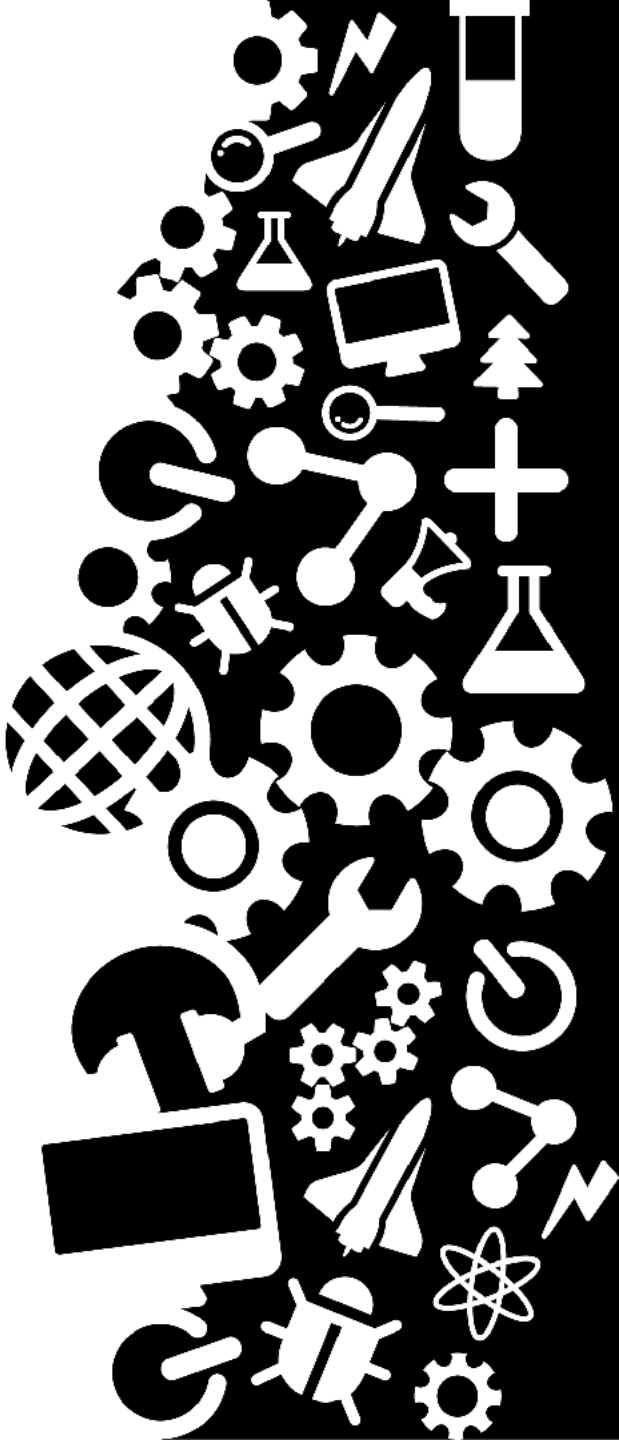
Engineering For Families

A six-week teacher-led after school club for families.

Developed by NUSTEM

Northumbria University NEWCASTLE

nustem



Engineering For Families

Course notes, slides and background information.

Everything you need to deliver the course in your school.

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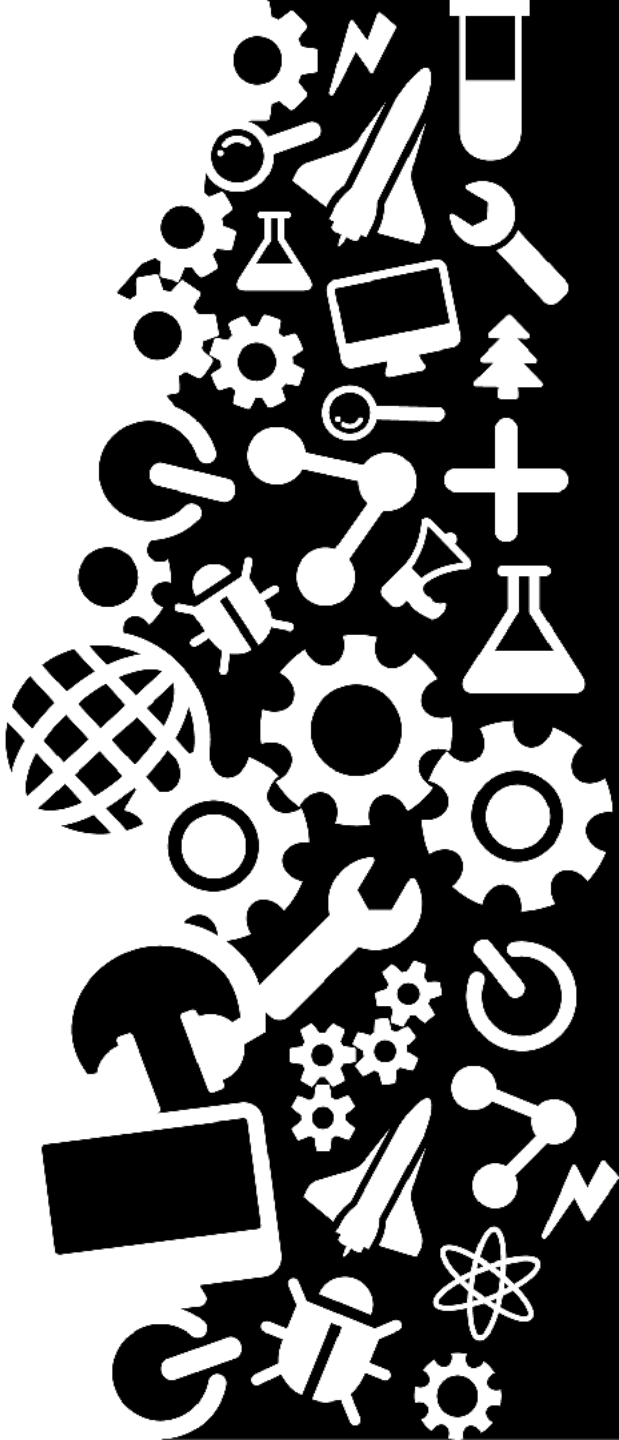


About NUSTEM

NUSTEM is an outreach and research group based at Northumbria University in Newcastle. Working with schools and teachers we develop activities and resources that support teachers to showcase careers to children, young people and families.

We believe that by supporting children, families and teachers to identify how their personal characteristics align with the characteristics of people that work in STEM, children (and their influencers) will feel more confident that a career in STEM is for 'people like them'. Alongside this, NUSTEM shows the breadth and application of STEM in the world around us.

To find out more about NUSTEM please visit nustem.uk

NUSTEM's vision is for a vibrant and sustainable STEM sector which meets the needs of learners and employers, reflecting the diversity of wider society.

Engineering for Families Overview

Engineering for Families is a 6-week, extra-curricular STEM club for children in Upper Key Stage 2 and their families.

Each week families are encouraged to solve real-world engineering challenges based around 5 engineering disciplines.

During the course, families develop their understanding of Engineering and develop their engineering and craft skills.

The original development of the resource was funded by the Platten Family Fund at the Community Foundation.

Engineering for Families Training Video

Click here to view the training video which gives more information about the ‘builds’ in the sessions:

https://www.youtube.com/watch?v=iMf97dhOAzM

We recommend that you watch the video before planning and delivering the course.

Note: the video will open Youtube in a browser window

Engineering for Families: how it works

Each 1-hour session is based around a specific field of engineering with two or three linked activities.

The activities in each session allow for families to develop their engineering skills and practice working together as a team. Each week the activities increase in their complexity, culminating with a final activity in week 6 that draws upon many of the skills they've learned along the way.

The objective of each session is to prompt meaningful exploration of the engineering ideas through activities. There are no 'right answers' and learning from mistakes is a key part of the process.

Engineering for Families: preparation

Inviting Families

The sessions work well with a small number of families (5-10). this will ensure that they have space to work, and that you can spend enough time with each group. Make sure to invite them well in advance of the session. Give clear guidance about where and when it takes place, and what will happen.

Setting up the space to create

Make sure you run the activity in a room with enough space for the participants. Setting the room up in-the-round so that families are facing inwards towards a central point allows them to see and learn from the successes and failures of other groups.

Provide easy access to all the materials that are available for each session and make sure there are ample resources so that families don’t need to share.

Facilitating a session

Facilitators of the sessions should use a hands-off approach. As there are no ‘right answers’ to the challenge activities, families should be encouraged to explore any solutions that interest them.

The activities within each session increase in difficulty and ideas explored in early activities will support families’ success in the later ones.

To help families get the most from the sessions, facilitators should:

- provide easy access to all the equipment on the equipment list.
- use questions (see next slide) to help families explore ideas.
- provide encouragement throughout the activities.
- encourage collective participation between parents and children
- build alongside families, but don’t do the work for them; show them possibilities without providing final solutions.

Questions to ask during sessions

- Explain to me what you're doing?
- What have you learned from that?
- Can you rebuild it differently using what you have learned?
- What will/won't you do next time?
- Why does/doesn't that work?
- How could you change that?
- Do you think … would work?
- What would happen if you used …?
- Why/where did that fail?
- How could you make it stronger / faster / bigger?
- Where do you think that might fail?

Make sure that you ask the questions to both the children and adults in each group and expect them both to answer!

Session 1: The Structural Engineer

This week you'll be a **Structural Engineering** designing and building towers.

Resources

- Activity 1 – Towers
  - Index Cards
- Activity 2 – Towers Again
  - Large lolly sticks
  - Bulldog/Binder clips
- Activity 2 – Build your own Towers
  - All of the above
  - Masking Tape
  - A paper cup
  - Some marbles

Activity 1: Build a Tall Tower

Using only Index Cards build a tall tower.

Things to think about:

Try out lots of different ideas.

When you've finished one idea, dismantle it and rebuild.

What makes a tower strong or weak?

Can you predict where it will fail?

The Burj Khalifa, UAE.
Image by Francisco Anzola

One World Trade Centre, USA.
Image by Phil Dolby

Activity 2: More Towers

You've been given some new materials. Use these to build another tall tower.

Things to think about:

This is a more challenging build, talk with your family about your ideas.

Make sure you work together.

If an idea doesn't work, take it apart and try again – you can learn lots from the things that go wrong!

The Shanghai Tower , China.
Image by ronghualo

Activity: A Final Tower

Now use all the materials, to build a tower that hold a paper cup 30cm above the ground (or table top). When you've built it, see how many marbles you can put in the cup before the tower fails!

Things to think about:

Use the skills you've learned from the last two activities.

Try out different ideas, and change your design as you go.

Talk about where your tower might fail and how you can fix it before it does!

Engineering at Home

This weekend take your tower building skills to the next level. Make a tall tower using only newspaper and sticky tape (or masking tape).

Take a photo of your engineering creation and bring it in next week.

Session 2: The Civil Engineer

This week you'll be a **Civil Engineer** designing and building bridges.

Resources

Activity 1:

- A3 or A4 paper
- Index cards
- Masking tape
- Scissors

Activity 3:

- Drinking straws
- Large lolly sticks
- Binder clips
- Paper
- Pencils
- Toy cars
- String
- And the Activity 1 materials

Activity 1: Build a Bridge

Using the resources provided, build a simple bridge.

Things to think about:

Try building bridges in a few different ways.

When you've tried an idea, dismantle it and try something new.

Think about failure – where might your bridge collapse, why?

Activity 2: Exploring types of bridges

Use the images on the next two slides to talk about different types of bridges with your family.

Things to think about:

How are the bridges similar to one another?

How are they different?

What holds the bridge up and stops it from collapsing?

Do you recognise any of the bridges?

The Tyne and Swing Bridges, England.
Image by Neil Turner

The Tyne Bridge,.
Image by Bob Castle CCA-SA3.0

The Tyne Bridge,.
Image by Heworthjb CCA-SA3.0

The Gateshead Millennium Bridge.
Image by Carol Davenport CCA-SA3.0

The Swing Bridge and High level Bridge.
Image by Tagishsimon CCA-SA3.0

Telford Bridge, Morpeth.
Image by Pete Reed CC BY NC

The Humber Bridge
Image by Tonyharp CCA SA 3.0

Middlesbrough Transporter Bridge
Image by Jon Oakley CCA 2.0

The Millennium Bridge opening
Image by Mike1024

Activity 3: Build a Road Bridge

Use the new materials to build a road bridge. This bridge should span the length of an A4 piece of paper and allow a toy car to drive onto and over it.

Things to think about about:

Did you get any ideas from Activity 2? How can you use them in this design?

Try planning and drawing your bridge first before you build it.

Test it out as you go.

How will the toy car get onto and off the bridge?

Tower Bridge. London, England.
Image by a.canvas.of.light

Engineering at Home

This weekend take your bridge building skills to the next level.

Build a bridge from materials you have around the house.

Can you find any examples of other types of bridges in the local area?

Take a picture of your homemade bridge or a bridge near you and bring it to the next session!

Session 3: The Aeronautical Engineer

This week you'll be an **Aeronautical Engineer** designing a building gliders.

Resources

Activity 1: Fish Tumblers

- A4 paper
- Scissors
- Ruler
- Pencil

Activity 2: Hoop gliders

- Bamboo Skewers
- Masking Tape
- A4 paper
- Scissors

Activity 1: Fish Tumblers

Build a Fish Tumbler and then practice flying. Then change different parts of your design to see how it affects the tumbler.

Things to think about:

What will you change about your design? Length, width, position of snips?

What makes a good or bad glider?

Make sure everyone has a go a designing, building and flying their tumbler.

Activity 2: Hoop Gliders

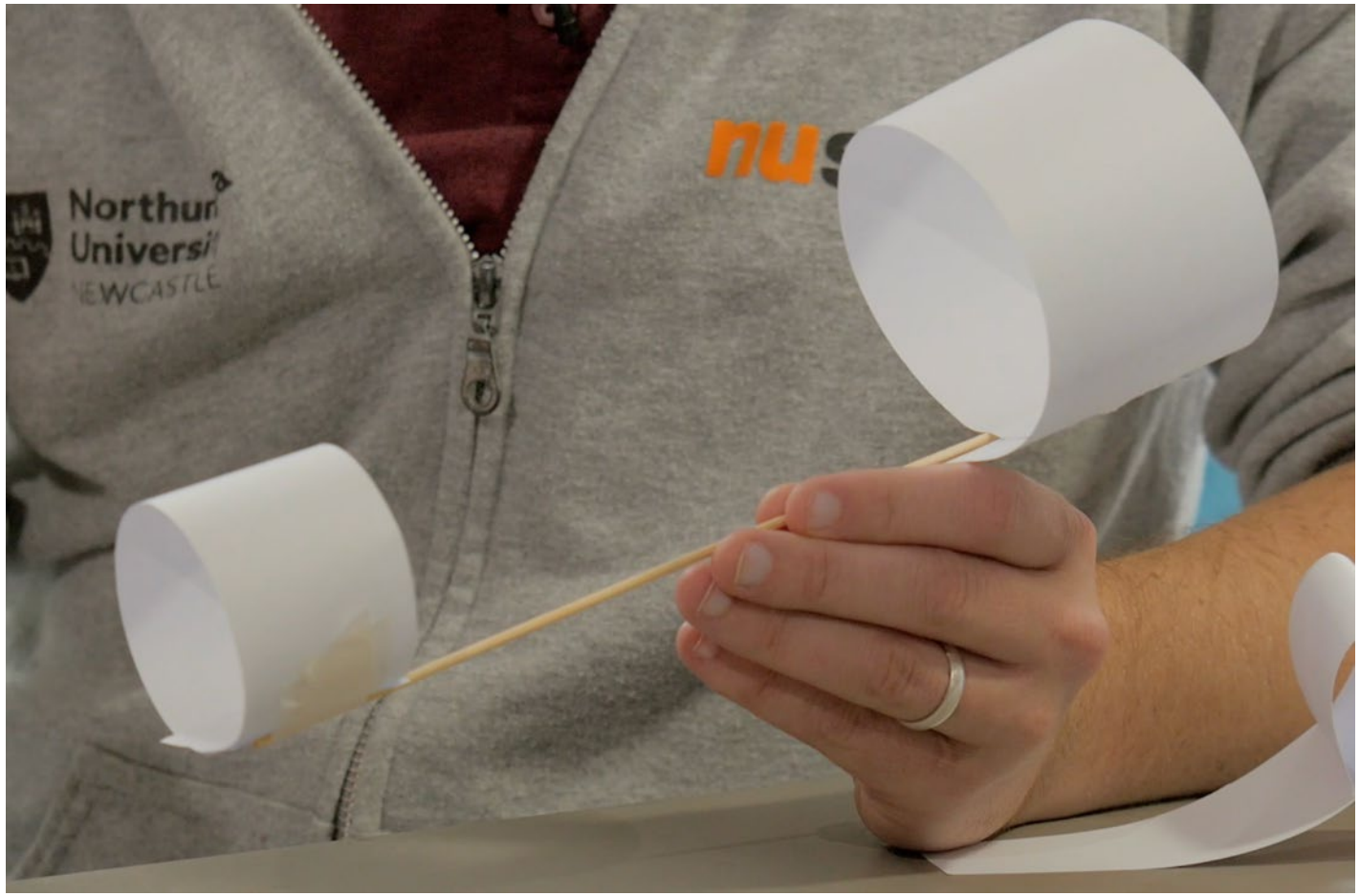
Now build a hoop glider and experiment with different designs to find out which glides the furthest.

Things to think about:

Experiment with a few different designs? Use different hoop sizes, more than one bamboo skewer – what works best?

Try things out and if they fail, learn from them to make a better version.

Make notes about your different designs.



Engineering at Home

This weekend practice flying your gliders!

Take a video of your flight and bring it in next week.

Session 4: The Automotive Engineer

This week you'll be an **Automotive Engineer** designing and building vehicles.

Resources

Activity 1

- Post-it notes
- Cardboard
- Masking tape
- Bamboo skewers
- Scissors
- Large straws
- Small straws
- Paper
- Pencils

Activity 2

- Balloons
- Rubber Bands
- Duct tape

Activity 1: A Carriage that Rolls

Use the materials provided to build a carriage that rolls along the ground.

Things to think about:

How can you make circular wheels?

What might you use to attached the wheels securely and make sure they roll easily?

Try out different ideas, test them and learn from any mistakes.

Trabant 601, 1963
Image by stanze

Activity 2: A Powered Vehicle

Now use a balloon or elastic bands to power your vehicle. You want to make a carriage that will roll without you pushing it!

Things to think about about:

This is tricky – think about different solutions and discuss which you think will work best.

Then test out your ideas. They might not work first time, so learn from your mistakes and then build and test again.

You'll really need to work together in this activity.

Scalextric TR7
Image by Phil Parker

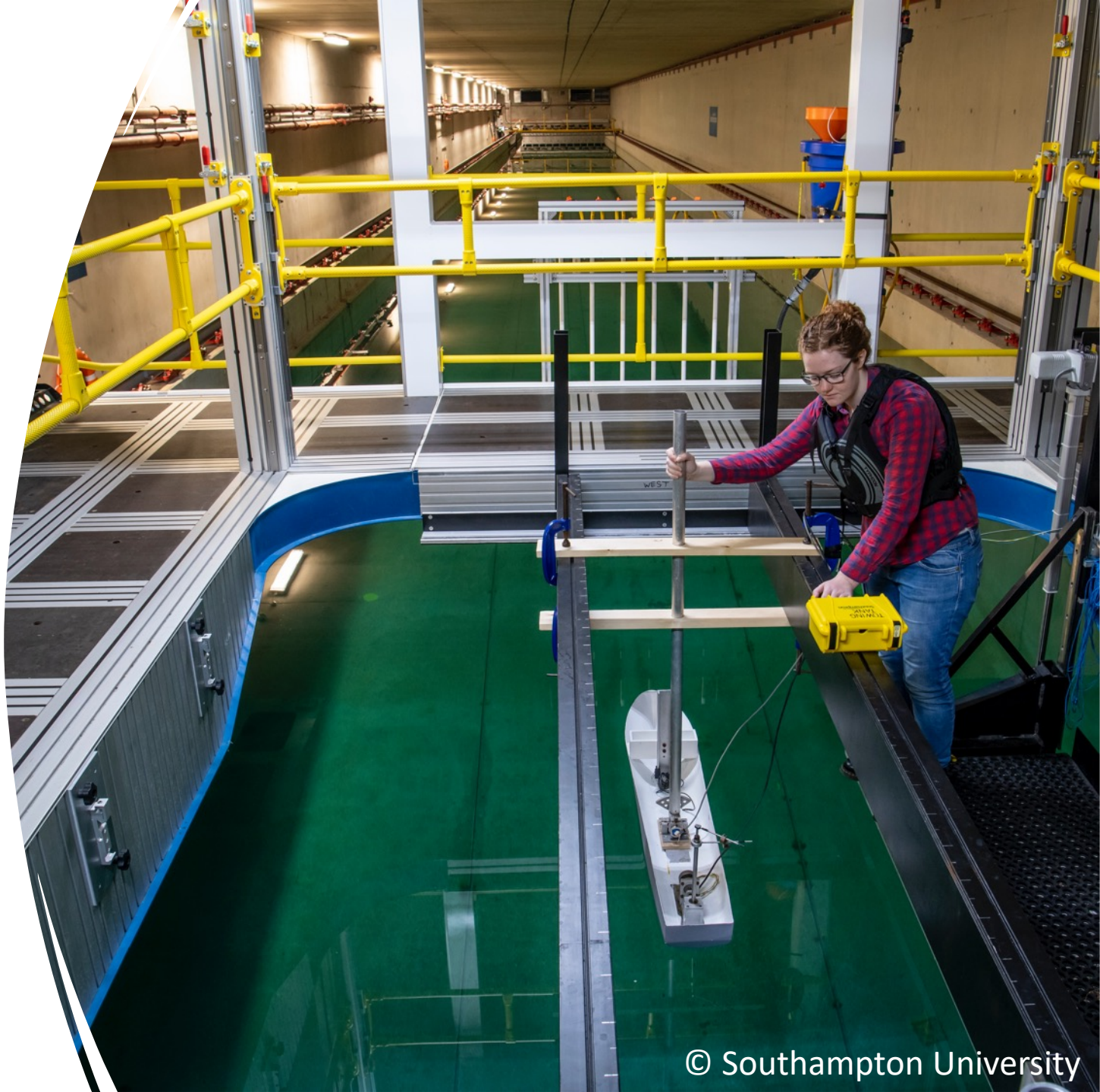
Engineering at Home

This weekend, can you build your next automotive creation? Can you increase the speed or use bigger wheels? How about designing the body of the vehicle too?

Take a photo of your engineering creation and bring it in next week.

Session 5: The Marine Engineer

This week you'll be a **Marine Engineer** designing and building boats.



Resources

Activity 1

- Water troughs
- Cardboard
- Masking tape, Duct tape
- Bamboo skewers
- Scissors
- Cling film, Foil
- Paper

Activity 2

- Elastic bands

For cleaning up

- Bucket
- Siphon tubing
- Cloths and towels

Activity 1: build a boat that floats

Use the materials provided to build a boat that floats and is waterproof.

Things to think about:

You can make a lovely cardboard boat – but what is going to happen when you put it into the water?

Experiment with different ways of water proofing your boat.

Keep experimenting a test your design in the water trough.

Look for points of failure, and plan for them.

Fishing boats.
Image by Kosala Bandara

Activity 2: Power Your Boat

Now add power to your boat so it moves along the water without you pushing it.

Things to think about:

Will you use elastic or balloons?

Test out different ideas in the water.

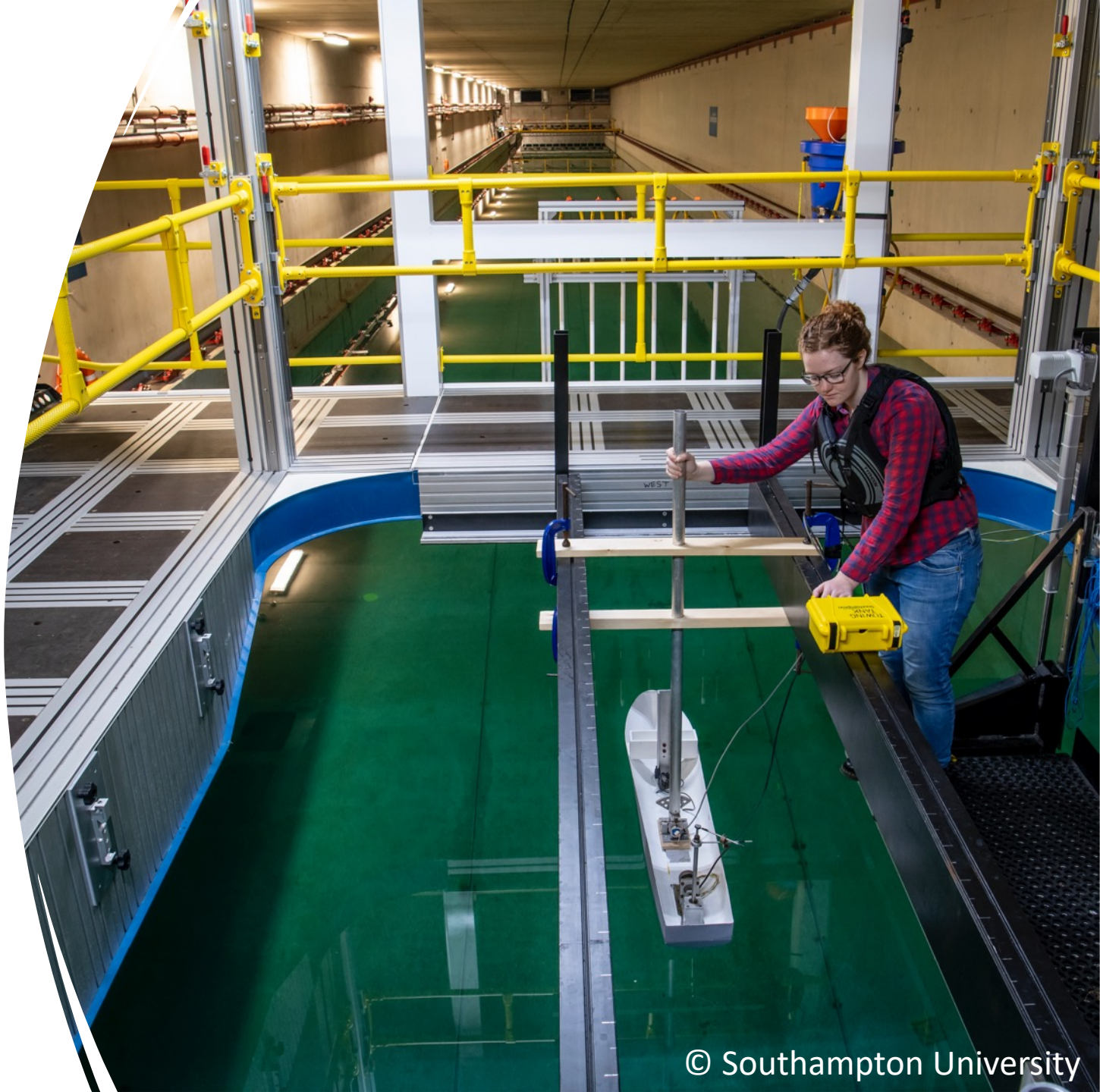
Be ready to build new boats quickly if everything gets a bit soggy.

Steamboat Natchez, New Orleans.

Engineering at Home

This weekend take your boat building skills to the next level. Can you build a new powered boat and use it in the bath?

Take a photo of your engineering creation and bring it in next week.



Session 6: Engineering Design Challenges

This week you'll combine different types of engineering to solve engineering design challenges.

Resources

For this session you'll need all of the resources from the previous sessions.

Solve one of these challenges

Amphibious vehicles

Using your **automotive** and **marine engineering** skills to design, build and test a vehicle that can move on land and water.

Moving bridges

Using your **civil** and **structural engineering** skills to design, build and test a bridge than can open and close to let an object pass underneath.

The Swing Bridge and High level Bridge.
Image by Tagishsimon CCA-SA3.0

Finally…

We hope that you enjoy using these resources provided by NUSTEM.

We'd love to hear how you've used them.

Do get in touch: nustem@northumbria.ac.uk