ice

Institution of Civil Engineers

THOUGHT LEADERSHIP

INFRASTRUCTURE TRANSFORMATION

Join the revolution and transform our infrastructure

Infrastructure is always a means to an end. It exists to provide services that meet human needs.

Too often the construction industry loses sight of these simple facts. Too often all we see is a series of projects. If we only focus on project outputs we run the risk of being blind to what owners and users really want and how this can best be delivered.

In October 2015 ICE Council gathered for its Annual Strategy Meeting. The outcome was a radical agenda to change how infrastructure is planned, delivered and operated (see page 8) so that it meets the needs of society.

Help us generate the ideas, enthusiasm and vision to drive the change.

Why do we need to transform our infrastructure?

In 2013 the McKinsey Group identified a global demand for a

$57 trillion investment in infrastructure in the years up to 2030.[1]

If that is to be affordable, we will certainly have to deliver new and upgraded infrastructure more efficiently.

But we will also have to use existing infrastructure in new ways to provide the services delivered via infrastructure be it faster journey times, reliable and affordable energy, economic growth or slashed carbon emissions.

In parallel, advances in technology, computing power and the sheer volume of data available look set to transform how infrastructure is operated and what it can do for its users.

We believe that civil engineering should embrace and shape this transformation. If we succeed we will transform infrastructure. We will also transform our industry.

What is the ICE Infrastructure Transformation programme?

ICE's Infrastructure Transformation programme will be a yearlong dialogue that draws on professionals from across the built environment and beyond. It will develop and share new thinking on how we can deliver and operate high performing infrastructure in the UK and around the world.

ICE Council has identified a long term agenda. In the following pages you will find some more detail on four areas we have selected to explore first: autonomous vehicles, agile infrastructure, artificial intelligence and future skills and delivery models.

The team behind these four areas:

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ROSS AGNEW
KPMG

TIM CHAPMAN
Arup

KYLE CLOUGH
Costain

How can I get involved?

Throughout this paper there are a series of questions we would like to tackle over the next six months. There are many ways you could contribute to the programme. You could write a blog or host a workshop based around these questions. You could share research or case studies. You could set up a dialogue with people outside the sector.

We also want to hear from you if you think we are asking the wrong questions or are missing a big opportunity.

To get involved contact Ben Goodwin at

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[1] McKinsey Global Institute. (2013) Infrastructure productivity: How to save $1 trillion a year. McKinsey & Company: New York

AUTONOMOUS VEHICLES

Autonomous vehicles could offer a fundamentally better way of meeting our demand for mobility. Why own a depreciating asset when you could use a mode of transport in which you could work, read and even have a drink!

If we are thinking about the built environment, autonomous vehicles may change the way our towns and cities look, how and where we live. We may need less space for car parks and street-side space, and fewer miles of tarmac if the autonomous fleet can utilise road space more efficiently.

If we are thinking about service, autonomous vehicles could change the future shape of mass transit – buses, trams and metros may become superfluous.

This all raises big civil engineering issues, but issues that will be entwined with political and legal decision-making. For instance, if we are to integrate fully autonomous and non-autonomous vehicles we will need to think carefully about routes, interfaces and interchanges.

More fundamentally we will need to change our mindset and embrace the idea that we are providing a service – mobility – and not just a set of built assets. We need to get beyond the current limited discussion around making our existing motorways a little bit smarter and start thinking about how we provide adaptable, flexible and dynamic infrastructure.

> Engineers can play a key role in driving this transition but we need to be proactive and collaborative.

Some questions we'd like to tackle:

Who can make this all happen?

Who do we need to work with?

What are the key enablers?

What kind of infrastructure investment and ownership models will we need?

How will we reconfigure networks and the towns and cities that they serve?

How do we maintain public trust in a period of radical change?

AGILE INFRASTRUCTURE

How infrastructure and buildings are conceived, planned and built is rarely how they are actually used.

Why? Because if we shift our perspective from being planners and designers of infrastructure to users we quickly recognise that our needs and wants change faster than our models can take account of. Demand for infrastructure services is dynamic, yet we continue to consider demographic and historical usage as the basis for future planning.

Infrastructure is an economic enabler, but it can rapidly become a constraint when we build it to last well beyond what we can realistically predict.

How might a technology business design infrastructure? They would design it knowing that users' needs will change. They would create a system with flexibility to allow users to benefit from the latest upgrades and to ensure that when the next generation of hardware comes along it can be rolled out smoothly.

Does infrastructure have to be so different? Like consumer technology new infrastructure will often first delight the user then it will rapidly become accepted as the status quo and then become mundane and ultimately obsolete. But at the moment that obsolescent infrastructure can hang around for decades.

Surely the way in which we design, develop and build our infrastructure needs to change.

BIM is a step forward but is it really much more than a digitisation of existing practices and an automation of conventional decision-making?

What if we reimagine the prevailing approach and build agile infrastructure? Infrastructure that is not just designed to accommodate change but infrastructure that is responsive and can flex to the changing needs of the user. Infrastructure that recognises both the inevitability and unpredictability of societal and economic change.

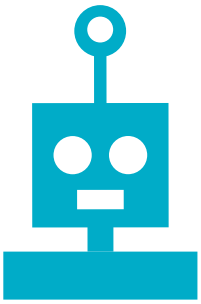
Some questions we'd like to tackle:

How can we create agile infrastructure and ensure users are never locked into obsolete technology?

Can we design infrastructure to allow both service upgrades and the next generation of hardware to be rolled out smoothly?

Can we identify what must be long lasting and what can be temporary?

How might we change standards to respond to this dynamic environment?



ARTIFICIAL INTELLIGENCE

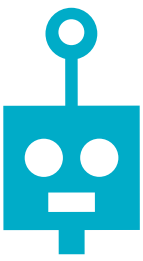
The UK's construction industry is being challenged to make huge improvements in its performance, in terms of the speed of project delivery, out-turn cost and contributing to reductions in national carbon emissions. These challenges come at a time when technology is creating the real prospect of machines that can think rather than just do.

We are used to computers and their ability to do tasks for us – the speed of communications has vastly increased over the past quarter of a century as email has replaced fax and telex. However, the power of computers to change our industry is just starting.

BIM is enabling electronic models of new schemes to be collaboratively shared and developed, saving time and improving deliverability.

> Artificial intelligence may be the next huge wave to engulf our industry.

There will be opportunities to harness the vast data banks built up on our projects – and the terabytes of easily accessible data from providers like Apple and Google. Once we start to detect patterns and learn from these experiences and processes, then we will enable computers to be vastly more helpful and to make our industry vastly more efficient. Crunching big data can reveal patterns that we humans may suspect but can't prove – so machines can assist our engineering judgement. The sorts of revolution that have happened in retail and financial services will be visited on us, for good and for bad.



The good could be excellent with a huge number of routine project planning and design tasks made so much slicker, with efficiencies feeding directly into construction processes too. The bad things may be more insidious. For example, artificial intelligence will render many existing professional tasks redundant, potentially replacing entirely many of the tasks by which our younger engineers learn the details of our trade.

Experienced engineers probably have less to fear, at least initially, but we will still need to decide how to form and develop the experienced engineers of tomorrow.

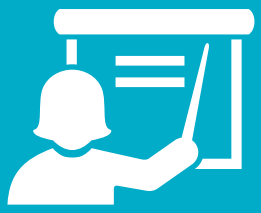
Some questions we'd like to tackle:

How and when will we move from automating existing practices to using artificial intelligence to drive radical changes?

Do we understand which engineering skills are next in line to be automated – and what will we do with the freed up brain power?

How will we develop the experienced engineers of the future if many of the tasks that are currently part of professional formation are automated?

How do we deal with the ethical issues arising from coding computers to do tasks that currently require human engineering judgement?



FUTURE SKILLS AND DELIVERY MODELS

The imperative to reduce cost, deliver faster, reduce emissions and improve asset performance will require a significant shift in how we deliver infrastructure.

At the same time technology is having a big impact on what the future of infrastructure looks like and what it does. We are already in the reality of 3D concrete printing from BIM models. We are discussing car trains on digitally controlled motorways. Renewable energy sources will become more sustainable as hydrogen technology and battery storage improves, but this will change energy distribution systems. Design life may shorten as we design to accommodate faster changing technology. Design itself may be carried out by computer algorithms.

In the sixties and seventies the car industry came under similar pressure to change its ways of working. This resulted in Japanese manufacturing principles appearing and transforming the American car manufacturing industry. Later, the Japanese companies disrupted the UK market to improve the speed of manufacture while at the same time improving quality.

Much of this was driven via changes to the supply chain, which in turn changed the demand for skills. Car manufacturers worked closely with their supply chain. The use of data and feedback loops was encouraged. The work force was re-engineered bringing in new technology and skills from outside the car manufacturing environment. Fundamentally the skills required to build a car and the relationships between participants in the supply chain were altered.

> We are starting to see changes in relationships and practices in the construction industry.

The amount of data collected is growing. So is the use of data analytics and modelling. Offsite manufacturing is developing. Asset monitoring techniques are being improved and embedded in infrastructure. Alliancing is taking hold in the utilities. What's next?

We should step back and ask the question who will we need to work with to deliver the infrastructure for the Google self-driving car that operates on an intelligent highway that responds to a user's requirement in real time? What skills set do we need? What set of relationships and business models can tie all of this together?

Some questions we'd like to tackle:

Should we reframe questions of skills shortages? Do we instead need to talk about future needs?

How will the capabilities of sectors such as manufacturing, logistics and technology be deployed to support infrastructure?

What are the truly innovative business models of the future? How do we incentivise the whole supply chain to work on a whole life basis?

TRANSFORMING INFRASTRUCTURE
ICE COUNCIL'S AGENDA

INNOVATION AND TECHNOLOGY

- Industrialisation and standardisation deliver significant time, cost, quality and safety benefits
- Users are never locked in to obsolete technology
- The capabilities and knowledge of the manufacturing and technology sectors are utilised for the benefit of infrastructure users
- Incentivisation of risk and proactive industry engagement
- Success paradigm: resilient, reliable, affordable and available

GOVERNMENT AND REGULATION

- Government's commit to a long term vision and objectives
- Government's utilise role as client to drive innovation
- More experts in government and greater evidenced based policymaking
- Long-term government vision, but must be adaptable. Marry infrastructure policy and investment with wider socio-economic objectives
- Greater use of TOTEX approach

MEDIA, PUBLIC OPINION, ETHICS, TRUST AND SECURITY

- Data privacy and security issues understood and managed through a robust framework
- Changes to patterns of employment are managed – people are systematically upskilled and redeployed
- Greater public understanding is built and trust in experts (re)established
- Entire supply chain should share data and ideas for mutual benefit
- Information and data flows throughout asset lifecycle

CARBON, ENVIRONMENT AND SUSTAINABILITY

- Lifecycle carbon is a routine design constraint
- Carbon is a driver of finance and funding decisions
- New environmental impacts e.g. from big data are understood and managed
- Strategic low carbon projects identified and delivered
- Delivering a circular economy

EDUCATION, PEOPLE AND SKILLS

- An agile, flexible skills pipeline – skills available as required
- Civil engineers understand how they will add value in 2025
- A serious commitment to diversity
- Adoption of lifelong learning approaches
- Instil an entrepreneurial spirit into the construction industry

SUPPLY CHAIN, INVESTMENT, DELIVERY, BUSINESS MODELS AND CULTURE

- All of supply chain focused on lifecycle performance – business models support
- Supply chain deals systematically with any technical and structural barriers to roll out of technology and innovation
- Collaboration endemic and professionalised
- A willingness to collaborate with other industries/ sectors and a system of procurement that enables such
- Enhanced and 'smarter' asset management

Get in touch

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About ICE

Established in 1818 and with over 86,000 members worldwide, ICE is a leading source of expertise in infrastructure and engineering policy and is widely seen as the independent voice of infrastructure. ICE provides advice to all political parties and works with industry to ensure that civil engineering and construction remain major contributors to the UK economy.

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