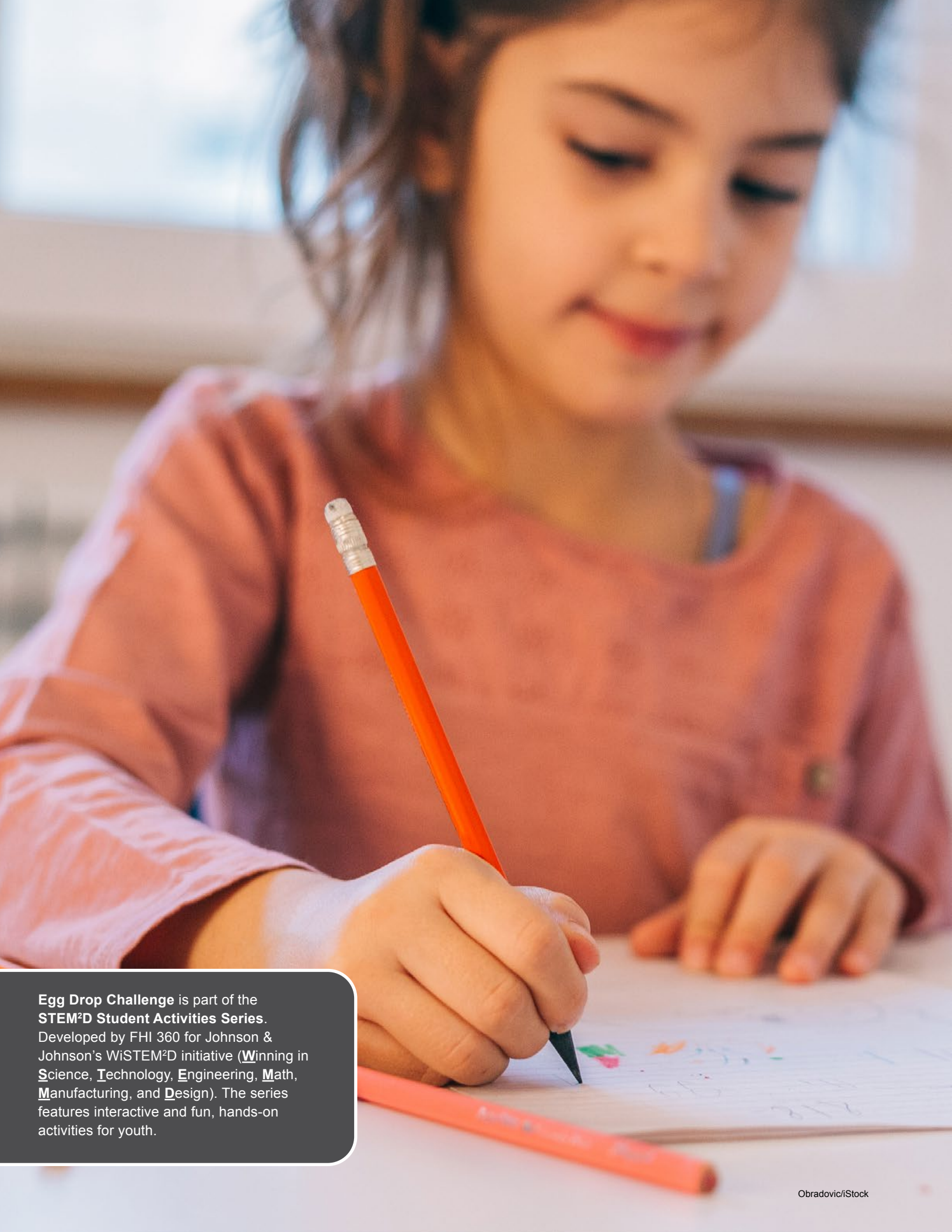


EGG DROP CHALLENGE

STEM²D Topics:
Design and Manufacturing

Target Population:
Students, ages 12–16



Egg Drop Challenge is part of the **STEM²D Student Activities Series**. Developed by FHI 360 for Johnson & Johnson's WiSTEM²D initiative (**W**inning in **S**cience, **T**echnology, **E**ngineering, **M**ath, **M**anufacturing, and **D**esign). The series features interactive and fun, hands-on activities for youth.

EGG DROP CHALLENGE

STEM²D Topics: Manufacturing and Design

Target Population: Students, ages 9–13

ACTIVITY DESCRIPTION

In this team-based, hands-on activity, students will explore design and manufacturing concepts by designing, building, testing, improving, and executing a device to protect an egg from breaking when dropped from a minimum height.



ESTIMATED TIME

This activity typically takes **90 minutes** to complete and should be conducted in **one** session.

STUDENT DISCOVERIES

Students will:

- Explore design and manufacturing concepts.
- Participate in a team-based learning experience.
- Build important STEM²D—Science, Technology, Engineering, Math, Manufacturing, and Design—skills, such as creative thinking, critical thinking, problem solving, decision making, and teamwork.
- Realize that STEM²D offers diverse and exciting career opportunities.
- Have fun experiencing STEM²D.

GETTING READY

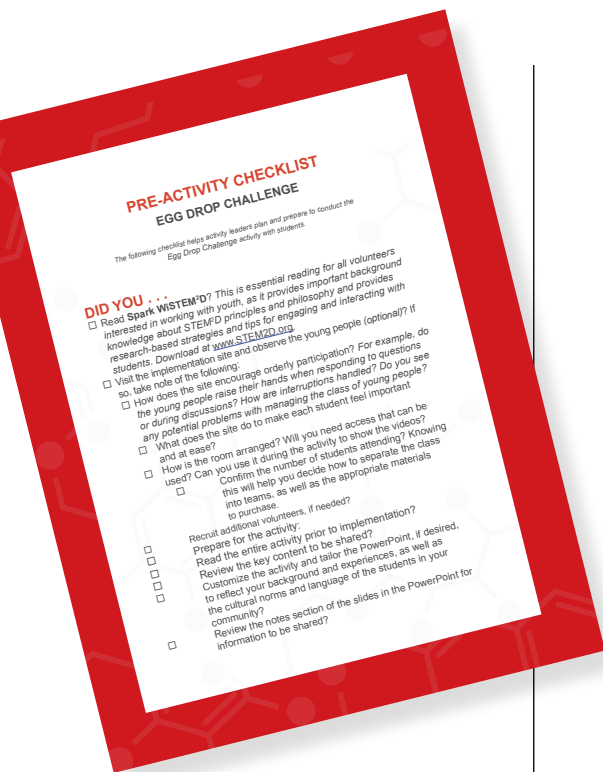
Materials:

- Pre-Activity Checklist
- Tell My Story Form
- Computer with projector, speakers, and Internet access
- PowerPoint: Egg Drop Challenge!
- Video: Manufacturing Contact Lenses (Johnson & Johnson)
<https://www.youtube.com/watch?v=0qRXyCQHkoM>
- Video: Inside Ford's Moving Assembly Line
https://www.youtube.com/watch?v=jLud5XYfY_c



STEM²D Skills

- Collaboration
- Communication
- Creative Thinking
- Critical Thinking
- Decision Making
- Problem Solving
- Teamwork
- Testing



- Video: The Science Behind Egg Drop Experiments
<https://www.youtube.com/watch?v=HeNBef3IQEI>
- Student Handout: Egg Drop Challenge, *1 per student*
- Student Handout: Materials Cost Form, *1 per team*
- Hand wipes or paper towels (for cleanup)
- Pen/pencil, 1 per student
- Egg Drop Challenge Materials, *per 20 students (five teams of four students):*
 - 20 sponges
 - 36 straws
 - 2 bags of cotton balls
 - 50 pipe cleaners
 - 20 pieces of paper
 - 5 rolls of clear or masking tape
 - 5 balls of string
 - 2 bags of large marshmallows
 - 10 uncooked eggs

Estimated Materials Cost:

Activity leaders can expect to incur less than \$40.00 in materials costs when completing this activity with 20 students organized into teams of four to five students.

Activity Leader Preparation

- Read **Spark WiSTEM²D**. This is essential reading for all volunteers interested in working with youth. It defines the STEM²D principles and philosophy and provides research-based strategies and tips for engaging and interacting with students. Download at www.STEM2D.org.
- Review the **Pre-Activity Checklist** (at the end of this document) for details and specific steps for planning, preparing, and implementing this activity.
- See the **STEM²D Student Activities Overview** for additional information.

STEP-BY-STEP INSTRUCTIONS: EGG DROP CHALLENGE

1. Welcome and Introductions (5 minutes)

- Welcome the students.
- Introduce yourself by saying your name, title, and your organization/company.
- Share that students will be learning about STEM²D careers and will be applying STEM²D skills during the session.
- **(What is STEM²D? Slide)** Explain that **STEM²D** refers to: Science, Technology, Engineering, Math, Manufacturing, and Design.
- Ask students and other volunteers to introduce themselves and state their favorite area of STEM²D.
- **(Today's Plan Slide)** Review the agenda. Explain that today students will explore two STEM²D topics: design and manufacturing. They will design, build, test, improve, and execute a device that protects an egg from breaking when dropped from a minimum height.

2. Career Awareness: Design and Manufacturing in the World of Work (10 minutes)

- **(STEM²D in the World of Work Slide)** Initiate an opening discussion and brainstorming activity. Consider asking:
 - How do you think design and manufacturing are used every day in the workplace?
 - What kinds of careers do you think people with an interest, aptitude for, or degree in design or manufacturing would have?
- **(Tell My Story Slide)** Talk about your educational and career path. Use the **Tell My Story Form** as the basis for your remarks. Be prepared to describe your job on a typical day, and provide information about your background including:
 - When/why you developed an interest in design or manufacturing?
 - The classes/courses you took in secondary school.

KEY WORDS

- Acceleration
- Force
- Gravity
- Impact
- Manufacturing
- Mass
- Physics
- Prototype
- Scrap

TIPS FOR STARTING CONVERSATIONS:

- What area of STEM²D is your favorite?
- Why did you choose that area of STEM²D as your favorite?
- What would your dream job be?
- Where do you see yourself in 5–10 years?

TIPS ABOUT STEM²D CAREERS

Share with students that there are many different careers related to STEM²D.

Possible STEM²D careers related to this activity:

- Design Engineer
- Quality Engineer
- Manufacturing Engineer
- Test Engineer

- Your post-secondary path, including the institution you attended and your degree.
If you switched disciplines, make sure you explain why to the students.
- What your current position entails. *Be sure to include how you use design and manufacturing and what you do on a typical work day.*
- Weave in facts about design, manufacturing, and STEM²D careers:
 - Tell the students that your career is only one of the many careers available in the STEM²D disciplines.
 - Explain that STEM²D careers are high-demand, high-growth careers and are predicted to remain in demand over the next ten years.
 - Share a few Johnson & Johnson job titles and careers that may align with this activity.

3. Content Presentation (10 minutes)

- **(What Do You Know About...? Slide)** Ask students to share what they know about design and manufacturing. Choose three to four students to share their thoughts. Provide feedback on their answers.
- **(Design Process Slide)** Give students an overview of the design process. Explain that there are many different design processes; today's activity will use a seven-step process:
 1. *Define* the Need: Determine the problem or challenge that needs to be solved.
 2. *Brainstorm*: Think about different ways to tackle the challenge. Share different ideas. Record all potential ideas for further discussion.
 3. *Design*: During this phase, teams collaborate and determine which ideas have the most potential given the available time, tools, and materials. Explore these ideas in further detail. Create sketches of ideas. Determine materials to be used. Create working drawings so the selected idea can be built.
 4. *Build*: Make a model or prototype of the proposed design using the available materials.

5. *Test and Evaluate:* Test the model in a controlled and working environment to see if it produces the desired outcome. Gather data on the performance of the model. Check the results to determine if the model solved the problem. Identify areas of concern and shortcomings. Determine any changes to be made.
6. *Rebuild:* Perfect the working prototype. Make any necessary changes to the design based on testing and evaluation.
7. *Share the Solution:* Answer the following questions: What's the best feature of the design? What different steps were taken to get the project to work? What modifications were made? Should this prototype be recommended for "market testing" and manufacturing?

- **(Manufacturing Slide)** Explain:
 - Once the design work is complete, a final product is manufactured.
 - **Manufacturing** is creating something from raw materials, either by hand or by machine.
- Click the links in the PowerPoint to watch one or both of the suggested videos to give students a closer look at manufacturing in action. The Johnson & Johnson video is four minutes long and the Ford Motor Company video is two minutes long.
- **(Questions? Slide)** Ask the students if they have any questions about design or manufacturing. Answer questions posed by the students.

4. Learning Activity: Egg Drop Challenge (55 minutes)

- **(Science Concepts Slide)** Explain that science has an important role in design and manufacturing. Click the link in the PowerPoint to show the video: Science Concepts Behind the Egg Drop Experiment, which is 2½ minutes long.
- Review the key terms outlined in the video that are important to understand for today's challenge:
 - **Acceleration:** an increase in speed
 - **Force:** a push or pull on an object

TIPS FOR MAKING CONNECTIONS

Encourage students to:

- Ask questions if they don't understand.
- Summarize what they have learned.
- Explain their thinking process aloud.

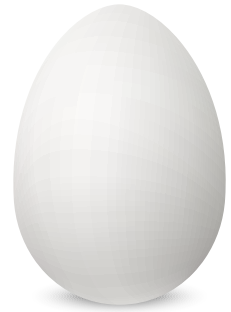
TIPS FOR ENGAGING STUDENTS:

- Encourage students to be creative in their designs.
 - Ask open-ended questions to encourage student reflection and discussion.
 - What factors determined the design of your device?
 - How did you decide which design to build?
 - Why did you use decide to use these materials?
 - What was most challenging about building the device?
 - Help students stay on track with time during the group challenge.
 - Encourage all students to participate in the challenge.
 - Move around the learning space and provide support when necessary.
- **Gravity:** a force that tries to pull two objects towards each other attraction
 - **Impact:** the striking of one thing against another
 - **Mass:** the amount of matter or substance that makes up an object
 - **Physics:** the study of matter, energy, and the interaction between them be solved.
- **(The Egg Drop Challenge Slide)** Break the group into teams of four to five students. Distribute the two Student Handouts. Introduce the challenge:
 - **(The Rules Slide)** As a team, your task is to design and build a device that can safely deliver an egg from a minimum height of 10 ft. (3 meters) using the least costly materials.
 - Only the materials provided can be used to build the device.
 - Each of the materials is allocated a cost. You may purchase as many items as your team needs, but you must keep track of the total cost of materials purchased using the Materials Cost Form.
 - Only one, final design will be tested per team.
 - The winner of the Egg Drop Challenge will be the team whose device cost the least while protecting the egg from any cracks or breaks after being dropped.
 - **(The Materials Slide)** These are the only materials that your team can use to build the device. All materials and their assigned costs are listed on the Materials Cost Form. Remember to keep track of all items purchased. If your team decides not to use an item it purchased from the market, the item must still be counted on the form.
- **(Scrap Slide)** Give an overview of scrap. Explain:
 - An important concept to keep in mind when purchasing materials is scrap.
 - Scrap is the unused, discarded, or rejected material from a project.
 - The cost of scrap to a project can be very high.
 - The cost of scrap affects organizations across all industries and product lines.

- Scrap costs are higher than necessary when the wrong parts are ordered, when engineering changes aren't effectively communicated, and when designs aren't properly executed during manufacturing.
- Give the following example:
 - If I purchase five marshmallows that are \$1 each to build the device for the Egg Drop Challenge and I only use one marshmallow, then I have four excess marshmallows (four marshmallows are scrap).
 - The apparatus cost me \$4 more than it should have, because I bought excess marshmallows.
- **(Let's Get Started! Slide)** Give teams 30 minutes to design and manufacture the egg-carrying device. Instruct teams to think about the following as they go through the steps of the product design process:
 - *Review the Challenge:* Build a device that will safely deliver an egg from a minimum height of 10 ft. (3 meters) using the least costly materials.
 - *Brainstorm:* Discuss potential ideas and/or sketch potential designs. Think about relevant science concepts and the materials that are available.
 - *Design:* Decide on the best design. Determine the required materials and how to build the prototype.
 - *Build:* the model or prototype.
 - *Test and Evaluate:* Think about critical items to inspect in your product design during the testing phase. Test your design. Evaluate the prototype. Ask yourself: What did we learn? What worked? What needs to be changed?
 - *Rebuild:* Manufacture the final design.
 - *Share the Solution:* Calculate the total cost of materials using the Materials Cost Form. The final cost must include all purchased materials (including scrap), not just the materials used in the device.
- **(Questions? Slide)** Ask the students if they have any questions about the challenge before getting started. Answer questions posed by the students.
- Instruct teams to start the challenge.

- Circulate around the room asking students questions about their designs. While you may be tempted to give suggestions for improvement, hold on to the suggestions until the reflection period of the activity so students have the opportunity to work through the product design process with their team.
- Give reminders about timing. For example, teams should move to the building/testing phase at least half way through the allotted time to ensure they time to manufacture the device.
- Make sure students are recording the amount of materials they purchase on the Materials Cost Form.
- After 15 minutes, give each team one egg to use for testing their prototype. If the egg breaks during testing, do not give another egg. Students should clean up any raw egg that has broken using paper towels, soap and water, or cleaning wipes.
- **(Performance Testing Slide)** After 30 minutes, reconvene the large group. Indicate that it is time to test the devices. Instruct each team to bring its device and its completed Materials Cost Form to the performance testing area.
- Establish the order in which the teams will test their devices. In that same order, first have a representative of each team state the total cost of their materials and record this next to their team's number on flipchart paper or on a white board.
- Give the first team representative an egg and instruct him/her to drop the device (with egg inside) from 10 ft. (3 meters).
- Once the device hits the ground, ask the team to open the device. Inspect the egg for any cracks or breaks. Disqualify the team if the egg is cracked or broken.
- Continue in the same manner until all teams have completed the performance testing.
- State which teams "passed the testing phase" (i.e., the devices protected the egg from any cracks and breaks). Then determine which of these teams had the lowest materials costs.
- Announce the winning team: the team whose egg did not crack or break in testing and had the lowest materials costs among the "passing" teams.

- **(What Did We Learn? Slide)** Recap the lessons learned during the activity. Ask one or more of the following questions:
 - What was the most critical decision your team made during your design phase?
 - What was the most critical decision your team made during the build phase?
 - What was the most critical decision your team made during the testing and evaluation phase?
 - What was difficult about designing and manufacturing the device?
 - What would you change about your design if you were to build it again?



5. Student Reflection (10 minutes)

- **(Reflection Slide).** Ask students to reflect on the activity. Pose one or more of the following questions:
 - What did you learn about Design and Manufacturing?
 - How do you think this activity relates to a career in Design and Manufacturing and/or working at Johnson & Johnson?



➤ Foam packing pellets

- Can you see yourself as a STEM²D professional? In what role? Why or why not?
- What would you need to do to make that happen?
- What is one thing you learned that you did not know coming into today?

Extended Learning

You can extend student learning. Click on the links below for different ideas:

- Try another STEM²D Student Activity focused on manufacturing and design: Create It, Try It, Manufacture It: <https://www.stem2d.org/activities/#makeit>
- Design a Parachute That Can Be Used When Dropping the Egg From a Specific Height: https://www.teachengineering.org/activities/view/design_a_parachute
- Eggshell Strength Experiment: <https://littlebinsforlittlehands.com/eggshell-strength-experiment-kids-stem-activity/>
- Recycle/Reuse the Egg Shells—Egg Shell Seed Growing Activity: <https://littlebinsforlittlehands.com/egg-shell-seed-growing-science-experiment/>

Key Words

Acceleration: an increase in speed

Force: a push or pull on an object

Gravity: a force that tries to pull two objects towards each other

Ideation: the formation of ideas or concepts

Impact: the striking of one thing against another

Manufacturing: the process of creating something from raw materials, either by hand or by machine

Mass: the amount of matter or substance that makes up an object

Physics: the study of matter, energy, and the interaction between them

Prototype: a simple model that lets you test your idea

Scrap: the discarded or rejected material from an operation

Resources and References

Special thanks to Joseph Lao, Product Quality Engineer, ASP and BTE—Santa Ana, California, Champion for his guidance and insights on this activity.

The following references and resources provide additional information or activities:

- Automation, Innovation, and Business—STEM for Kids: <https://stemforkids.net/programs/advanced-manufacturing/>
- How It's Made: <https://www.neok12.com/Industry.htm>
- Introducing the Design Process: https://pbskids.org/designsquad/pdf/parentseducators/DS_TG_DesignProcess.pdf
- Tackle the Engineering Design Process—with Kids! <https://stemactivitiesforkids.com/2016/02/25/690/>
- Video: The Engineering Design Process—A Taco Party. https://www.youtube.com/watch?v=MAhpfFt_mWM
- Video: Kid Engineer—The Design Process Design Squad. <https://www.youtube.com/watch?v=FuzmxrqqBLc>

PRE-ACTIVITY CHECKLIST

EGG DROP CHALLENGE

The following checklist helps activity leaders plan and prepare to conduct the Egg Drop Challenge activity with students.

DID YOU . . .

- Read **Spark WiSTEM²D**? *This is essential reading for all volunteers interested in working with youth, as it provides important background knowledge about STEM²D principles and philosophy and provides research-based strategies and tips for engaging and interacting with students. Download at www.STEM2D.org.*
- Visit the implementation site and observe the young people (*optional*)? If so, take note of the following:
 - How does the site encourage orderly participation? *For example, do the young people raise their hands when responding to questions or during discussions? How are interruptions handled? Do you see any potential problems with managing the class of young people?*
 - What does the site do to make each student feel important and at ease?
 - How is the room arranged? Will you need to move desks or chairs for any part of your presentation?
 - How can you engage the site representative in your presentation?
- Meet with and finalize the logistics with the site representative? Did you:
 - Confirm the date, time, and location of the activity?
 - Confirm the technology needs? *Do you need to bring a computer, projector, or speakers to show the PowerPoint and videos? Or, does the site have one that you can borrow? Does the site have Internet access that can be used? Can you use it during the activity to show the videos?*
 - Confirm the number of students attending? *Knowing this will help you decide how to separate the class into teams, as well as the appropriate materials to purchase.*
- Recruit additional volunteers, if needed?

- Prepare for the activity. Did you:
 - Read the entire activity prior to implementation?
 - Review the key content to be shared?
 - Customize the activity and tailor the PowerPoint, if desired, to reflect your background and experiences, as well as the cultural norms and language of the students in your community?
 - Review the notes section of the slides in the PowerPoint for information to be shared?
 - Complete the **Tell My Story Form**, which will prepare you to talk about your educational and career path with the students? *If desired, include key points about your story on the PowerPoint (see Tell My Story Slide).*
 - Photocopy the Student Handouts?
- Obtained the required materials? *See the Materials and Estimated Materials Costs sections.*
- Practice your presentation, including the hands-on, minds-on activity? Did you:
 - Do the activity? *Make sure you are able to explain the concepts to students, if needed, and that you know the correct answers.*
- Set up the site appropriately for the activity? Did you:
 - Create a designated area for performance testing? *The designated area should be an open space where the devices can be easily dropped from a minimum height of 10 ft. (3 meters). This may be accomplished by standing on a chair, staircase, or ladder and dropping the device.*
 - Establish an area (table) where students can purchase the egg drop materials? *If additional volunteers are available, ask one of the adults to oversee the distribution of materials.*
 - Make sure tables and chairs are arranged to accommodate teams of up to five students?
 - Set up the computer and projector for the PowerPoint presentation? Connect the speakers? Make sure the Internet connection is available to show the videos?
- Bring a camera, if desired, to take photographs?
- Obtain and collect permission slips and photo release forms for conducting the activity if applicable?
- Have fun!**

Tell My Story Form

This form will help activity leaders and other volunteers prepare to talk about their STEM²D interests, education, and career path.

ABOUT YOU

Name: _____

Job Title: _____

Company: _____

When/Why did you become interested in STEM²D? _____

What do you hope young people will get out of this activity? _____

FUN FACT

Share a little about your background. Ideas:

- Share a memory from childhood when you had your first 'spark' or 'interest' in STEM²D.
- Detail your journey—highlight what you've tried, what you learned, steps to success, etc.
- Failures or set backs are also great for talking about difficulties and/or challenges and how you overcame them.

EDUCATION AND CAREER PATH

What classes/courses did you take in secondary school and in college that helped or interested you most?

How did you know you wanted to pursue a STEM²D career?

What was your postsecondary path, including the institution you attended and your degree? *If you switched disciplines, make sure you explain why to the students.*

What your current position entails. *Be sure to include how you use STEM²D on a typical work day.*

EGG DROP CHALLENGE

Student Handout

CHALLENGE

Work as a team to build a device that can safely deliver an egg when dropped from a minimum height of 10 ft. (3 meters) using the least costly materials.

THE RULES

- Teams have 30 minutes to complete the challenge.
- Teams can purchase as many materials as they need but can only use the materials provided.
- Each team must track all materials purchased (both used and unused), and list all materials purchased on the Materials Cost Form.
- Each team must choose only one design to carry out in the final group test.
- Have fun!

INSTRUCTIONS

Think about the product design process as you design and manufacture the device:

- **Review** the challenge.
- **Brainstorm:** Discuss potential ideas and/or sketch potential designs. Think about the science concepts and the materials that are available.
- **Design:** Select the best design. Determine the required materials for building the design.
- **Build** the model or prototype.
- **Test and Evaluate:** Think about critical items to inspect in your product design during the testing phase. Test your design. Evaluate the prototype. Ask yourself: What did we learn? What worked? What needs to be changed?
- **Rebuild:** Manufacture the final design.
- **Share the Solution:** List and calculate the total cost of materials using the Materials Cost Form. The final cost must include all materials purchased (including scrap), not just the materials used in the device.

MATERIALS COST FORM

Student Handout

INSTRUCTIONS

You may use as many of the materials as your team would like, but you must keep track of the total items purchased in the chart below. When you're done, calculate the total cost of materials you used, as well as the cost of your scrap. The sample line shows how to calculate your costs.

| Item | Item Cost (\$) | Total Items Purchased | Total Cost Purchased Items (\$) | Total Items Used | Total Cost of Used Items (\$) | Total Cost of Scrap (\$) |
|--|-----------------|-----------------------|---------------------------------|------------------|-------------------------------|--------------------------|
| <i>SAMPLE</i> | <i>\$1 each</i> | <i>5</i> | <i>\$1x5=\$5</i> | <i>1</i> | <i>\$1x1=\$1</i> | <i>\$5-\$1=\$4</i> |
| Cotton Balls | \$1 each | | | | | |
| Marshmallows | \$2 each | | | | | |
| Straws | \$1 each | | | | | |
| Sponges | \$5 each | | | | | |
| Paper | \$1 each | | | | | |
| Pipe Cleaner | \$1 each | | | | | |
| TOTAL | | | | | | |
| Add all rows of the following three columns: 1) Total Cost of Purchased Items; 2) Total Cost of Used Items; and 3) Total Cost of Scrap. Record the totals in the highlighted spaces. | | | | | | |

The background of the page is a solid red color with a repeating pattern of white chemical structures. These structures include various organic molecules such as benzene rings, alkenes, alcohols, and amides, arranged in a dense, overlapping grid.

Content and graphic design courtesy of FHI 360.
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Revised design, JA Worldwide, April 2018.