

The background of the entire slide is a deep blue color with a pattern of concentric, overlapping ripples, resembling water droplets hitting a surface. The ripples are lighter blue and create a sense of movement and depth.

WHAT IS INFRASTRUCTURE FOR?

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Smart infrastructure can underpin societal resilience but only if cities break down their existing silos. Are we asking the right questions? Do we have the right focus?

Editor's Note:

DesignIntelligence's theme for Q4 2024 is "Consequential Questions." To address our theme, we call on a presenter from our recent Denver conference. In this 2021 essay, Clare Wildfire, Mott MacDonald's Global Cities Lead, and her colleague Lissadell Karalus-Breinholt highlight the questions with the biggest consequences as they consider how smart infrastructure can solve the challenges of today's world.

What is infrastructure for? The UK Centre for Digital Built Britain (CDDb) has articulated a new take on this question, describing it as a series of interconnected systems that exist to support society. This is such a simple sentence, it is hard to see why we didn't see it that way before. The evolution of the infrastructure industry sheds some light on this.

In the 20th century, the focus was on providing nations and their citizens with efficient, reliable and affordable services. While this remains important, today resource constraints, environmental and health concerns, the climate emergency and social inequality have become pressing issues. In addition, society's expectations on quality factors such as time, reliability, safety and well-being have risen.

In a paper called "[Flourishing Systems](#)," the CDDb outlined how the infrastructure industry is stepping up to respond to this challenge, embedding the concept of smart infrastructure and broadening it to

promote long-term societal resilience. The following learnings from the report need to be considered by all smart city practitioners. Smart city infrastructure should be:

People-Focused

Recognising the fundamental role of infrastructure in the social, economic and environmental outcomes that determine the quality of people's lives.

With an increased focus on outcomes for people, we raise the age-old conundrum about whether we should work for the benefit of the individual or the benefit of society. This is epitomised by the trolley problem – the ethical dilemma of whether to sacrifice one person to save a larger number – and has huge implications for the application of AI in smart cities: for example, in the rules we programme into the decision making of autonomous vehicles.

As smart cities practitioners, we need to think about how our actions support the development of social capital, because outcomes that benefit the many rather than the few will achieve longer-term social resilience.

The understanding of what society values and what concessions people are willing to make is an important part of applying this concept. The smart cities agenda can support citizens' assemblies and other forms of participatory decision making. For example, the city of Auckland has used its Moata SafeSwim digital platform to create supportive citizen behaviour by demonstrating the impact of infrastructure-related municipality decisions on outdoor lifestyles.

Systems-Based

Recognising infrastructure as a complex, interconnected system of systems that must deliver continuous service to society.

Since the industrial revolution, the infrastructure that underpins our cities has developed into a complex, interconnected system of systems. We did not always have the tools to envision the system in its entirety and thus manage it as a complete system. But, with vastly improved data-processing power and the ever-increasing abundance of data, we can now address interconnected challenges in a way that would previously have been unthinkable.



Data Is Key to Address the Plethora of Challenges Cities Face Across Numerous Sectors

The opportunities are considerable if we can unlock the systems approach. Examples would include:

- **Integrated energy systems:** Digital innovation and new energy technology enable engineers, striving for ultimate energy efficiency, to work across the supply/demand boundary. For example, traditionally the flexibility needed in our electricity system to match supply with demand has been provided through adjusting supply-side generation. But smart, decentralised energy systems create the opportunity to access a huge, dormant flexibility asset that exists within cities – in the thermal mass of buildings, in heating systems, hot water tanks or in electric vehicle batteries.
- **Green infrastructure and resilience:** Trees, green roofs/walls and parks absorb airborne pollution, reduce carbon emissions (through shading and evapotranspiration), provide shelter, decrease soil erosion, enhance biodiversity, benefit health and well-being and encourage physical activity. Where designed as part of an integrated system, green infrastructure can also help manage water resources and mitigate flood risk.

- **Accessibility:** The design of cities, in terms of spatial proximity to services and digital infrastructure, can facilitate a modal shift away from motorised transport, helping people walk or cycle to their destinations and leading to better citizen health and well-being, improved air quality, reduced carbon emissions, local economic uplift and social inclusion.

Use of system-level data will improve cities' ability to track these beneficial outcomes and make transparent and replicable decisions based on them.

However, the challenge involved in unpacking our historical construct is not to be underestimated. Helping a whole industry push through invisible boundaries that are steeped in precedent is a significant undertaking. Arguably the shift is so great that the change needs to start in the education system and the teaching of new “systems thinkers” who are comfortable with interconnectedness and the tools for engaging with it.

New Value Paradigms

One of the challenges of adopting this new way of thinking is our approach to cost. As the “Flourishing Systems” paper outlines, our industry has historically based decisions on capital cost. But with a better understanding of what constitutes a successful outcome and the ability to envisage an interconnected city system, there are new ways to monetise value. Technology is allowing us to “servitise,” and the possibilities are endless.

Take “Heat as a Service” (HaaS) for example. The increasing integration of the energy system – across the supply/demand boundary, between the provision of heating and cooling, and even across sectors such as heat and transport – creates the potential for a new operating model for the provision of heating and cooling, based on the sale of thermal comfort rather than the sale of energy.

This approach could assist in the decarbonisation of cities as, given the complex and fractured nature of the supply chain related to the provision of heat, it is likely that a new operating model with fewer actors could optimise capital and operating expenditure, improve the ability to implement change and reduce system inefficiency. Once established, it may also provide the opportunity for previously unexplored monetisation avenues given that, as the operator is now

selling an outcome (thermal comfort) as opposed to an output (kWhrs of energy), it has more freedom to innovate in the provision of the service.

Again, the availability of and ability to make sense of cross-sector information underpins such innovation.

Resilience

Through a smart cities approach, cities can increase social and economic resilience by:

- **Reducing vulnerability:** Treating the city as a system of systems can help city authorities understand where potential points of failure exist and highlight the best places to instill new resilience, resulting in lower long-term costs for the city.
- **Conducting scenario planning:** In a time of fast-moving change, there are many possible futures, and scenario planning can help us steer towards a preferred future – one that is resilient in the face of deep uncertainty.

Bringing It All Together

The increasing availability of data will assist in understanding how city systems interact, enabling earlier warnings of potential system shocks, better decision making, more effective use of assets and improved predictions of cause and effect, thus increasing system resilience.

However, before we can make great strides in applying the power of data and technology to analyse inter-sectoral city dependencies, we must be able to recognise, challenge and deconstruct these silos so that we apply our skills to the right problems – the ones that will bring the most benefit to society.

This is the underlying premise that drives our smart city leaders. It can be a game changer when disruptive technology and the fast-moving power of AI are combined with the industry expertise whose remit has always been to create better places to live, using the available tools of the day to improve outcomes for people.

An earlier version of this essay was originally published in SmartCitiesWorld in 2021. Reprinted with permission. Link: [Latest news and case studies - Smart Cities World](#). SmartCitiesWorld is a forum to encourage these two historically separate industries to come together in support of a flourishing global future.

Since its original publishing, in the explorative spirit of the essay form, author Clare Wildfire invited colleague Lissadell Karalus-Breinolt to add perspective and introduce new questions. Comments follow:

On Autonomous Vehicles ...

- We're still debating the ethics of driverless vehicles three years later. What does this say about the relationship between efficiency and social outcomes? And when we're seeing a move towards pedestrianisation and 15-minute cities, does efficiency still mean speed, or does it rather mean closeness and convenience? Do we still want a physical world that gets us from A to B at high speed, or do we want to save that type of efficiency for the digital world and focus on leisure and presence in the physical world?

On Green Infrastructure ...

- Green infrastructure and resilience was once a relatively novel concept, but it's now an idea everyone is familiar with. Is it becoming a reality in the way we expected? How has our relationship to mitigation versus adaptation changed?

On COVID-19's Urban Impact ...

- When this was written, we were on the tail end of COVID-19. Did we know then that it would have such an impact on how urban spaces are used? How must our paradigms change to accommodate a post-COVID urbanism in which the productivity of a service economy is now largely digitalised and the demands placed on urban infrastructure are increasingly geared towards leisure?

On Systems Adaptability ...

- And what do these developments mean from a systems perspective? We have designed a complex system based on needs and assumptions that have now changed. Since infrastructure is far from the most adaptable system, how do we facilitate innovation in a system seemingly hypersensitive to external/organic changes and insensitive to the purposeful changes we try to make?

In search of responsible answers, we continue to ask such questions. Join us.

Clare Wildfire is Global Cities Lead with global engineering, management and development consultancy Mott MacDonald. Having led regeneration, low-carbon and sustainable innovation projects across the globe, Clare uses systemic engineering to push boundaries and, most importantly, improve people's lives. From her 35 years' experience in the sector, originally as a building services engineer on sustainable buildings, she combines her practical understanding of construction and development drivers with policy engagement, bringing insight into the technical, political, financial and behavioural aspects of sustainable development and healthy, resilient, low-carbon living.

Lissadell Karalus-Breinolt is a management consultant in international development services at Mott MacDonald, supporting urban infrastructure interventions. With a background in the delivery of systems-thinking programmes across education and sustainability sectors, Lissadell is passionate about systemic approaches to development. Her work is driven by a belief that integrated systems are key to creating sustainable and impactful change in communities globally.