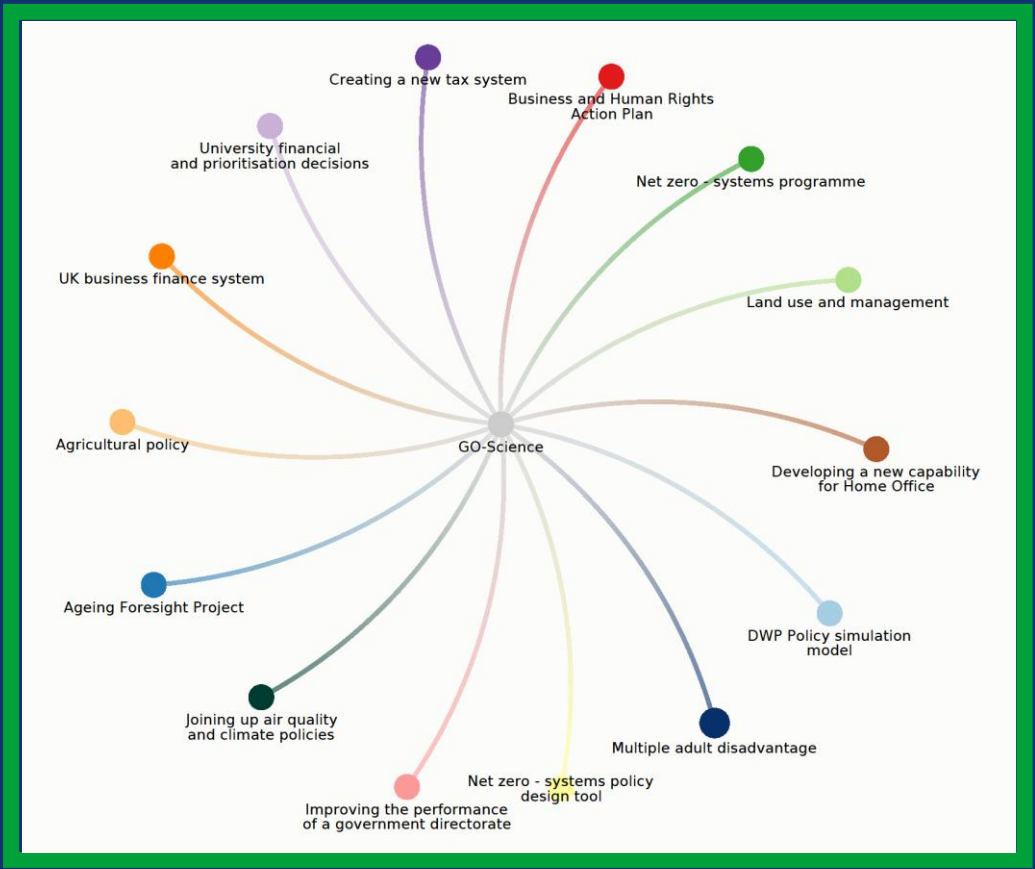
Government
Office for Science

The Government Office for Science Systems Thinking Case Study Bank



The Government Office for Science Systems Thinking Case Study Bank is one component of a suite of documents that aim to act as a springboard into systems thinking for civil servants unfamiliar with this approach. Across our documents we introduce a small sample of systems thinking concepts and tools, chosen due to their accessibility and alignment to civil service policy development, but which are by no means comprehensive. We hope this acts as a first step towards using systems thinking approaches to solve complex problems and we strongly encourage the reader to go on to explore the wider systems thinking field further.

Introduction

This Systems Thinking Case Study Bank has been produced by the Government Office for Science as part of a wider programme to promote and embed systems thinking across the Civil Service. The programme includes the Systems Thinking Journey, which weaves systems thinking through policy making, and the Systems Thinking Toolkit, which takes a step-by-step approach to 11 systems thinking tools.

The systems thinking case study bank contains a collection of 14 personal testimonials from a diverse range of civil and public servants. Each case study tells a story of how and why systems thinking was applied to a specific project, what worked well, and any barriers or challenges that were encountered. Examples range from working on net zero to understanding how universities make financial prioritisations. We also signpost at the end of this document to a small sample of further examples of systems approaches that have been used in policy development or public management.

The aim of this case study bank is to highlight the wide range of projects that have benefited from a systems approach, as well as the tools and techniques that other civil and public servants have used and found valuable. Likewise, descriptions of the barriers that different individuals have encountered may also help readers to anticipate and mitigate potential challenges ahead of using systems thinking in their own work.

To create the case study bank, a group of volunteer systems thinking practitioners from across government gave a 30-minute interview to the Government Office for Science on their experiences of using systems thinking for a specific project. Case studies were written up after each interview, and then circulated for review and permission to publish by authors and relevant stakeholders. It should be noted that all views and opinions are those of the individual interviewee and do not represent government policy.

Key themes and perspectives

The case studies in this bank highlight useful themes and perspectives on the benefits and barriers to using systems thinking. The benefits include the power of systems thinking approaches in bringing together diverse stakeholders with unique perspectives and together agreeing a shared goal. Systems thinking was frequently used to highlight the interrelationships within a system and promoted a better understanding of different problems. Some of the common barriers were the time and

resource required for workshops, and how to effectively convey the complexity of key findings (e.g., systems maps) to different audiences. However, this barrier was often overcome by bringing in design experts and consultants with expertise in data visualisation, and by creating a good narrative to accompany systems maps.

Methodology

The testimonials were collected from individuals working across a range of professions in six government departments, one public body and one executive agency. These individuals cover a range of grades from Senior Civil Servants to Higher Executive Officer, with approximately equal numbers of men (56%) and women (44%). We hope to continue to add further case studies to this bank; if you are interested in featuring, then please get in touch with systems@go-science.gov.uk.

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My experience of using systems thinking: Creating a tool to improve net zero policy design

Adam Mackenzie-Jones is an experienced analyst who leads the Net Zero Systems Team in the Department for Business, Energy, and Industrial Strategy (BEIS). This testimony describes Adam's personal experience of using systems thinking to design a tool that aims to improve Net Zero policy design.

What were you trying to do?

My role in BEIS is about embedding systems thinking across the Net Zero programme to facilitate more systemic and effective collaboration. My team wants to help make policy design in the net zero space more robust by avoiding unintended consequences and leveraging synergies in the system. For this specific project, we secured funding from the shared outcomes fund[1] to do an initial exploration of how systems approaches might be applied to land use and heat and buildings systems. The aim of this project was to create an interactive tool that helps officials to explore both these systems. The tool highlights interdependencies, trade-offs, unintended consequences, and feedback loops to give policy officials a richer understanding of the system they are designing policy for. Outputs of the tool will be indicative of what might happen in the system if a certain course of action is taken, which could lead on to further research being commissioned. This also means that any further analysis will be underpinned by a systemic appreciation.

Why did you think that a systems approach was right?

Net zero is a complex problem, in part because it requires a complete transformation of many of our existing systems (by complex, I mean something that is comprised of many parts that are interconnected). Human behaviour is an important part of this system, and our goal is for systems approaches to be used widely across the net zero world to tackle this complexity. Land use and heat/buildings are at opposite ends of complexity; land use is broad and less quantifiable while heat and buildings are narrower and more quantifiable. Using a spectrum of system types like this will help provide proof of concept for the tool.

What did you do?

Causal loop diagrams underpin the tool that we are creating. These diagrams were developed across several workshops with government officials, academics, and third-sector parties. It was important from my perspective to get a broad view of the system that isn't purely government focused. These initial workshops were focused on the key

[1] https://www.gov.uk/government/publications/shared-outcomes-fund-round-two

factors in land use and heat and buildings systems. This helped to scope out boundaries and delve more into the detail of individual sub-systems. The next workshops aimed to iterate these boundaries and gain a broad consensus on the way forward. We cross-referenced our maps against existing government models as a form of validation to gain quality assurance. The key thing was to go beyond having a map and move towards creating a tool that people can interrogate and use. Causal loop maps usually sit in posters or on a static computer screen and are hard for people to engage with. The aim of this project is to create a causal loop map-based tool that people can explore themselves.

After the workshops we created a proof of concept for what the tool would look like; consultants were brought in at this stage to help make it attractive and useable. There will be many possible applications for the tool, and we are looking to embed this in as many processes as we can. For example, we are looking to use this tool to feed into the identification and capture of key interdependencies in the system for delivery reporting purposes. We are also looking at embedding this in appraisal and monitoring/evaluation processes to define theories of change in different policy areas**.**

What worked well?

The workshops worked well. We gathered diverse perspectives on what the most important factors (variables) are in the land use system and heat and building system. It is important to ensure that everyone is on board with the exact phrasing of a variable, and I think that aspect this went particularly well since we worked through the problem iteratively in multiple workshops. I hope that the tool will work well in embedding systems approaches through net zero and policy design. We plan to conduct an evaluation with the Evaluation Task Force[2] which will give a good idea of how effective the tool is being.

What didn't work so well (what challenges or barriers did you encounter)?

One of the challenges we encountered when making the tool was ensuring that causal loop diagrams are easy to read and interpret. It is important to remember that just because a certain notation makes sense to you it doesn't mean that it will make sense to everybody. The challenge is to make sure that the tool tells a story to people and doesn't depend on being too analytical. To help overcome this we bought in consultants with expertise in visualisation to bring out different perspectives with different tabs to help people to interpret the map.

What were the outcomes of using systems thinking in your work?

We are helping to facilitate systemic discussion across different net zero policy areas. At the end of this project, we should have a tool that people can easily navigate to explore land use and heat and buildings systems, with the opportunity to easily expand this proof of concept to wider sectors. More generally, we expect to see longer term policy outcomes through the course of net zero.

[2] https://www.gov.uk/government/organisations/evaluation-task-force

My experience of using systems thinking: Reforming agricultural policy design

Caitlin Jones is a Senior Operational Research Officer in the Department for Environment, Food and Rural affairs (Defra, Future Farming and Countryside programme). This testimony describes Caitlin's personal experience of using systems thinking to deliver large-scale, rapid change in agricultural policy design and evaluation.

What were you trying to do? What was the project and what were its overarching aims?

Leaving the EU has meant that there needs to be a large-scale, rapid change in agriculture policy design and evaluation. This system deals naturally with complexity, and we had always wanted to understand where there might be risks, opportunities, loops, and non-linear interactions. The aim of this project was to undertake an ambitious participatory systems mapping exercise to understand the real-world agricultural system and generate a conceptual model that could be used to draw insights for policy and evaluation design.

Why did you think that a systems approach was right?

Agricultural policy space is complex and interconnected, and we wanted to clarify relationships to build up a big picture of the whole system. There are around 500 people working on this programme, with many teams working on individual products, schemes, and interventions. Things can easily fall into siloes, which wouldn't have worked well for this project. We wanted to use systems thinking to build a shared understanding of what the system looked like with key stakeholders, challenge assumptions, and break down boundaries between different teams and policy areas. This policy area also relies on a mixture of quantitative and qualitative data, which systems approaches can handle quite well. We knew that analysis could be run on a systems map to gain useable insights such as risks and opportunities.

What did you do?

The basis of our approach was a participatory systems mapping exercise that was completed internally. First, we ran a preliminary workshop with policy and analysis leads to identify stakeholder interests, with the purpose being to try and get into the headspace of key stakeholders. We then worked with The Centre for the Evaluation of Complexity Across the Nexus (CECAN) to deliver a one-day participatory systems mapping workshop, which was delivered in person before the COVID-19 pandemic. As we had four main agricultural policy areas, we broke these up into four separate maps, with a different team working on each map. We then got people to rotate around tables to start linking maps together. People drew stars on each other's maps to highlight the factors that linked to the map that they had originally drawn.

After this workshop, the team at CECAN took all four maps and put them into Draw.io software. This would not have worked for the whole map as it was too big and unwieldy to deal with. We then ran a set of verification workshops where people came back in pairs or trios to address the map that they had originally worked on. Another round of updating followed on from this workshop, and we then used Gephi software to visualise networks and generate a final systems map (see page 3 of case study for the final version of this systems map).

What worked well?

We ran this project in early 2018 when systems thinking was still a novel concept for the department. There was a recognition that agricultural policy space is a highly complex and that something needed to be done to understand this. Everyone was very keen to engage with systems thinking which was a pleasant surprise. The workshops were very effective in challenging perspectives, and we found it useful to show people their thoughts written down on the map. The participatory nature of the systems mapping workshops really helped create a shared understanding of the system.

We did find that the mapping workshop was a little slow at first, with people being reticent to jump in, but things got going quickly with some strong facilitation involved. By including stakeholder interests as well as policy outcomes in these discussions, we really helped steer the conversation towards the bigger picture of the system.

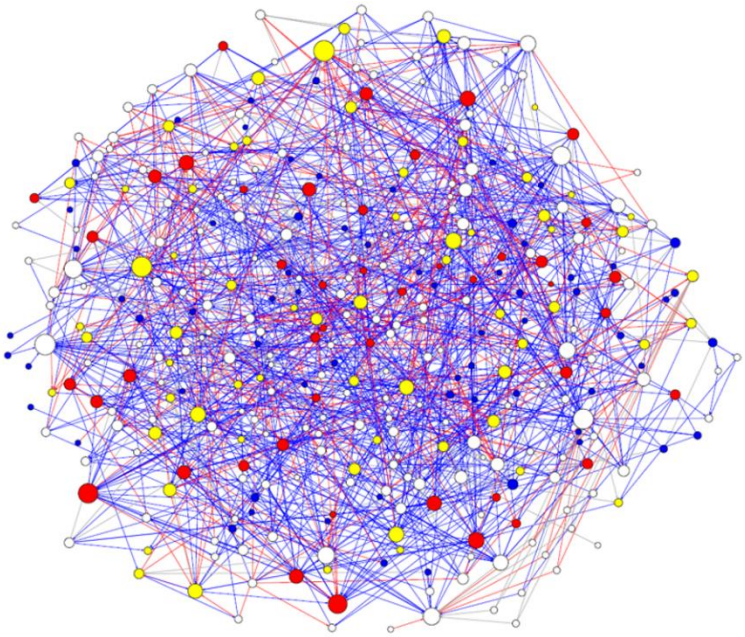
What didn't work so well (what challenges or barriers did you encounter)?

One difficult aspect in steering people away from linear, siloed thinking is the different levels involved in causal loop maps. The high-level outcome is different to the policy outcome, and we found that people were uncomfortable with the idea of mixing these levels. People also struggled with the idea of positive and negative relationships in causal loop diagrams. They often confused positive and negative notations with factors being desirable or undesirable, rather than a correlative effect.

The scale and novelty of techniques used in the workshop meant that we needed expert facilitators and lots of help from CECAN to steer the systems thinking aspect and hammer home key concepts. A technical issue that we encountered was how we should combine data from the big systems mapping exercise.

What were the outcomes of using systems thinking in your work?

The outcome of using systems thinking in this project was an increased awareness and appreciation of this technique as a way of dealing with complex policy problems. Nobody in our workshops had ever used techniques like this before, whereas now people actively ask for systems thinking-based input into policy. The causal loop maps we created were powerful as they conceptualised theories of change and reframed how people approach doing evaluation. A longer-term outcome is that there is now a willingness to engage with different systems thinking methods in Defra. We also have a community of systems thinking practitioners within Defra that didn't exist before.



Final systems map generated by Gephi software to visualise networks, contributed by Caitlin Jones.

My experience of using systems thinking: Improving the performance of a government directorate

Dr Gary Preece is Head of the Systems Research Programme in the Department for Environment, Food, and Rural Affairs (Defra). Gary is also an analyst in the Government Operational Research Service. This testimonial describes Gary's personal experience of using systems thinking to improve the performance of a directorate as an analyst for the Government Operational Research Service.

What were you trying to do? What was the project and what were its overarching aims?

I led this project during my time working as an analyst for the Government Operational Research Service. A directorate wanted an evaluation of how well it was working and how it might be able to perform better in the future. The aim of this project was to work out what was working well, what was driving issues and help people decide how to solve these issues.

Why did you think that a systems approach was right?

The directorate consisted of around 80 people, so I was never going to be able to interview all of them individually. A systems approach is great for bringing people together to share and challenge perspectives. A range of issues were being flagged within the directorate and it sounded like these were all interlinked. For example, teams were not as joined-up as they could have been, and interlinkages were broken. Systems thinking is great for tackling complex and interlinked problems.

What did you do?

I held a workshop with staff in the directorate and used soft systems methodology[3] to get people thinking about how the directorate was currently working. First, I put people into small groups and got them to draw a rich picture[4] of how they thought the directorate was working. Each group had a facilitator to support them in creating this, and we then got everyone to present their rich pictures to the rest of their peers. These brought up some interesting issues on how people were working, such as a lack of information sharing across teams. I then used viable systems modelling[5] to dig further into these issues to see how the rich pictures mapped onto this model. This tool

[3] Soft systems methodology developed by Peter Checkland (Checkland P. 1981. *Systems Thinking, Systems Practice*. John Wiley: Chichester).

[4] Rich pictures are explored in the Civil Servant's Systems Thinking Toolkit

[5] The viable systems model developed by Stafford Beer (Beer S. 1979. The Heart of Enterprise, Wiley Chichester; Beer S. 1985. Diagnosing the System for Organisations, Wiley Chichester)

models an ideal system with effective and efficient functions and provides a way of comparing the current system to this ideal system. This process helped to identify what was driving issues in the directorate and what steps might be taken to solve them.

What worked well?

A systems approach was great for highlighting interrelationships between issues and understanding how certain issues can cascade into others. This information is helpful, as it highlights how issues could become more serious over time if left unchecked. We found that people really enjoyed drawing rich pictures after a few minutes of settling into the activity. There was a huge amount of energy in the room with people bouncing ideas off one another, which created a great atmosphere. Rich pictures were also great for providing a visual representation of the problem. When creating a workshop, it can be difficult to know where to get started. Systems thinking tools offered structure and flexibility to support the design and delivery of the workshop.

What didn't work so well (what challenges or barriers did you encounter)?

At the start of the workshop some attendees were clearly not comfortable with drawing a rich picture. People did get into it, but every individual has a different preference for how they express themselves, and drawing does not work for everybody. Time is a common challenge with using systems thinking. There is always the classic problem of trying to get everybody in the same room at the same time for workshops. Another challenge is that people often view systems thinking as something that provides all the answers to a problem. Systems thinking is great for clarifying a problem and setting people off on a journey to start analysing and solving it. This approach gets people into a holistic mindset to start thinking about complex problems and how to tackle them. However, systems thinking can often be too abstract and high-level to give the complete and final answer to a problem.

What were the outcomes of using systems thinking in your work?

The outcomes of using systems thinking in this project were a better understanding of where there were issues in the directorate and how these could be tackled. The collaborative nature of the workshops generated buy-in from attendees and a willingness to make changes in the directorate.

My experience of using systems thinking: Creating a new tax system

Hazel Challenger is an Operational Researcher in the Ministry of Justice. Before this, Hazel worked as a Higher Scientific Officer for Inland Revenue: a predecessor of Her Majesty's Revenue and Customs. This testimony describes Hazel's personal experience of using systems thinking to create a new tax system during her time at Inland Revenue.

What were you trying to do? What was the project and what were its overarching aims?

This project was initiated soon after the poll tax riots when the old rate system was thrown out by the public. The overarching aim was to introduce a new tax system that would cover approximately nine million taxpayers. This applied mainly to self-employed people and higher rate taxpayers. If this hadn't worked, there would have been a break in funding arriving at the Treasury. My aim was to identify key factors in this system to ensure that the new tax system went live smoothly.

Why did you think that a systems approach was right?

Everyone was using a siloed approach to view this problem, which was driven by how budget was allocated to each part of the process. Due to the scale of the project, there was no overarching view end-to-end. Creating a new tax system requires an overarching view of the whole system, which is why I thought that a systems approach was right for this project. Systems thinking was a mostly unknown concept in the civil service at this time and had not been widely used across government, although this approach is much more normalised today.

What did you do?

I ran workshops with the people who were working within each silo to create causal loop diagrams. This was the first time that these individuals had been brought together to talk about how to create the new tax system. I also trained a consultant in causal loop mapping beforehand so that he could support people during the workshop. As a result of the causal loop mapping exercise, people recognised that the success of each silo was dependent on each of the other silos; people began to work collaboratively and were no longer defensive of siloed approaches

Next, our consultant created a numerical model of these maps in excel to do a cost-benefit analysis. This helped to justify why there should be an increase in funding on the marketing element of the project. The result was a massive increase in the marketing budget, meaning that Inland Revenue were able to advertise on TV for the first time. This resulted in the creation of the marketing figurehead - Hector the Taxman.

What worked well?

Mainly getting everyone to talk to each other, collaborate, and realise the interdependencies of their individual work areas. The conversations that people had in the workshop were really helpful and meant that things continued to go smoothly afterwards. Getting everyone together in the same room is a huge benefit of causal loop maps - as well as the conversations that are held while creating them. This is a standard approach that allows people to express opinions, explores the what and why of a problem, and captures conflicting opinions. The result of putting in a budget for marketing was a great outcome that came from using systems approaches in this project – at that time it was rare for the Inland Revenue to spend money on something like this!

What didn't work so well (what challenges or barriers did you encounter)?

This was the first time that systems thinking had been used in an Inland Revenue project, and the first time that I had used the approach in a real situation. A big challenge that I encountered was the lack of guidance on how to effectively run a workshop. Without good technique or facilitation skills people interpret causal loop maps differently, and the power that comes from creating them dissipates. At the time, we didn't have a scribe there to point out when something has been missed and annotate the 'why's' of the problem. Since that time, I have developed a standard way for recording this information.

What were the outcomes of using systems thinking in your work?

The outcomes of using systems thinking in this work were that the self-assessment tax system went live successfully. Without this, we could potentially have had lots more objection to the new tax system, and in the worst case, more tax riots.

My experience of using systems thinking: Understanding how universities make financial and prioritisation decisions

Isabel Ruckelshauss is the Principal Analyst for systems thinking at UK Research and Innovation (UKRI). This testimony describes Isabel's personal experiences of using systems thinking to understand if research in UK universities is funded in a sustainable way.

What were you trying to do? What was the project and what were its overarching aims?

Universities in the UK deliver teaching and research activities to benefit society and the economy. These activities are funded through a variety of income sources (including tuition fees and project-specific research grants).

Our project centred around the financial sustainability of research activity and understanding the factors that affect financial and prioritisation decisions in universities.

We wanted to work with universities all over the country to understand nuances in the system and emphasise any differences in their views.

Why did you think that a systems approach was right?

We decided that a systems approach was appropriate because this is a question to which there is no single answer, and we wanted to use systems thinking to understand which incentives we might set through our policymaking.

This was more about:

- gaining a better understanding of the system,
- the different views that stakeholders hold of it and
- the complexity associated with it.

What did you do?

Together with policy colleagues, I spent time defining the problem as there were lots of questions relating to research sustainability overall. We then ran a series of causal loop mapping workshops with internal and external stakeholders with the eventual aim of identifying key loops and any systems archetypes[6] along with themes to broaden our understanding of how universities behave (see page 16 for one of the initial maps created, with loops highlighted in blue).

We also looked at what dynamics play the greatest role in this system. Building separate maps with internal and external stakeholders will help us to identify where

[6] System archetypes are patterns of behaviour of a system.

the key differences between them lie. Causal loop maps are very handy for this kind of analysis as they highlight which factors and interrelationships play the biggest role in the behaviour of the system. The outputs of these mapping exercises will be used for scenario analysis.

What worked well?

For a project to work well you need to have strong stakeholder engagement. It's vital that these stakeholders have an interest in working with systems thinking and are willing to dedicate time and resource to the project. I was very lucky in that regard.

Causal loop diagrams promoted interaction and a shared learning that we found to be very useful. The fact that stakeholders must come to an agreement on what they put on their causal loop map worked well, and many people exchanged contact details to continue this shared learning after the workshop. I thought that this was a very positive outcome given that many first met in the workshop!

We also found causal loop maps to be extremely effective in communicating complex situations to senior decision-makers.

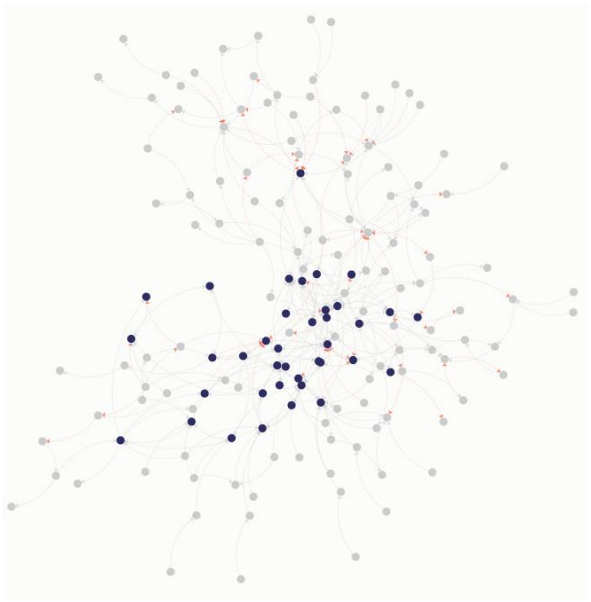
What didn't work so well (what challenges or barriers did you encounter)?

We found time-constraints to be the biggest problem. Causal loop mapping takes a long time and requires many resources to be done well, especially for bigger projects. During the eight months that I have been working on this project I have had to adapt to changes in the organisation. It can be challenging to adapt to the constant fluctuation around you and ensure that everything still works around set timelines. We also had to convene all our workshops via Zoom, which had advantages, but also meant it could be difficult to encourage reluctant speakers to contribute to the discussion.

What were the outcomes of using systems thinking in your work?

After our causal loop mapping workshops people always say "I had never thought about a problem this way before".

I have had positive follow-up from people who participated in the workshops and lots of colleagues are interested to find out what we have discovered through the system mapping approach. Specifically, I expect that systems thinking will promote a much greater understanding between internal and external stakeholders. We are starting to convince senior stakeholders of the patterns that we are seeing and issues that will need to be addressed. The work is being used to inform the analysis of drivers of change and policy work on addressing sustainability pressures in the research and innovation sector.



Causal loop map generated by Kumu.io software, contributed by Isabel Ruckelshauss.

My experience of using systems thinking: Creating a healthy business finance system in the UK

Mark Renshaw, Jennifer Panting and Nafeesah Ameerudden (photo not included) work within the Technology, Strategy, and Security Team in the Department for Business, Energy, and Industrial Strategy (BEIS), along with two others who were not interviewed. This joint testimonial describes Mark, Jennifer, and Nafeessah's personal experiences of using systems thinking to understand how businesses in the technology sector (deep and emerging) can be scaled-up.

What were you trying to do?

The UK is very good at creating start-up and spin-out companies but less efficient at scaling small firms into large firms. Furthermore, everyone has different ideas on what the enablers and blockers are to scaling-up a business. As a team, we decided that the crux to solving this problem is reducing complexity so that policy officials can make interventions that are evidenced and supported. We wanted to create something that we could show to stakeholders to create a shared understanding of the problem.

Why did you think that a systems approach was right?

We thought that a systems approach was right due to the complexity of the problem and the diverse range of stakeholders involved. Systems thinking is a great way for engaging stakeholders and aligning people's understanding on a complex problem.

What did you do?

We followed a course on systems practice provided by Acumen Academy[7], which was very practical as opposed to theoretical. First, we identified a set of candidate problems that were amendable to a systems approach and developed a long-term goal for the system known as a 'guiding star'. This describes an aspirational state for the system and acted as an anchor for the questions that we asked stakeholders. Our long-term vision (guiding star) of a healthy UK business finance system for deep and emerging technology is one that effectively invests money into firms with the highest potential for creating positive economic and societal impacts. In the nearer term (near star), we want investors to be increasingly comfortable backing UK deep and emerging

[7] https://acumenacademy.org/course/systems-practice

technology firms, understanding the risks and the rewards this could bring given immature markets. We want firms to demonstrate the potential impacts and markets of their technologies to investors, and government to cultivate a healthy ecosystem of investors and firms. To understand how the system currently works, we will use the framing question[8] "what constrains and enables effective investment into UK deep and emerging technology firms?"

Next, we brainstormed all relevant factors (those that constrain and enable effective investment in UK emerging and deep technology firms) into one big Visio[9] file, which included virtual post-it notes. We identified eight broad themes that were relevant to explore and used these as a basis for a series of consultations with people in the Civil Service. These consultations fed into big workshops that were held with stakeholders to flesh out themes and identify key insights/narratives (see page 19 of this case study for examples of the brainstorms that were generated during these workshops).

We are now taking our learning from these workshops to generate a series of loops. In consultations there were 32 individual stories that seemed relevant, and we built these out into a series of causal loop diagrams. This was a complex, iterative process. We are now in the process of distilling these loops into 15 or 16 key loops and will then condense these further into a core story on why the system functions as it does. This core will be used to build up a final systems map that our team and stakeholders can use to identify points of leverage in the system.

What worked well?

Taking a systems approach was effective in helping us to work with different teams and stakeholders to gather diverse perspectives. Working together to create causal loop maps was very useful from an analytical point of view and helped us to summarise evidence on key enablers and inhibitors in the UK business finance system for deep and emerging technology.

What didn't work so well (what challenges or barriers did you encounter)?

The biggest challenge that we face is time (we are the three core members of this project team) and the fact that we have been working at home due to the COVID-19 pandemic. This has not presented a major barrier so far, but it might make the process trickier now that we are ready to build our systems map. It would be most efficient and effective to do this in person so that we can highlight key information and cut out unneeded bits. Having said that, working from home has made it much easier to talk to a wide diversity of people and gather a broad range of perspectives. We are also

[8] A framing question is a compelling question that guides your work, and is especially relevant to acting as an anchor when creating maps of your system.

[9] Microsoft Visio is a data visualisation app

limited by technology; now that we are building a systems map we may need to explore mapping options requiring additional resource.

What were the outcomes of using systems thinking in your work?

We have not finished this project and so do not know what the long-term outcomes of using systems thinking will be. However, so far systems thinking has helped to create a shared understanding between stakeholders on how to create a healthy finance system for businesses in the UK. By taking a systems approach, we have bought together a range of stakeholders from across the Civil Service to create a core working group. The short-term goal of this working group is to decide how we should talk to senior government leaders to address the problem.

The longer-term goal of this project is to provide an essential framework that will enable the Civil Service to start thinking about this issue from different perspectives. The evidence generated from working group consultations formed the basis of a paper that was sent to senior Government leaders.

Examples of brainstorms generated during workshops, contributed by Mark Renshaw, Jennifer Panting, and Nafeessah Ameerudden.

My experience of using systems thinking: Improving Net Zero policy design

Jonathan Hoare is a Deputy Director in the Net Zero Strategy Directorate at the Department for Business, Energy, and Industrial Strategy (BEIS). This testimonial describes Jonathan's personal experiences of embedding systems thinking into the Net Zero strategy. This work was initiated in response to a pull from the Prime Minister's Council for Science and Technology in 2020.

What were you trying to do?

The UK Government has set a bold and ambitious target to reach net zero carbon emissions by 2050. In our team, we use a systems approach to visualise how different parts of this the net zero system are interconnected. This helps identify where to make changes in the system to achieve government priorities. We can then use this insight to support delivery modelling, policy development, and the reporting/understanding of net zero.

Why did you think that a systems approach was right?

Achieving net zero carbon emissions requires a massive change in the way that society operates, and this will include a whole economy transformation. The sheer complexity of this problem means that a systems approach is required to tackle it. It is important to recognise the timeline of net zero, and the fact that during the next 30 years there will be changes in science, technology, and economies that impact the whole system. A combination of hard and soft systems tools is required to tackle this issue.

What did you do?

We have three main missions; to ensure that governance of Government programmes is organised in a holistic way, to use a strategic systems approach as an organisational learning machine, and to embed a culture of learning and reflection across the net zero landscape.

We have used lots of systems maps to build our understanding, and Sankey diagrams were used in the Net Zero Strategy[10] to show anticipated changes to the energy system over time. We are also building and developing a systems interrogation tool for land use and heat and building systems to help inform decisions by policy makers (see case study by Adam Mackenzie-Jones for further details). At a strategic level we work with the Council for Science and Technology (CST), subgroups of CST and others such as The Royal Academy of Engineering) for advice on how best to approach different issues.

[10] https://www.gov.uk/government/publications/net-zero-strategy

What worked well?

Systems reasoning also informs our decisions on what factors need to be kept on close watch. We're continuing to embed the approach, and systems approaches have enabled us to think about interdependencies in the system. It's not a totally new approach. BEIS has used cutting-edge whole energy systems models like UK TIMES for a number of years, which have helped the whole of government design policies and programmes to meet our Carbon Budgets.

What didn't work so well (what challenges or barriers did you encounter)?

We haven't encountered any barriers, but there are things that we might have done differently. When building things like tools there is a risk of doing so in a non-systemic way, it's important to bring in stakeholders right at the beginning of this project to ensure that we are working within the policy making system (as opposed to outside the policy environment). There is also a risk that people can think that they are already doing systems if they have used systems thinking in the past. It is important for people to understand that this isn't something that they do once and then go back to the 'normal' way of doing things, and a shift in perspective is needed here. But people are also right that excellent policymaking and advice means thinking beyond the immediate issue and time horizon.

What were the outcomes of using systems thinking in your work?

We are now approaching the challenge of achieving Net Zero in much more sure-footed way. We know that there is uncertainty in the system, but by using systems thinking we are equipping ourselves to deal with this in best way.

My experience of using systems thinking: Developing a new capability for the Home Office

Dr Niki Jobson is a Chief in Systems and Consulting at the Defence Science and Technology Laboratory (Dstl). This testimony describes Niki's personal experiences of using systems thinking to help establish a new capability for the Home Office.

About Dstl

Dstl has a cadre of staff, with highly developed systems thinking and systems leadership skills, that work closely with senior Defence and Security decision makers to:

- accelerate their understanding of complex, turbulent challenges with high degrees of uncertainty.
- structure the problem they are facing and develop sound, evidence-based approaches to addressing them.
- explore, develop, and test potential systemic intervention strategies.
- design collaborative approaches for working effectively across multiple organisation boundaries and technical disciplines.

What were you trying to do? What was the project and what were its overarching aims?

Dstl was tasked by the Home Office to help them identify options for establishing a new systems-of-systems capability. As several government departments had a stake in the situation it was vital to agree the purpose of the endeavour, explore the policy, operational and technical challenges, and constraints holistically and generate a coherent set of requirements.

Why did you think that a systems approach was right?

We took a systems approach because we needed to work across organisational boundaries with a diverse set of stakeholders, each with different foci, roles, responsibilities, and technical knowledge. No single organisation had a holistic view of the challenge nor owned the system-of-systems that needed to be delivered. Successful outcomes would only be achieved by bringing the stakeholder organisations' together to develop a shared understanding of the challenges faced, agree the purpose of the capability, and collaboratively develop a way forward

What did you do?

As with any challenge, we started by exploring the multiple perspectives on the purpose of the capability and the context it would operate in. This provides a sound

foundation for moving forward. This activity was based around the PQR formula of soft systems methodology. We developed scenario narratives to help stakeholders collaboratively explore and debate the broad range of policy, operational and technical issues they would need to address to achieve the desired outcomes. The approach was based on an iterative cycle of interviews and workshops that enabled us to build knowledge and understanding progressively, across the stakeholder community, adapting the approach as we learned what we needed to know next.

What worked well?

This was the first time the stakeholders had come together to explore and understand the capability as a cohesive whole. The collaborative and consultative approach allowed the team to harness the intelligence of the collective, but more importantly see the issues, challenges and needs of others from alternative perspectives. This created greater empathy in the stakeholder a group, making it easier to find accommodations and establish a more unified approach for moving forward.

What didn't work so well (what challenges or barriers did you encounter)?

Collaborative working requires stakeholders to dedicate time to coming together; diary availability was a recurring issue. People can find it challenging to leave behind today's urgent operational challenges to address scary, future problems. Understanding the complexity and variety of requirements and challenges across the whole system is cognitively taxing. Hearing alternative perspectives and views that challenge your own understanding can be uncomfortable. Dstl was fortunate to have customer who championed the systems approach and corralled stakeholder attendance for the initial workshops. After the first couple stakeholders began to see the value in attending and prioritised their time to do so – they had a vehicle to get their voice heard and they got a much better understanding of the context of their work.

What were the outcomes of using systems thinking in your work?

Option development is currently paused as our exploration of the space identified some intermediary issues that need to be addressed first. These range from putting in place policy enablers and addressing gaps in technical knowledge that would enable the cost-benefits of the options to be properly explored. However, with all the information gathered we were able to rapidly identify and agree a set of actions that the Home Office and its stakeholders could take immediately to effect change and yield improvements.

My experience of using systems thinking: Explaining the Department for Work and Pensions policy simulation model

Rachel Bennett is an operational researcher in the Department for Work and Pensions (DWP). She recently completed a master's degree in systems thinking with the Open University. This testimony describes Rachel's personal experience of using systems thinking in her master's dissertation project to help explain the DWP policy simulation model.

What were you trying to do? What was the project and what were its overarching aims?

I was working in a modelling team, and my specific team were looking after a model called the policy simulation model. This looks at all the benefits that the Department for Work and Pensions (DWP) is responsible for such as universal credit and legacy benefits. The model can be used for 'what if?' analysis; for example, if an extra ten pounds was added to universal credit, how many people would it affect and what would it cost the government? This is a very powerful tool that can look five years ahead and is used for forecasting in the department. The model itself consists of lots of modules of code. A user interface is essential so that analysts can reach in and get outputs without going into the depths of the code.

When I joined the department there was no schematic to visualise the policy simulation model and what it does. People would have to jump into the code, read it, and look at the data outputs. Therefore, the aim of this project was to use systems thinking to explain the model to new modellers and analysts.

Why did you think that a systems approach was right?

This was a collision of two things; I was learning about systems thinking and had an interest in it. I felt that this situation needed pictorial representation and knew that systems thinking could do that. I also wanted to bring people into the process to promote shared learning and knew that systems approaches are helpful for doing that. It was important to shed light on the complexity of the situation and I knew that systems approaches are good for bringing people with different perspectives on board. This wasn't a policy process with different individuals disagreeing, so I wasn't sure if it was the right approach. It was pitched more as an experiment.

What did you do?

Everything that I did was internal to DWP. I experimented with several different systems thinking techniques to see if they were helpful. Firstly, I drew a rich picture[11] of how the policy simulation model sits in the organisation (see page 26 for final rich

[11] Rich pictures are explored in the Civil Servant's Systems Thinking Toolkit

picture). This included what the model is used for and who the different actors are. Once I had drawn the rich picture, I shared it with analysts to test my understanding and made further changes based on their feedback. I then made a cognitive map of me, my Grade 6, and Grade 7's views about the policy simulation model's relative strengths and weaknesses (see page 26 for final cognitive map). This helped us to articulate what we thought the key issues were with the model as well as what was going well and helped us focus our efforts on where systems approaches could most help. We concluded that the model had great quality assurance and was robust. The key issue was trying to improve accessibility. The crux of this was to get modellers and analysts together in a workshop to talk about the model and do some mapping of how key elements within the model worked together. In the end we made a hierarchy of maps, including a high-level map and some detailed maps for more specific benefit types.

What worked well?

Drawing the rich picture went better than I expected – this was quite a risky thing to do as rich pictures can look quite naive. I did this more for myself, but other people found it helpful when I showed it to them. This is now used in the team induction pack to describe the model, what it does and how it is used. The cognitive map was useful in the process of articulating what I wanted to do for the workshops, but the outputs were not surprising as the people who helped to create them already knew the outcomes. The workshops worked well as people talked to each other and shared their knowledge about the model. This verbal sharing of knowledge to capture everyone's collective learning had not happened before.

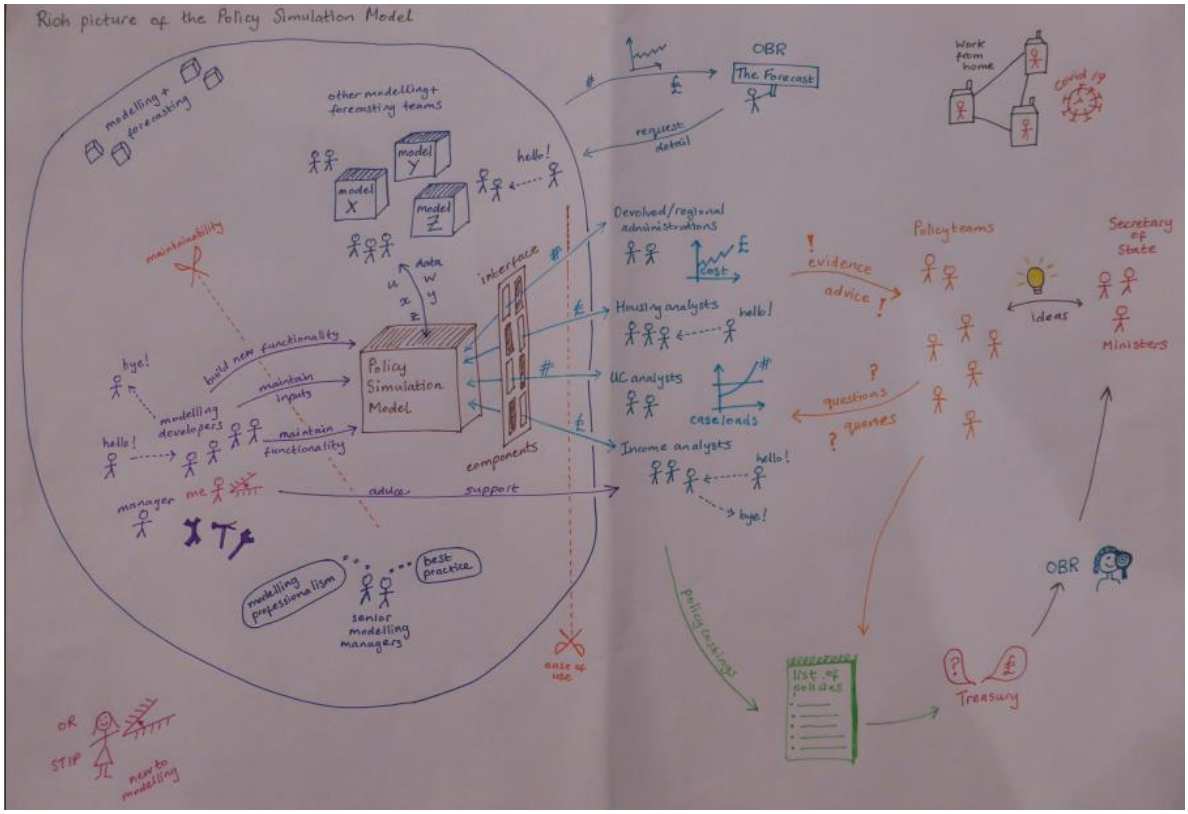
What didn't work so well (what challenges or barriers did you encounter)?

Systems thinking was a new concept for everybody in the team, so I felt that I had to pitch its usage as an experiment to limit expectations. The challenge was to get people's time whilst promoting this as something new to try. If systems thinking based workshops do not stack up with people's day to day priorities it can be hard to get them to contribute. It is also important to come up with a collaborative learning outcome to show workshop benefits and convince people to spend time on them.

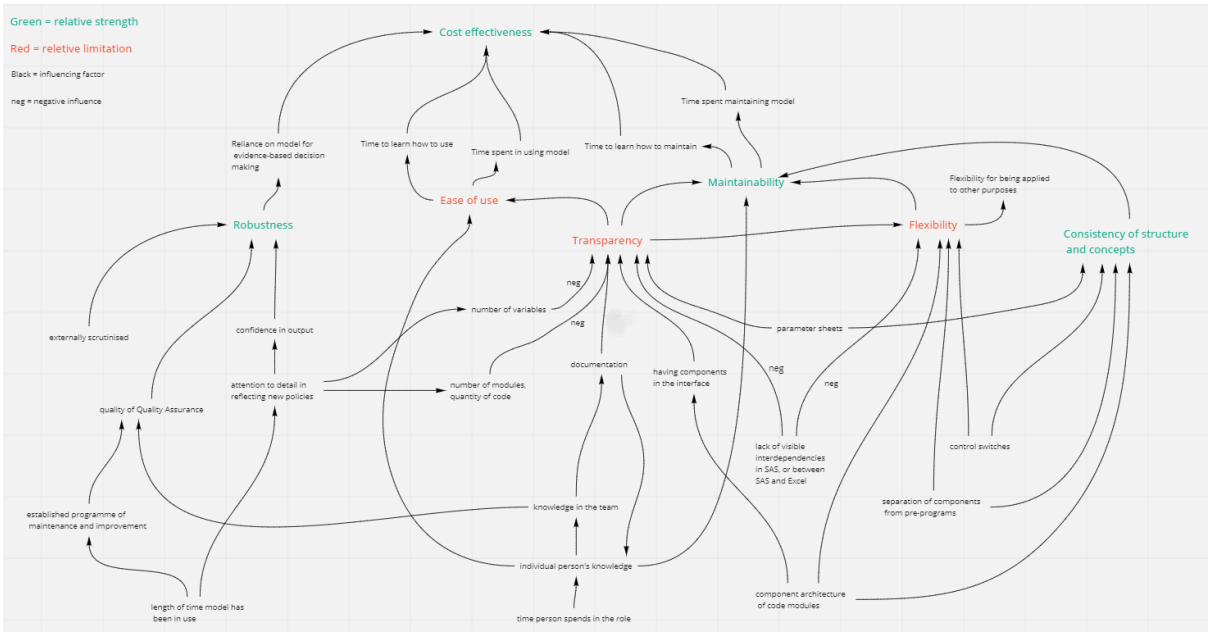
What were the outcomes of using systems thinking in your work?

The rich picture that I drew is in our team induction pack along with the other maps. The primary objective of the project was to enhance the accessibility of the policy simulation model for people coming into the team and the department. This objective was definitely met and has given me confidence that these systems thinking approaches can work for these types of problems.

I learnt that we need to be careful with what language is used when presenting systems thinking to people. I realised that it can be more off-putting than helpful to name the specific type of approach used. For example, rather than saying 'systems maps' it can be good to simplify this by using a phrase like 'collecting ideas'. In addition, I was able to put the outputs from this project into the dissertation for my master's degree.



A rich picture to understand how the policy simulation model fits into DWP, contributed by Rachel Bennett.



A cognitive map to bring together people's different perspectives about the relative strengths and weaknesses of their model, contributed by Rachel Bennett.

Our experiences of using systems thinking: Tackling multiple disadvantage

Shane Britton is the Lead Policy and Programme Advisor for the Changing Futures Programme at the Department for Levelling up, Housing and Communities (DLUHC). Richard Lewis is the Engagement Advisor for this programme. This testimonial describes Shane and Richard's personal experiences of using systems thinking to help tackle multiple disadvantage.

What were you trying to do? What was the project and what were its overarching aims?

Changing Futures is a cross-government programme funded by HM Treasury's Shared Outcomes Fund with additional aligned funding from the National Lottery Community Fund[12]. It aims to improve outcomes for adults experiencing multiple disadvantage – including combinations of homelessness, substance misuse, mental ill health, domestic abuse, and contact with the criminal justice system.

Working with 15 local areas, our work focuses on three interlinked levels of activity. At an individual level, areas are coordinating better 'whole person' support for local cohorts of people experiencing multiple disadvantage. At a service level, we are exploring how services can join up and work together more effectively to coordinate that support. At a systems level, we want to determine how to drive long-term impactful change in local systems in a way that is sustainable. We will also consider how to achieve more join-up across government to understand and address the systemic challenges that exacerbate the problem.

Why did you think that a systems approach was right?

This is a complex challenge. Individual services and siloed approaches are limited in how far they can address this challenge and deliver outcomes for people with multiple disadvantage. Taking a system-wide view is therefore key and brings together the right partners to coordinate a more effective response.

This also means working differently. Traditional methods of public management focus on a linear method of inputs and outputs which is hard to follow with this cohort, who face complex needs and require support from a range of partners in a local system. A wide range of services and other factors influence the outcomes in peoples' lives. Local partnerships of statutory and voluntary sector agencies therefore need to build shared ownership of the problem and continually learn and adapt in developing

[12] https://www.gov.uk/government/collections/changing-futures

solutions, listening to people with lived experience and to emerging learning about systemic barriers and challenges from their frontline delivery.

What did you do?

We have embedded systems thinking into all our plans from the start, with all areas required to develop system-level theories of change and to identify a named system change lead locally. By acknowledging that local systems vary, and that local partners know their own system best, we have built in a high level of local flexibility. However, our prospectus[13] established a set of core principles for areas to follow, including a focus on driving lasting system change. All of this means that alongside frontline delivery, areas are investing in their strategic partnership and system change capacity; looking at how improved data sharing and systems can improve their understanding of the problem; and are undertaking system mapping and lived experience engagement to identify key barriers and points of the local support system that need a specific priority focus.

The evaluation running alongside this also takes account of systems thinking, with evaluators supporting local system mapping sessions and social network analysis. Understanding to what extent and how areas have been able to drive local system change, and how this affects people's experiences of services, will be a key part of the evaluation.

One benefit of systems thinking is the many voices and perspectives that this approach brings in. We have involved people with lived experience of multiple disadvantage in developing our core principles and set a requirement for each area to co-develop their delivery plans with input from people with lived experience.

What worked well?

It is still early in the programme, so we will see more as the approach develops and is embedded in areas. So far, we have found that our locally driven and system focused approach has helped generate strong local ownership, buy-in from a wide range of local partners and powerful momentum for change.

What didn't work so well (what challenges or barriers did you encounter)?

Systems thinking can appear very abstract which is sometimes a challenge in supporting areas with their approaches. We have tried to overcome this with a support provider helping areas develop and think through their approaches, but it is something we are continually learning how best to develop and support. A further challenge is linking up with the range of other transformation and change activities across different parts of the system that also impact on local areas, from health transformation to probation changes. All of these present opportunities to improve local systems, but also mean lots of change and competing demands on local leaders from different parts of the system.

[13] https://www.gov.uk/government/publications/changing-futures-changing-systems-for-adults-experiencing-multiple-disadvantage

What were the outcomes of using systems thinking in your work?

The programme is still in the early stages, but a focus on systems change and systems thinking from the start has encouraged areas to think early about their wider partnerships and the long-term impact of their work. By looking outside the usual structures of service funding, Changing Futures has given local areas space to think about new approaches to tackle multiple disadvantage. In the longer-term, we hope that this programme will generate important learning that can lead to long-lasting and transformational change for a very vulnerable group.

My experience of using systems thinking: Developing the business in human rights action plan

Richard Fitzgerald is an Operational Research Analyst at Department for Business, Energy, and Industrial Strategy (BEIS). This testimonial describes Richard's personal experiences of using systems thinking to help develop a policy called the Business and Human Rights Action Plan.

What were you trying to do? What was the project and what were its overarching aims?

I was working as part of an internal consultancy in BEIS called the Operational Research Unit. This specific project was on a policy called the Business and Human Rights Action Plan. BEIS held the lead in terms of policy development but were dealing with lots of internal and external stakeholders. The aim of this policy was to ensure that businesses review their Human Rights impacts across national and international supply chains and take action to mitigate any harms. Businesses operating in the UK should have an awareness and responsibility for how suppliers overseas treat their own workforce and their sub-suppliers. This was the overarching aim of the Business and Human Rights Action Plan. This project involved multiple stakeholders with different approaches/points of view. There was no immediate consensus on what needed to be done or who was responsible for what, so the policy team invited me and my colleague to set up and facilitate a workshop with stakeholder representatives. The aim was to bring people together to reach a consensus and validate areas of concern.

Why did you think that a systems approach was right?

We were invited in because systems thinking had been used for a previous piece of work on a different policy relating to gender representation. This had involved a workshop with a broadly similar systems mapping approach. The policy sponsor was pleased with the outputs and invited us to use a similar approach for the Business and Human Rights Action Plan. Our team had also been encouraging the use of soft systems[14] for complex problems which had multiple viewpoints and no shared understanding of the whole system. Soft systems techniques help to solidify this shared understanding and give a clearer picture of key issues and interrelationships. Our previous work raised the profile of this technique, and our policy sponsor realised that this approach was a way to help crack other problems which had so far been intractable.

[14] Soft systems methodology developed by Peter Checkland (Checkland P. 1981. *Systems Thinking, Systems Practice*. John Wiley: Chichester).

What did you do?

First, we organised a workshop with representatives for the main stakeholders involved in the Business and Human Rights Action Plan (e.g., Department for International Trade, Foreign, Commonwealth and Development Office, Confederation of British Industry). These sessions were 2-3 hours long and it was important that these were as productive as possible.

At the start of the session, I emphasised the importance of the Chatham House rule[15] to encourage people to talk freely. It was also important to emphasise that I was independent to the policy sponsor team to show that I had no pre-conceived views on the policy myself. This helped reassure participants that I would respect all viewpoints and give people a fair hearing. I took a systems approach to leading conversations and drawing out the potential conflicts that might impact policy goals. I then presented my assessment on what further work needed to be done before the policy could work in practice. We validated this as a group at the end of the session and everyone committed to delivering on specific outputs.

We also took photos of the workshop outputs and I used this to create a 'first pass' draft systems map in Vensim software[16]. This highlighted the interrelationships and risks associated with the policy that the stakeholders had articulated in the session. We then validated this map with stakeholders and policy sponsors over the course of a few iterations. The map was then adopted by our sponsors as a reference guide to help explain the policy to other people and clarify responsibilities. Finally, this was converted into a massive printout for the office wall, as a visible reminder of what had been agreed.

What worked well?

Although systems thinking was not applied to the workshops *per se*, the sessions were structured with a systems approach in mind. I used the building blocks of a systems map in conversations with stakeholders without drawing it out in real-time. Systems thinking was also useful in setting up a framework for how to approach the session and helped us to home in on key emerging areas that were most important. The final map was converted into a printout that was circulated to people for comment and subsequently used as a reference point for policy professionals.

What didn't work so well (what challenges or barriers did you encounter)?

The main barrier that I encountered was getting buy-in from stakeholders to go along with the technique itself. One problem that I have found in workshops is that people can get more hung up on the technique rather than the purpose of the workshop itself, which can detract from what you are meant to be talking about.

[15] https://www.chathamhouse.org/about-us/chatham-house-rule#:~:text=The%20Rule%20reads%20as%20follows,other%20participant%2C%20may%20be%20revealed.
[16] https://vensim.com/

What were the outcomes of using systems thinking in your work?

The workshop generated a real consensus on who was responsible for different actions. There was also an agreement on which areas stakeholders needed to focus on going forward in terms of policy development. The systems map was effective in highlighting areas that we didn't have a lot of knowledge on. For example, how would consumers react to publicity around infringement of human rights by a High Street brand? Would this influence their buying decisions and, if so, would this be a lasting effect? We initiated research to anticipate and uncover this type of reaction, which formed the basis for further work by the policy team.

My experience of using systems thinking: Joining-up air quality and climate change policies

Department for Environment Food & Rural Affairs

Rose Willoughby is a systems research scientist in the Department for Environment, Food, and Rural Affairs (Defra). This testimonial describes Rose's personal experiences of using systems thinking to help join up air quality and climate policies.

What were you trying to do? What was the project and what were its overarching aims?

The aim of this project was to integrate thinking around climate change and air quality. When the government announced plans to achieve net zero carbon emissions by 2050, we saw an opportunity to integrate climate and air quality policy decisions.

Why did you think that a systems approach was right?

Climate change and air quality were historically seen as two separate issues, although greenhouse gases and air pollutants are co-emitted. A systems approach seemed like a really good way to join-up these two areas and build a shared understanding of how to simultaneously tackle both issues. There are many past examples of where actions have been taken to combat one of these issues but had a knock-on effect on the other. For example, diesel cars were incentivised to tackle greenhouse gas emission, but also had unintended consequences on air quality.

What did you do?

We used a soft systems methodology[17] to convene experts and facilitate knowledge exchange between stakeholders holding responsibility for different parts of the system. We identified stakeholders by deciding as a team what expertise we needed present. These included representatives from a number of government departments such as the Department for Transport, as well as the Climate Change Committee and Air Quality Expert Group. We designed workshops to ensure that a broad range of experts and policy design makers were brought together to share information.

To ensure that workshops were productive, we set expectations on what information we wanted to gather and what we wanted participants to gain from attending the workshop. We also completed a lot of pre-work and considered what information we should share in advance and/or during the workshop. For example, we pre-shared an information pack with participants to ensure that they came armed with knowledge on what the team wanted to get out of the workshops.

[17] [17] Soft systems methodology developed by Peter Checkland (Checkland P. 1981. *Systems Thinking, Systems Practice*. John Wiley: Chichester).

On the day, there was an excellent presentation from the Climate Change Committee; representatives were great at fielding questions and discussing what measures they had put forward to achieve net zero. This gave participants a good understanding of what each of these measures actually meant. People were then put into breakout groups which enabled valuable conversations on how different interventions might affect levels of specific air pollutants. We ensured that we had air quality and climate change experts in each room to facilitate conversations on what different interventions for climate change could mean for air quality.

What worked well?

Holding workshops at an early stage of the project helped to spark and enable conversations that contributed to our success. It ensured that our message on air quality was weaved into key thinking and strategy making by policy officials. It was great having a mix of policy leads in the room, and the workshops helped develop a shared understanding between these stakeholders in a way that felt open and engaging. Their perspectives helped us to develop a much wider breadth of knowledge on the subject matter, which enabled us to have lot more impact in the long-term. Bringing new perspectives and in-depth knowledge into the workshop meant that policy officials were able to further their understanding of how different policies might impact greenhouse gases and air pollutants.

The workshops also enabled us to start building informal networks. The timing of the workshop worked well because we were quick to act after the UK government announced their commitment to achieving net zero greenhouse gas emissions by 2050. We were well poised to get people thinking about different climate policies and ensure that they were taken into consideration. Important conversations were sparked early and allowed air quality to be considered upfront in climate policy decisions. The Climate Change Committee also submitted a progress report to parliament stating that air quality and health impact must be considered alongside climate change policies. Ultimately, taking a systems approach allowed us to get our message into key strategies and decisions.

What didn't work so well (what challenges or barriers did you encounter)?

It was a challenge to organise the workshops at the time because there was no sense of urgency; the joining-up of air quality and climate change policies was not seen as a pressing issue at that time. It was also a challenge to gain buy-in from some stakeholders who could not immediately see why the problem was relevant to them.

What were the outcomes of using systems thinking in your work?

The obvious output was the report that the Air Quality Expert Group wrote up to summarise the findings of our workshop. This publicly available report shares key findings and highlights potential risks associated with different policies[18]. For example, the report summarises the risks and hazards of potential climate policies (e.g., the risk of bioenergy to air quality) which helps stakeholders consider how these could be

[18] https://uk-air.defra.gov.uk/library/reports.php?report_id=1002

mitigated. The Climate Change Committee also submitted a progress report to parliament stating that air quality and health impact must be considered alongside climate change policies.

Taking a systems approach has also enabled the Air Quality Team to proactively engage with different policy areas and have evidence-based conversations. Furthermore, we have raised awareness of the interlinkages between climate change and air quality. Ultimately, we have raised the profile of this issue so that policy officials are now aware that air pollution needs to be considered alongside greenhouse gas mitigation policies.

My experience of using systems thinking: Ageing Foresight Project

Tom Wells is a deputy director at the Government Office for Science (Emerging Technology, Futures and Projects division). Stephen Bennett is co-head of Policy Lab at Policy Lab UK. This testimony describes Tom's and Stephen's personal experience of working together and using systems thinking to help deliver objectives in the Ageing Foresight project.

What were you trying to do? What was the project and what were its overarching aims?

The Government Office for Science led a Foresight project on the future of population ageing and collaborated with Policy Lab specifically to help policymakers think strategically about what population ageing would mean for the UK. Foresight projects use science and evidence to help ministers create policies that are more resilient to the future. Please see the link below to access the Ageing Foresight report[19].

Why did you think that a systems approach was right?

Population ageing is one of those long-term, thorny issues that you can come at from multiple angles. Is it an NHS issue or pensions? Was technology coming to the rescue, or does it all boil down to education opportunities earlier in life? Or housing? As we got into the evidence, it became increasingly clear just how interconnected and mutually reinforcing the issues were. Good health makes it easier to keep active, both socially and in work. That is likely to mean someone is wealthier in later life and better able to afford good housing… and in turn they are likely to be associated with better health outcomes. There's a vicious circle version of that. Whether you took an individual focus – how do we help people age well? – or a national perspective – how do we make sure the UK makes the most of population ageing? – our challenge was to bring these things together in a way where people could quickly visualise the linkages.

What did you do?

The Government Office for Science commissioned the Operational Research team in BEIS to develop a systems map through a series of workshops. They created a detailed map in PowerPoint, with lots of nodes and connections. Policy Lab then asked

[19] https://www.gov.uk/government/publications/future-of-an-ageing-population

designers to create and deploy a clear visual language which brought out the important systemic fundamentals, including reinforcing loops, critical nodes, and unintended consequences (see page 37 for the final systems map). That map then was an input to workshops we collectively ran for policy officials to think through interventions in the "ageing system" that would lead to better outcomes for people and the UK by 2040.

What worked well?

The systems approach really helped the project team to develop a coherent narrative around ageing and how all the different levers fitted together to affect outcomes across departments. It also led us to one of the solutions to the challenge – better cross-government working. If we respond to ageing by working in silos, we will never solve some of the structural and systemic issues or take advantage of important cross-sector benefits. Finally, the designed map was a useful prompt to challenge policymakers. We could help them see that their policy challenge may lie in one part of the system, but the solution may lie in another part - and that part may not necessarily be one that they had jurisdiction for.

What didn't work so well (what challenges or barriers did you encounter)?

We learnt that systems maps can paralyse people. The final map is often huge, messy, and complex. It is intimidating to anyone presented with it, whether they be stakeholders, policymakers, or ministers. Working with designers we have learnt some useful tactics to overcome this. First, clear and intentional visual language can bring out key systems concepts, like reinforcing circles or critical nodes. Second, it is helpful to build up the map gradually using different layers, so that readers can orient themselves before the map becomes too complicated. Third, narratives are extremely important. The map is really just a device to identify systemic policy stories relevant to the challenge - for example the interplay of education, housing, and health in ageing. These stories are as important as the map itself.

The facilitator plays an important role here helping people navigate, contribute to, and make sense of the map, although ultimately the design and narrative needs to be strong enough that people can use it without that person. Finally, our map was entirely qualitative: for example, X helps or hinders Y. We didn't say how strong the connection was or how much impact each factor had on the next. That would be an interesting additional layer of analysis to help a policymaker identify what would make the biggest difference - or where the government should prioritise its efforts.

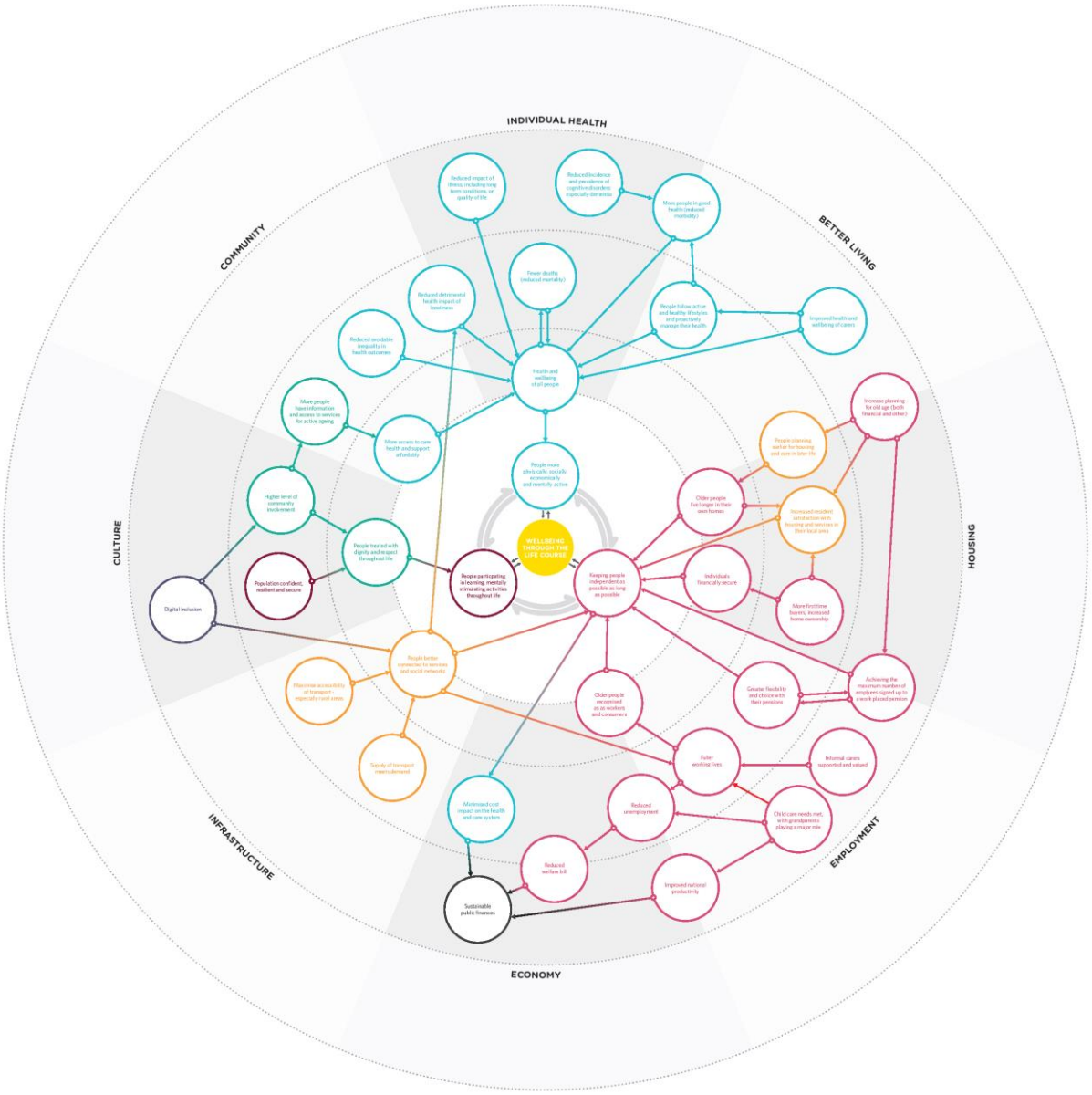
What were the outcomes of using systems thinking in your work?

In the end the systems approach was integral into the Industrial Strategy Ageing Society Grand Challenge that we helped BEIS design[20]. That Challenge focused on the intersection of education, public health, innovation, and technology. We could not

[20] https://www.gov.uk/government/publications/industrial-strategy-the-grand-challenges/industrial-strategy-the-grand-challenges).

have helped them think through all the aspects of ageing, how they fitted together and how that could be addressed through industrial policy, without having taken a systems approach. The fact that you had an industrial strategy talking about much broader issues, and even measuring success in terms of public health, is a sign that the systems analysis landed well with our colleagues.

Policy Map | Wellbeing through the life course



A systems map of the different factors involved in wellbeing, contributed by Tom Wells and Stephen Bennett.

My experience of using systems thinking: Establishing a systems team to inform land use policy

Dan McGonigle is the head of Systems, Innovation and Futures in the Department for Environment, Food and Rural Affairs (Defra). This testimonial describes Dan's personal experience of setting up a systems team in Defra and leading on systems programmes across the department.

What were you trying to do? What was the project and what were its overarching aims?

I joined the Chief Scientific Adviser's Office in the Department for Environment, Food and Rural Affairs (Defra) in May 2019 to set up a new research capability in systems thinking. At the time, environmental and agricultural policies were highly fluid as a result of Brexit; the department was developing new bills on the environment, agriculture, and fisheries. The 25 Year Environment Plan had recently been published setting ambitious and broad policy goals. With so much changing, the systems team was set up to help the department navigate interdependencies and trade-offs between policy goals.

My team consisted of fifteen people, including six externally seconded academics who came into Defra two or three days a week to help develop the systems programme. Our programme was split thematically into five cross-cutting areas relating to different parts of Defra's agenda. My role was to establish a systems team in Defra and to establish systems approaches that can be integrated into the way that policy is developed.

Land use is at the core of much of what the department does. It affects food production, bioenergy, recreation, water quality, air quality, biodiversity, resilience to flooding and many other outcomes. Our transition to net zero will have fundamental implications for land use, so I set up a programme to help recognise the trade-offs between outcomes.

Why did you think that a systems approach was right?

We were dealing with highly complex systems involving many interacting environmental, social, economic and political processes. The interactions that feed into policy outcomes are complex, evidence is fragmented, and we have indirect control over the nature of these policy areas and the way that land is used. In many cases issues are contested – different groups have different goals, perspectives, and knowledge of the system. We needed to find ways to cut through this complexity and to help different policy teams to come to a common understanding.

What did you do?

We broke the problem down into three sets of questions:

1. **The social, environmental, and economic drivers of land use change:** *What are the main drivers and when do particular drivers become dominant?* We held workshops with academics, farmers and other stakeholders and developed causal loop maps to explore interactions between drivers and shed light on areas for policy interventions.
2. **Configuration of land use:** *What is the trajectory of land use in different parts of the country? How does this align with our policy goals?* We held regional workshops to identify trajectories of change and policy workshops to identify land allocation 'rules' which colleagues built into a spatial model.
3. **Trade-offs between multiple environmental outcomes:** *How might actions to meet net zero affect water quality, air quality, flooding, wildlife, water resources, biodiversity, access to land for recreation etc?* We reviewed evidence and held expert elicitation workshops with academics to develop cross-impact matrices to show potential areas of conflict. We also worked with BEIS to develop an overall land use systems tool, allowing users to explore the overall system.

What worked well?

We used lots of workshop-based mapping approaches to develop a shared understanding of the interactions between different factors in the system. To do this, we brought together expert witnesses and academics from different parts of the country to help identify the major drivers of land use change. This provided a space for dialogue between different disciplines and interest groups. We also used ideas from Critical Systems Heuristics to explore differences in perception, goals, and knowledge.

The process of engaging people with different purposes, knowledge, and value sets on how the system operates was invaluable. Having a collaborative and open conversation worked well and meant that we got a shared output and shared goals from workshops. We worked with stakeholders to develop causal loop maps and used these to understand the major factors involved. Causal loop maps are often only intelligible to those involved in drawing them, so we found it worked well to engage stakeholders in this process.

We used the opinions and perspectives of experts in this area to deepen our own understanding of the system and develop a policy dialogue. Since these workshops, we have taken our perspectives forward to begin developing some systems dynamics modelling of the land use system.

What didn't work so well (what challenges or barriers did you encounter)?

We treated this whole programme as an action learning process. There are plenty of things that have not worked so well and that we have learnt from. For example, people viewed the land use system from different angles and had different goals. Bridging these can be difficult and this needs to be built into the design of how you structure your work. Another challenge was the difference in language that people use to talk about the same system. Fundamentally, different stakeholder values can also be challenging.

What were the outcomes of using systems thinking in your work?

Systems thinking helped bring together policy teams across the department and helped us to frame the land use problem in a more systemic way. Our work is helping to frame a more holistic approach to land use policy, and our systems approach to framing the problem has changed the way the department thinks about these types of issues and provided a common language to overcoming these.

We have built on our experiences from our work to develop a *Systems Primer* for Defra staff, which sets out some broad considerations for applying systems thinking: (1) to frame policy, (2) for two-way learning at the science-policy interface, and (3) in working with stakeholders. We also developed a *Stepwise Approach* which provides a how-to guide to applying systems thinking in policy development.

Selected further examples of systems thinking in policy/public management

The case studies listed in this section highlight how systems thinking has been used in a policy development/public management setting. It is not designed to be a comprehensive selection of all applicable examples but is a selection of examples that seemed particularly accessible and relevant to civil servants.

Publications on gov.uk

Net Zero Strategy: Build Back Greener

A study published by the Department for Business, Energy and Industrial Strategy (2021). Describes how a systems approach will help deliver a better transition towards the net zero emissions target. Includes a causal loop map that was used to visualise interactions between factors that need to be considered in the roll-out of electric vehicles.

Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf

Understanding child and adolescent wellbeing: a system map

A study published by the Department for Education (2019). Uses causal loop maps to capture the interdependencies and interrelationships between the various factors influencing child and adolescent wellbeing.

Available at: https://www.gov.uk/government/publications/understanding-child-and-adolescent-wellbeing-a-system-map

Independent Review of Building Regulations and Fire Safety: Hackitt review

A study published by the Department for Levelling Up, Housing and Communities and led by Dame Judith Hackitt (2018). Details how causal loop maps were used to review high-rise building safety and reveal unexpected areas for intervention.

Available at: https://www.gov.uk/government/collections/independent-review-of-building-regulations-and-fire-safety-hackitt-review

Munro review of child protection: a child-centred system

A study published by the Department for Education and led by Professor Eileen Munro (2011). Details how causal loop maps were used to help understand past failures in the child protection system and help inform new policy recommendations.

Available at: https://www.gov.uk/government/publications/munro-review-of-child-protection-final-report-a-child-centred-system

External publications

Safer complex systems case studies

A collection of 18 case studies commissioned by the Royal Academy of Engineering as a part of the Engineering X programme (2022). These cover a number of complex systems successes and failures around the world.

Available at: www.raeng.org.uk/safer-complex-systems/case-studies

Beyond Net Zero: A systemic design approach

A publication from the Design Council (2021). Describes how a systemic design approach can be used to design new interventions that will help achieve net zero targets.

Available at: https://www.designcouncil.org.uk/resources/guide/beyond-net-zero-systemic-design-approach

Critical Capabilities: Strengthening UK Resilience

A report produced by the Royal Academy of Engineering (2021). Details how systems approaches can be used to help build whole society resilience and leverage the UK's strengths to address emergencies of the future.

Available at: https://www.raeng.org.uk/publications/reports/critical-capabilities

Decarbonising construction: building a new net zero industry

A report by the Royal Academy of Engineering and National Engineering Policy Centre (2021). Uses the concept of systems levers where action taken now will result in rapid decarbonisation of the construction sector.

Available at: https://www.raeng.org.uk/publications/reports/decarbonising-construction-building-a-new-net-zero

Human learning systems: Public service for the real world

A selection of human learning system case studies (2021). Details how human learning systems can be used to improve public service and management.

Available at: https://www.humanlearning.systems/case-studies/

Rapid 'low regrets' decision making for net zero policy

A report by the Royal Academy of Engineering and National Engineering Policy Centre (2021). Uses elements of a systems approach to identify low regret decisions that can be taken now to decarbonise the UK economy.

Available at: https://www.raeng.org.uk/publications/reports/rapid-low-regrets-decision-making-for-net-zero-pol

Transport strategies for Net-Zero systems by design

A book from OECD (2021). Details how systems thinking can be used to inform transport strategies that will help achieve net zero targets.

Available at: https://www.oecd.org/environment/transport-strategies-for-net-zero-systems-by-design-0a20f779-en.htm

Video explainers - Getting to net zero: a systems approach

A series of five short films from the National Engineering Policy Centre (2021). Explain why reaching net zero in time requires a new approach to transforming infrastructure, and how a systems approach can help tackle such a complex and broad challenge.

Available at: https://www.raeng.org.uk/policy/policy-projects-and-issues/net-zero-a-systems-perspective-on-the-climate-chal/net-zero-video-explainers

Safer Complex Systems and Safer Complex Systems Strategy

Reports produced through the Engineering X Safer Complex Systems Programme with the Royal Academy of Engineering (2020). Draws on complex systems theory and real-world experience of complex systems engineering and operation to provide an initial framework for complex infrastructure systems safety management.
Available at: https://www.raeng.org.uk/publications/reports/safer-complex-systems
https://www.raeng.org.uk/publications/reports/safer-complex-systems-strategy

Sustainable living places

A report by the Royal Academy of Engineering and National Engineering Policy Centre (2020). Provides a systems perspective on planning, housing and infrastructure.

Available at: https://www.raeng.org.uk/publications/reports/sustainable-living-places-(1)

Engineering Better Care

A report produced by the Royal Academy of Engineering, the Academy of Medical Sciences, Royal College of Physicians and Future Hospital (2017). Details how a systems approach can be used to help make improvements to the UK's Health and Social Care System.

Available at: http://www.eng.cam.ac.uk/uploads/news/files/engineering-better-care-report-web-3mb-20170922.pdf

Systems Approaches to Public Sector Challenges

A publication by OECD (2017). Details how systems approaches can be used in the public sector to help solve complex or "wicked" problems and includes a selection of case studies.

Available at: https://oecd-opsi.org/wp-content/uploads/2019/09/OPSI-Systems-Approaches.pdf

Systems Thinking: An introduction for Oxfam programme staff

A publication by Oxfam (2015). Introduces the concept of systems thinking for Oxfam staff and the broader development community. Contains case studies and questions for staff to consider, as well as useful tools and links to resources on systems thinking.

Available at: https://policy-practice.oxfam.org/resources/systems-thinking-an-introduction-for-oxfam-programme-staff-579896/

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