Teacher Guide

3D modelling - Thinking inside the box Practical Activity

About the activity

This practical activity is supported by the video "A Snowy 2.0 3D experience". Watch this video first and pause when prompted for this activity.
This hands-on activity introduces students to the engineering challenge of constructing a power station underground, just like Snowy 2.0. Working in pairs, students have 10 minutes to first design and build a model power station on a specified footprint size, just like they would have to if building a power station anywhere. This activity has two options (or a combination of both;

1. Either using simple materials like cardboard, paper, and popsticks or;
2. If available to you, a Lego board and lego building bricks.

Students' models must include key features such as turbines and components of varying heights.

Once built, students are presented with the size of the cavern that their power station must fit; a box with a small circular opening simulating an underground access tunnel. The challenge: their power station has to be constructed *inside* the box, only by transporting their power station components via the tunnel! Students will then have 5 minutes to **plan only** how they'll break down and rebuild their model within the confined space, but without touching it. The will then rebuild the power station from their plan.

Students will then brainstorm what kinds of things they would need to know about the components of the power station, such as dimensions, as well as what can and cannot be taken apart. They will consider the pros of ease of transport and construction within the confined space against the cons of having integral parts of the power station that are taken apart and put back together, including weaknesses in joins, construction time and effort, etc..

This engaging challenge emulates how Snowy Hydro recognised that significant planning needs to go into not just what is in the power station, but how to transport it there and how to build it. With spatial reasoning, design thinking, collaborative problem solving and thinking outside the box to think inside the box.

Following the practical activity, one of Snowy Hydro's experts in 3D modelling, Lachlan Marks will introduce the power of 3D modelling that was used by Snowy Hydro in building Snowy 2.0 as a 3D model first and the ease of using the 3D model to create 2D models to communicate how to build each component to the relevant experts via the supporting video.

Teacher guide

Year level: years 7-10. Use the extension activity to cater to year 10-12 students for extra challenge and relevance.
Group size: 2-3 students per group.
Timing: 25-30 mins for core activity, plus allow 25-40 mins if engaging in extension activity
Two options for build: Option A - Craft materials build, Option B - Lego build. Of course a combination of both is feasible too.

Materials required

Option A - Craft materials

- Cardboard offcuts
- Cardboard rolls (paper towel rolls or similar)
- Popsticks
- Sticky tape and masking tape
  Glue (optional)
- Blu-tack or plasticine
- Straws or small tubes (for water pipes)
- Paper (scrap and A3 sheets for diagrams)
- Round, flat objects (e.g. jar lids, soft drink bottle caps, playdough disks) to simulate turbines
- Cylindrical objects (e.g. small cans, mini yoghurt tubs) to simulate generators
- Rulers and/or measuring tapes
- Scrap paper for planning and notes in stage 2
- *If also conducting extension activity: A3 blank sheets of paper for diagrams*

Option B - Lego Build

- Lego baseplate roughly A4 size
- Assorted bricks, flat tiles, etc
- Wheels (optional – can represent turbines if placed flat)
- Clear or coloured bricks to simulate pipes
- Rulers/tape measures
- Scrap paper for planning and notes in stage 2
- *If also conducting extension activity: A3 sheets and graph paper for diagrams*

For both Options A and B

You will need a cardboard box that will represent the cavern in the power station that needs to be built in. This box will represent the limitations of building a power station underground, including both the size and access to the cavern.
Students will not build within this box, but will need to plan to build within the box, so having one box between 2-3 groups for measuring will be adequate.
To prepare boxes, we suggest:

- An open bottom to be able to fit over the top of the students' initial builds, and an openable top (or cut off top) to enable seeing into the confined area.
- The box should be slightly larger than a shoebox to allow for height of turbines and generators
- An A4 paper reem box could be a great fit
- Circular hole cut in any side to simulate tunnel entrance (must be slightly **larger than the largest turbine cylinder** to ensure it *can* fit through)

Set up instructions

Prior to lesson

Cut a circular hole on one side of each box.
Ensure the hole size is just larger than the widest turbine cylinder (but not too large so students still have to plan).
Students should not be shown the boxes for the first section of the activity

Start of lesson - Set up student work areas

On each bench space, provide

- Materials that can be used to build the station - we recommend setting up 3-4 stations around the room with varying craft materials that students can go to, rather than setting up each individual group with kits, although this may save time.
- Use an A4 sheet of paper or a lego build board to clearly give the footprint for the power station.
- Scratch/scrap paper for planning. Graph paper recommended.
- Rulers and tape measures.

Activity instructions

Part 1: Build a power station (10 minutes)

Students must build their model power station on the provided footprint (either A4 paper base or LEGO baseplate). Depending on time and your class, you may like to allow students 2 minutes planning time prior to their 10 minute build time.

Emphasise that the power station has to be sturdy and able to stand on its own.

The station must include the following features:

- **3 circular turbines** (flat on the ground)
- **Each turbine must have a cylindrical generator** placed **10cm above it**
- **Each turbine must have:**
    - One **inlet pipe** (straw/tube) coming in from the edge of the footprint and connecting to the turbine
    - One **outlet pipe** going from the turbine out to the edge of the footprint
- Students may use any materials available to support and stabilise structures.

Part 2a: thinking inside the box (5 minutes)

Introduce the confined space: the box with a single tunnel entrance. Students cannot touch their power station or the box apart from measuring their power station pieces and the tunnel entrance and height of the box. In this section of the activity, students need to **create a plan** to get their power station, which is currently outside the box, inside the box and rebuild it once the pieces are in there.

Their challenge:

- Plan how they would take their model apart and fit each component through the tunnel.
- Think about:
    - What could **fit through the tunnel**?
    - What would **need to be deconstructed** to fit through the tunnel and then rebuilt once inside?
    - How would they **rebuild** everything inside the box?
    - The **order of assembly,** to ensure that once a piece is rebuilt, it can't be moved around to build other things.

Students should:

- Use rulers to measure pieces
- Jot down notes and diagrams on scratch paper
- Consider size, fragility, and ease of reconstruction

Part 2b: executing the plan (5 minutes)

Set a timer for 5 minutes viewable to the students. Give students 5 minutes to recreate their power station by passing all of their parts through the hole in the power station and reconstructing within the cavern.

Group and class reflection (5-10 minutes)

Facilitate a class discussion around:

- What information did you need to know to do this successfully?
- What else would you need to know in real life?
- What could and couldn't be taken apart and how did you navigate this?
- What are the trade-offs in breaking up parts of the structure?
    - E.g., ease of transport vs. risk of weakened joins
    - Construction time vs. simplicity

Encourage students to connect these ideas to real-world infrastructure and construction projects, especially those with limited access or built underground. (This will be further discussed in the video.)

Optional extension: Turning 3D into 2D (20-40 minutes)
Ideal for year 10-12 engineering classes

Task students with creating drawings (plans/diagram-only instructions) to show another team of people how to build their power station in the box via the tunnel. They can use as many 2D plans as they like that show varying perspectives of constructing the final product, but no written 'step-by-step' instructions are to be given.

- Use 2D visual plans only. No written step-by-step instructions.
- Consider what each drawing is showing the constructors and ensure its labelled appropriately.
- Include:
    - Scales, where relevant
    - Colour coding
    - Numbered and labelled parts of the final constructed products
- They can use multiple A3 sheets to represent different angles or stages.

This activity simulates how Snowy Hydro uses 3D models to generate precise 2D plans to communicate with engineers and construction teams.