Royal Academy of Engineering

MANCHESTER 1824
The University of Manchester

Ask – 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 St Mary's College, Derry
Beech Hill Community Primary & Burlington Junior school

The Progressing to be an Engineer Cycle

Overview

Ask – Systems Thinking – a system is a collection of parts or processes that work together to achieve a common aim. Systems thinking is the ability to stand back and visualise the whole picture, understanding how the different elements interact and seeing patterns. It is an essential skill for engineers and allows them to make things that work and fix things that don't.

ILOs	Key learning	Possible activities
What do we want pupils to understand about Ask – Systems Thinking?	Pupils need to learn to step back and appreciate the whole picture before focussing on the individual elements. They should learn how to break apart the big idea that they're studying and think about how the parts connect or relate to each other. ■ They should ask questions such as: ■ What role does each part play in the system? ■ How do these parts work together? ■ What would happen if we left this part out?	**Seeing the whole picture:** Sometimes the whole picture isn't that obvious. You may have to rely on clues and apply existing knowledge. **Activities:** **1.** Zoom in zoom out **2.** Take it apart
How do we want them to apply their knowledge?	Pupils should think about different types of system that they have come across in their curriculum subjects. These could come from all areas – particularly science – where they may have heard the word 'system' being referred to: ■ circulatory system, ■ digestive system, ■ skeletal system, ■ cardiovascular system. Can they recognise the parts within these systems and how they work together?	**Investigating ecosystems:** Discovering the delicate nature of ecosystems and the devastating impact that small changes can have. **Activities:** **3.** The old ladies who liked cats

	From	To	Towards
	Suggested 5–7 years	**Suggested 7–11 years**	**Suggested 11–14 years**
Pupils should be taught to:	Explain how simple systems work.	Explain how simple systems work, identifying how each part depends on another and predicting what would happen if there is a missing piece or link.	Explain complex systems, including subsystems, describing how they depend on each other and predicting what would happen if there is a missing piece or link.
Success was demonstrated when pupils:	■ described what a simple system was by identifying the different parts of a mechanism and explaining their purpose.	■ were able to explain using words and diagrams how a simple system works, showing understanding of the connectivity between different parts, and the impact of a missing piece.	■ were able to explain using words and diagrams how complex systems work, showing understanding of the connectivity between subsystems and parts, and the impact of a missing piece.

Generic task

Initial learning activity – eliciting and developing understanding

Seeing the whole picture – getting started

Zoom in, Zoom out: The pupils were shown a section from a photograph and asked what they thought the whole picture might contain. Were there any clues to help them?

"The pupils were very surprised when the complete picture was finally revealed."

Acknowledging the photo image is not credited to the authors. With thanks to the originator.

Generic task

Initial learning activity – eliciting and developing understanding

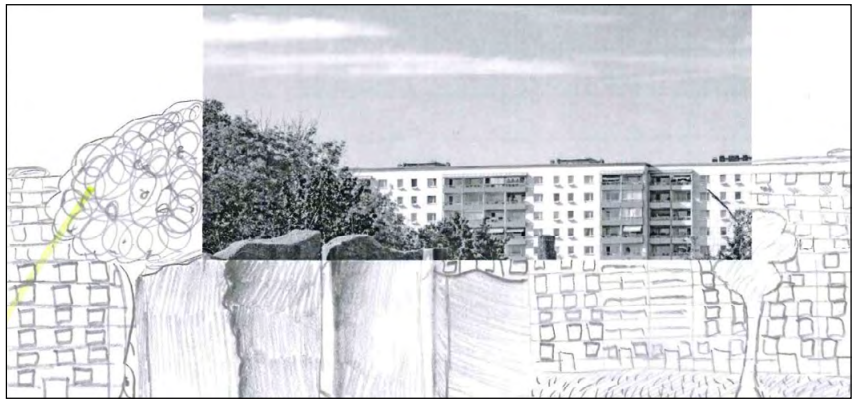
Seeing the whole picture – getting started

Zoom in, zoom out: The pupils were then asked to draw what they thought the rest of the picture might look like.

"There were a wide variety of responses but all centred around urban areas.

Some students followed the black and white of the original which we were not able to photocopy in colour but others used colour."

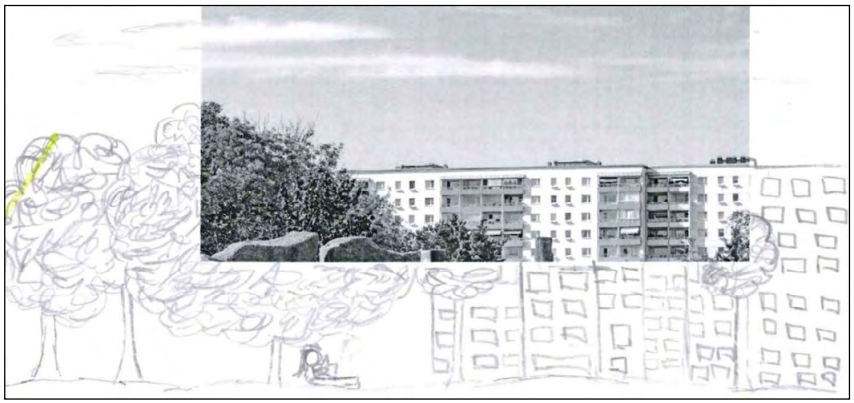
Activity 1



Activity 1

Activity 1

Activity 1



"The laughing in the room when the full picture was revealed to the class was amazing and it set a wonderful tone for the rest of the lesson(s). A very interesting task. Students enjoyed this one in particular. Suitable for all abilities of students."

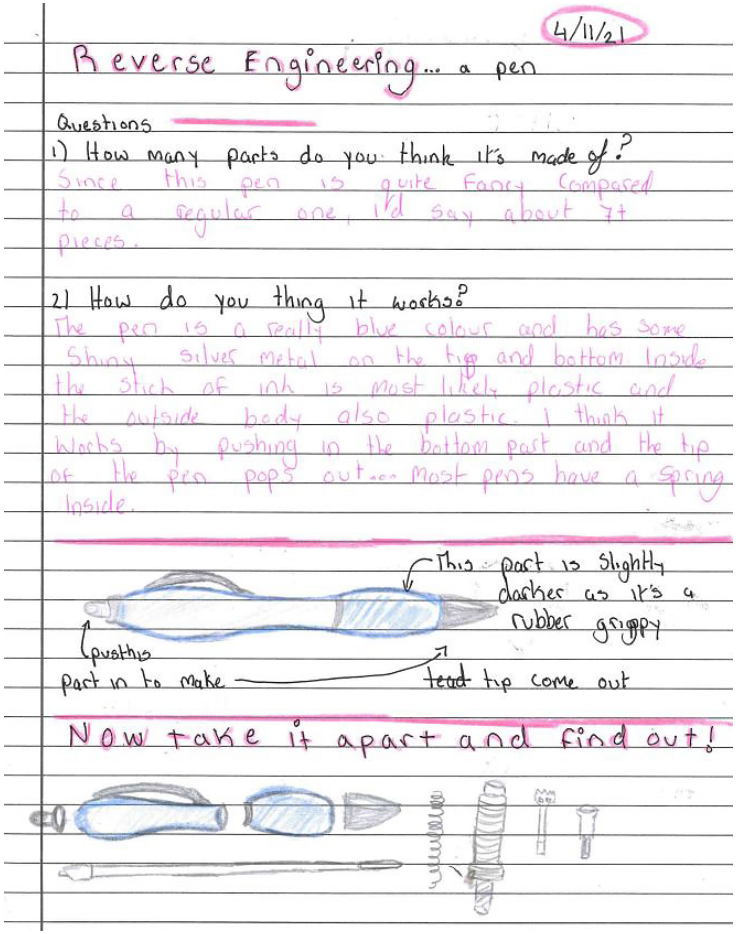
Acknowledging the photo image is not credited to the authors. With thanks to the originator.

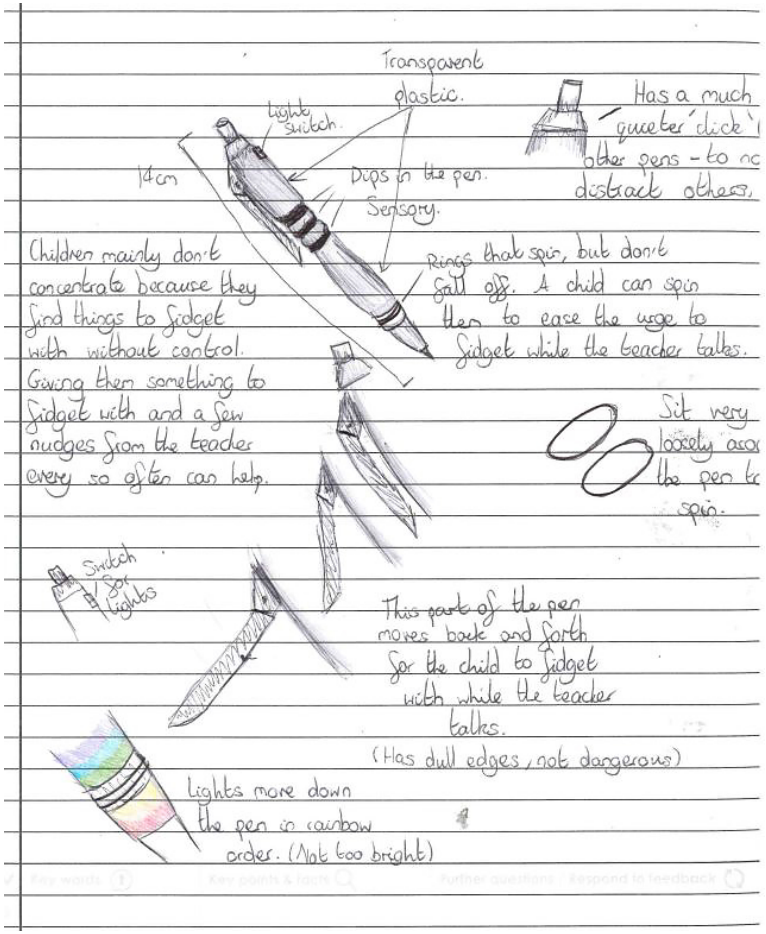
Generic task

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

Seeing the whole picture – applying what you know

Take it apart: This led to the taking apart of a piece of classroom equipment – a retractable ball point pen. Pupils were asked to sketch and label each part, explaining their function in the product.





'This activity generated a lot of student discussion on how simple things are clever things.

Suggestions were made of other products that are similar or those that are over complicated.'

'Before the pupils thought very little about everyday products and how they work.

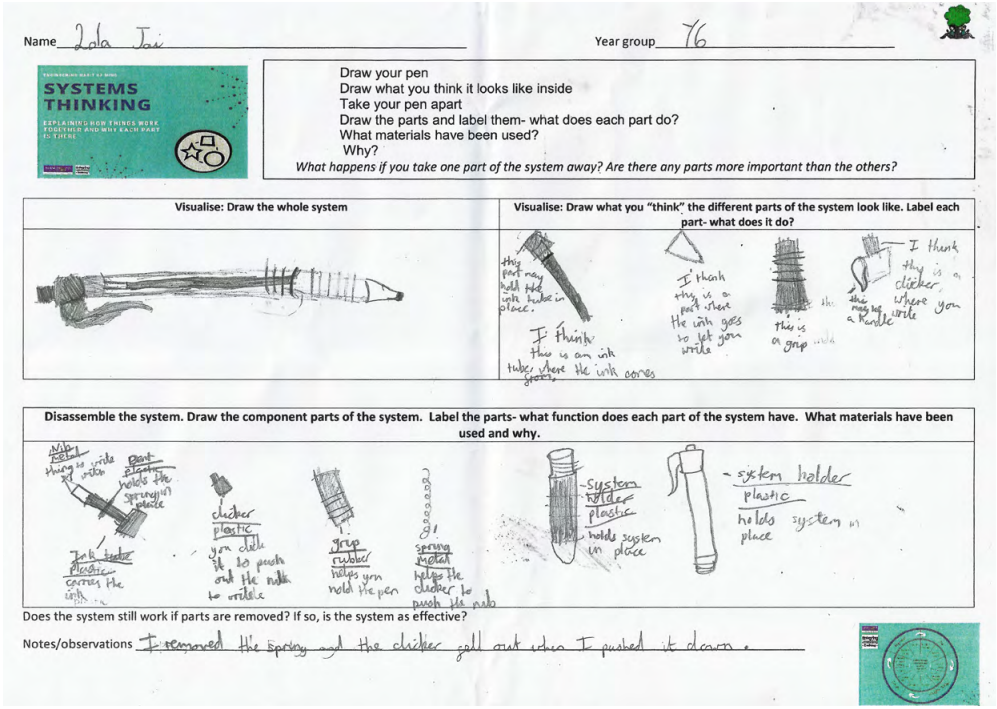
They didn't think there would be more than four parts to a pen.'

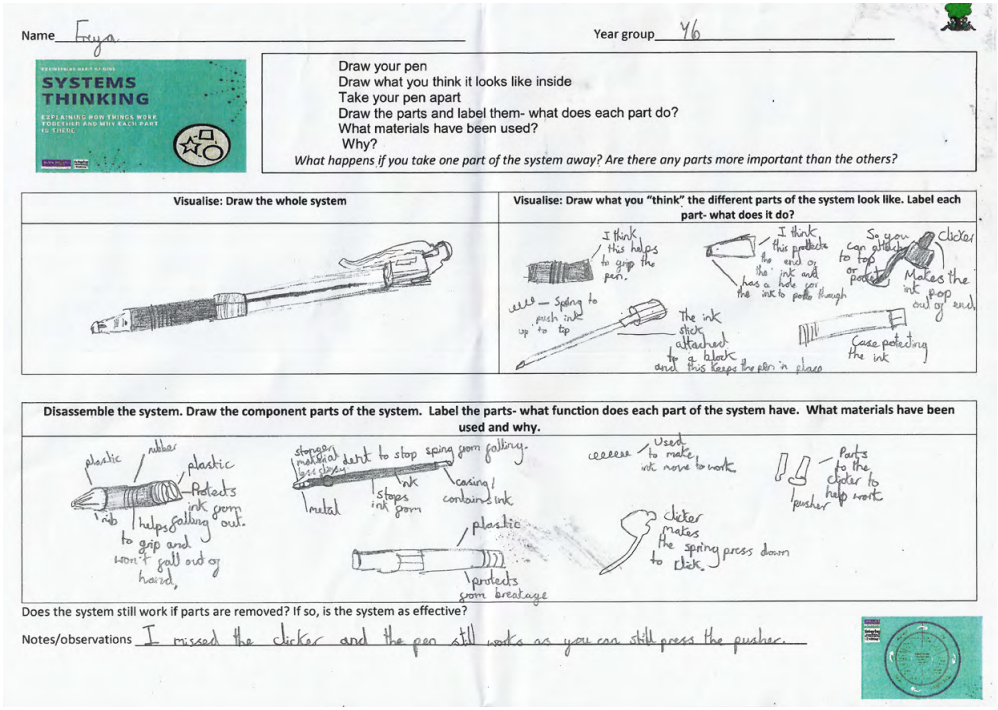
Generic task

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

Seeing the whole picture – applying what you know

Take it apart: Teachers and pupils interpreted the task in different ways. These are examples from Y6 pupils.





"I thought the lessons were perfect. I enjoyed exploring the system of the pen and looking at how each part played an important role in making sure the pen worked effectively. I also enjoyed finding out about the past and how the pen as a system has evolved."

"I think there is a big problem with the pens we looked at because many of them are disposable and this would be something I would look to solve as a problem if I had the chance. I really want to go to university and I think this sort of learning will help me to achieve that."

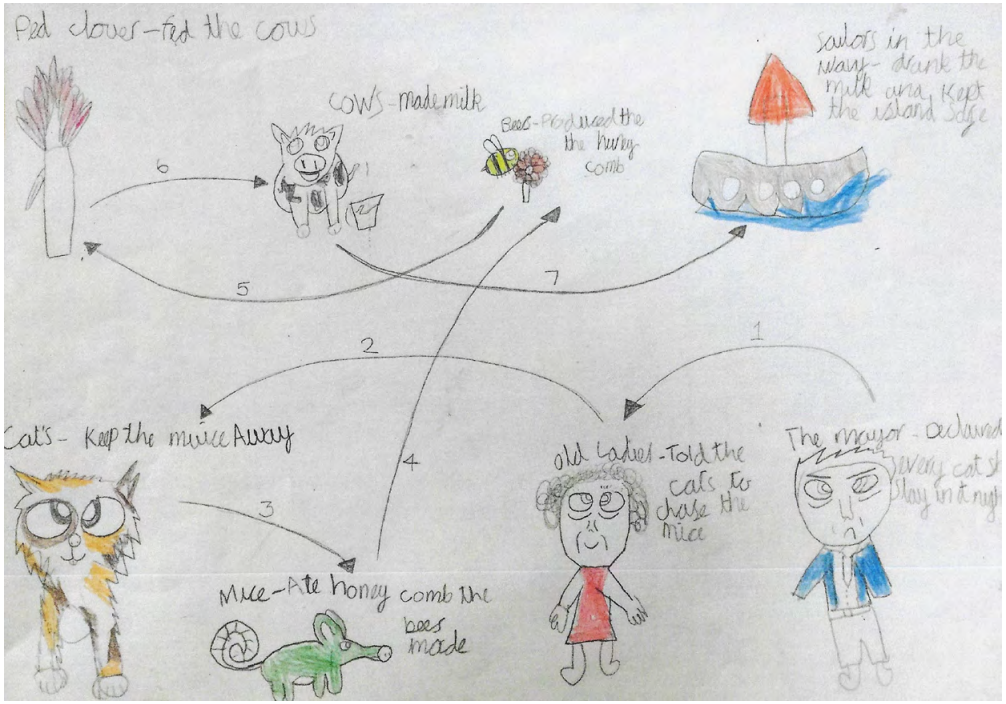
Embedded task

Exploring the EHoM in context

Understanding how nature is connected

The old ladies who liked cats: Pupils were introduced to a story involving an island with a unique ecological system. They were encouraged to consider how all the elements were interrelated and produce a concept map of the whole system, clearly showing how the different characters and animals are linked.

This pupil has drawn a story map, which explains the sequence of events as they are told. To develop this into systems thinking, the child would be encouraged to expand the map to show the relationships between different aspects e.g. characters, people, plants or places.



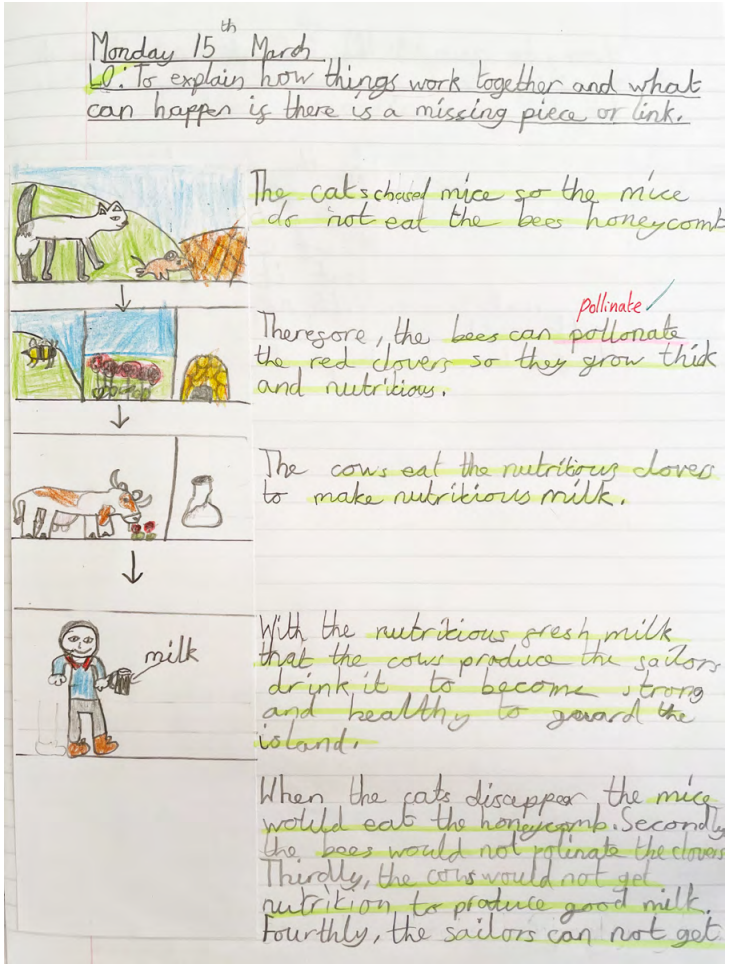
In this example the pupil has used drawings to identify the different components and their relationships within an ecosystem. The annotations are sequenced and descriptive, showing a better understanding of the contribution each animal had to the ecosystem.

Embedded task

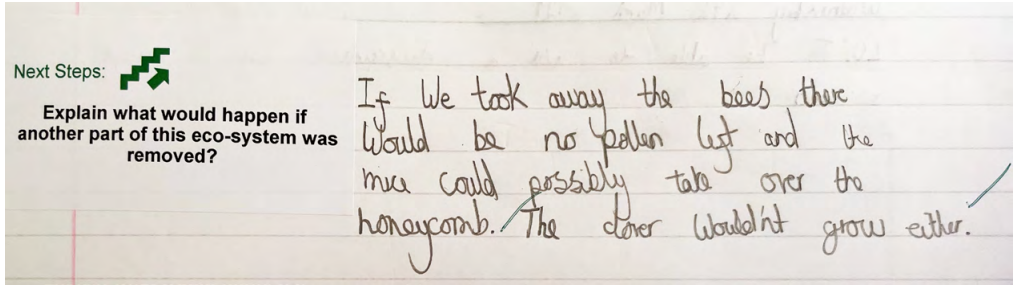
Exploring the EHoM in context

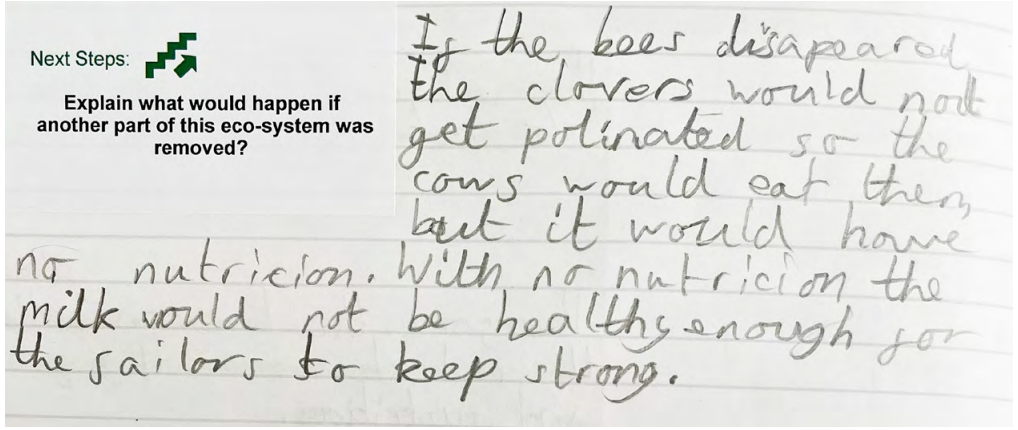
Understanding how nature is connected

The old ladies who liked cats: As an extension, the pupils were asked to consider what would happen if any of the elements were removed.



In the final paragraph this pupil shows an understanding of the impact of removing the cats from the ecosystem.





In the above paragraphs, these pupils are beginning to demonstrate a greater understanding of systems thinking, as they are explaining the impact that a different part being removed would have on the system.

Teachers' ideas to extend and support thinking

Extending

Cats in Borneo: **https://www.youtube.com/watch?v=17BP9n6g1F0&list=RDCMUCB_yeT6WwVLJjCsZFt2oQfA&index=1**

How wolves change rivers:
https://www.youtube.com/watch?v=kvKCTZf_-e4

(Wolves are ecosystem engineers that play an important role in the habitats they live in by improving the environment and helping to increase biodiversity.)

Further support

Pupils may struggle to draw the ecosystem. If this is the case then images of the different elements could be provided for the pupils to cut out and then arrange on a piece of paper. This would allow pupils to have multiple attempts at explaining the ecosystem before committing to one idea.

Ask – Systems Thinking

Explaining how things work together and why each part is there

FROM – explaining how simple systems work.

TO – explaining how simple systems work, identifying how each part depends on another and predicting what would happen if there is a missing piece or link.

TOWARDS – explaining complex systems, including subsystems, describing how they depend on each other and predicting what can happen if there is a missing piece or link.