Teacher Resource: Shake Platform

This activity is a guide for running a shake table activity with your students, based on Questacon Smart Skills Teacher Workshop 1. Curriculum links are provided at the end of this document, but this hands-on design thinking activity is suitable for students from year 6 to 9.

In this workshop, participants use simple materials to build small scale shake platforms and towers that represent how engineers and scientists test building structures under earthquake-like conditions. Engineers usually test structures until they reach seismic failure (i.e. collapse at different degrees of movement) and they analyse data to further test and strengthen buildings against collapse in earthquake-prone areas.

The workshop’s two part hands-on design thinking challenge includes the construction of a desktop-sized shake platform then building a tower on the shake platform that survives and collapses at different degrees of shaking (seismic failure). The activity encourages participants to observe, try and refine different prototype designs, modeling the innovation process and developing creative problem solving skills. The activity also incorporates a smart phone app which roughly displays the amount of shaking according to the Mercalli Scale.

Resources and requirements

Any available materials can be used to build the shake platform and a tower, but the suggestions below offer a starting point. Feel free to adapt or limit materials according to your students’ needs, confidence and maturity:

- Stiff boards such as old arch lever folders, small pieces of plywood, plastic Frisbees, etc.
- Drinking straws; wooden skewers; paddle pop sticks; toothpicks; dry spaghetti
- Plasticine; BluTac; elastic bands; stockings; yoga resistance bands, etc.
- Marbles; squash balls; ping pong balls; wooden balls, etc.
- Sandwich bags; sand; paper clips; balloons, etc.

You may choose to limit the amount of tape to 1.5 metres per group, or use a length of tape equal to the length of the desk they are working on, or not use hot glue, etc. To bring more maths into this STEM activity you could even develop a materials budget for your students to follow.
Optional smart phone or tablet app

Smart Tools (no affiliation with Questacon Smart Skills) produces a range of apps for smart phones/tablets, available through Google Play or iTunes store either for free (with adverts and reduced features) or for approximately AUD4.00 for the full suite of apps. During this workshop, we use Smart Tool’s vibrometer which represents the Mercalli Scale. The Mercalli Scale is used to measure the magnitude of earthquakes within populated areas.

These apps take advantage of the built-in sensors within the phone and turn them into readable and usable outputs. Once you’ve used the vibrometer, check out some of the other measuring tools within the app.
# Shake Platform Activity

**Introduction**

Introduction to the activity, including how scientists use large scale, controllable platforms to test seismic failure of building structures. The largest seismic testing platforms are typically found in earthquake prone areas like Japan, China and California. Check out some videos of real life examples at this [YouTube shake table playlist](https://www.youtube.com/playlist).

**Part 1: Build a shake platform**

Working in groups of two or three, create a ‘shake platform’ that fits on a desk or table top. Try setting a limit of using only four different types of materials (in any volume). Attachment material such as masking tape or hot glue isn’t included in the material limit.

The shake platform’s movements must be controlled by hand. Test and refine the shake platform design. Initially you may just aim to make the table shake back-and-forth and side-to-side, but if this is achieved easily, try and make the table shake up and down too.

**Introduction to Smart Tools vibrometer app (smart phone or tablet)**

Place a smart phone or tablet containing the Smart Tools vibration app onto your shake platform. Shake your platform by hand and observe how the vibration app detects movement.

The effect of an earthquake on the Earth’s surface is called the intensity. The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture, damage to chimneys, etc.

While the magnitude of earthquakes are often reported against the Richter Scale, scientists also used the Modified Mercalli Intensity Scale. The correlation between earthquake magnitude and intensity depends upon:

- the depth of the earthquake
- surrounding terrain
- population density
- building density and observable damage.

Source: [The Modified Mercalli Intensity Scale, US Government](https://www.nndc.buffalo.edu/intensity/)

**Part 2: Build a tower**

Build a tower for your shake platform using up to four materials of your choice and attachment material such as masking tape or hot glue. Other guidelines may be more suitable for your students, but during this workshop, we set the following parameters.

Your tower must:

- a) be fixed at its base to the shake table
- b) be at least 30 cm high
- c) hold a 100 g mass around mid-way
- d) survive shaking on your ‘shake table’ up to Mercalli V BUT topple over at Mercalli VIII.
To increase the challenge for students, try one of the following options mid-way through the tower build session (depending on how you think your students will respond).

- **a)** Ask whole groups to move clockwise to the next table and keep working on that next group’s tower
- **b)** Ask 1-2 people from each group to move to a different group and work on the new group’s tower with existing members who stay in place
- **c)** Tell groups to return one of their remaining materials to the supply table, so groups are limited to whatever material is left on their desk

These techniques help participants to avoid over analysing their model and encourage participants to undertake more hands-on testing through trial and error. It also offers opportunities for older groups of students to see how other groups changed their model and whether there were unexpected changes at the end of the session.

### Wrap-up

Each group demonstrates/tests their shake table and tower for the group and reflects on:
- How they went about designing and testing different models
- What worked well, what didn’t work well?
- How would you improve those designs given more time or resources?

### Possible extensions

Disaster relief architecture is a large area of research and development. For example, Hexayurts are transported and delivered as flat packs, so hundreds can be delivered to refugee camps, etc. for emergency shelter and transitional housing. A Plywood Hexayurt costs around $100 and takes a few hours to erect, with few loose parts. Painted plywood Hexayurts are believed to last for up to three years and can withstand strong winds and rains as well as earthquake aftershocks. Students could build model Hexayurts to test on a shake platform.

Explore the [resource area for teaching (RAFT) website](https://www.raft.org.au) and try and recreate their build designs for an unmotorised shake table and a motorised shake table.

Turn a desk/table upside down onto semi-inflated balloons to make a giant shake table (hold the table’s legs to control movement). Use the giant shake table to build larger or interconnected buildings and test larger or interconnected towers.

Place cornflour slime (2 parts cornflour: 1 part water) inside a large zip-lock bag. Expel all the air and seal the bag. Place it under the tower (on top of the platform) to represent liquefaction of soil during an earthquake.
Curriculum Links

Australian Curriculum: Science

Science Inquiry Skills Strand
This workshop’s activities relates to Science Inquiry Skills across all years by encouraging:

• Questioning and predicting
• Planning and conducting
• Processing and analysing data and information
• Evaluating
• Communicating

Science as a Human Endeavour Strand
If this workshop is extended to research and discuss the challenges faced by engineers in prototyping and developing earthquake-resistant structures such as buildings and bridges, it links to the Science as a Human Endeavour Strand.

Science Understanding Strand
This activity links to Physical sciences units in the Science Understanding Strand. The activity can be used to investigate physical forces tectonic plate movements and their impact on human-built structures, properties of materials and the effects of gravity and objects in motion (e.g. cars on bridges).

Years 7 and 8 Physical sciences
Change to an object's motion is caused by unbalanced forces acting on the object (ACSSU117)
Earth's gravity pulls objects towards the centre of the Earth (ACSSU118)

Years 9 and 10 Physical sciences
The motion of objects can be described and predicted using the laws of physics (ACSSU229)

Years 9 Earth and space sciences
The theory of plate tectonics explains global patterns of geological activity and continental movement (ACSSU180)
**Australian Curriculum: Design and Technology**

**Knowledge and Understanding Strand**

**Years 7 and 8**

Analyze how motion, force and energy are used to manipulate and control electromechanical systems when designing simple, engineering solutions (ACTDEK031)

Analyze ways to produce designed solutions through selecting and combining characteristics and properties of materials, systems, components, tools and equipment (ACTDEK034)

**Years 9 and Year 10**

Investigate and make judgments on how the characteristics and properties of materials are combined with force, motion and energy to create engineered solutions (ACTDEK043)

Investigate and make judgments on how the characteristics and properties of materials, systems, components, tools and equipment can be combined to create designed solutions (ACTDEK046)

Investigate and make judgments, within a range of technologies specialisations, on how technologies can be combined to create designed solutions (ACTDEK047)

**Processes and Production Skills Strand**

**Years 7 and 8**

Critique needs or opportunities for designing and investigate, analyse and select from a range of materials, components, tools, equipment and processes to develop design ideas (ACTDEP035)

Generate, develop, test and communicate design ideas, plans and processes for various audiences using appropriate technical terms and technologies including graphical representation techniques (ACTDEP036)

Effectively and safely use a broad range of materials, components, tools, equipment and techniques to make designed solutions (ACTDEP037)

**Years 9 and 10**

Critique needs or opportunities to develop design briefs and investigate and select an increasingly sophisticated range of materials, systems, components, tools and equipment to develop design ideas (ACTDEP048)

Apply design thinking, creativity, innovation and enterprise skills to develop, modify and communicate design ideas of increasing sophistication (ACTDEP049)