Digital transformation

Harnessing the digital revolution for better business outcomes

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The road to digital transformation

Mark Enzer
Chief technical officer

In the UK, there is strong government alignment on the need for digital transformation. Three key reports came out in quick succession which highlight the benefits and help pave the way for change: Industrial Strategy: Building a Britain Fit for the Future (HM Government); Transforming Infrastructure Performance (Infrastructure and Projects Authority); and Data for the Public Good (National Infrastructure Commission).

The last of these documents, launched by the Chancellor in 2017, shows that information and data management are more important than any individual technology development, and made three recommendations:

- A UK national digital twin to help plan, predict and understand our assets
- A digital framework for secure sharing of infrastructure data
- A digital framework task group to co-ordinate key players

An industry ripe for change

A report by McKinsey & Company[1] stated: "Productivity in manufacturing has nearly doubled, whereas in construction it has remained flat." However, while ICT, media, professional services and manufacturing have embraced digitisation, construction sits alongside agriculture as the least digitised major industry[2]. Digital transformation will help close this productivity gap.

We have entered an era of digital abundance. The unit costs of collecting, transmitting, processing and storing data have fallen drastically since digital technology first emerged. In fact, if you imagine the original costs as a distance of 10,000km – roughly the distance from Singapore to the UK – then today's costs would represent just 200 microns, less than the width of a human hair! This is how far the unit costs for managing data have declined, and this digital abundance inevitably paves the way for a digital revolution.

[1]The construction productivity imperative. McKinsey & Company. S Changali, A Mohammed, M van Nieuwland. July 2015

[2]Imagining construction's digital future. McKinsey & Company. R Agarwal, S Chandrasekan, M Sridhar. June 2016

Developing a maturity mindset

We know digital transformation is going to happen. But we shouldn't let it happen in a 'Wild West' sort of way, where different organisations – even parts of the same organisation – operate to different standards, missing out on the efficiency of a joined-up industry. To realise the true benefits, digital transformation has to be done as a matter of strategy. Infrastructure in developed countries is already mature, with existing infrastructure far exceeding the value of new infrastructure being added each year. Yet, the industry has a 'growth mindset', with incentives around building more and a focus on CapEx and outputs. A 'maturity mindset' would see greater emphasis on whole-life costs and managing existing assets rather than just building new ones. Our industry must adapt to reward the supply chain based on outcomes, not just how much they build.

The value of information

What will digital transformation look like for our industry? Exciting technologies like robotics, artificial intelligence and AR/VR may be the first things that come to mind, but information is the golden thread that joins everything together, enabling all of the key productivity gains. Digital transformation applies to every aspect of the built environment; not just the delivery of new infrastructure, but also the operation, maintenance and use of existing assets. Building information modelling (BIM) can be seen as a key foundation of digital delivery, which is why the UK government has mandated BIM level 2 for all public projects, with many private clients following suit. Digital component catalogues are increasingly popular, and it is easy to imagine industry-wide platforms to facilitate digital design and delivery. In the coming years, it is likely the delivery process will be driven straight from information-rich models on enterprise-wide common data environments.

As well as basic 3D geometric data, there are many other classes of data that relate to the asset, such as its condition, performance and status, which can be integrated to create a 'digital twin' of the physical asset. It is conceivable that a data-rich digital twin could have comparable value to the physical twin, but together they have the greatest value, as a cyber-physical system (CPS). This is smart infrastructure. The key is that it isn't about any single technology – better information management is what will help us boost productivity and improve infrastructure performance in our sector.

So, the opportunity of digital transformation requires us to rethink the connection between value and information. If we redefine value in terms of outcome per whole-life pound for the ultimate customers, then integrated digital-physical solutions are the most cost-effective way of providing value. This leads us to understand infrastructure as an information-based industry, with better information enabling better and faster decisions, which in turn lead to better outcomes. This is the 'information value chain' that connects outcomes and data, with decisions being the key value-adding step in between. Information must be recognised as an asset, and be valued and managed as such.

Our industry is ripe for digital transformation, but is it ready for change? Part of this must be to develop alternative business models – ones that reward outcomes and the value added to information rather than the time spent doing so.

Growth mindset	Maturity mindset
Focus on asset creation	Focus on asset management
Focus on capital cost	Focus on whole-life cost
Clients	Owners
Outputs	Outcomes
Projects	Programmes
Construction industry	Infrastructure industry
Traditional constructed solutions	Innovative, integrated digital/physical solutions
Greenfield (new build)	Brownfield (interface with existing assets)
Reward outputs	Reward outcomes + efficiency
More hardware, less software	More software, less hardware

Is the industry ready for digital transformation?

Ian Gill
Principal information consultant, Smart Infrastructure

We all know the importance of digital transformation, but organisations – or even the individuals therein – may have a different interpretation of what this means. Some will default to thinking 'digital' means exclusively IT; of course, IT does play a significant role, but we take it to mean something much broader and richer than that.

Digital is about realising the true value of information and recognising it as an asset. It includes combining physical and digital systems to deliver more value, and it's about using data to proactively make better decisions. It involves new ways of working, changes to mindsets, behaviours and organisational culture, and being more open, trusting and collaborative than ever.

Digital transformation is a continuous journey, with the end goal moving further into the future as the industry discovers new ways to unlock value. To understand how best to embark on this digital journey, it's important to establish a baseline – where your business stands now in terms of digital maturity.

We led the Digital Transformation Stream of Project 13, working with the Infrastructure Client Group (ICG) to develop the Industry Readiness Level (IRL) assessment. This is a self-assessment tool for businesses to measure their digital maturity and to compare themselves to the industry average, enabling them to establish their baseline and to measure and monitor progress.

The IRL is based on leading industry thinking and involves a range of infrastructure owners who between them represent £20bn of infrastructure investment each year.

Six key themes are included in the IRL self-assessment:

Customers
How do you use information to better understand your customers and improve your services?

Leadership
Do you believe you need to transform your business around the value of information to deliver a step-change in performance?

Commercial
How do you recognise the value your partners add to information and do your commercial models provide the neccessary incentive?

Capability
Do you and your partners have the skills, knowledge and mindset needed to unlock the value of information?
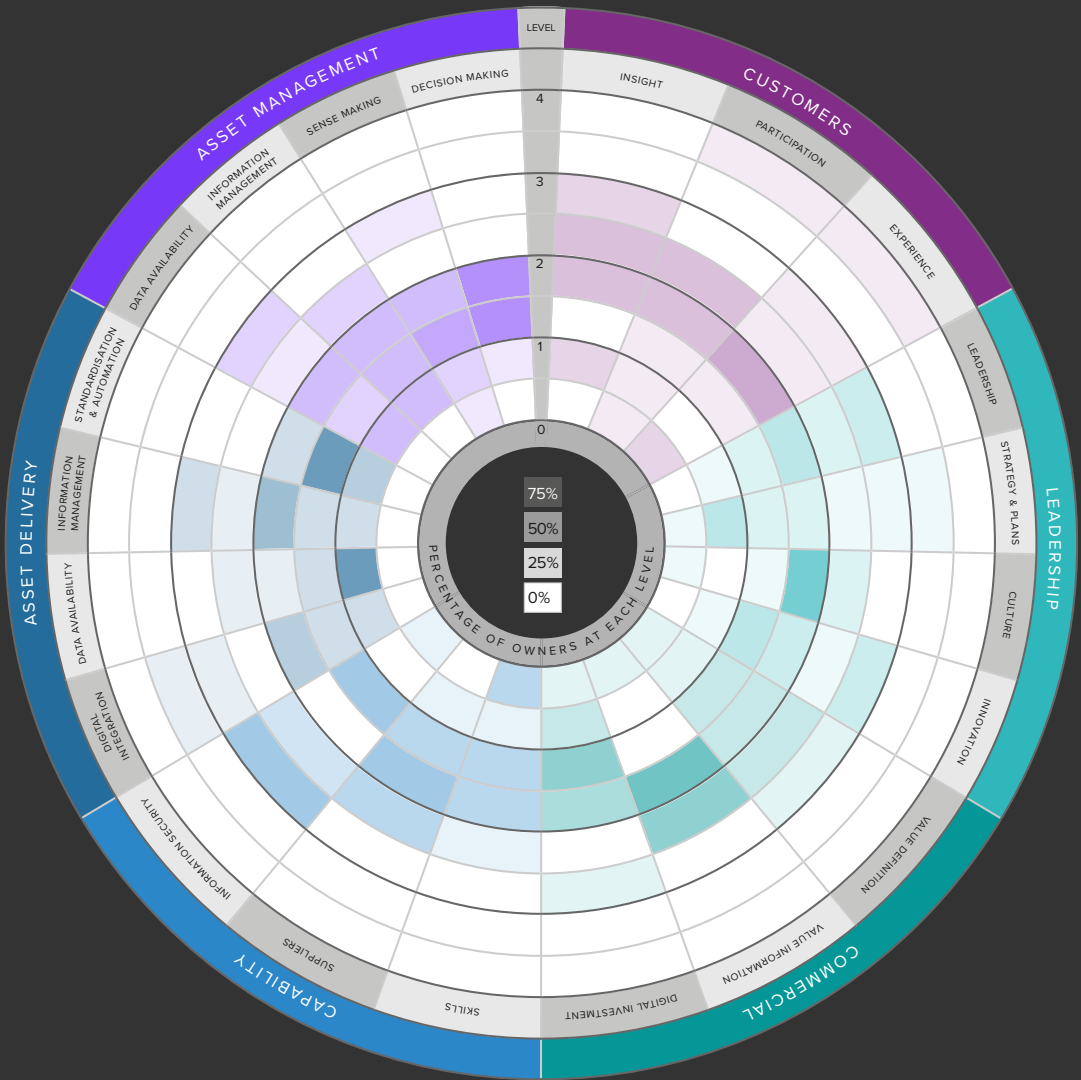
Asset delivery
How do you use information to deliver new assets efficiently and make it available throughout the asset lifecycle?

Asset management
How do you use information throughout the asset lifecycle to make better decisions and deliver improved outcomes for customers?

These six themes are broken down further into 21 sub-topics, with organisations receiving a numerical score in each category:
0 (traditional)
1 (simple collaboration)
2 (integrated functions and relationships)
3 (high performing enterprise)
4 (interconnected industry)

This heat map gives an indication of the digital maturity of the UK infrastructure industry:

Our work developing the IRL with key clients produced seven key recommendations:

1. **Understand your customers – and what they want:** What do the ultimate customers want? How do they value infrastructure? What outcomes really matter to them? The answers will guide investment in digital transformation.

2. **Embrace digital transformation as key to business success:** This means implementing a coherent digital transformation strategy that has leadership at executive level and is embedded in the overall corporate strategy.

3. **Break down data silos and better understand whole-life performance:** Better use of information will unlock more whole-life value from existing assets.

4. **Keep aspirations high – but get the basics right first:** Focus on embedding good practice across the organisation to build a suitable foundation for digital transformation.

5. **Make information security everyone's responsibility:** As the value of asset information increases, so does the level of risk when it comes to loss, mismanagement or cybercrime. As with health and safety, develop a culture where everyone has personal responsibility for information security.

6. **Incentivise outcomes, not hours spent on outputs:** New commercial models are required that reward partners for the value they add to information and how that results in better outcomes for customers.

7. **Bridge the skills gap:** The challenges of attracting and developing digital skills affect all infrastructure organisations.

Mott MacDonald's new Smart Infrastructure division has built upon this leading work and further developed the thinking into their 'Smart Infrastructure Index'. A tool which improves upon the original in many ways – leveraging technology to collect structured data which can provide insights into many parts of the participating organisations.

Transforming the industry
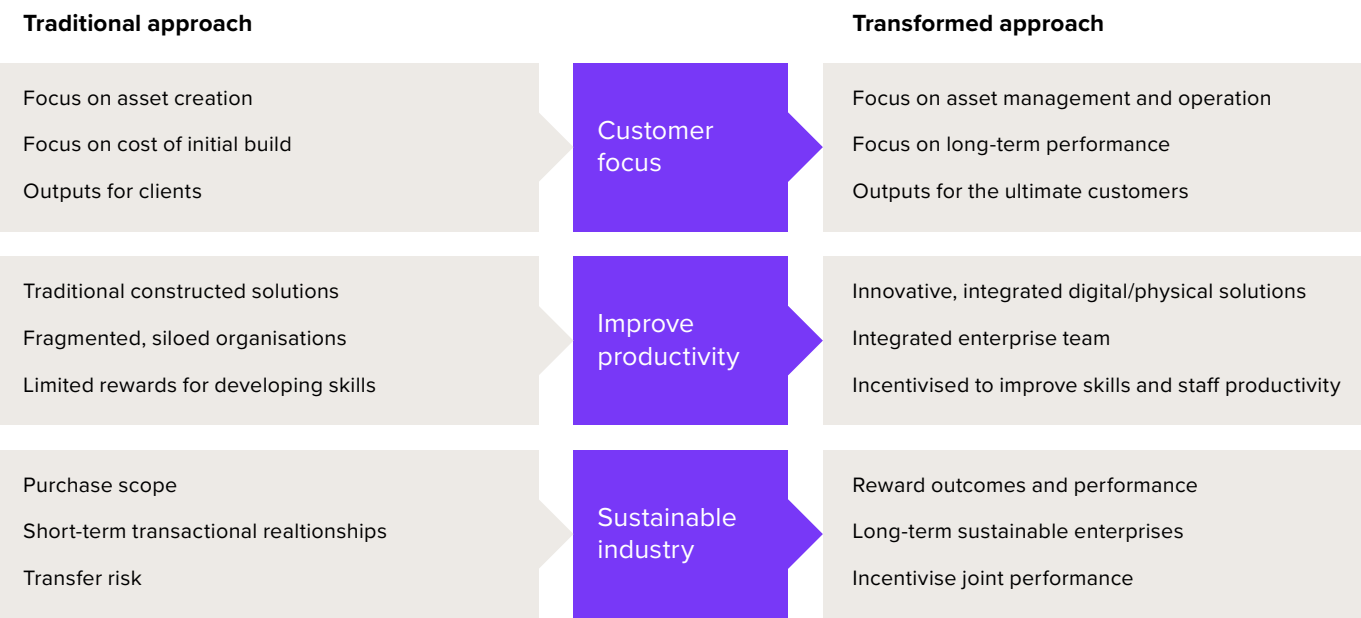
Clare Wildfire
Technical principal

The traditional way of doing things in our industry is not producing the best outcomes. Delivery teams often involve isolated and highly transactional relationships, with a focus on lowest capital costs and maximum transfer of risk from the client to the supply chain. Low margins, low investments, dysfunctional relationships and ineffective knowledge transfer are hallmarks of this approach, resulting in expensive networks and assets, poor performance and inability to take advantage of the digital revolution.

The digital transformation of our industry must be accompanied by a transformation in the way our delivery teams work. If the traditional approach to construction sees success as 'a project delivered on time and on budget', then the new approach should focus on delivering 'services the public need at a price they can afford'. Such an approach shifts the focus from capital costs and 'getting the job done' to whole-life costs and having a positive social outcome.

Project 13 is an industry-led response to infrastructure delivery models that fail not only clients and their suppliers, but also the operators and users of our infrastructure systems and networks. The table on page 12 shows the changes in thinking and behaviour organisations need to adopt to use the Project 13 model to transform how they deliver infrastructure.

A shift in thinking

Traditional approach

Focus on asset creation
Focus on cost of initial build
Outputs for clients

Customer focus

Transformed approach

Focus on asset management and operation
Focus on long-term performance
Outputs for the ultimate customers

Traditional constructed solutions
Fragmented, siloed organisations
Limited rewards for developing skills

Improve productivity

Innovative, integrated digital/physical solutions
Integrated enterprise team
Incentivised to improve skills and staff productivity

Purchase scope
Short-term transactional realtionships
Transfer risk

Sustainable industry

Reward outcomes and performance
Long-term sustainable enterprises
Incentivise joint performance

Developing a new business model, based on a shared enterprise rather than traditional transactional arrangements, has several benefits:

- Boost certainty and productivity in delivery
- Improve outcomes in asset operation
- Support a more sustainable, innovative and high-skill industry
- More effective in bringing through the right skills and new technologies

An enterprise structure puts the owner at the centre of the delivery team, retaining more responsibility for creating an effective team and with direct relationships with suppliers.

Key to the enterprise business model is the 'integrator', which actively engages and brings together all tiers of the supply chain as one cohesive team. The integrator will also bring in appropriate suppliers and advisors when needed, while the owner will remain as the central and leading member of the enterprise.

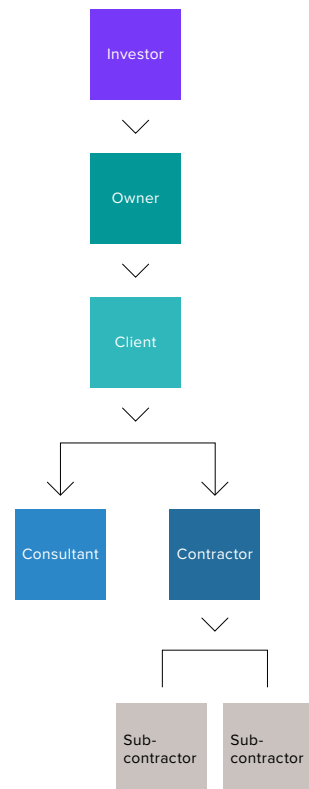## A successful enterprise: Anglian Water's @one alliance

The @one alliance is a commercial model that encompasses all members of Anglian Water's supply chain, including Mott MacDonald Bentley, Balfour Beatty, Barhale, Skanska, Stantec and Sweco. It's a zero-fee model, meaning all rewards are based on out-performance. Costs are covered but full overheads aren't – alliance members are incentivised to drive innovation to improve outcomes and gain financial rewards, with 75% of efficiencies being divided up between alliance members. The approach includes shared risk and reward among members – if one is underperforming, all lose out, but if they all perform well this leads to rewards for all. As the client is also part of the alliance, it encourages all parties to work together to drive whole-life savings. An 'open book' approach means costs are openly shared, which does make some businesses uncomfortable but is becoming increasingly common in the UK. As trust is crucial for such a relationship, Anglian Water carried out behavioural workshops with potential partners to ensure the alliance comprised the best team to deliver long-term value, rather than the cheapest team to offer the lowest initial price.
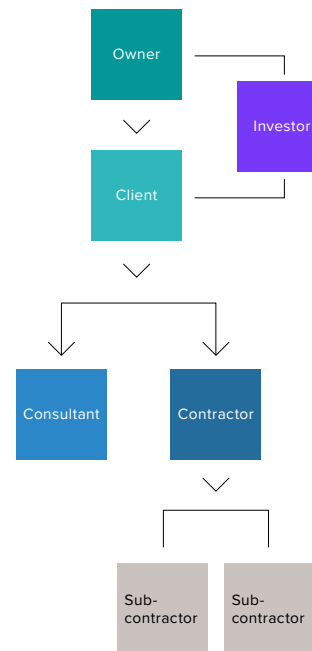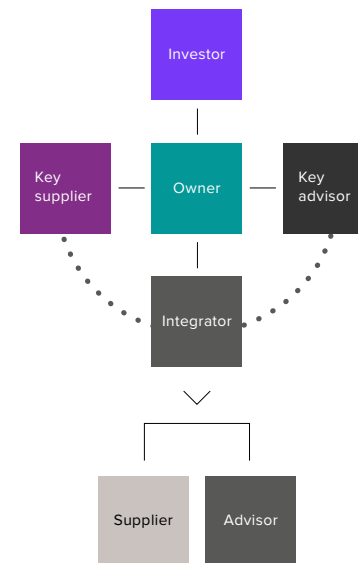
From transaction to shared enterprise

Transactional structure (private)

Transactional structure (public sector)

Project 13 enterprise structure

Establishing a high-performance enterprise requires fundamentally different leadership, governance, behaviours and skills.

There are five key features of the enterprise model:

1. **Governance:** The owner's definition of value will change to consider whole-life cost savings, while social impact will form a key part of the brief. High-performing enterprises encourage long-term relationships with suppliers and advisors, with rewards based on innovation and outcomes rather than working hours and outputs.
2. **Organisation:** Enterprises will increasingly be coalitions of suppliers working with aligned commercial interests within a defined framework. Reward and risk are shared between all members of the enterprise.

3. **Integration:** An effective integrator will foster strong teamwork, and introduce new partners and disruptive digital processes to the delivery team when needed. The integrator has strong skills in complex management and a good understanding of all the processes involved in delivering a successful long-term project outcome. Health, safety and wellbeing are also a key focus.
4. **The capable owner:** The owner sits at the heart of the enterprise. It has direct relationships with all suppliers and advisors on the team, retaining more risk than in traditional business models.
5. **Digital transformation:** As well as new behaviours, processes and tools, business disruption will include collaboration with new partners in the technology sector, leading to more efficient delivery and better outcomes.

Becoming a capable owner

John Seed
Global sector leader, Advisory

The 'owner' of infrastructure typically owns and operates the infrastructure, so is responsible for ongoing maintenance, upgrades and capacity enhancement. However, the Project 13 enterprise structure requires a 'capable owner' to lead the enterprise and define what long-term value for the enterprise will be.

There are three fundamental areas of responsibility for a capable owner under the new enterprise model:

Ownership: The capable owner understands existing network demands, capabilities and constraints through data capture and performance metrics, and must act as the 'voice' of the ultimate customer.
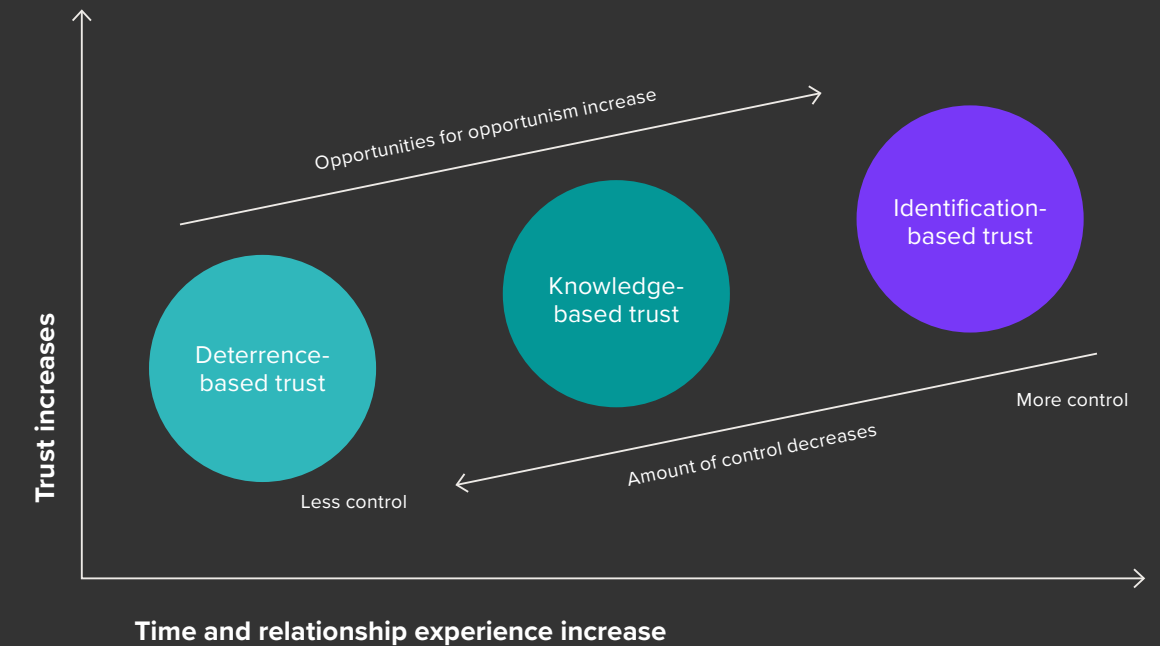
Leadership: This means managing internal and external stakeholders, approving the delivery strategy and appointing the integrator and advisors. The capable owner also promotes collaborative working across the delivery team.

Value for money: The capable owner defines the long-term outcomes (rather than short-term outputs) based on long-term value. The owner should also develop and own functional specifications.

Managing risk

Collaborative arrangements are based on trust and the belief that all team members are doing everything they can for the good of the project. Yet, there remains the risk of unsatisfactory co-operation and the possibility of opportunistic behaviour. Opportunism depends on factors such as the incentives a partner has to follow that course of action, their own propensity towards taking advantage of opportunities to exploit the relationship, perceived penalties and probability of forgiveness, and situational dissatisfaction.

Where the owner has little control or involvement in the project, partnerships are based on deterrence-based trust – good suppliers are sifted from the bad by making them agree to strict contract terms. As the owner spends more time with suppliers, this moves towards knowledge-based trust, where partners are chosen based on skills and past experience. Taking this further, when a capable owner sits at the centre of the delivery team then partnerships tend to be based on identification-based trust – the suppliers the owner knows best.

Although the capable owner has more control, the risk of opportunism increases as trust moves from deterrence to identification, so steps must be taken to promote better collaboration:

Employ the right people:
Individual relationships are more important than organisational relationships.

Invest in your people:
Train and encourage future leaders in collaborative techniques and appoint staff with the right attitude.

Understand what others want:
Respect each partner's fundamental objectives for the project and create a space which promotes mutual benefits.
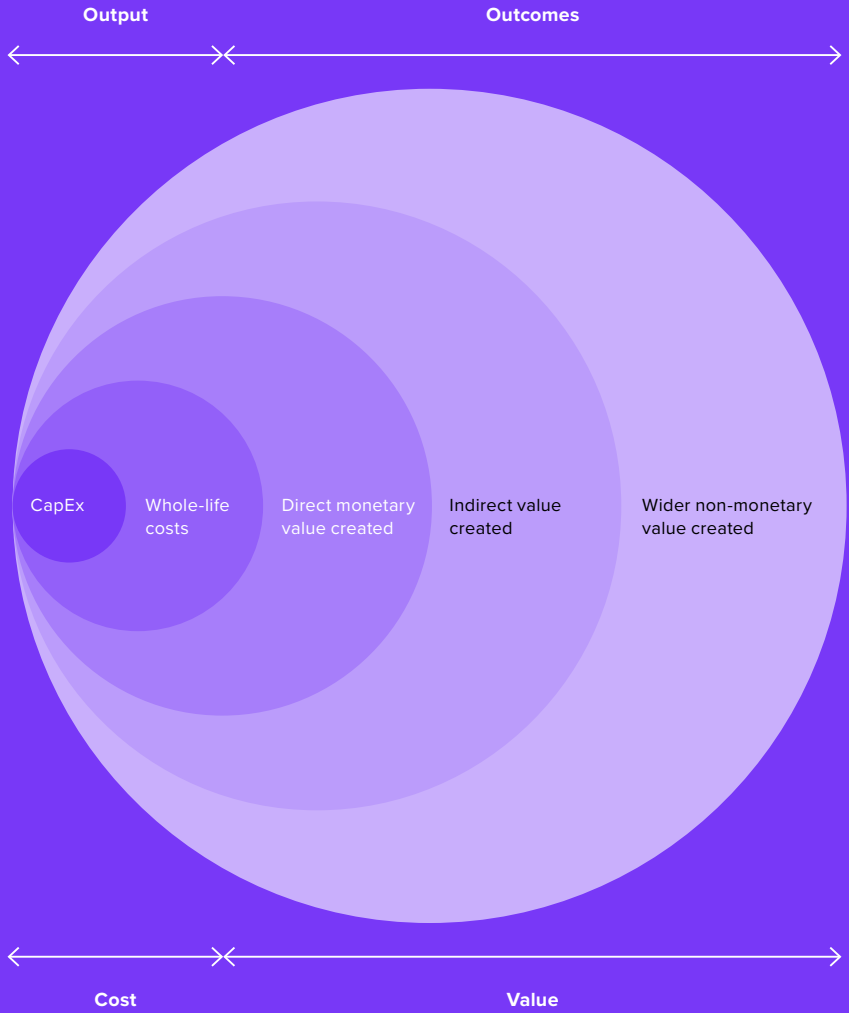
Make it profitable:
Provide incentives to collaborate that are greater than any incentives for opportunism.

Rethinking value: The Project 13 approach
Traditional projects just focus on capital costs and outputs on completion when developing the business case. Project 13 still considers these, but the definition of value is based on 'outcomes' rather than CapEx outputs, and encompasses the direct monetary value created as well as indirect and wider non-monetary value. This often requires the input of economists, sociologists and environmentalists, as the wider value of an asset can be felt downstream from the immediate service users.

The focus on wider benefits allows greater scope for value capture from third-parties or the communities that benefit from the asset. For example, approximately 30% of the £54bn Crossrail scheme is being paid for through an increased levy on all businesses in Greater London, as it is accepted that the scheme will benefit the city as a whole. In Auckland, New Zealand, a NZ$600M investment in 24,000 new homes and infrastructure is being part-funded by an annual dwelling levy and developer contributions. The Project 13 approach to value enables new schemes to attract diverse sources of funding, reducing risk and aiding the business case for development.

Project 13 Governance: A vision for value

Value measurement moves beyond output per CapEx pound and extends to outcomes per whole-life cost pound.

New models: Project teaming/partnership

John D'Arcy
Development director, Transportation

Although the terms 'co-operation' and 'collaboration' are often used interchangeably, there is a big difference between them. When people co-operate, they work together on a common project but each with their own self-defined outcomes. When people collaborate, they work together to achieve a single-shared goal. True collaboration can only result in a 'win-win' or a 'lose-lose' result for all parties.

Achieving a 'win-win' result requires courage from all participants to commit to the shared goal, and consideration of what other parties need from the process. BS 11000/ISO 44001 provide a framework for collaborative business relationships. It helps companies develop and manage their interactions with others for mutual benefit, using an eight-stage approach to encourage organisations to apply best practice principles to delivery.

New dynamics, changing needs

The digital age is characterised by several pressures on our infrastructure base, including: an ageing population; growing urban populations; shifting patterns of employment and household structures; climate change and environmental pressures; shifts in attitudes between generations; and persisting inequalities across society.

These pressures, coupled with the opportunities provided by the digital age impact the solutions we must provide. Taking transportation as an example, we no longer see the ultimate customer as passengers but as 'transport consumers'. Their shift from 'owners' to 'users' of transport means a change in focus from 'driverless cars' to 'carless drivers', and from 'travel time' to 'activity time'. We need to adapt existing infrastructure, but the pace of change is so great that it races far ahead of decision-making timescales.

Existing business models are not fit to meet these challenges. The time taken to develop infrastructure solutions in the transactional model means they may be overtaken by technological, economic or sociological disruptions. Moving towards a business model where the client works in collaboration with an integrator and project partners, and where

knowledge can be shared more openly between them, allows the delivery team to be more agile and to respond quickly to disruptive changes.

As well as embracing new partnership models, there are specific ways the infrastructure industry must adapt to the needs and pressures of the digital age:
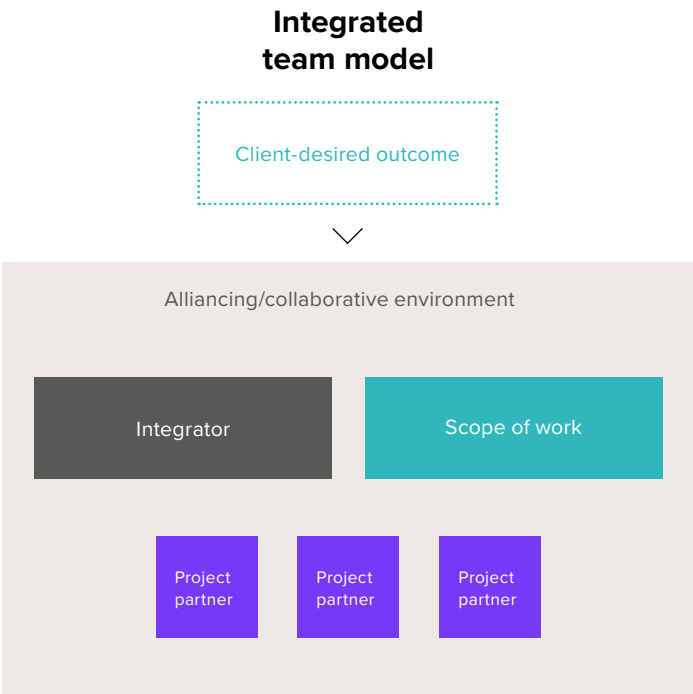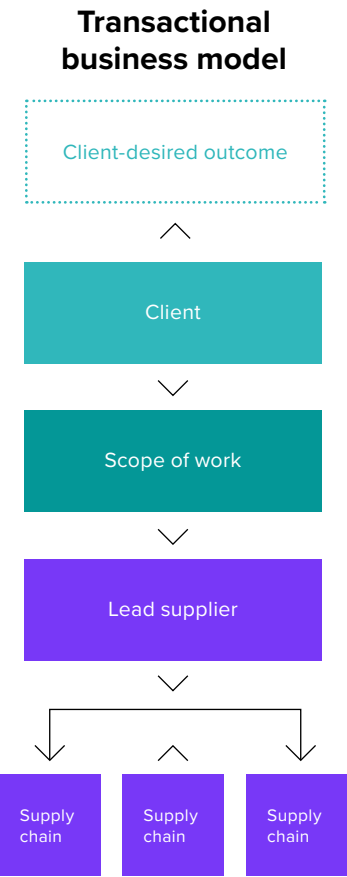
Be technology agnostic: A focus on the outcomes rather than the process will mean you choose the technology solution that best meets the need.

Understand the wider picture: Keep in mind how social and technological change is influencing the behaviour of the ultimate customers.

Utilise scenario-based thinking: Navigate the unknowns by delivering sustainable solutions that work in all foreseeable conditions.

Foster constructive dialogue: Interrogate and challenge all ideas across the delivery team to refine and future-proof the design.

Keep on learning: Be aware of new research, technologies, data and current trends in your sector.

Transactional business model

Client-desired outcome

Client

Scope of work

Lead supplier

Supply chain | Supply chain | Supply chain

Integrated team model

Client-desired outcome

Alliancing/collaborative environment

Integrator | Scope of work

Project partner | Project partner | Project partner

New models: Trading/business models

Simon Harrison
Group strategic development manager

Our traditional trading relationship involves us developing a solution, providing it to our client, then raising awareness of it in the wider market to interest other clients in our skills and experience. Then the process repeats itself. Work is paid for according to the time it takes, and we see a slow but continuous incremental rise in innovation and skills across the industry.

So why change this business model? Clients want us to do things better, faster, cheaper and more sustainably, and they want supply chains to align with this goal. The line between disciplines and professions is becoming blurred. Digitisation brings new potential to our industry, such as crowdsourced and platform-based design, and we will need to adapt to realise the benefits.

But the main reason for alternate trading models is that the design process itself is changing. We can now develop global standard designs with parameters that can be adjusted according to project need. These have zero marginal cost to deploy, so clients get better outcomes more quickly. But the development of standard designs has high fixed costs, with large upfront investment in intellectual property. For us to bring this benefit to clients we need to find a way of realising this embedded value.

This could be through a fee levied each time a standard design is used, or it could be via a focus on outcomes, where money saved to the client is shared with its supply chain.

An alternative idea would be the development of a client platform. This is shared across the supply chain, which is encouraged to propose solutions directly on the platform. The client can then pay suppliers for each use of their solutions. The method also works where the client wants to define a specific outcome: the design can be assembled from solutions on the platform (and new content if needed) and this is validated and delivered, with suppliers again paid per use.

Many may be uncomfortable with the open-source nature of a client platform or a payment model based on use or outcomes. Yet, both would support collaboration, while boosting innovation in developing design solutions with a focus on whole-life outcomes.
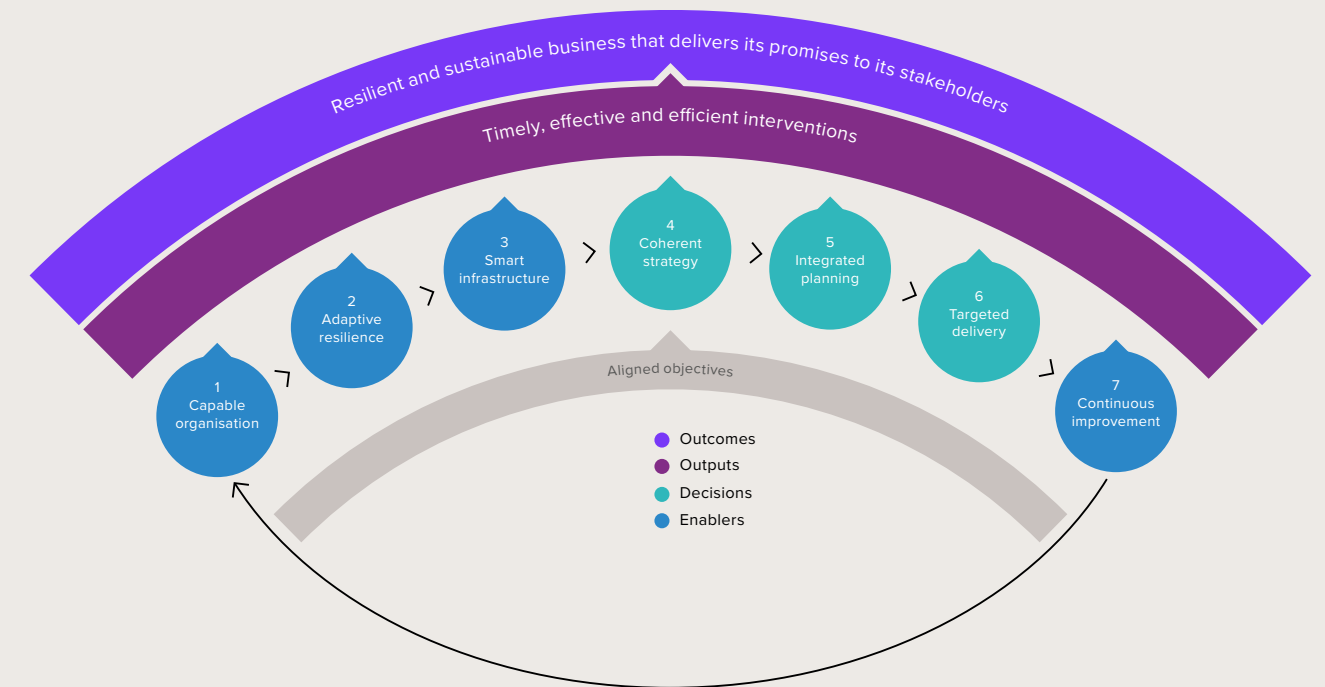
Smart asset management

Judy Anderson
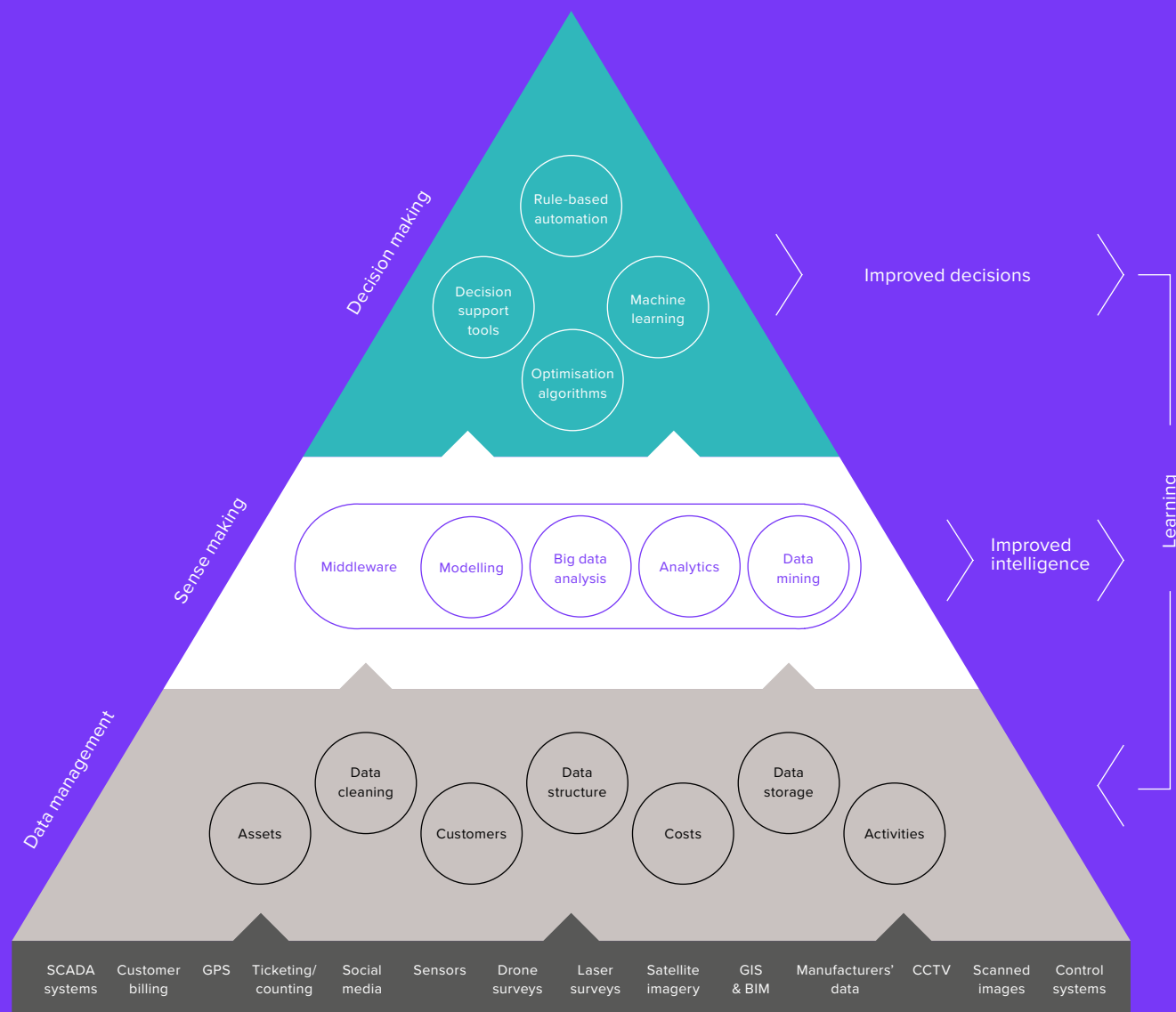Global practice leader, Asset Management

Assets have value for an organisation and asset management is co-ordinated activity to realise that value. Done well, asset management helps organisations make better decisions, improve cost controls, demonstrate regulatory compliance, build stakeholder trust and manage risk. Activity needs to be joined-up – aligning processes, people, investments, operations and delivery of asset interventions around common objectives.

Mott MacDonald has developed a seven pillars approach to guide clients on their asset management journey, creating the organisational capability to evolve towards a position of maturity where you continue to derive maximum value from your assets. The seven

pillars are consistent with ISO 55000, the international standard for asset management, and other frameworks for good practice in managing and optimising assets.

Smart infrastructure is an enabler and is where crucial digital information about your assets supports timely and effective decisions, underpinned by an asset management information strategy. It's about enhancing physical infrastructure with digital technology to provide improved information to enable better decision making, faster and cheaper. It enables owners and operators to improve the performance of assets, extend their life, release capacity, enhance service provision and cut cost.

Decision making

Rule-based automation

Decision support tools

Machine learning

Optimisation algorithms

Improved decisions

Learning

Sense making

Middleware | Modelling | Big data analysis | Analytics | Data mining

Improved intelligence

Data management

Assets | Data cleaning | Customers | Data structure | Costs | Data storage | Activities

SCADA systems | Customer billing | GPS | Ticketing/ counting | Social media | Sensors | Drone surveys | Laser surveys | Satellite imagery | GIS & BIM | Manufacturers' data | CCTV | Scanned images | Control systems

Smart infrastructure begins with data, which needs to be harvested, cleansed and structured. Value is added by making sense of the basic data using middleware, data mining, big data analysis and analytics. Intelligence gained can be used by operators and users to see and understand what's going on. Moata, Mott MacDonald's cloud-based analytics and visualisation service, provides real-time insight into asset performance to enable predictive maintenance and support decision making, leading directly to improved reliability and reduced through-life cost.

We are applying information management to the creation of new assets. On the Northern Line extension in London we are working directly with developers and operators to structure data for the future. It's an approach that works equally well for existing infrastructure. When water and wastewater assets fail, we tend to find out when the taps run dry or when the sewers overflow. Establishing what the fault is and its exact location using physical evidence above ground takes time. However, by applying data-based systems we can get a much better idea about how water assets are performing. Moata comprises sensors installed at critical points of the water or wastewater network, collecting real-time information on flow rates, water levels and pressures. This is combined with core asset information and performance data sourced from BIM and GIS models, asset management systems, hydraulic models and external sources such as SCADA.

Reap the benefits of digital delivery

Michael Gaunt
Information manager

Digital delivery is core to developing efficient infrastructure solutions that maximise whole-life value. Key to this is the use of a common data environment (CDE) that enables all members of the delivery team to collaborate and manage project information in real time.

The UK industry is moving towards the use of CDEs as standard. In April 2017, the government mandated BIM level 2 for all public projects, and many private clients are now requesting the same. BIM level 2 uses a CDE to provide a single source of information to the whole delivery team. It boosts collaboration and the ability to make decisions based on real-time information – enabling vast efficiencies from design through to completion and, if data is properly managed, operation and maintenance.
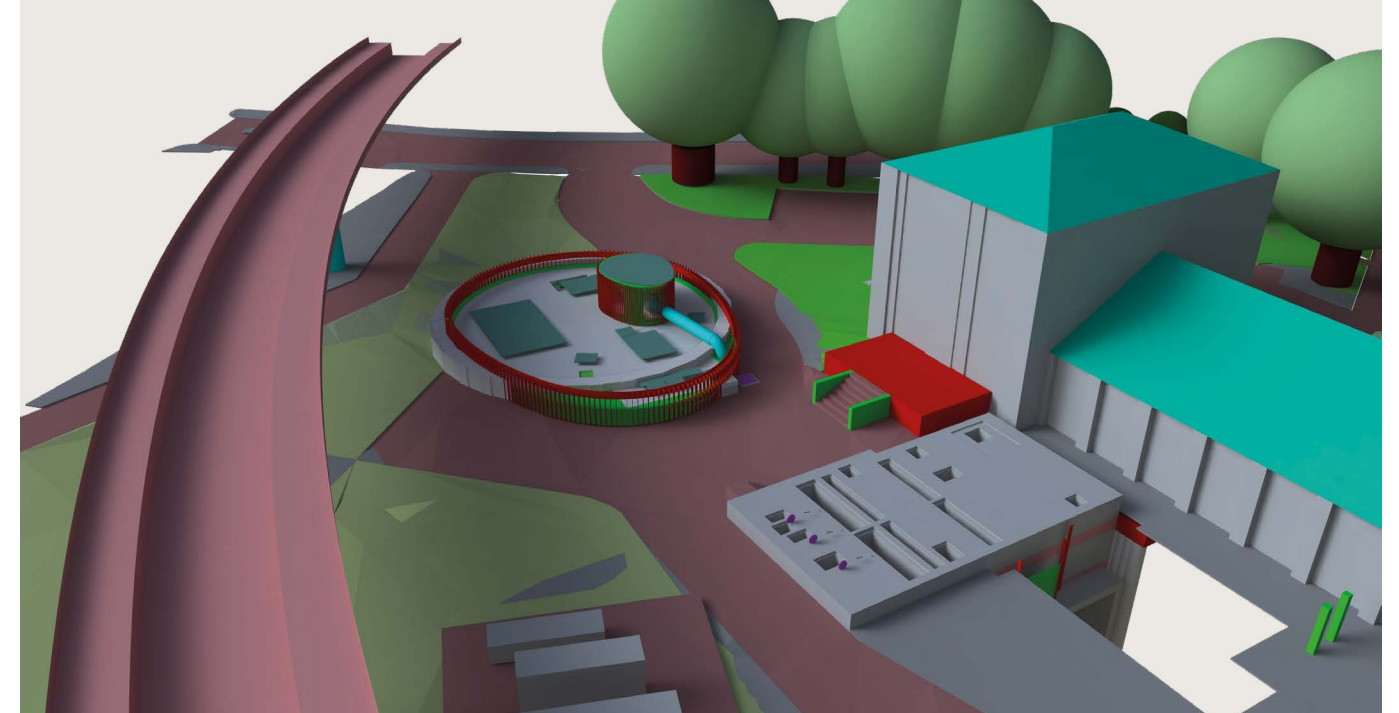
However, a change in behaviours is needed to make the most of BIM level 2:

Adopt the digital mindset: Going digital is as much about shifting behaviours and thinking as it is about installing software or using new technologies. People must be willing to change and adapt to new ways of working. Strong leadership is needed to drive change.

Focus on people: The CDE is just a tool, not the endpoint. It's all about collaboration, and employees may need to be upskilled to make the most of BIM level 2.

Get the process right: Consider the practicalities of how the delivery team can work effectively in a CDE. By keeping in mind future use of information assets, you can ensure suitable data management processes are put in place from the outset.

Know your tools: As well as the capabilities that technologies and software can bring, consider the limitations, and how these may impact on the project. Both disruptive technologies and unforeseen bugs can derail progress.

Case study 1: Thames Tideway Tunnel

The £4.2bn Tideway Tunnel project runs through London and will significantly reduce sewer overflow incidents into the River Thames. We hosted the CDE via ProjectWise, bringing together our BIM models, project controls, project and design costs and all deliverables. This enabled strong control of information, a sense of clear ownership, efficient delivery and co-ordination, and most importantly, intelligent reporting, which provided the client with consistent outputs based on real-time data.

The project was divided into 12 disciplines, two programme splits (early works and main works) and five design delivery gates. Each unit of data was allocated to one category, enabling us to link design costs, programme, and information from the CDE to get better insights into how the project was running, and the costs associated with each element.

Early in the process the project manager was challenged to reduce the programme by two years – a challenge that fell to us. By focusing on the BIM model rather than 2D drawings, we shrunk the workflow and enabled a faster, more efficient design process. This led to a 32% reduction in design production compared to traditional delivery methods, cutting design time by six months, and avoiding the need for 350 drawings. This reduced delivery programme will assist the client to reduce the programme by two years.

Case study 2: High Speed 2

This rail project will introduce high-speed train travel between several major cities in the UK. The first phase comprises 225km of new track, four new stations, seven civils packages and will take eight years to complete. We are working on one of the civils contracts and were required to get a cost to the client in a short timeframe.

The project has been very challenging for several reasons. The team comprises more than 1000 people spread over the UK, Australia, France, India, Poland and South Korea. There is a vast quantity of information involved – more than 40,000 files, which need to be managed, controlled and co-ordinated to produce over 300 assets. It's demanding, but a common data environment makes it possible. As well as enabling the team to access and manage all information in real-time, the CDE enables progress reporting for the client – more than 2000 documents were sent to the client in just four months.

Let's truly value information

Jon Malam
Group IT director

"We must treat information as an asset. This means bringing a rigour and discipline to managing data that has not been there before."

The great potential provided by information was highlighted by marketing commentator Michael Palmer in 2006, who said: "Data is just like crude oil. It's valuable, but if unrefined it cannot really be used."

There is truth in this. Data is just data, it takes management and analytics to produce meaningful information to inform decision making and create better outcomes. The more ways you find to refine data, the greater it's value. Despite the superficial similarity between crude oil and data, there are many differences that work in data's favour. Unlike oil, data is non-depleting and non-rivalrous. It is regenerative and almost unlimited, with low inventory and transmission costs, plus it's eco-friendly.

Information is steadily becoming more abundant. Research and advisory firm Gartner predicts that annual data generation for top Internet of Things (IoT) data sources by 2020 will hit more than 54 exabytes – that's 54M terabytes!

Information management is a relatively new discipline, so it can be difficult to control and manage, and there is often uncertainty over what we can do with it. For our industry to make use of this growing resource, we must treat information as an asset. This means bringing a rigour and discipline to managing data that has not been there before.

We are already using data-based solutions to bring added value to our customers and our business. Safeswim is an online platform using 1bn data points from across Auckland's wastewater network and external sources, including weather data, to provide residents with accurate, real-time information on water quality at 84 beaches around the city. Internally, we are using new data insights to help us manage and deploy skills globally, and we have even used machine learning to assist us in choosing what projects to bid for.

However, this is just the beginning of infrastructure's journey into using data to create better outcomes. The opportunities are vast, if we are willing to embrace change.

Information security is crucial

Bob Grahame
Group information security manager

Smart infrastructure is the merger of two very different worlds – engineering and information technology (IT). The IT industry moves very quickly. Software may not work perfectly first time, but regular updates mean it's ok to make mistakes if they can be quickly remedied, while the rapid process of prototype-test-fail-learn stimulates the great innovation we have seen in IT.

In engineering, where we are dealing with essential assets such as bridges, roads or a water network, failure is not an option. We must get things right first time, while an environment of professional licensing, detailed pre-planning and strong government regulation means it takes a relatively long time to get new products to market.

What would happen if we combined both worlds? Things could go wrong – we have already seen car crashes involving self-driving cars, while cybercrime poses a threat to all smart systems.

Keeping smart assets safe means embedding an awareness of information security risks at the heart of the design process. Here's what we've learned to make smart infrastructure secure for all:

Make safety paramount: Never compromise on safe engineering design.

Start simple: At the beginning, overlay 'smart' where a system failure can't cause harm.

Ensure the physical asset 'fails safe': Engineer whole-system safety into the 'dumb' components that is not dependent on the 'smart' components behaving smartly.

Security is crucial: Make information security assurance a core deliverable.

Test it to breaking point: Bring the prototype-test-fail-learn ethos of IT to your smart infrastructure solutions.

Hack it yourself: Hire a 'red team' to find weak points in the system.

Blockchain will disrupt our industry

Many people are excited about how blockchain will impact their work and lives, and with good reason – ledgers to record transactions are a fundamental part of the economy at every level. If you decentralise trust and put it in the hands of companies or individuals, then new partnerships and new value can be created.

An example of the potential for value can be seen in Bitcoin, a revolutionary currency proposed in 2008 as a response to the financial crisis, based on the idea that money should be independent of governments and central banks.

Blockchain is highly relevant to the infrastructure industry because it forces us to rethink business models, value transfer, and the merits of decentralisation.

Artificial intelligence will be the next big 'moment' in the history of blockchain, as the technology will provide all important accountability, which is vital in a world where machines learn from and manage other machines. Other uses of the technology in our industry include supply chain management, where records of provenance, settlement and resistance to fraud are crucial, and the token economy, where we can create new trading relationships between consumers and producers.

Blockchain can also bring great efficiencies to facilities management, in areas as diverse as title verification, tenant billing, co-working transactions, occupancy tracking, equipment warranties, smart contracts for maintenance, and peer energy trading.

Despite the vast potential of blockchain our industry has been slow to adapt. Upfront planning is needed to make the most of the technology:

Identify the business problem: Blockchain forces you to rethink value transfer, stimulating great insights into existing and potential ways of working.

Consider blockchain's properties: Blockchain enables you to work from a 'single source of truth', providing consensus, provenance and immutable records of all actions.

Undertake detailed mapping of 'problem-solution-fit': What advantages will blockchain bring you over your existing technology solution? What other changes do you need to embed to make this happen?

Think about governance and business model design: Most blockchain applications focus on this area, using ledger technology to provide trust and bypass third parties.

Map stakeholder needs: Be sure that no party is disadvantaged and each one understands what they will get from transactions.

Work with partners who understand your domain: Blockchain 'experts' are springing up everywhere but remember that a background in your industry is crucial if you want to make the most of the technology.

Learn by doing: Having a blockchain strategy is not an end game – be prepared to regularly update your strategy as you learn more about how the technology can unlock efficiency.

Where can Smart
Infrastructure
take you?

See.
Act.
Impact.