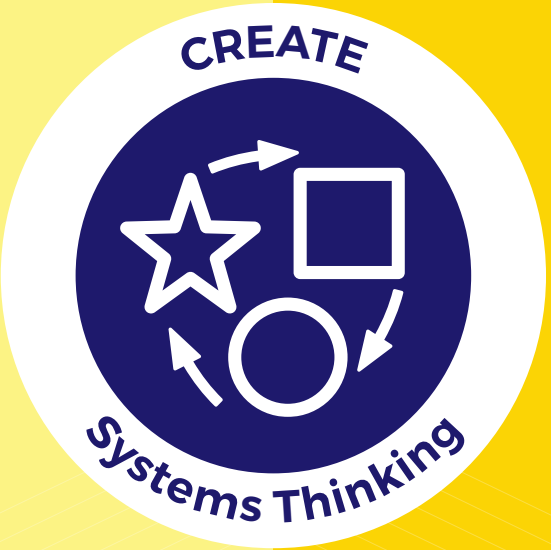
Royal Academy of Engineering

MANCHESTER 1824
The University of Manchester

Create – Systems Thinking

Explaining how things work together and why each part is there

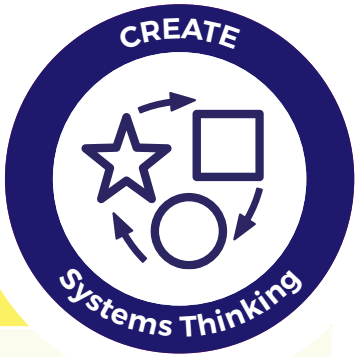


Download the full report:
Bianchi, L. and Wiskow, J. (2023) Progressing to be an Engineer – The Approach. Royal Academy of Engineering.

Informed by work from project schools:
Archway School, All Saints' Primary School, Beech Hill Primary School, Ince Church of England Primary School, Ribblesdale High School, Salusbury Primary School, St Bartholomew's CofE Primary School, St Charles RC Primary, St Edmund's Primary School, St Wulstan's Primary School

The Progressing to be an Engineer Cycle

Overview



Create – Systems Thinking is the process of prototyping a product which includes components. Depending on the complexity of the product it may include multiple components that work together to achieve a specific purpose. By thinking about the ways the components work together as a system, pupils can identify the purpose of the components and the suitability of their choices.

ILOs	Key learning	Suggested activities
What do we want pupils to understand about Create – Systems Thinking?	Pupils will have already had some experience with Systems Thinking in the Ask and Imagine & Plan stages of the Engineering Design Cycle. Key learning here relates to systems thinking when hands-on making a product. In this case, pupils will be able to directly add or remove components from a design to understand their purpose and the implication of removing them from the system.	**Creating products:** Using components that work together in a system. **Activities:** **1.** Clothes Peg Toys **2.** Food Chain Demonstrators
How do we want them to apply their knowledge?	Pupils will apply their understanding of systems and sub systems – when things connect together to create a product for a specific purpose that has multiple components. They can then investigate the needs of their users and create products accordingly to meet these specific needs. A simple way to explore this idea is a Rube Goldberg knock-on system where pupils can directly see the impact of one component when added or removed from a system.	**Application into science:** Engineers take many of their ideas from observing what happens in the natural world – how plants and animals have adapted over the years to survive in a changing environment. **Activity:** **3.** Product Design

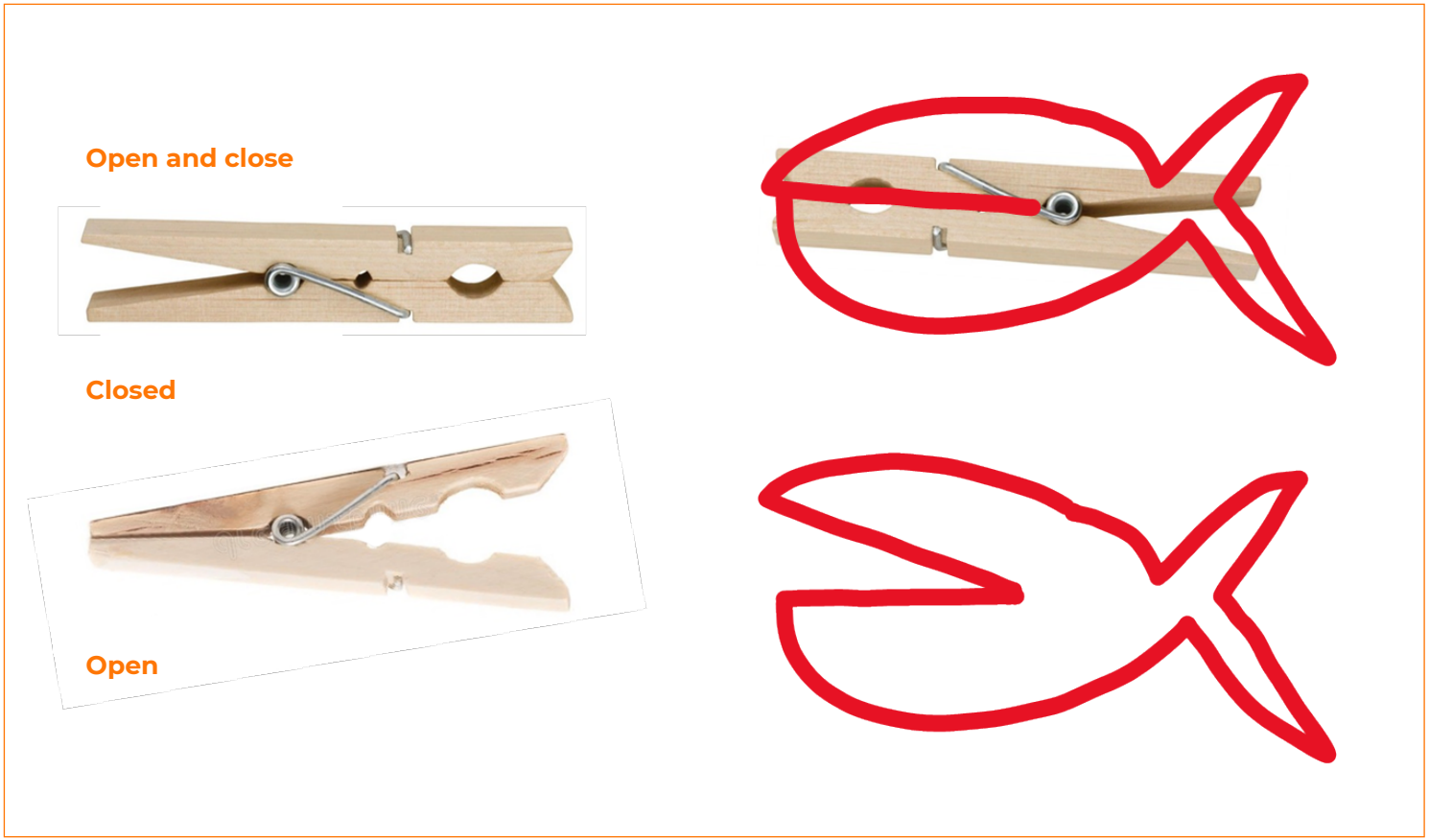
	From	To	Towards
	Suggested 5–7 years	**Suggested 7–11 years**	**Suggested 11–14 years**
Pupils should be taught to:	Use components to create a product of multiple parts.	Use knowledge of how components work and interact to create a product that achieves a specific purpose.	Create a product for a specific purpose justifying the suitability of choices based on local and global issues, e.g. sustainability, energy and economic aspects.
Success was demonstrated when pupils:	■ included more than one part functioning together.	■ made something that worked which included different components interacting together.	■ made something that worked which included different components interacting together and can explain aspects that show they have an awareness of wider issues.

Generic task

Initial learning activity – eliciting and developing understanding

Activity 1: Clothes Peg Toys

The pupils were challenged to look at and use a simple, wooden clothes peg mechanism to create a moving toy. They were guided to look closely at the way the 3 components in the mechanism worked together.



Generic task

Initial learning activity – eliciting and developing understanding (continued)

Activity 1: Clothes Peg Toys

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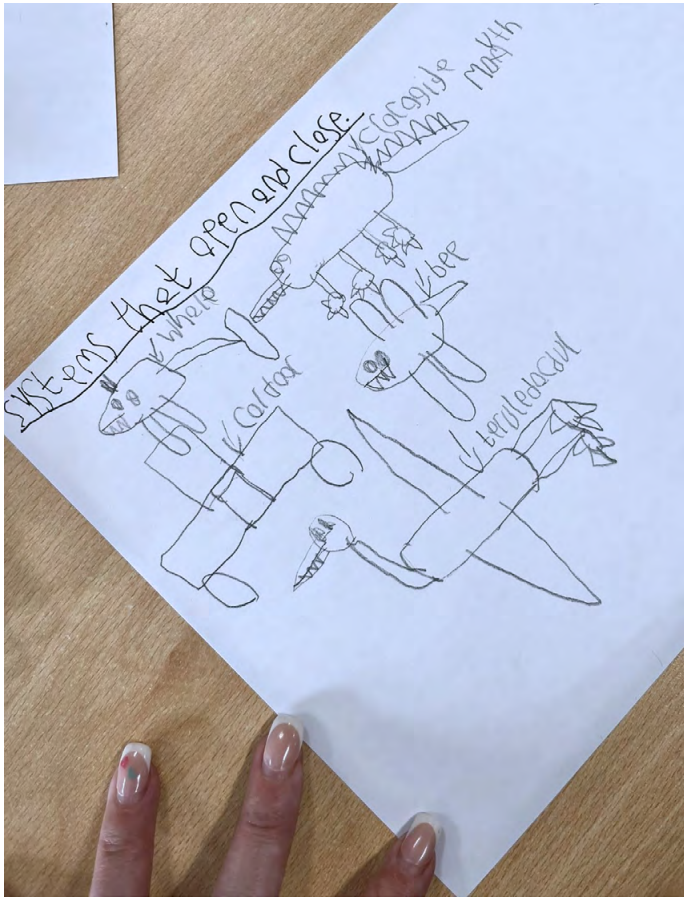
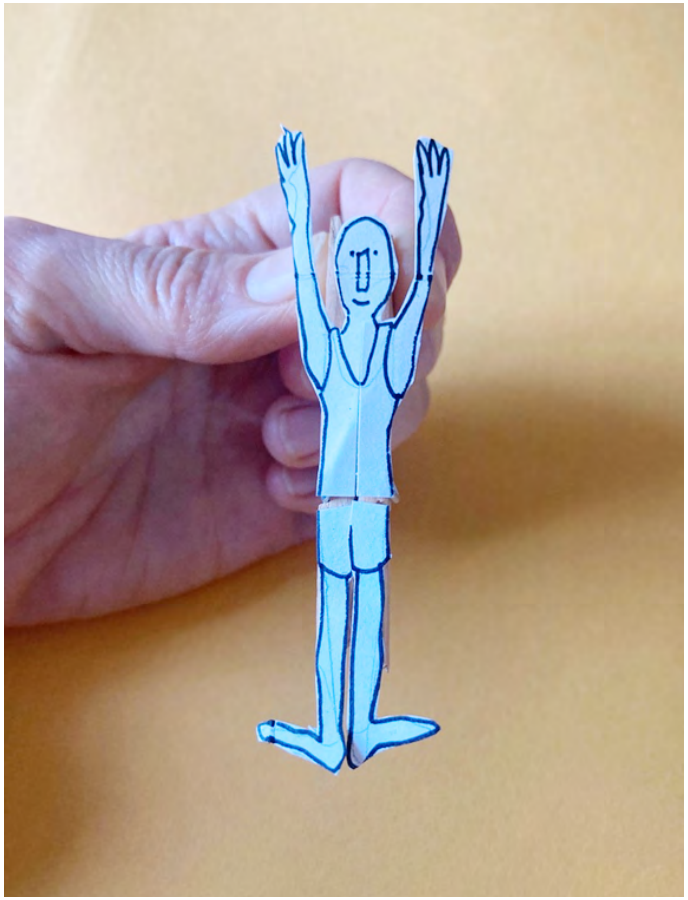
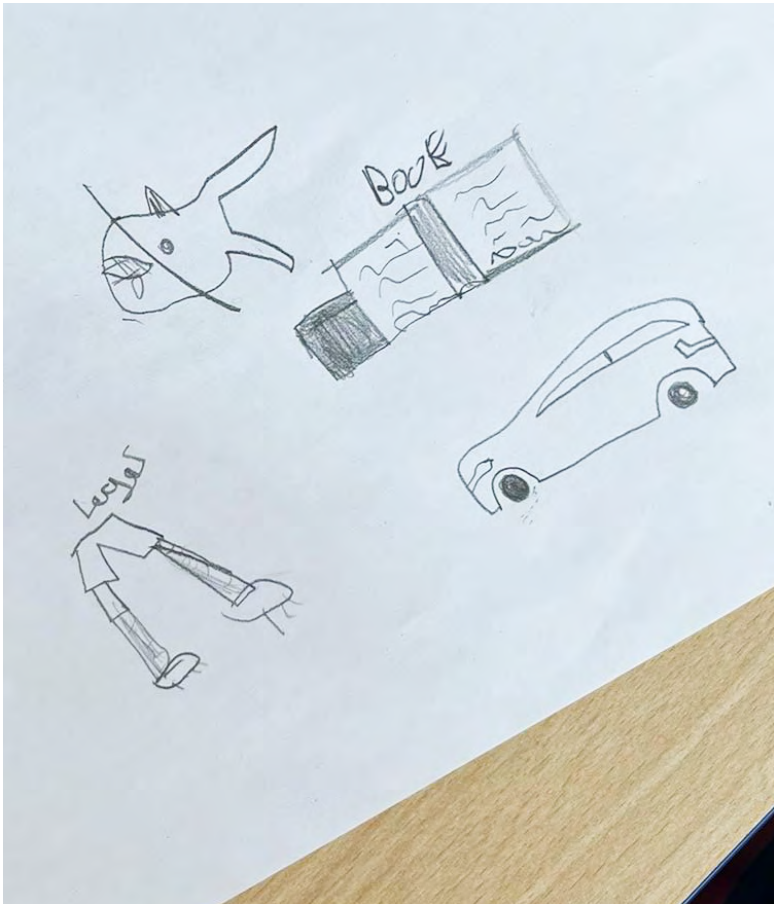




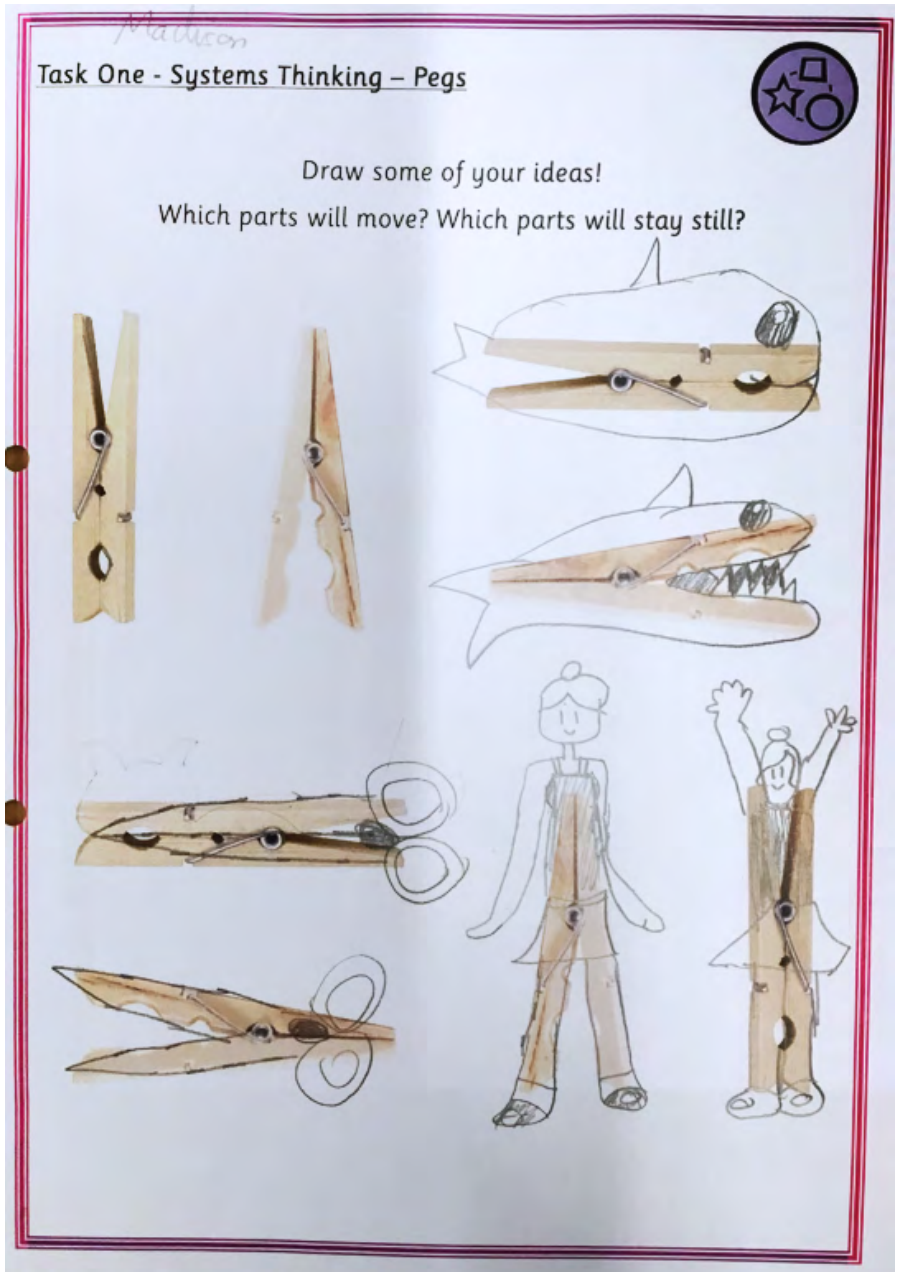
Initial learning activity – eliciting and developing understanding using a generic task (continued)

This led to the following types of ideas.



'Pupils gained a clear understanding that they needed all parts of the peg to make it move.

We took apart one peg as a class so they could see it no longer worked. Seeing the system work as a whole showed them how important the whole system is.'


Task One - Systems Thinking – Pegs
Draw some of your ideas!
Which parts will move? Which parts will stay still?

'We noticed that the mechanism of opening and closing on this particular one didn't work properly as the child has aimed to make the legs move. They wouldn't move unless they were pressed using the peg. The child realised she needed to adjust the placing of the little girl.'

Embedded task

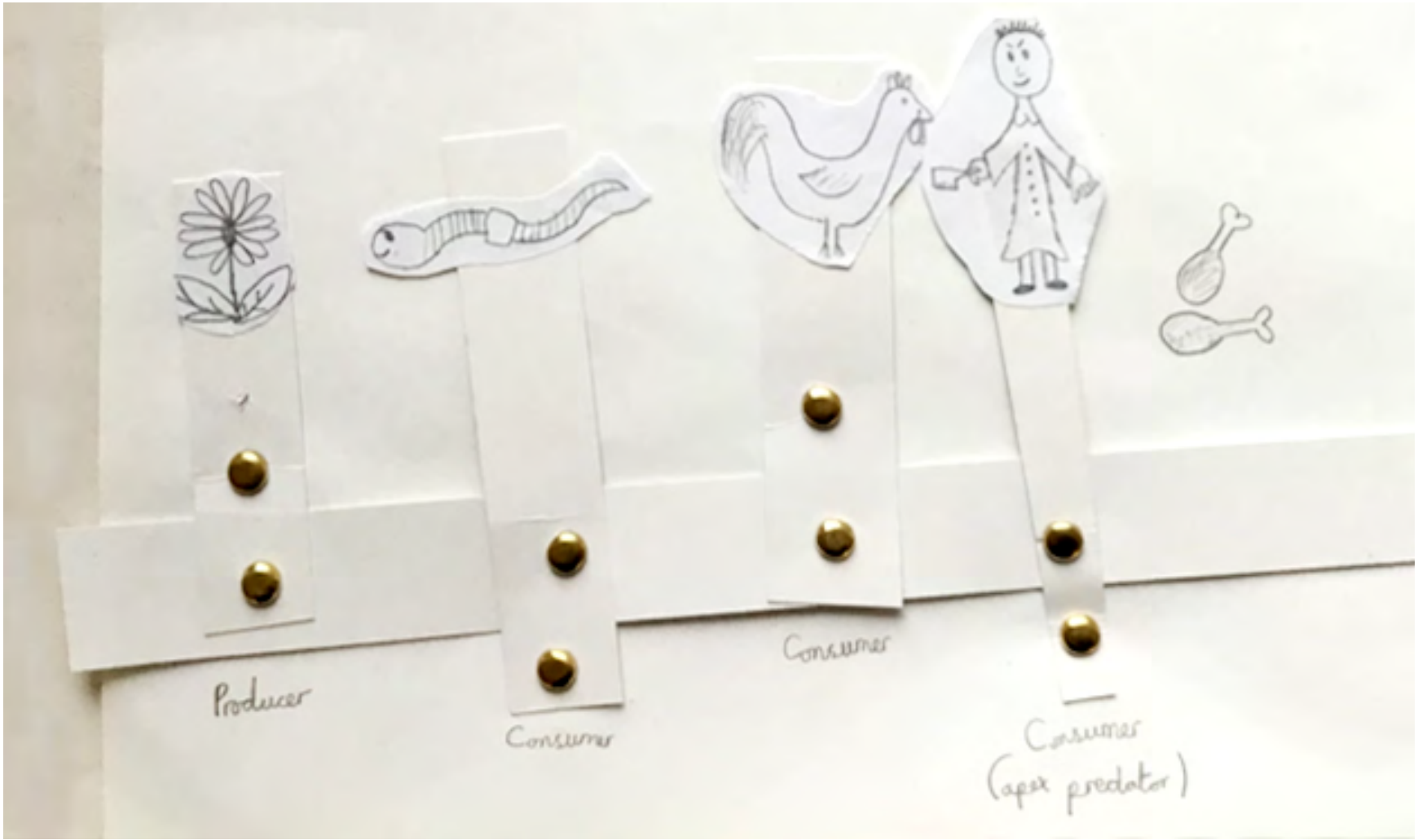
Exploring Create – Systems Thinking in context

Activity 2: Food Chain Demonstrators

Linking to the science curriculum, this Create task encouraged pupils to apply their knowledge of food chains to make a moving model to demonstrate the relationship between predators and prey.

Using simple equipment of card and paper-fasteners pupils had time to discuss, design and make moving strip demonstrators using pushes and pulls to create movement.

'Children were able to recall their prior knowledge of food chains and where children couldn't recall, teachers were able to reteach. The task began with an exploration of levers/pivots, which meant they learned about a key Design & Technology mechanism. Children were able to troubleshoot and problem solve if their design didn't immediately work. Children were able to work with a purpose, within constraints, but still apply their own imagination and design.'

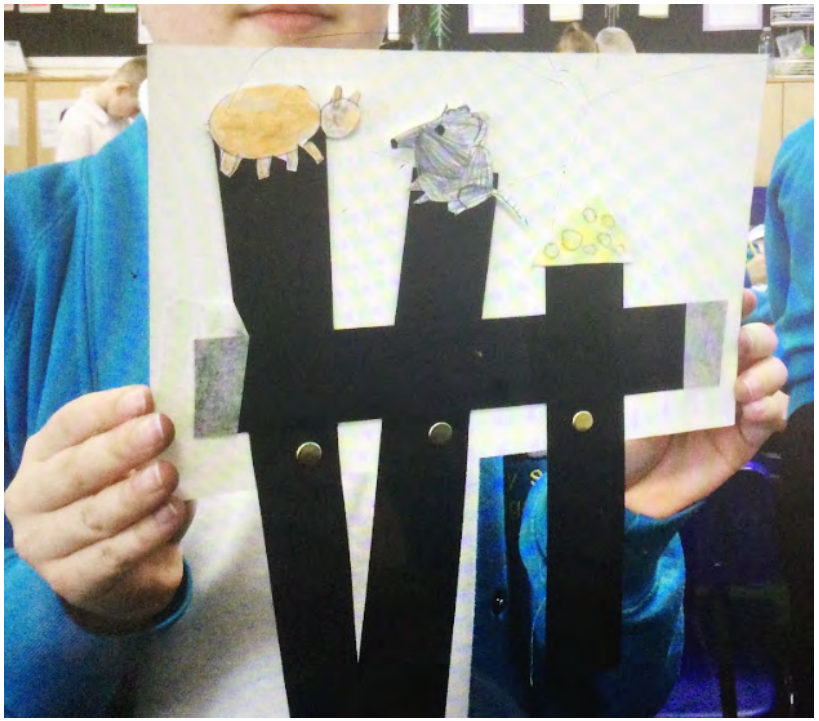

Producer
Consumer
Consumer
Consumer
(apex predator)

Embedded task

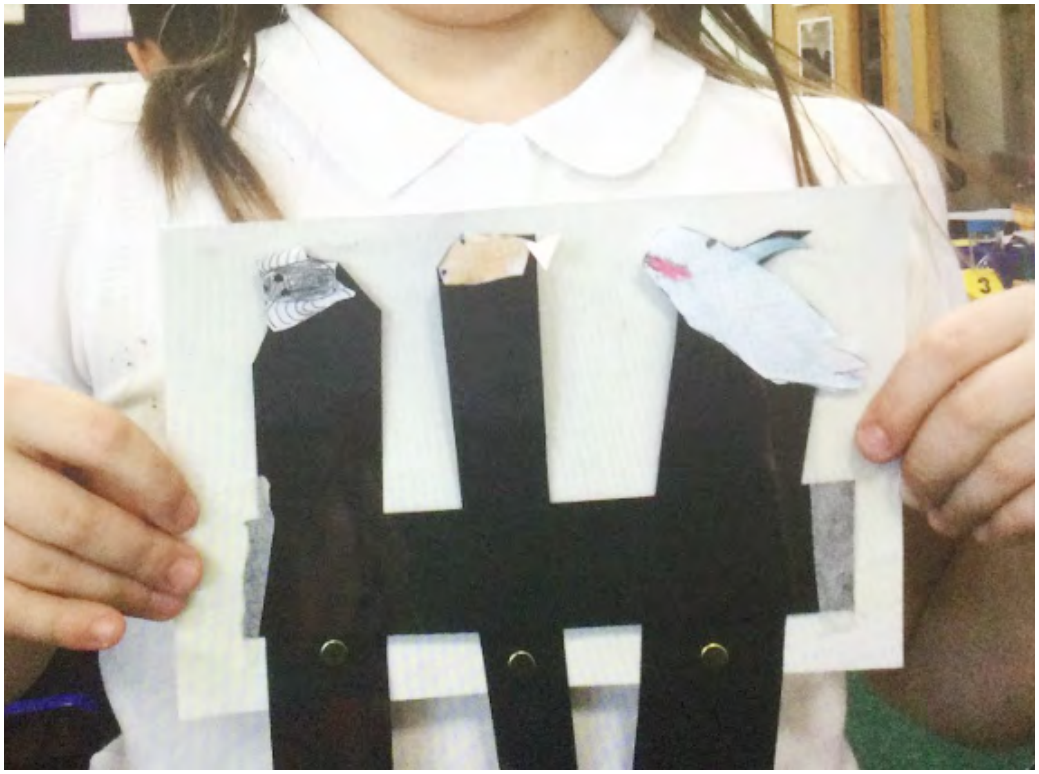
Exploring Create – Systems Thinking in context (continued)

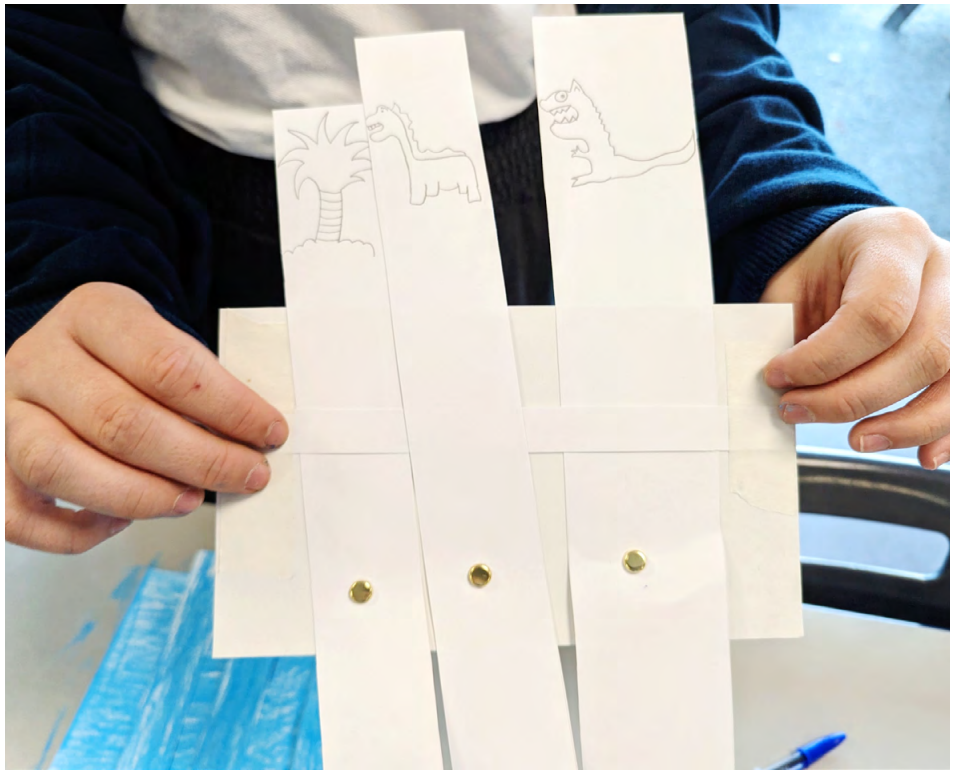
Activity 3: Product design

Pupils were asked to choose one of the special features they had identified from their research and use this to inspire a new product design. The following examples were generated by KS3 pupils.



'As food chains had yet to be taught in the curriculum for the 7–8 year olds, some of the children were focused on the Make, and the food chain itself needed tweaking (although it did work). They showed how the mouse eats cheese and the cat eats mice.'





‘A clearer understanding of a food chain can be seen here. The pupil was able to reflect on her work, she like the way she had positioned the shark. The ‘bug’ needed to be on a thinner strip of card and away from the strip guiding the levers.’

Teachers' ideas to extend and support thinking

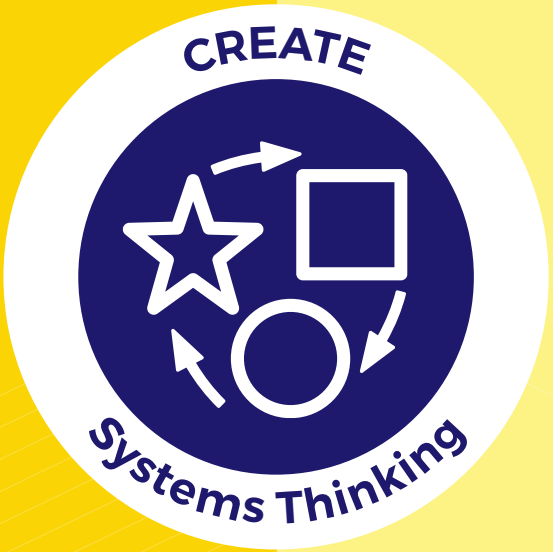
Extending

Increase complexity by encouraging pupils to explore how their food chain can then interact as a web with multiple chains coming together.

Further support

Pupils may struggle with their dexterity of paper cutting and fixing. They should recognise that the prototype doesn't have to be perfect, and that tinkering and refining can take place afterwards. Clear designing from the outset however avoids a haphazard and serendipitous approach.

For lower ability students, scaffold the task by giving them pre-cut strips.



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FROM – using components to create a product of multiple parts.

TO – using knowledge of how components work and interact to create a product that achieves a specific purpose.

TOWARDS – creating a product for a specific purpose justifying the suitability of choices based on local and global issues, e.g. sustainability, energy and economic aspects.