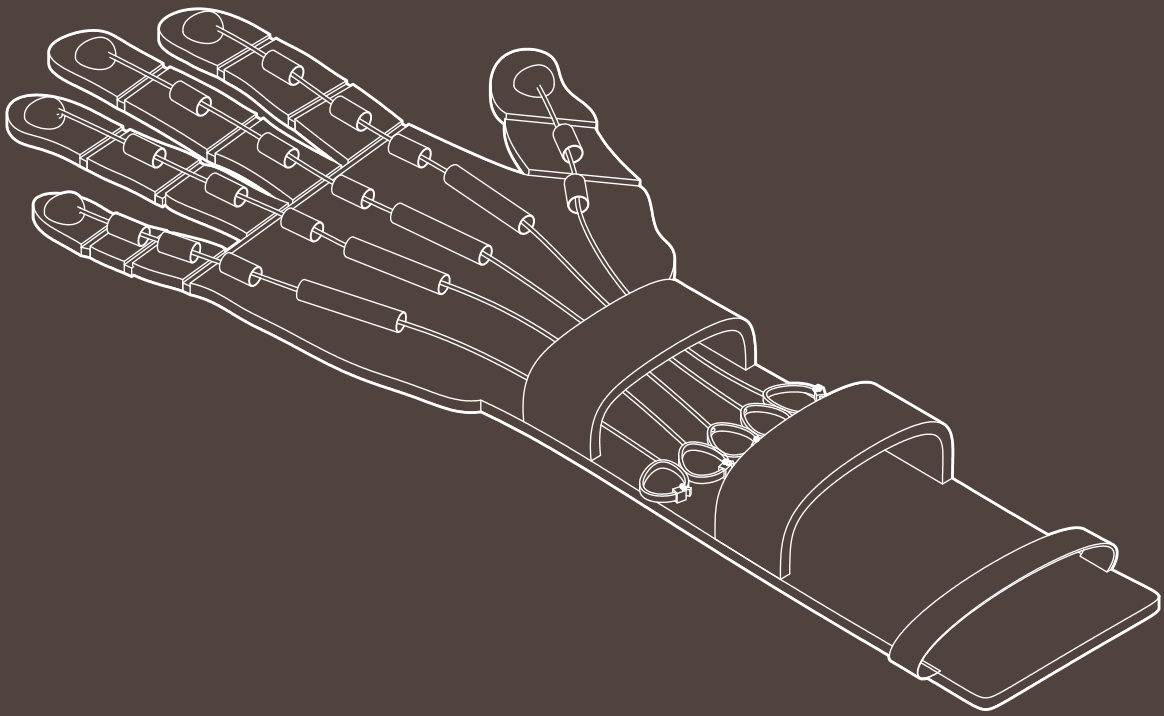


CHALLENGE

MECHANICAL HAND

The Mechanical Hand build is a creative engineering activity that challenges students to construct a working mechanical hand using everyday household items.



TEACHING NOTES

SUMMARY

The Mechanical Hand session will challenge students to design and build a working model of the human hand, with fingers that can move independently.

This project will allow students to take a deeper look into the biomechanical make-up of our hands, whilst taking into consideration how the joint structure and tendons can be manipulated to create different movements.

Working individually or in teams, students will use a few simple materials to create their mechanical hand, whilst ensuring it is stable enough to pick up and stack three empty cans.

At the end of the session, they have the option to complete a short quiz to test their knowledge.

LESSON PLAN

ACTIVITY	DESCRIPTION	TIMING
Introduction	Set out the goal of the session and hand out the student worksheets. Divide them into teams of 2-3, providing a set of materials to each. Students can also work on their own.	5-10m
Warm-up Activity A	Introduce the warm-up activity and ensure students have what they need to complete it.	5-10m
Warm-up Activity B	Introduce the hand structure activity and ensure students have the necessary materials to complete it.	10-15m
Main Challenge	Explain to students that their mechanical hand must be able to pick up and stack three empty cans.	10-40m
Measuring Up	When students have finished constructing their mechanical hand, they will have to test it.	30-40m
Extension Activities	If any of your teams finish their build early, have them try one of the extension activities.	10-15m
Extra Content	We have provided additional educational content for those with enquiring minds.	10-15m
Quiz	Ask your students to complete the quick quiz at the end to test their knowledge.	10-15m
Wrapping Up	Cover discussion points with students to close the session.	10-15m

LEARNING OUTCOMES

Students will learn:

- How to solve an engineering problem.
- How to perform testing on their design.
- How to develop a prototype.
- How to identify and describe the functions of the muscular and skeletal systems.
- How to identify and describe the interaction of forces acting on the prototype.

CURRICULUM

KS1 Design Technology

- **Make** - select from and use a range of tools and equipment to perform practical tasks. For example, cutting, shaping, joining and finishing.
- **Evaluate** - evaluate their ideas and products against design criteria.
- **Technical Knowledge** - build structures, exploring how they can be made stronger, stiffer and more stable.

KS2 Design Technology

- **Evaluate** - evaluate their ideas and products against their own design criteria and consider the views of others to improve their work.
- **Technical Knowledge** - apply understanding of how to strengthen and reinforce more complex structures.

KS3 Design & Technology

- **Evaluate** - test, evaluate and refine their ideas and products against a specification, taking into account the views of intended users and other interested groups.
- **Technical Knowledge** - understand and use the properties of materials and the performance of structural elements to achieve functioning solutions.

KS1 Science

- **Year 2, Uses of everyday materials** - find out how the shapes of solid objects made from some materials can be changed by squashing, bending, twisting and stretching.

KS2 Science

- **Year 3, Animals, including humans** - identify that humans and some other animals have skeletons and muscles for support, protection and movement.

KS3 Science

- **Biology, Skeletal and muscular systems** - biomechanics – the interaction between skeleton and muscles, including the measurement of force exerted by different muscles.
- **Physics, Energy changes and transfers** - other processes that involve energy transfer: stretching a spring.
- **Physics, Energy changes and transfers** - using physical processes and mechanisms, rather than energy, to explain the intermediate steps that bring about such changes.
- **Physics, Motions and forces** - forces as pushes or pulls, arising from the interaction between two objects.
- **Physics, Motions and forces** - using force arrows in diagrams, adding forces in one dimension, balanced and unbalanced forces.
- **Physics, Motions and forces** - forces associated with deforming objects; stretching and squashing springs.
- **Physics, Motions and forces** - forces measured in newtons, measurements of stretch or compression as force is changed.
- **Physics, Motions and forces** - force extension linear relation; Hooke's Law as a special case.
- **Physics, Motions and forces** - balanced forces, opposing forces and equilibrium; weight held by stretched spring or supported on a compressed surface.
- **Physics, Motions and forces** - forces being needed to cause objects to stop or start moving, or to change their speed or direction of motion (qualitative only).
- **Physics - motions and forces** - change depending on direction of force and its size.

KS4 Science

- **Physics, Forces** - elastic and inelastic stretching.

TOP TIP

Ensure students have enough room to work without the risk of disrupting others.

DOWNLOAD

Download and print student worksheets from imeche.org/stemathome

WRAPPING UP

MEASURING UP



10-15m

A successful build will be able to grasp and stack three empty cans.

If students are completing this challenge in teams, the winner will be the team who can stack three empty cans in the quickest time.

EXTENSION ACTIVITY



10-15m

Engineers have to take multiple factors into consideration when they design and build systems. If students finish early, ask them to complete one of the following extension activities:

A

Give students 5-10 minutes to design and construct an extender for their arm.

They'll have to consider what adding extra length to their mechanical hand will do to the overall stability of their structure, and counteract this using the materials they have to hand.

B

Ask students to utilise any remaining materials to modify their design, so that they are able to pick up a heavier weight.

Encourage them to think about the tension and friction in their current design and how this could be adjusted to help them lift a heavier weight.

Ensure they plan and discuss their modifications before starting construction.

DISCUSSION POINTS



10-15m

To close the session, hold a class discussion and cover the following points:

- Did students succeed in creating a functioning mechanical hand?
- If not, why did it fail?
- What items can you pick up with your mechanical hand?
- Why is it difficult to pick up certain items with your mechanical hand?
- What could a real mechanical hand be used for?
- What would happen if you added more fingers?
- If the students had to do this again, how would they change their design?

REMEMBER

Provide a recap or short summary to the class, highlighting the key engineering skills that have been learnt during this activity.