Systems thinking in the built environment: examples

	Connected systems: the Climate Resilience Demonstrator (CReDo)
Challenge	Extreme weather events caused by climate change are on the rise. When we're not prepared for these events, localised disruption, damage or failures can propagate across interconnected infrastructure networks. For example, a flooded electricity substation could impact transport, water, healthcare, or any other service reliant on that part of the electricity network. Cascade effects can have far-reaching impacts on people and the economy. Understanding vulnerabilities, interdependencies and potential consequences, and prioritising action to mitigate them, is crucial to achieving climate resilience.
Solution	CReDo connects data to enable climate adaptation and improve resilience across a system of systems. It allows organisations responsible for critical national infrastructure to share information in a safe and secure way. Infrastructure owners retain control over their data but share those data aspects that enable others to better understand interdependencies. For instance, CReDo has allowed data to be shared and used between Anglian Water, BT Group and UK Power Networks, through a connected digital twin, to better understand the effects of extreme weather events on their interconnected infrastructure.
Benefit	CReDo improves infrastructure owners' and operators' ability to identify critical systemic connections and dependencies, and examine the probability, severity and consequences of different climate impacts. This enables infrastructure owners to invest in the right areas to protect their assets and continue to deliver services to their customers. It increases systemic resilience. The more organisations that participate and share data, the better the understanding of infrastructure performance and resilience, at a system of systems scale. This in turn enables more holistic and effective adaptation solutions to be developed and deployed.

Systems thinking in the built environment: examples

Built Environment Connective

	Understanding systems: Anglian Water strategic resource options
Challenge	To secure water resilience for the East Anglia region, two new reservoirs were proposed: the South Lincolnshire Reservoir and Cambridgeshire Fens Reservoir. Regional water company Anglian Water needed to understand water resources (quantity, quality and uses) within each catchment, and in neighbouring catchments, to maximise the benefits of the reservoirs. Anglian Water also sought to identify opportunities for delivering additional social, environmental and economic value – co-benefits that could attract co-funding.
Solution	A systems mapping exercise was undertaken to identify interventions required alongside the reservoirs to improve the availability and quality of water across the region. Considerations included land use, agricultural productivity, carbon sequestration, flood management, biodiversity, and socioeconomic improvements. Systems mapping also allowed diverse stakeholders to contribute and collaborate. This enabled consideration of how interventions in one area can affect others, to create cascading benefits. Additionally, various funding and finance sources were identified and mapped to the relevant reservoir and system interventions.
Benefit	In addition to the £4.5 billion capital cost of the reservoirs, systems mapping identified the opportunity to leverage an additional £900 million investment in associated interventions, yielding an estimated £5.7 billion worth of benefits. This opened new conversations with lenders and investors. Overall, the approach encouraged the development of solutions integrating nature-based and traditional engineering, with co-benefits for the environment, society, water customers, Anglian Water, land users and investors alike.

Systems thinking in the built environment: examples

Built Environment Connective

	Effective interventions: the Transpennine Route Upgrade
Challenge	The Transpennine Route Upgrade is a major, multi-billion-pound programme of railway improvements that aims to deliver better journeys for passengers travelling across the Pennines between Manchester, Huddersfield, Leeds and York. It includes upgraded, remodelled track, full route electrification, station remodelling, signalling upgrades and timetable changes. It has demanded an approach that goes beyond 'the way we have always done things before'. It focuses on improving outcomes rather than simply delivering the outputs of individual projects.
Solution	The upgrade is being delivered using a rigorous system assurance case (SAC) process. This validates proposed changes to the system, ensuring that each intervention will deliver an improved operational railway. The SAC is guided by a set of desired outcomes. Each aspect of the programme is checked for alignment with the outcomes and for integration with each other, so that the programme overall works harmoniously.
Benefit	The approach enabled programme stakeholders to work together to develop common goals for delivery and assurance, enabling a transparent, progressive approach and keeping the programme on time and to budget.

Systems thinking in the built environment: examples

Built Environment Connective

	Understanding systems: Wye Catchment participatory mapping
Challenge	The River Wye faces numerous challenges to restore the natural environment and recreate a thriving landscape with its considerable agricultural, economic, cultural, environmental and social value. In preparation for a new catchment management plan that appreciated all of these aspects as one system, the Wye Catchment Partnership (WCP) needed to understand the potential opportunities and trade-offs in the development of the plan.
Solution	Participatory systems mapping (PSM) was used to understand the system. It gathered the insights of catchment stakeholders to show how the catchment functions as a system. The insights allowed WCP to understand interconnected links between catchment interventions and outcomes. These insights were used to inform Imperial College London's Water System Integrated Water Model (WSIMOD). It showed the impacts of diverse activities across the catchment on water quality and flow. WSIMOD allows for future scenarios (eg climate change and population growth) and potential interventions in the catchment to be modelled, and their impact on river flows and water quality to be quantified. WCP can continue to use the systems map as the basis for a monitoring, evaluation and learning framework for the catchment management plan that sets out how to measure impact, evaluate success and continually improve the plan.
Benefit	PSM enabled detailed consideration of complex and, at times, contested topics within the catchment. The process led to production of a long list of interventions and metrics that are now being progressed in a collaborative planning exercise, under the catchment management plan 'task and finish' group. This adds important democratic legitimacy because of the process by which the list has been produced. Treating the catchment as a system has enabled the WSIMOD analysis to indicate the big picture in relation to what can be achieved in the catchment and priorities for intervention (eg, the management of manures and fertilizer application has the greatest positive impact on water quality).

Systems thinking in the built environment: examples

Built Environment Connective

	Effective interventions: Infrastructure Coordination Service
Challenge	Many operators and authorities have to dig up roads to install and maintain utility infrastructure. Repeated roadworks for utilities can be disruptive and result in congestion. It is estimated that 15% of the cost to the economy of street works in London alone (£4.1 billion per year) arise because they are siloed and uncoordinated. Each operator has its own planning cycle, annual budgets, and planning consents that are not aligned. The Greater London Authority's Infrastructure Coordination Service (ICS) is adopting a more interconnected way of managing roadworks, working with stakeholders to align their programmes, coordinate work and limit disruption to communities. This seems obvious but requires extensive system planning to accommodate often conflicting requirements.
Solution	After running a series of pilots, the ICS coordinated an 11-week closure of a residential street. It is 700m long with a school at one end, meaning that closures are normally planned during school holidays and long closures are usually unviable. The ICS developed a digital tool to map planned utility work and local authority street works so that overlaps can be spotted. The tool identified that water and gas mains replacement, fibre-optic cable installation and resurfacing were all anticipated within the next three years. The ICS team helped the utility companies plan and phase the work, as well as developing clear lines of communication between the firms. The council agreed to put its planned resurfacing back a few months so that this could take place after the utilities had finished. While the work will be disruptive for residents, the road will be fully resurfaced at the end of the project and there will be no outstanding utility work in the road.
Benefit	By utilizing a more interconnected way of managing the road, the ICS combined three planned utility upgrades and a road resurfacing job into one programme of work, saving 55 days of disruption. This is a significant improvement for the residents, local businesses and the school. Collective time and cost savings across all ICS pilot projects saved utility firms almost £1M and avoided 681 days of disruption.