Deloitte.

Digital Capital Projects

The capital project of the future

Capital project insights

Contents

Capital Project Insights is a series of papers bringing together the latest thinking from members of our team on optimising performance and value across the lifecycle of capital projects.

Executive summary

A digital capital project is more than simply the use of technology in delivering a project. It represents a fundamental shift in how a project is designed, constructed, operated and decommissioned.

Digital transformation provides an opportunity to gain safety, efficiency, and significant financial benefits. However, unless strategically planned, the investment in digital can be costly, time and resource intensive, with benefits only attained several years down the line.

Projects need a digital strategy and data foundation to succeed, this considers an organisation's current digital maturity and provides an achievable roadmap to adopt and sustain key technologies such as a digital twin. Digital technologies should be selected to add value throughout the journey and build on previous successful initiatives. It is just as important to develop the team's digital skills as it is to roll out new technology.

Deloitte has extensive experience of digital transformation. While the journey can be complex, we know that a successful outcome can be characterised very clearly and simply:

- A data-driven approach that runs through everything and everyone in the project.
- An innovation process that tests the value and opportunities of technology in an ongoing and agile way, backed by a sustainable strategy that recognises the evolving nature of technology.
- A digital mindset that permeates teams, culture and working practices within capital projects, and understands fully how technology can realise the value behind the digital opportunity.

What is a digital capital project?

The digital capital project has data at its heart, as an integral and crucial part of managing successful delivery. Technology is used to capture, store, analyse, display and use this data allowing project teams to make faster and better decisions.

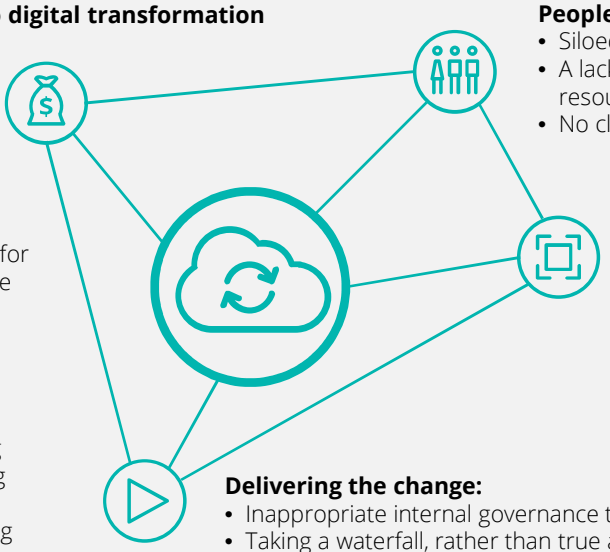
For project owners willing to invest, future digital capital projects will be designed and built to be safer and more efficient. Importantly, digital initiatives can influence each stage of the project lifecycle.

Why now is the right time?

The industry is always looking to reduce design, construction, and handover costs and scope risk. Current technology now makes data collection, analysis and interaction more powerful and intuitive than ever before, bringing benefits from early phase design through to de-commissioning. These benefits can outweigh the costs, as long as investment is approached early, consistently and strategically. If you invest late, you get left behind.

Four challenges to digital transformation

Finding funding:
- A lack of a clear commercial or procurement approach to technology
- Building the case for R&D and intangible benefits
- Underestimating operational and support costs
- Finding and leveraging existing innovation funding channels
- Effectively engaging the supply chain to share the innovation cost



People and buy-in:
- Siloed teams with differing views on requirements
- A lack of internal skills and reliance on external resources
- No clear sponsorship to drive investment

Selecting the answer:
- No overall strategy to support choice of applications, infrastructure and tools. (A 'project-by-project' mindset)
- Solutionising before focusing on user needs and requirements
- Understanding the complex web of solutions and suppliers on the market
- Not thinking about investment from a portfolio, programme and project perspective

Delivering the change:
- Inappropriate internal governance to support technology development
- Taking a waterfall, rather than true agile approach
- Tactical implementation that limits wider transformation
- A lack of a business change approach that looks at the impact of digital across the operating model – i.e. people, processes and systems.

Where is the industry now?

Digital initiatives seldom deliver and sustain the value anticipated, or achieve their full potential. We've observed many reasons why this happens in capital projects.

The capital projects industry has traditionally prioritised investment in conventional tools, techniques and process changes, as familiar ways to improve delivery on time and budget. Technological change can seem more uncertain, and digital initiatives have been less ambitious as a result.

While digital maturity varies from sector-to-sector, the whole industry lags behind other sectors, such as media, retail and finance. However, those organisations that have invested wisely are seeing significant benefits.

For example, Rio Tinto's[1] Pilbara mine uses a fleet of autonomous trucks to haul ore, which improves safety, productivity and cost, as one remote operator can supervise multiple trucks running 24 hours a day.

For the majority of the industry, digital investment has typically been ad hoc. Initiatives have simply emulated that done elsewhere, or used what seemed most convenient or readily-available. Historically, project teams have tended to work in silos, adopting piecemeal and unconnected technologies that fail to serve the full project lifecycle. Such thinking and practices have led to inconsistent data and information management within and between projects, leaving capital projects organisations unable to develop and mature their digital capabilities in the longer term.

Project teams, owner organisations, and the supply chain are coming to the overwhelming realisation that their traditional approach to technology investments are not yielding the benefits they'd hoped for.

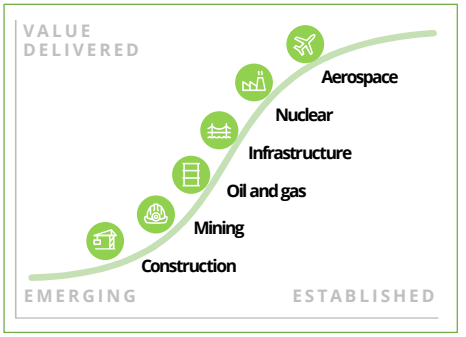


Figure 1: Construction and mining lag furthest behind regarding digital maturity. However, all these sectors are significantly behind other industries such as technology, media, finance.

Source: Deloitte

Projects are still not delivering a fully digital operation. Typically, they're delivering a traditional asset with some digital functionality, and this fails to realise the full potential of the technology. In other cases, digital 'quick fixes' may be too limited in scope to deliver meaningful improvements.

Central teams still focus on impressive-sounding 'headline' initiatives, but the advanced technology is often not mature enough, and as a result, fails to solve key business problems and delivers no immediate value to projects. This can discredit further initiatives, limit budgets and stall new digital ideas.

The scale and complexity of the digital landscape makes it hard to determine the most appropriate solution, with multiple providers, manufacturers and consultants each pushing different solutions. The right approach requires a fit-for-purpose, organisation-specific digital vision and strategy that allows cohesive piloting and appraisal, investment, planning and implementation.

[1] Rio Tinto

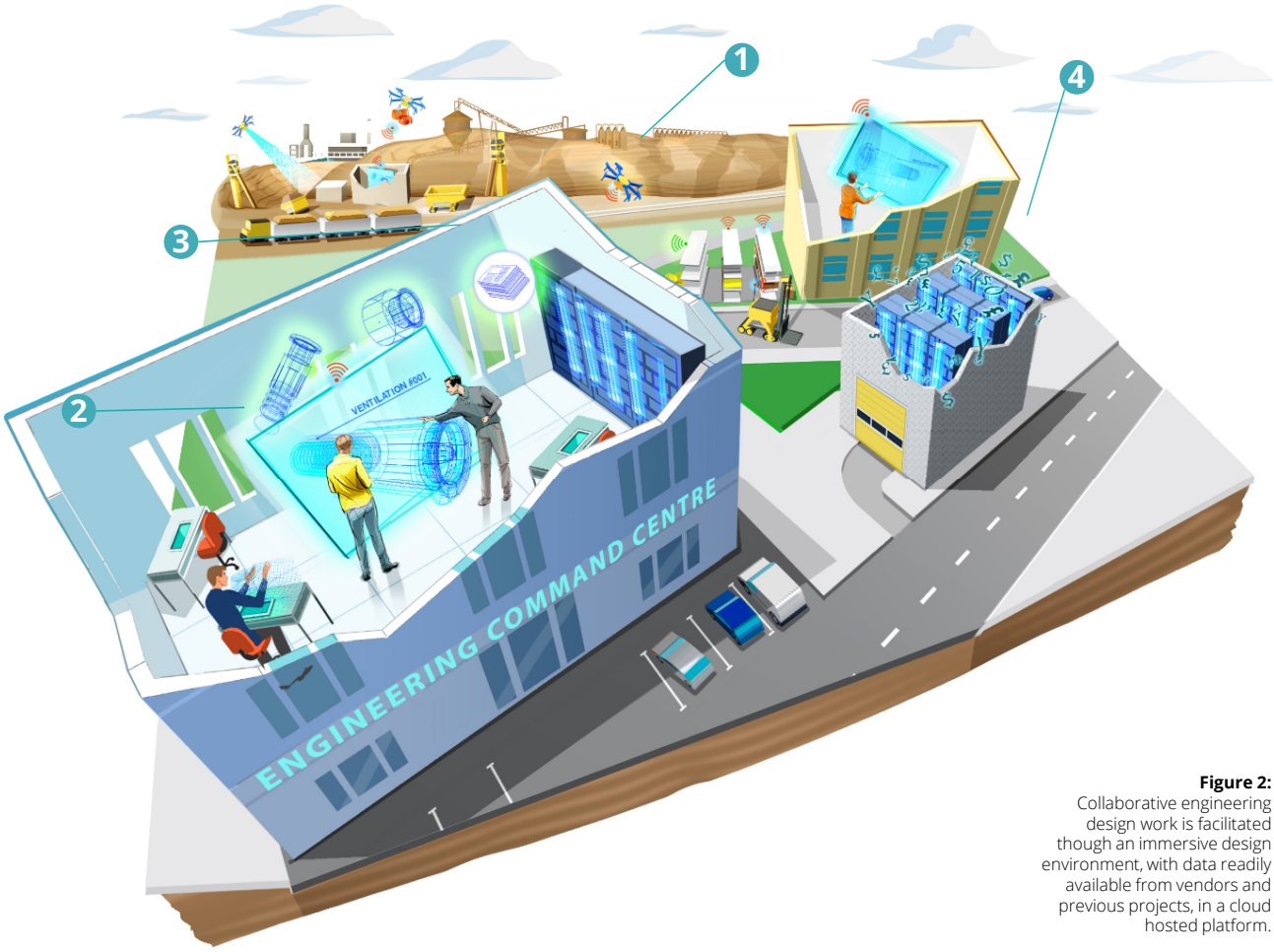


Figure 2:
Collaborative engineering design work is facilitated though an immersive design environment, with data readily available from vendors and previous projects, in a cloud hosted platform.

Example technology[1]: digital through the lifecycle – Phase 1: design, financing & procurement

1 Drones

Surveillance, inspection and topographical surveys are just some of the applications for drones in the field. For example – a drone can provide live visual support to a design or construction team, with off-site teams viewing footage and relaying feedback, or the construction team viewing drone visuals through augmented reality wearables.

2 Collaborative design

The advance of 3/4/5D modelling and visualisation technologies supported by cloud hosted data enables a highly collaborative design process, with multiple engineers working on the same design in real time. Live manipulation of the design is possible, and Virtual Reality (VR)/Augmented Reality (AR) can be utilised to provide a fully immersive design experience and capability.

3 Intelligent design search

Organisations have access to huge amounts of information from previous projects – engineering designs, inventory lists, technical standards, historic costs, trends and project plans. Artificial intelligence can provide real time support in the design process by analysing and processing vast amounts of data to provide insights and comparisons with previous projects.

4 Blockchain (digital ledger)

Blockchain has an application as a secure transaction and record platform – a digital ledger. Throughout a project, the complex network of interactions between the project owner, contractors, suppliers and other stakeholders necessitates an environment where digital information (e.g. financial transactions, equipment history, inventory) is securely managed.

1. Some of the technologies listed will be applicable in other lifecycle phases.

What's the value of digital?

Digital – when integrated and used effectively – has the potential to add value throughout a project's lifecycle. Those who invest with a 'data from day one' approach can realise significant benefits.

Cost benefits come from targeting the fragmented supply chain, and minimising intermediary costs. Capabilities are needed in the provision of collaboration tools; programme controls governance and standards; and general technology competency. As a result, benefits can be seen in:

- CAPEX savings on construction, design and delivery
- OPEX savings through Enterprise Asset Management (EAM) technology.
- OPEX savings due to automated business processes.

Time benefits arise from improving design, capital delivery and operational efficiency. These follow directly from the 'data from day one' approach and visualisation capabilities, giving value such as:

- Time saved by reusing designs, rather than recreating them or searching for information.
- Reduced time to review and approve submissions, by using automated workflows.
- Efficient and better-informed business decisions through clearer visualisation.
- Use of technology such as robotics to reduce or replace manual design, construction or operations tasks.

Digital can **reduce risk** and enhance risk assessment in delivery and operation. Central capabilities include cybersecurity strategy; big data analytics and modelling capability risk-based project controls; data quality and governance. Risk value benefits include:

- Lower risk and cost contingency.
- Better, repeatable designs, improved design assurance, compliance and integrity management.
- CAPEX and OPEX savings through risk-based and predictive maintenance.
- Insights into efficient spending: analytics help reduce the risk of expenditure in the wrong areas, by using historic data to predict future outcomes.

Health and safety benefits are typically focused on minimising human intervention in hazardous areas, as well as having appropriate tools to capture, manage and mitigate incidents through awareness and training. This requires capabilities in data analytics; defined processes and standards; and data quality and governance. The value can be seen in:

- More efficient and real-time safety information.
- Reduced near misses and safety incidents.
- Easier warnings and safety contingency planning capability.
- A healthier, happier and more productive workforce.

Building a truly digital capital project means much more than adopting ad hoc technologies into an existing project delivery framework.

By starting with a solid digital foundation, built around data, subsequent investment in technology can be much more effective. The earlier that initial investment is made, the more that digital can add value[2] throughout the lifecycle. For instance:

Design, financing and procurement
10–30 per cent reduction in engineering hours.

Construction
5–10 per cent reduction in build costs.

Operations and asset management
10–20 per cent reduction in operating costs.

Decommissioning
5-10 per cent reduction in decommissioning hours.

[2] Deloitte cross-industry analysis

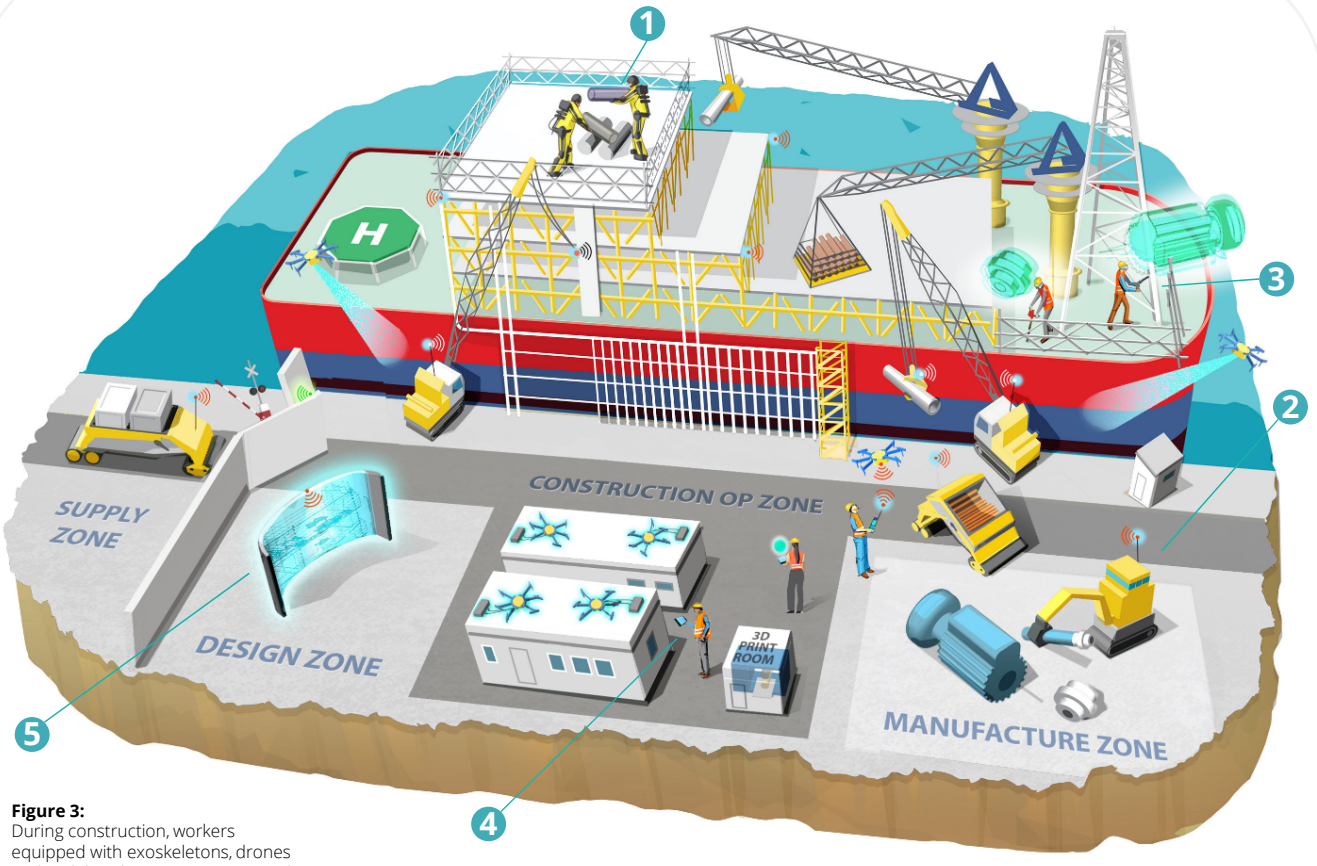


Figure 3:
During construction, workers equipped with exoskeletons, drones and mobile solutions are supervised off-site through augmented reality technology.

Example technology[2]: digital through the lifecycle – Phase 2: construction

1 Exoskeletons

Although in its infancy, exoskeletons augment the human body to provide the ability to avoid repetitive strain injuries, and add additional strength and dexterity.

2 Modular design & construction

Modular construction (closely linked to pre-fabrication) allows construction assemblies to be built more efficiently than ever before. Through the use of a standardised design inventory, and a set number of commonly used components, complex assemblies can be built by robots with minimal human interaction. 3-D printing can often be used in parallel to manufacture elements of the design with greatly reduced lead times. Ideally, the construction process can occur off-site in a controlled and hazard free environment, limiting on-site activities to installation and commissioning.

3 Augmented Reality

AR technology provides a virtual overlay of information onto a real-world view. Construction workers equipped with AR headsets can view design schematics during on-site activities. Integration of wearables with live video-feed and sound allows offsite personnel to 'view what the worker is viewing' – one technical specialist can provide live oversight and support to a team of on-site workers.

4 Mobile/tablet solutions

Mobile/tablet solutions are already being used in many construction projects, providing worksite personnel with easy access to designs and work instructions, as well as being able to submit project data (e.g. health/safety audits, progress data and images).

5 BIM (Building Information Modelling)

Advanced 3D models through BIM can be used to understand the impact of design changes and inform sequencing of tasks. This also includes capture of operational asset data throughout the design and construction stages.

2. Some of the technologies listed will be applicable in other lifecycle phases.

Transforming to a digital capital project

The journey to digital maturity must be planned properly. A holistic approach that encompasses the digital workforce, current and future maturities, along with targeted business outcomes is required.

Capital project organisations need a digital strategy and vision to realise and gain early value from digital, by having tangible ambitions and timelines. This work needs to be split into distinct stages that progress the organisation from a traditional approach through to a digital capital project that can routinely adopt the latest technology. This ensures the strategy can deliver on project needs, as well the enterprise's broader digital vision.

Each stage should focus on the consistent adoption of specific technologies across project portfolios. There must be an investment plan, project sponsors, and clearly-defined outcomes, combined with a benefits realisation plan. Digital solutions can then be designed and piloted in an agile manner. When benefits are proven, those solutions can then be scaled across the organisation.

The scope and pace of each stage must be driven by a realistic view of the organisation's current digital capability, not just by considering its future aspirations. Each stage should deliver technology with the largest return given current maturity.

Once technology from one stage is operating, it can prove its value to the business, embed new ways of working and provide the basis for building the next stage. Outputs from one stage should enable the technologies in the next.

For example, Google applied machine learning to data collected by thousands of sensors to reduce the energy consumption of its data centre cooling systems by up to 40 per cent. After a successful pilot, where the algorithm made recommendations for human operators to implement, today it is in direct control of the system.

Alongside technology, organisations must build a digital team, equipping their staff with the requisite digital skill sets to use the data the organisation is generating. The more familiar people are with digital ways of working, the more effectively they can test and adopt new technology. In technology firms, for example, the pace of innovation shows how agile a truly mature digital operation can be. Project teams must be equipped to use the initiatives in each stage, and able to see tangible benefits from them. Initiatives are likely to fail through lack of support if the benefits aren't both realised and felt to be useful.

Technology will change, and what is new now will soon be outdated, so a sustainable innovation process is the most important investment for ongoing digital uptake. The approach of creating a proof of concept (POC) means that failing or outdated initiatives can easily be stopped, and decision-makers can avoid falling foul to the 'sunk cost fallacy'.

The digital journey:

Digital Diagnostic
Assess existing digital capability, level of maturity and identify appropriate solutions to meet the digital strategy.

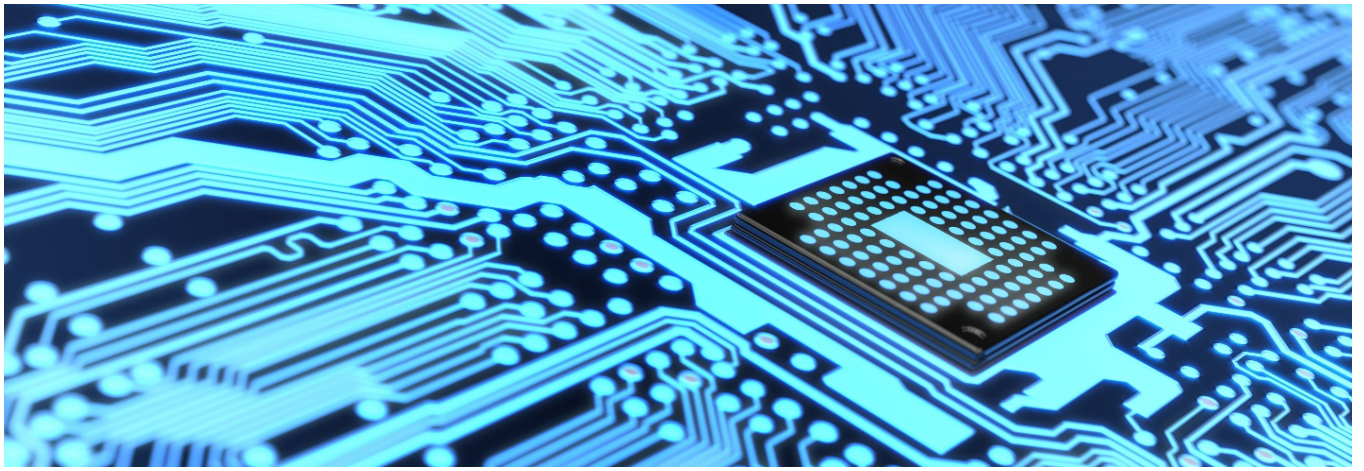
Digital strategy
Define a vision and strategy for a coherent approach to realise and accelerate value through digital with tangible ambitions and timelines.

Investment planning
Create an investment plan considering benefits against a robust evaluation model.

Design
Based on the investment plan, design digital solutions for future delivery.

Deliver
Deliver digital solutions in an agile manner, supported by technology capability.

Operate & optimise
Run capital projects with enhanced digital capability, review against strategy and continue to evolve.



Data is the foundation

Building a data foundation (with a governance framework, tools, process and capabilities) is critical to the digital capital project. This can progress from simply making data available in a single database through to an advanced digital twin. New trends in digital and technology should be considered, but only if they ultimately contribute to building the maturity of the data landscape.

- Most 'physical' digital initiatives (e.g. sensors, drones, AR/VR) are about interfacing with this data.
- Suppliers and partners must also be integrated into this ecosystem.
- Even physical technologies such as robotics are reliant on data, and most current applications relate to collecting data more safely and efficiently.

Build a digital twin

A digital twin combines many different technologies (e.g. modelling, sensors, analytics and 3D visualisation) to create a 'live' digital replica of a physical asset in operation. Both are dynamically connected, so the digital twin provides ongoing visualisation and analysis of the asset's performance. It is a solution that unlocks significant value from design, through construction and into operations.

We take a staged approach to building digital twin capability, to ensure that each stage provides business benefits in itself, while serving as a solid foundation for the next:

- Be ready to adopt new technologies in augmented reality; robotics for remote operations; AI-driven plant diagnostics and operational enhancement; AI-driven plant design.

4. Emerging technology

- Complete full digital twin.
- Have integrated digital team (including data scientists).
- Link data and operations, so most decisions are driven by data, using predictive and reliability-centred maintenance.
- Advanced physical tools are in use, such as workforce monitoring, smart hard hats, drones and laser mapping.

3. Fully digital

- Build an interactive 3D visualisation of the asset used for construction and operations.
- Designate digital roles and responsibilities.
- Make all operational data easily accessible.
- Implement data-based maintenance tools, and physical tools, like tablets, so teams can interface with data.

2. Improvement

- Digitise project data to a single platform, where it can be searched easily and contextually.
- Install networked sensors, along with wireless connectivity throughout the facility.
- Empower people to adopt a digital mind-set.

1. Foundation

To embed any digital initiative effectively (not just digital twin), projects should fully complete each stage before progressing to the next. We find companies are often looking at Stage 3 initiatives while still struggling to implement a single data platform. This means that benefits aren't realised, digital loses credibility and therefore becomes harder to adopt.

Develop a digital mindset and capability

Digital maturity isn't just about technologies and data. It's also about ways of thinking and working, so the capability must permeate the project's people and suppliers through a fundamental shift in how they value data.

Projects should have a digital lead who is accountable for meeting digital objectives. This should be a dedicated role, filled by someone with relevant experience, not a secondary responsibility for an engineer or traditional project manager.

The project's people must be trained to use digital systems to gain greatest benefit from them. In particular, they should learn how to ask questions of data and draw on the expertise of data professionals. Skilled technology professionals should also be available to support project teams as they develop for tasks such as building interactive dashboards, or providing monitoring and training for using tools and data.

Operations and maintenance should be designed from the ground up with data in mind, including training engineers and operators, so that decisions are based on data, and can change dynamically as parameters change.

The operations data should keep its active link with assets as they are upgraded or renewed to ensure ongoing digital twinning.

For example Microsoft's HoloLens 2 allows an engineer in an office to see what a remote worker is viewing and then highlight areas of interest for them using augmented reality.

Quality assurance processes must include digital data, and give data quality comparable status to other design parameters.

Supply chain contracts and deliverables must meet digital standards at the procurement phase. There can be significant value in making operator performance data and past designs available to suppliers and technology firms (e.g through the PAS 1192 framework), allowing new applications and collaborations to be explored and encouraged. For example, as-built information should be stored in indexed open source file formats which have greater future value than scans of wet signed drawings.

Critical success factors

Based on our experience, we have identified four key factors that are critical for successful digital transformation.

Develop your digital roadmap: this is the foundation for digital transformation. The design must consider current digital capability, investment environment and key issues that could be addressed by digital. The roadmap depends on the project or organisation's lifecycle phase, and will evolve as these progress. Transformational leadership is needed to set the direction for and drive the organisation's digital journey.

Ready your digital workforce: digital capability is not simply about technology, systems and data. Successful transformation comes from people, culture and behaviours, so preparing for the 'future of work' is essential. Today's digital natives will be the people delivering projects in the medium and long term, and they will expect a digitally mature working environment. The future workforce will demand agility, efficiency and the facility to use the vast amounts of project data available.

Invest at the right time, for the right reasons: develop a strong business case and clear sponsorship for the digital journey. The ability to introduce digital to the heart of the organisation may be affected by the current data and information landscape, level of design standardisation, risk appetite, and organisational culture, so all these areas should be considered. A holistic business case and clear vision can make the difference between an investment being a success or a failure.

Embrace the digital operating model: digitally transforming a capital project is a major undertaking. Such scale and complexity requires careful considered assessment, design and implementation; bringing the team along on the journey is a must. It's essential to consider and understand all the strategy, capability, organisation, process, systems and data elements.

Figure 4:
A network of sensors capture data from the operating asset, with background AI analysing the digital twin to generate predictive maintenance regimes.

Example technology[3]: digital through the lifecycle – Phase 3: operations and asset management

1 Robotic Process Automation (RPA)

Technicians are supported by computer software which enables the automated processing of transactions, data manipulation, and communication with other systems. Companies are able to spend less time on administrative tasks and more time supporting value-adding tasks. Back-office functions can also benefit from RPA, enabling an organisation to be more efficient.

2 Digital twin

The digital twin is a complete digital replica of an existing asset - created through the combination of 3D visualisation, analytics and sensors (IoT). Sensors attached to the operating asset provide real-time data, with analytics capabilities giving insights from other similar assets. Predictive maintenance regimes can be established, as well as the digital twin feeding the design for new assets.

3 Internet of Things (IoT)

The introduction of sensors and internet connectivity to new applications enables complex equipment and networks to provide live feedback on various operating parameters. The vast amounts of data being fed back is supported by analytics capability to analyse, process and provide insights based on the data. Operating patterns and malfunctions can be identified and proactively addressed.

4 Predictive maintenance

Equipment and network connectivity supported by Artificial Intelligence enables maintenance regimes to be more effective and proactively designed. Significant reductions in equipment down-time can be achieved when a network is managed in this way, with data and information at the heart of the maintenance process.

3. Some of the technologies listed will be applicable in other lifecycle phases.

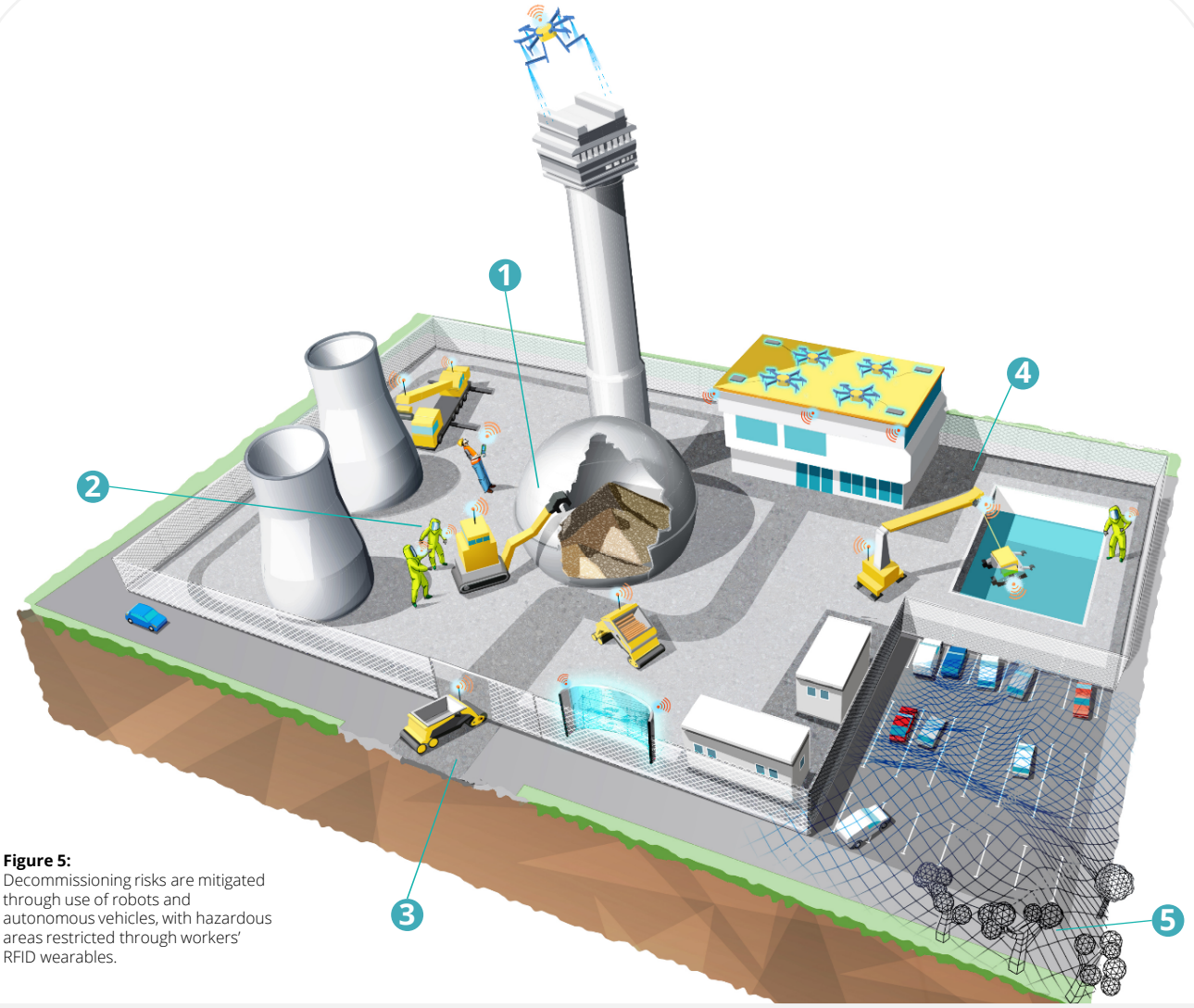


Figure 5:
Decommissioning risks are mitigated through use of robots and autonomous vehicles, with hazardous areas restricted through workers' RFID wearables.

Example technology[4]: digital through the lifecycle – Phase 4: decommissioning

1 Robotics

The application of robotics across asset management and decommissioning significantly reduces hazards on-site. As well as being able to enter environments unfit for humans, multiple types of data collection are possible during operations.

2 Wearables

Wearables have a wide ranging number of applications, including monitoring of remote workers and external environmental factors (such as radiation and gas concentrations in enclosed spaces).

3 Autonomous vehicles

Autonomous vehicles combine sensors and software to allow driverless carrying capabilities. In applications with fixed-routing (e.g. transportation of goods in a warehouse, or mining trucks ferrying waste tailings along a predefined route) these solutions are in place. The driverless car revolution, combined with advances in battery technology, has the potential to transform the construction site into a safer, and more environmentally friendly place, with reduced demand on the workforce.

4 RFID identification

RFID (Radio Frequency Identification Technology) uses electromagnetic fields to identify and track proximity of objects. It has various applications – for example, workers can be alerted when entering restricted areas controlled by an RFID sensor – called geofencing. The restriction of various areas of a site can be remotely controlled, minimising the need for physical barriers.

5 Environmental modelling

Following decommissioning of engineering facilities, it is important to understand how quickly the natural environment will regenerate. Advanced modelling and impact assessment software is supported by GIS to provide project owners with long term project impacts. (Geographical Information Systems – systems designed to capture, store and analyse spatial and geographic data).

4. Some of the technologies listed will be applicable in other lifecycle phases.

How we can help

Our three-phase transformation process supports you on your journey to a holistic, digital way of working, while our experience, tools and partnerships are available to help us help you with that process.

1: Imagine. We work with you to identify where you want to be, where you are now, and a plan for the journey.

- Digital diagnostic: assess your existing digital capability and identify the issues that could be addressed by digital initiatives.
- Digital strategy: define your vision and strategy to inform a coherent approach which can realise and accelerate value through digital, measured against tangible ambitions and timelines.
- Investment planning: create an investment plan considering economic drivers against a robust evaluation model.

Deloitte's Venture Path approach can help you innovate faster and cheaper; our extensive thought leadership in engineering and construction helps us solve your business and technology problems; while our investment appraisal and benefits modelling toolkit can help you assess and decide between your investment options.

2: Deliver. Our business and technology experience helps you put the plan into action.

- Design: based on the investment plan, design and pilot solutions for future delivery.
- Deliver: implement digital solutions, supported by analytic capability to maximise investment value.

We offer a Centre of Excellence (CoE) for construction analytics; draw on extensive experience in transition and readiness planning; provide agile delivery for new capabilities and staff empowerment; and have an Insight Driven Organisation (IDO) offering that builds analytics into your ongoing decision-making and improvement.

3: Run. We'll stay with you once your projects are up and running, to keep them performing.

- Operate: run the capital project with enhanced digital capability, review against strategy and continue to evolve.
- Optimise: enhance your digital solutions to better suit your operations as they adapt.

Deloitte has strong partnerships for delivering simulated reality and 3D digital twin models. We can help you visualise and interact with data to give clear insights to project teams, management and executives.

Get in touch with one of our capital projects leaders

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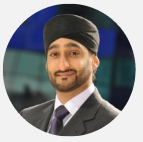

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