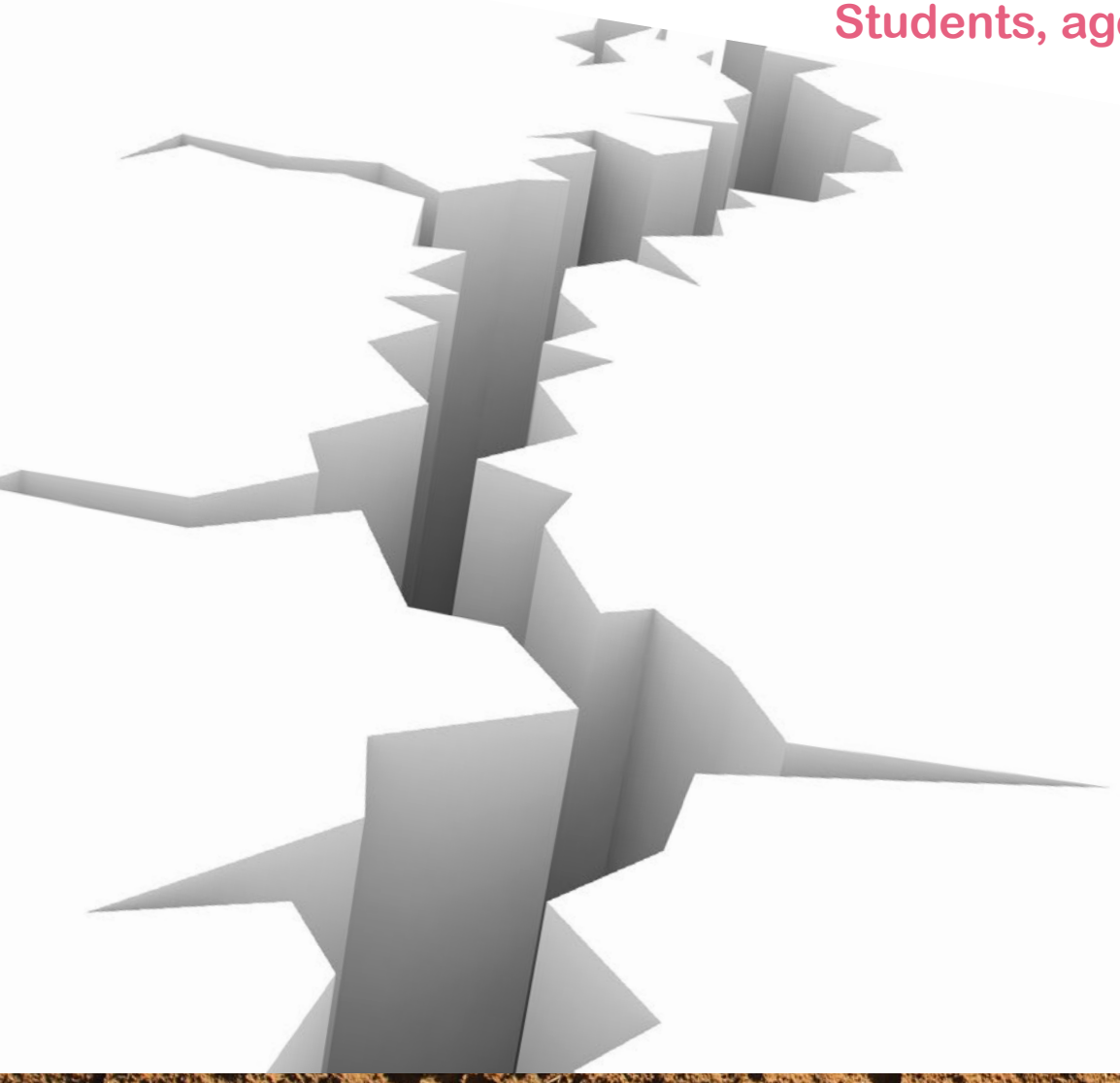
IGNITE ACTIVITY

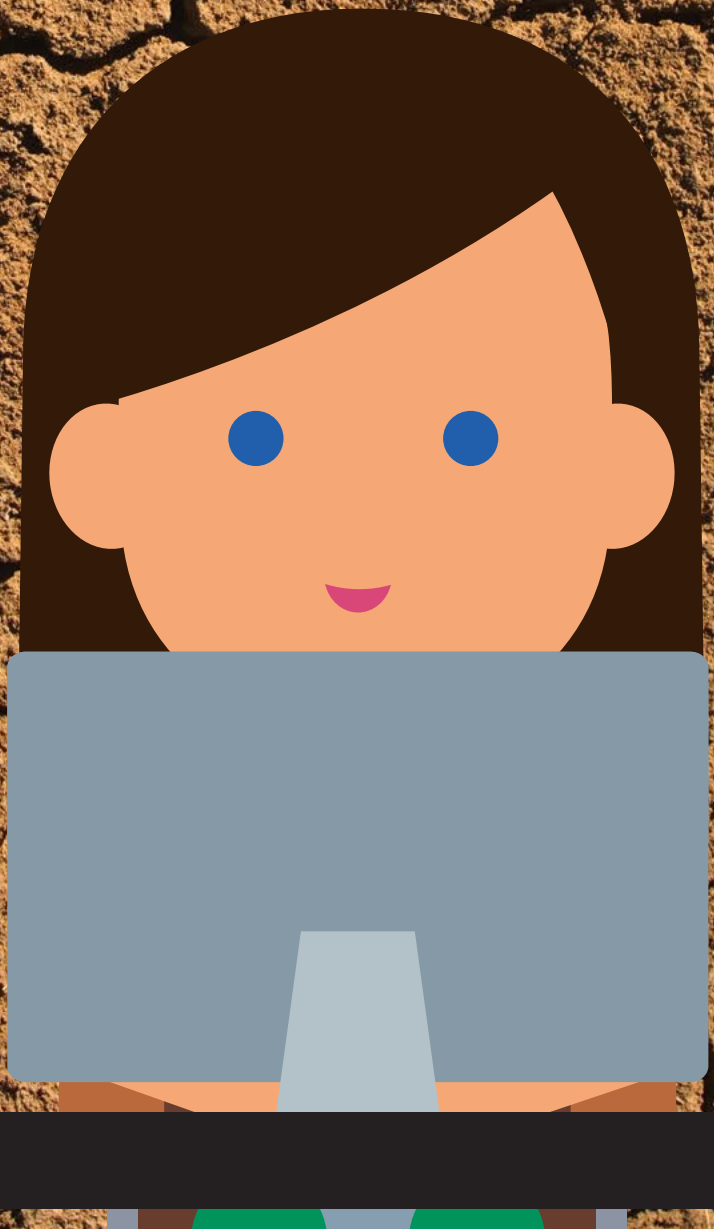
BUILDING QUAKES

STEM^{2}D Topics: DESIGN AND ENGINEERING

Target Population: Students, ages 11-14



Building Quakes 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.



Building Quakes

STEM²D Topics: Design and Engineering
Target Population: Students, ages 11–14

ACTIVITY DESCRIPTION

In this Ignite STEM²D activity, students will design and build a structure that is resilient during an induced earthquake.

ESTIMATED TIME

This activity is intended to be done at a career fair, science fair, exhibit, or other type of "booth" event. It typically takes **10 to 15 minutes** to complete.

STUDENT DISCOVERIES

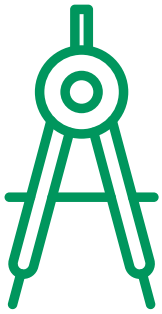
Students will:

- Apply design and engineering principles to build a resilient structure.
- Learn more about the impact of earthquakes (*optional*)
- Build important STEM²D skills, such as thinking critically, drawing conclusions, and problem solving.
- Realize that STEM²D offers diverse and exciting career opportunities.
- Be inspired to participate in other types of STEM²D experiences.
- Have fun experiencing STEM²D

GETTING READY

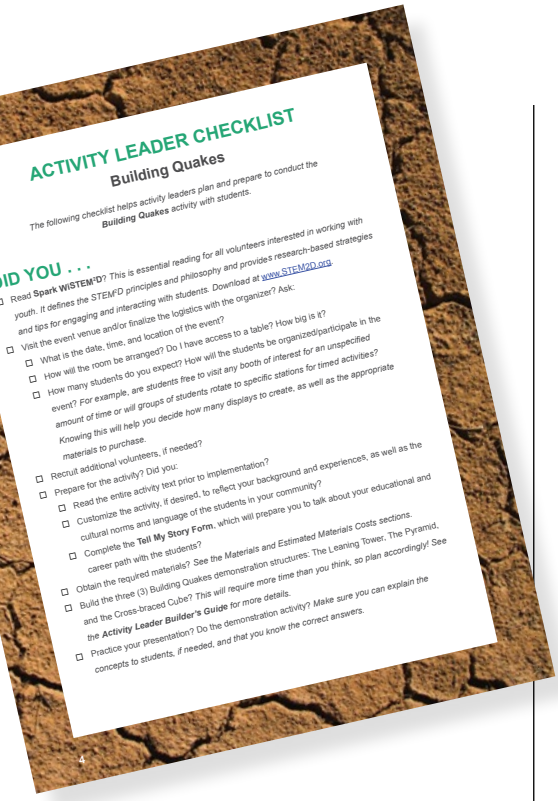
Materials:

- Pre-Activity Checklist
- Tell My Story Form, *optional*
- Activity Leader Builder's Guide



STEM²D Skills

- Creative Thinking
- Decision Making
- Drawing Conclusions
- Problem Solving
- Teamwork



ACTIVITY LEADER CHECKLIST

Building Quakes

The following checklist helps activity leaders plan and prepare to conduct the **Building Quakes** activity with students.

DID YOU . . .

- ☐ 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
- ☐ Visit the event venue and/or finalize the logistics with the organizer? Ask:
  - ☐ What is the date, time, and location of the event?
  - ☐ How will the room be arranged? Do I have access to a table? How big is it?
  - ☐ How many students do you expect? How will the students be organized/participate in the event? For example, are students free to visit any booth of interest for an unspecified amount of time or will groups of students rotate to specific stations for timed activities? Knowing this will help you decide how many displays to create, as well as the appropriate materials to purchase.
- ☐ Recruit additional volunteers, if needed?
- ☐ Prepare for the activity? Did you:
  - ☐ Read the entire activity text prior to implementation?
  - ☐ Customize the activity, if desired, to reflect your background and experiences, as well as the cultural norms and language of the students in your community?
  - ☐ Complete the **Tell My Story Form**, which will prepare you to talk about your educational and career path with the students?
- ☐ Obtain the required materials? See the Materials and Estimated Materials Costs sections.
- ☐ Build the three (3) Building Quakes demonstration structures: The Leaning Tower, The Pyramid, and the Cross-braced Cube? This will require more time than you think, so plan accordingly! See the **Activity Leader Builder's Guide** for more details.
- ☐ Practice your presentation? Do the demonstration activity? Make sure you can explain the concepts to students, if needed, and that you know the correct answers.

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KEY WORDS

- Design
- Engineering
- Geology
- STEM²D

- Building Quakes materials; *1 set of the following items for the three displays:*
  - 25 mini-marshmallows
  - 40 toothpicks, skewers, or pieces of spaghetti
  - 3 serving trays
- STEM²D brochures, flyers, or other informational materials, *optional*

Estimated Cost:

Activity leaders can expect to incur less than $15.00 in materials costs when conducting this activity multiple times with student groups.

Activity Leader Preparation

1. 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.
2. See the **STEM²D Student Activities Overview** for additional information.
3. Review the **Pre-Activity Checklist** (at the end of this document) for details and specific steps for planning, preparing, and implementing this activity.
4. Pre-build the three demonstration structures: The Leaning Tower, The Pyramid, and the Cross-Braced Cube. This will require some time; plan accordingly! See the Materials section for required materials and the **Activity Leader Builder's Guide** for instructions.

STEP-BY-STEP INSTRUCTIONS: BUILDING QUAKES

1. **Welcome & Introductions (2–3 minutes)**
   - Welcome the students as they arrive at the table/booth.
   - Introduce yourself by saying your name, title, and your organization/company.
   - Explain that your career is one of many **STEM²D** careers. Indicate:
     - STEM²D refers to Science, Technology, Engineering, Math, Manufacturing, and Design.

- Individuals with an interest or degree in these areas are in demand.
- Ask the other volunteers and students to introduce themselves.

2. **Learning Activity: (5–10 minutes)**
   - Introduce the activity. Give a quick overview of earthquakes and how they impact the design and engineering of buildings:
     - Contrary to popular conception, during an earthquake, the ground moves in a rolling, back and forth motion—not in an up-and-down motion.
     - Because of this motion, buildings actually sway back and forth in an earthquake, however imperceptibly.
     - Buildings that crumble or collapse easily can't handle this swaying motion.
   - Introduce the three, pre-built structures. Ask:
     - Which structure will hold up best during an earthquake?
     - Why do you think so?
   - After several students made predictions (guesses), put the structures to the test:
     - Push and pull the tray that is holding The Leaning Tower back and forth to simulate the rolling motion of an earthquake.
     - Have students observe the "earthquake."
     - Repeat for remaining two structures: The Pyramid and The Cross-braced Cube.
   - Initiate a discussion. Pose open-ended questions that encourage students to share their ideas and explain what occurred:
     - Which structure best resists the force of the earthquake?
     - Why do you think this is the case?
   - Confirm students' thoughts by making one or more of the following points:
     - The Pyramid and The Cross-braced Cube use cross-bracing, which is the practice of using x-shaped braces. Cross-bracing provides additional support and enables the building to respond to the movement in an earthquake. The shape resists twisting.
     - Wider bases also make buildings more stable.
     - Symmetrical buildings are also more stable.

TIPS FOR WORKING WITH STUDENTS

Involve students in the demonstration:

- Check frequently for understanding by asking open-ended, topic-specific, or process questions.
- Ask students to talk about what they already know.
- Encourage students to ask questions to gain deeper understanding.
- Have students simulate the earthquakes, pushing and pulling the trays holding each pre-built structure.

- If time permits, describe the STEM²D disciplines this activity touches on:
    - **Engineering:** Applying science and math principles to design and develop products, structures, machines, tools, or systems that improve everyday life. It was demonstrated here by buildings designed according to science and math principles to survive earthquakes.
    - **Design:** Creating, constructing, or inventing an object, plan, product, or system; it is also a human-centered mindset and collaborative approach that results in better experiences by uncovering unmet needs and championing meaningful relationships through user-friendly products, environments, and systems. It was demonstrated here by the idea that buildings should be constructed to meet specific needs; i.e., surviving earthquakes in areas where earthquakes are common.
    - **Geology:** a subset of science that involves observing and studying the earth's physical structure and substance, its history, and the process that act on it.

3. **Student Reflection (2 minutes)**
    - Wrap up the activity by asking any of the following reflection questions:
        - What did you learn about building for earthquakes?
        - What did you learn about how engineering or design is used in construction?
        - What kind of careers do you think people with an interest/ degree in this area would have?

Extended Learning

You can extend student learning or expand this activity to a one-hour activity:

- **A Team Challenge:** After the demonstration, break the students into teams of 2–3 students per team. Provide each team with building materials: 30 mini-marshmallows and 50 toothpicks. Challenge teams to build the tallest, most structurally sound tower. After 15 minutes, put each structure to the test by placing it on a tray and simulating an earthquake.

Key Words

Design: Creating, constructing, or inventing an object, plan, product, or system; it is also a human-centered mindset and collaborative approach that results in better experiences by uncovering unmet needs and championing meaningful relationships.

Engineering: Applying science and math principles to design and develop products, structures, machines, tools, or systems that improve everyday life through user-friendly products, environments, and systems.

Geology: The science that deals with the earth's physical structure and substance, its history, and the processes that act on it.

STEM²D: An acronym referring to the Science, Technology, Engineering, Math, Manufacturing, and Design disciplines.

Resources and References

Activity concepts and real-life connections adapted from:

- "Hands-on Activity: Testing Model Structures: Jell-O Earthquake in the Classroom." *Teach Engineering: STEM Curriculum for K-12.* Accessed 8 November 2018. https://www.teachengineering.org/activities/view/cub_natdis_lesson03_activity1
- "Marshmallow Earthquake!" 2013. *Community Science Workshop Network.* Accessed 8 November 2018. http://cswnetwork.org/projects/pdf/236.pdf

TIPS ABOUT STEM²D CAREERS

Share with students that there are many different kinds of careers related to STEM²D. Some STEM²D careers related to this activity are:

- Architect
- Structural Engineer
- Geologist

ACTIVITY LEADER CHECKLIST

Building Quakes

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DID YOU . . .

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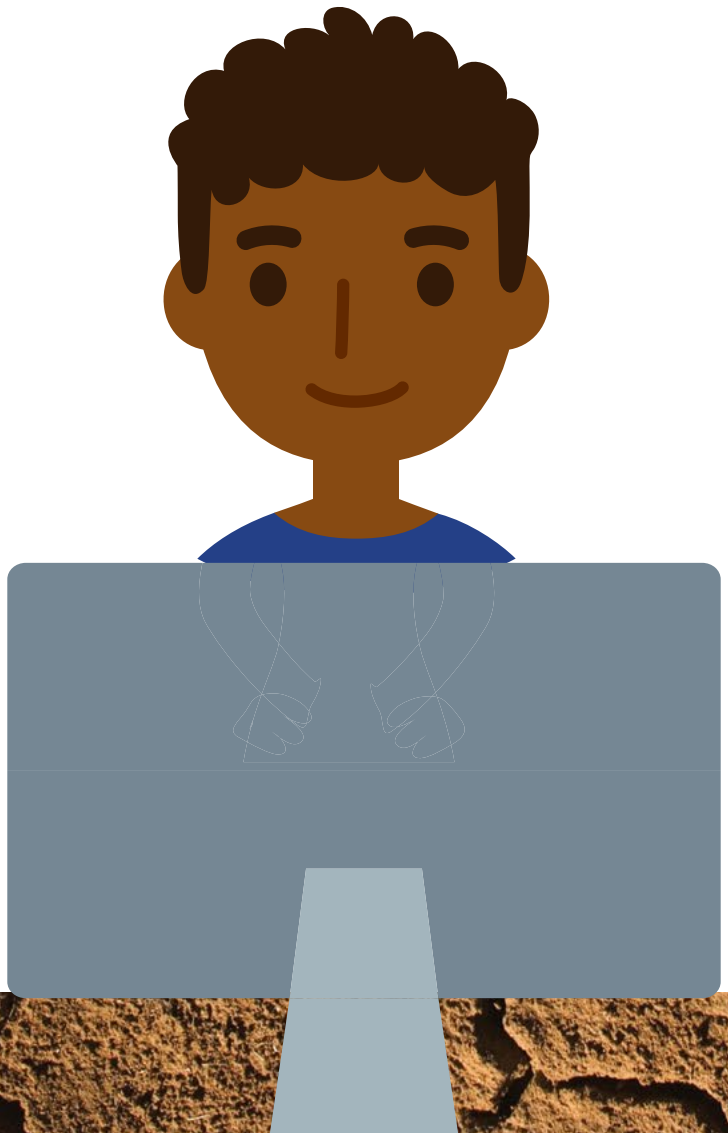
- ☐ Visit the event venue and/or finalize the logistics with the organizer? Ask:
  - ☐ What is the date, time, and location of the event?
  - ☐ How will the room be arranged? Do I have access to a table? How big is it?
  - ☐ How many students do you expect? How will the students be organized/participate in the event? *For example, are students free to visit any booth of interest for an unspecified amount of time or will groups of students rotate to specific stations for timed activities? Knowing this will help you decide how many displays to create, as well as the appropriate materials to purchase.*
- ☐ Recruit additional volunteers, if needed?
- ☐ Prepare for the activity? Did you:
  - ☐ Read the entire activity text prior to implementation?
  - ☐ Customize the activity, if desired, to reflect your background and experiences, as well as the cultural norms and language of the students in your community?
  - ☐ Complete the **Tell My Story Form**, which will prepare you to talk about your educational and career path with the students?
- ☐ Obtain the required materials? *See the Materials and Estimated Materials Costs sections.*
- ☐ Build the three (3) Building Quakes demonstration structures: The Leaning Tower, The Pyramid, and the Cross-braced Cube? *This will require more time than you think, so plan accordingly! See the **Activity Leader Builder's Guide** for more details.*
- ☐ Practice your presentation? Do the demonstration activity? *Make sure you can explain the concepts to students, if needed, and that you know the correct answers.*

- ☐ Set up the site appropriately for the activity? Specifically:
  - ☐ Arrange your booth/table? *On the table, place the three trays holding the pre-built structures (The Leaning Tower, The Pyramid, and the Cross-braced Cube).*
  - ☐ Designate an area for the Team Challenge, if extending the learning? *You will need the following additional building materials for each team of 2-3 students: 30 mini-marshmallows and 50 toothpicks.*
- ☐ 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!**



ACTIVITY LEADER GUIDE

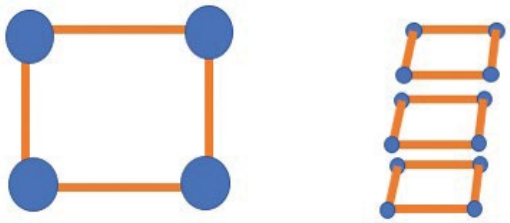
Building Quakes

*The following guide helps activity leaders build the three **Building Quakes** displays.*

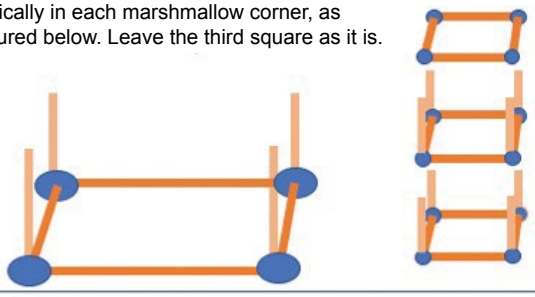
The Leaning Tower

Materials:

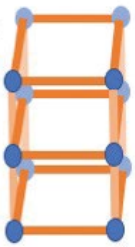
Step 1: Use 4 marshmallows and 4 toothpicks to build a square. as pictured below. Repeat this for a total of 3 squares.



Step 2: In two of the squares, place a toothpick vertically in each marshmallow corner, as pictured below. Leave the third square as it is.



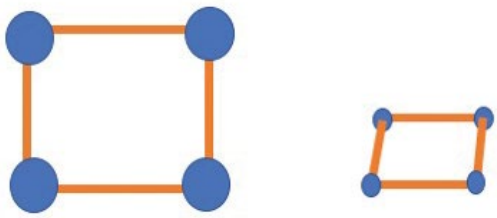
Step 3: Stack your three squares, using the vertical tothpicks as connectors. Place the square without vertical pieces on top.



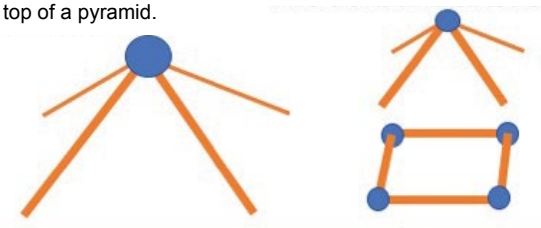
The Pyramid

Materials:

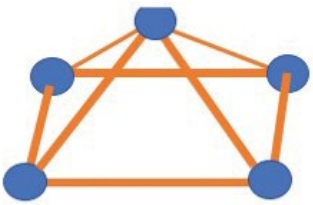
Step 1: Use 4 marshmallows and 4 toothpicks to build a square. as pictured below.



Step 2: Place the other 4 toothpicks in 1 (additional) marshmallow. Place each toothpick at a 45 degree angle from the center of the marshmallow. Think of the marshmallow as the top of a pyramid.



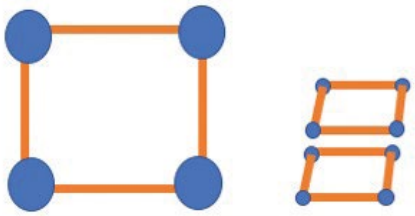
Step 3: Place your pyramid top onto the square base to complete your pyramid



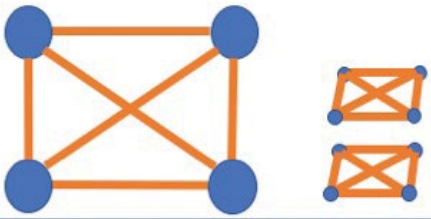
The Cross-Braced Cube

Materials:

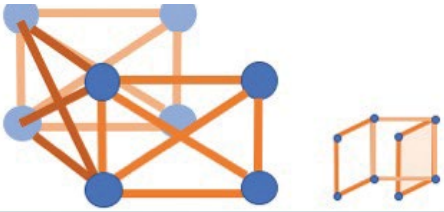
Step 1: Use 8 marshmallows and 8 toothpicks to build 2 squares. as pictured below.



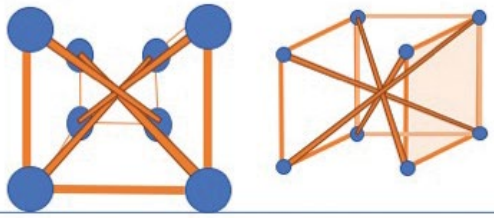
Step 2: Add diagonal cross pieces to each square, using 2 toothpicks per square (4 toothpicks total).

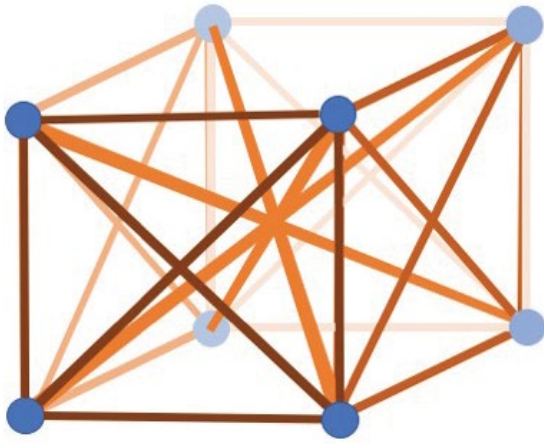


Step 3: Connect 2 of your completed squares with 2 toothpicks (one at the top and one at the top and bottom). Then, using 2 more tooth[icks, add an “X” shape between them. You should now have three sides of a cube.

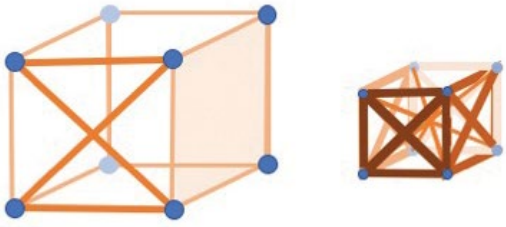


Step 4: Add cross-brace to the middle by connecting diagonally opposite corners of your cube with 4 toothpicks. For example, one toothpick should connect the lower-left front corner to the upper-right rear corner.





Step 5: Using your last 4 toothpicks, connect the open corners of the front of teh cube (with two toothpicks) and add two cross-braces



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 first had your "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 to talk 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 the 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.*

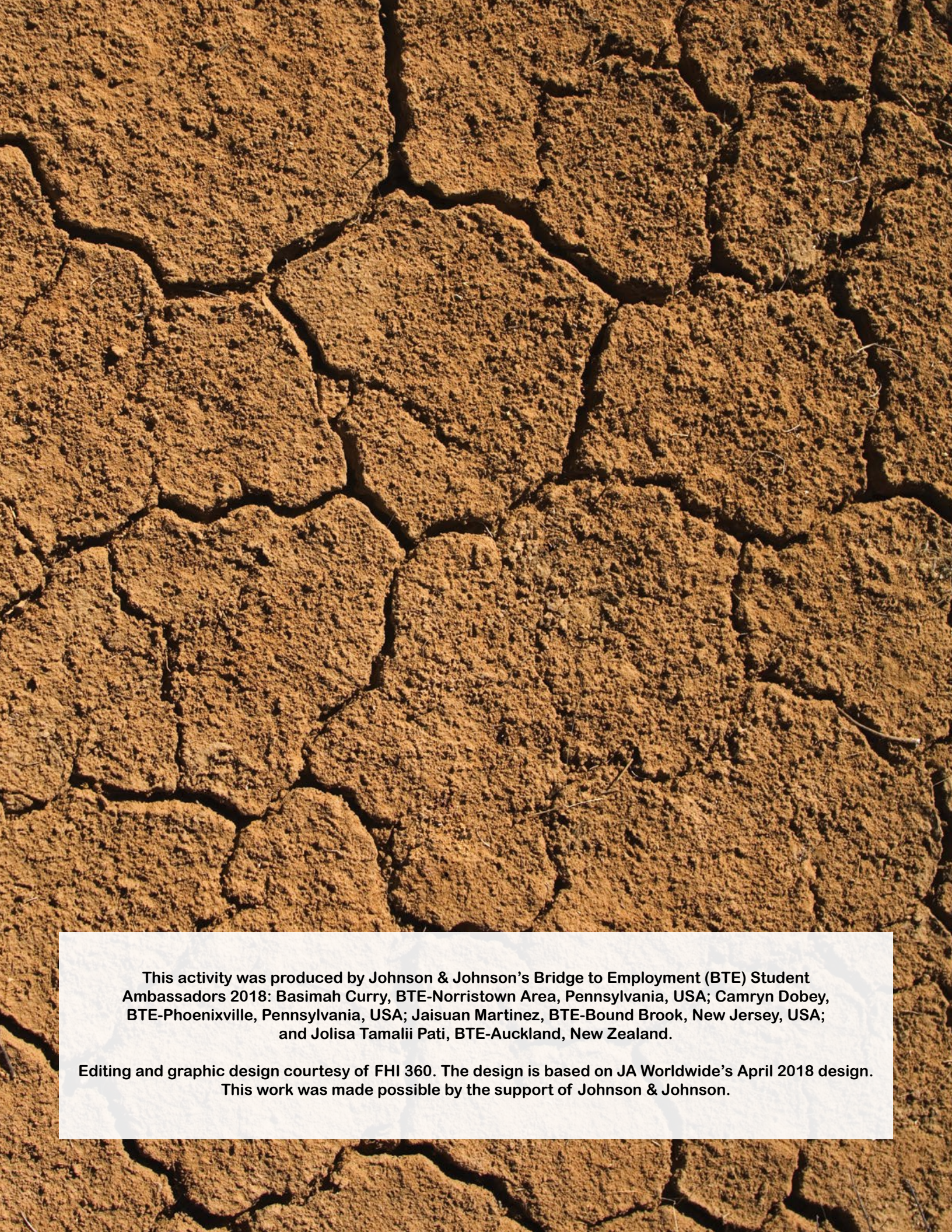
_____

_____

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

_____

_____



This activity was produced by Johnson & Johnson's Bridge to Employment (BTE) Student Ambassadors 2018: Basimah Curry, BTE-Norristown Area, Pennsylvania, USA; Camryn Dobey, BTE-Phoenixville, Pennsylvania, USA; Jaisuan Martinez, BTE-Bound Brook, New Jersey, USA; and Jolisa Tamalii Pati, BTE-Auckland, New Zealand.

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