The Tech Interactive at Home

The Tech Challenge
Presented by Dell Technologies

Engineering for Earthquakes

Inspired by The Tech Challenge 2019

Who says all the fun has to happen at The Tech Interactive? This DIY engineering activity can be done with inexpensive supplies and things you find around your home!

Introduction

Get ready to shake things up! In this design challenge, you'll engineer a structure and see if it can survive an earthquake you create! Although we are still figuring out how to reliably predict earthquakes in the real world, we can prepare for these disasters by designing structures that are less likely to be damaged or collapse. As earthquake engineers, you'll use materials from around your home to build an earthquake-safe structure. Have fun perfecting your creation as you build a seismically sound structure to withstand your own "earthquake"!

Design Challenge

Part 1: Build a DIY Shake Table that creates reliable "earthquakes" to test your structure.

Part 2: Design and create a structure at least 1 foot high that can survive an earthquake.

Structural engineers focus on the design and construction of structures to ensure they are comfortable for users while being strong and stable enough to withstand a variety of factors from structural loads to natural disasters. **Earthquake engineers** design, analyze and construct structures that won't be damaged in minor earthquakes and avoid serious damage or collapse in a major earthquake.

Subject:
Engineering Design Challenge

Age:
8+

Time:
DIY Shake Table: 5-30 min
Earthquake-Safe Structure: 45+ min

Key Concepts:
Structural engineering, earthquake engineering, design, iteration

Materials

The materials for this challenge are divided into two parts: 1) the DIY shake table and 2) your earthquake-safe structure.

1) DIY Shake Table

Shake tables come in all shapes and sizes, from the world's largest shake table in Japan to the simplest test rig, your hands! Designing the test rig for your structure can be a bonus design challenge! We've included a few examples here to inspire you. Think about the size of your final structure and use whatever you have on hand — be creative!

Option 1	Option 2	Option 3
• Flat, thin surface/ board (hardback book, cutting board, piece of cardboard) • Table/chair or smooth surface	• Two sheets of cardboard (or a similarly rigid, flat material) (approx 8.5"x11") • Ruler/paint stick • Rubber bands/tape • Balls of the same size (tennis balls/bouncy balls)	• A low box or box lid/ baking pan • Rolling/moving items (marbles, small balls, pencils, rice, sand) • A rigid, flat material (cardboard, smaller baking pan, smaller cutting board, hardback book, smaller box)

2) Earthquake-safe structure

The structure can be built from all types of materials. Explore your junk drawer or recycling bin to find unique items. Use the table below as a guide to help you pick out the best tools and materials for your version of the activity. And remember, everything is going to shake!

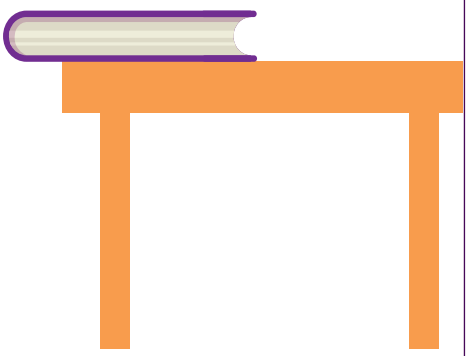
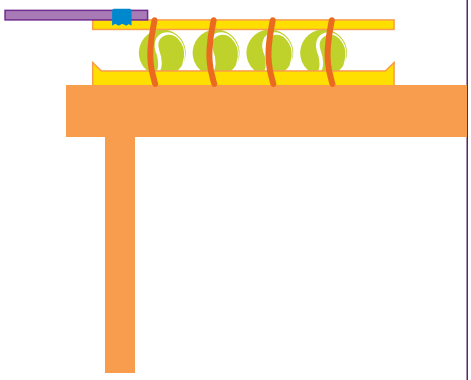
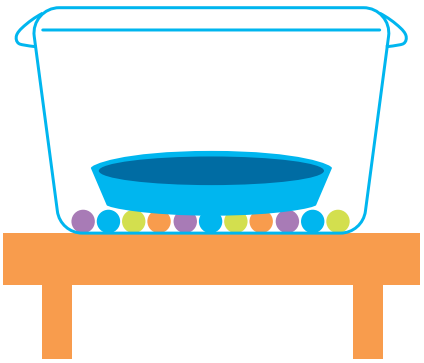
Structural Pieces	Connectors	
• Cardboard, cut into different sizes and shapes • Toilet paper rolls • Paper/plastic cups or plates • Wooden craft sticks • Building blocks (wood blocks, magnet tiles, etc.) • Plastic utensils • Chopsticks/wooden or plastic dowels/pencils • Straws • Paper, junk mail *(Can you engineer this into a strong building material?)*	• Rubber bands • Paper clips • Binder clips • Twist ties	• String • Pipe cleaners/ chenille stems • Tape *(optional)*
	Tools	*(Optional)* **Live Load/Weights**
	• Scissors • Hole punch • Pencil & paper for sketching	• Small toys • Small play-doh/ putty container • Small water bottles • Deck of playing cards

Tip: Try building without tape or glue so you can change your designs faster and reuse materials.

Instructions

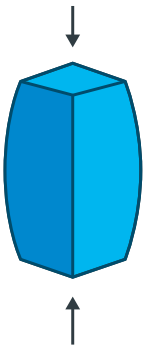
Design and build your DIY Shake Table

Before building your structure, design and build your DIY Shake Table. Use one of the examples below or design your own! You could even try placing your structure on a trampoline, bed or anything else that will shake or vibrate.

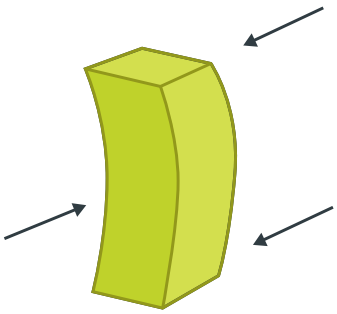
Option 1	Option 2	Option 3
Put the flat surface/board on top of your table or chair. Slide it from side to side to shake it! 	Secure the balls between your sheets of cardboard. Add a handle with the ruler/paint stick. Pull on the handle to shake your "table"!  **Tip:** Secure the bottom sheet of cardboard to a table/chair.	Place rolling items in the bottom of the larger box. Put the flat rigid item on top. Shake the box! 

What happens to structures during earthquakes?

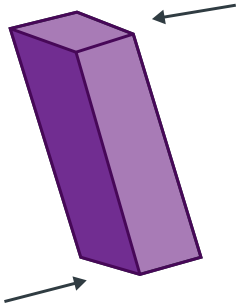
Compression



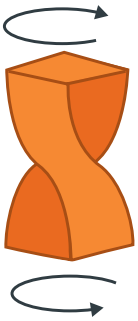
Buckling



Shear



Torque



What causes real earthquakes?

Earthquakes occur when two tectonic plates slip on a fault line and release energy.

Your earthquake story

Before building, think about the story behind your structure: who, what, and why. Your story can be related to the real world or just a fun, whimsical idea.

- **Who/what** is in or around your structure? Why do you need to make your structure stable?
- **What** kind of structure are you building? You do not need to limit yourself to a building — how about a bridge or a cell phone tower?
- **Why/how** is your structure in danger? How will its collapse affect the surrounding community/neighborhood/planet?

Building and testing

Start building right away or try sketching your ideas as you explore your building materials. As you build, think about:

- How do you build a stable structure?
- Are your materials durable and sturdy **and** flexible?
- What kinds of shapes are more stable under pressure? How can they be used in your design? (Test out some ideas from the Strength of Shapes!)
- How do you need to design your base so that your structure is at least 1 foot high? (Make sure your base fits on your shake platform.)

Test and Reflect

Once you have engineered and built your structure, it's time to test it out! Place your structure on your shake table. "Shake" your surface for a few seconds and watch what happens.

- Did it stay upright? What features of your build do you think helped it stay up?
- Did any parts fall off your structure? What were they?
- Did your structure collapse the way you expected? Why or why not?
- Were certain building techniques stronger than others? Certain materials?

Use what you observed to make changes to your design, then keep testing, observing and reiterating.

Tip: During testing, attach your structure to the shake table with binder clips or tape for more reliable results!

Live Load

Try adding a **live load**. A live load is the weight of all the stuff inside a building, like people and furniture. Where you put the live load will affect how the building moves in an earthquake.

- How does the weight affect the stability of your structure?
- Some live loads, like tables, may not be secured within a building. What happens if you secure the live load instead of leaving it free-standing?

Share Your Results! Keep us posted about your progress on social media with **#TheTechatHome**.

Story examples

- An asteroid crashed into the earth near your city. It caused earthquakes under the skyscrapers downtown.
- Godzilla's stomping is shaking the nuclear power plant. Make sure it doesn't collapse and cause a meltdown.
- Keep the cars and trains on both levels of the Bay Bridge safe during the next big earthquake!

Explore More

- **Shake more:** How many earthquakes can your structure withstand? Try shaking your structure longer; how long does it last until it collapses?
- **Add height:** How high can you go before your structure collapses?
- **Need more inspiration?** Check out online examples of dampers, base isolators and bracing! Try to add some of these techniques to your design!

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