



Guide the Tunnel Boring Machine (TBM)

An ICE do-at-home activity for ages 4-18

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Background

TBM stands for **tunnel boring machine** which is a special machine engineers use to dig really big tunnels; for example to make the path for underground trains and sewers. The first thing engineers do in a project like this is they dig a giant hole in the ground called a **drive shaft** then they slowly lower in parts of the TBM and complete the building of the machine underground.

It's a very delicate operation dealing with the huge TBM parts and the engineers managing it need to ensure that it's done with great precision so that nothing is damaged and the project isn't delayed.



Photo: AP Photo/Ted S. Warren from nationalpost.com

What you'll need

Suggested resources – but feel free to use similar alternatives.

Biscuit tin (drive shaft)
Egg (TBM)
Sellotape
Pipe cleaner
Cardboard
Several toilet roll tubes
Balloons (uninflated)
Stopwatch and tape measure

The challenge

Your task is to see if you can lower a TBM part (the egg) into the drive shaft without it breaking. To make sure your TBM survives the drop you will need to devise a protective cover out of the material provided. (TBMs aren't dropped in real-life but carefully lowered of course!)

1. Give yourself 10 minutes to make your protective cover for the TBM. Here are some top tips...
 - Will you have a 'crumple zone' that absorbs the impact of the drop?
 - How will you keep the TBM the right way up on its descent / stopping it turning/spinning?
 - Which materials that you've got will provide the most cushioning?
 - What is the best way to secure the protection around your TBM on its way down?
2. Drop your TBM with its protective cover from a height of 1m into the biscuit tin (your drive shaft).
3. Examine your TBM – is it whole or are there any cracks? Perhaps it's broken into two or more pieces? Think about how well your protection worked (or didn't!). What would you do differently next time? Have another go if you want to improve your outcome, and don't forget to take a photo of your TBM to show us!

For 11-16 year olds

Extra challenge 1: See if you can increase the height to 2m and still protect the TBM (egg) from being broken.

Extra challenge 2: Engineers have to know the specifications of everything they build and move to be successful. Can you work out the volume of the egg by using the water displacement method (you may have heard the story of Archimedes' 'eureka!' moment in the bath)?

1. Place a cup in a clean, empty bowl and fill the cup to the brim with water.
2. Drop the egg whose volume you want to measure into the cup. It will sink to the bottom, and water will spill out of the cup and into the bowl.
3. Pour the water from the bowl into a measuring cup. The volume of water that you collect equals the volume of the egg.

[For an extra challenge you can work out the volume of the egg by using just a [calculation](#) instead.]

For 16-18 year olds

Extra challenge 1: See if you can increase the height to 3m (you may have to drop it from a stair or use a safe and stable stepladder to gain the extra height – don't do this on your own!) and still protect the TBM (egg) from being broken.

Tell us what you thought!

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Civil engineering project case studies: [ice.org.uk/what-is-civil-engineering/what-do-civil-engineers-do](https://www.ice.org.uk/what-is-civil-engineering/what-do-civil-engineers-do)

Civil engineer (people) case studies: [ice.org.uk/what-is-civil-engineering/who-are-civil-engineers](https://www.ice.org.uk/what-is-civil-engineering/who-are-civil-engineers)

Info about all types of engineering careers (not just civil): Tomorrow's Engineers
[tomorrowsengineers.org.uk](https://www.tomorrowsengineers.org.uk)