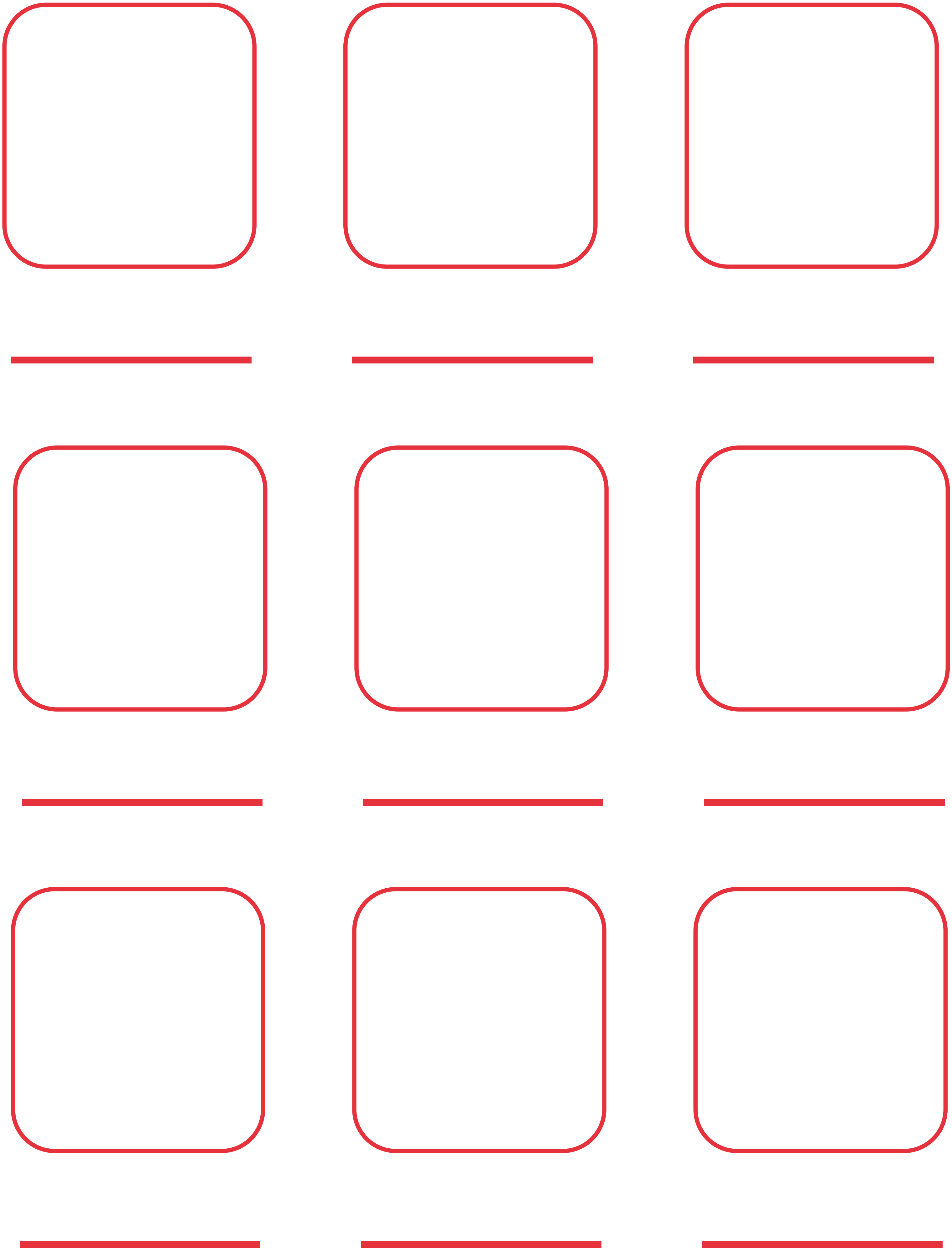

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FACILITATION GUIDE

Save the Day

Description: Students play a card game to generate ideas for creative designs that will help different people and animals in various disaster scenarios.

Promoting collaboration and organization

- Encourage collaboration through communication with teammates and other groups.
- Suggest that students use drawings with labels or physical demonstrations using building materials to communicate their ideas clearly.
- Encourage students to think big and use their imaginations. These are extraordinary situations they are designing for!
- Point out how students are following the engineering design process.
- Have each student build a different part of the design

Encouraging iteration

- Challenge students to dream up the ultimate invention to solving their problem, as presented by their set of cards:
    - "What does this part do?"
    - "How does this [object] help the [user] in the [disaster]?"
    - "How does the [user] hold/wear/use your invention?"
    - "What can you do to adapt your invention to meet the new constraint?"

Helping those who are stuck

- Give each student on the team an opportunity to share his or her thoughts and ideas regarding the design. Leading questions may include:
    - What objects fit in this category?
    - What problems will come up in this disaster?
    - What do we know about this user?
    - How will this disaster affect this user?
    - Will this user need any special adaptations to use this object?

Real-world applications

- "Can you think of any specialized tools you would like to have around to stay safe in a natural disaster and protect your house?"
- People can get really creative when designing objects to protect people in natural disasters.
    - An inventor in China named Wang Wenxi has designed a bed that drops you and your mattress into a re-enforced box full of supplies if it senses an earthquake.
    - A company named MPowered designed the Luci Light to help people affected by disasters and people living in places without electricity. It is solar-powered and inflatable.