CitA TECHLIVE 2024 AI in Construction

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Practical implementation of AI in the Built Environment

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We are witnessing a shift towards an integrated digital engineering environment

- Digital technology, data and new skills are changing the way we plan, build, maintain and use critical infrastructure.
- Information Management, Building Information Modelling (BIM) & Geographic Information System (GIS) are already transforming the construction industry.
- **They are now converging with Digital Twins, Artificial Intelligence (AI) and gaming technology capabilities.**

However central to this is connected quality data

Accuracy and reliability	AI models learn patterns and make predictions based on the data they are trained on. If the data is accurate and reliable, the model is more likely to produce accurate and reliable results. Poor-quality data can lead to incorrect conclusions and unreliable predictions.
Cost efficiency	Poor-quality data can lead to inaccurate predictions, which can result in costly errors and inefficiencies. Investing in high-quality data from the beginning can save resources in the long run by reducing the need for model retraining and correction of errors.
Generalisations	AI models are often designed to generalise patterns from training data to make new predictions and include those in future outputs. High-quality data ensures that the model learns relevant and representative patterns, allowing it to generalise well to new situations.
Bias mitigation	Biases present in training data can be learned and perpetuated by AI. Data taken from sources such as the internet (web scraping) are particularly susceptible to bias. Data should not be skewed toward specific groups or perspectives.
Ethics	Data must enable ethical and responsible AI systems, minimising the risk of unintended consequences and harmful outcomes.
Regulatory compliance	The data being used by AI must be stored, shared, maintained, and used in compliance with legal and regulatory requirements such as GDPR.

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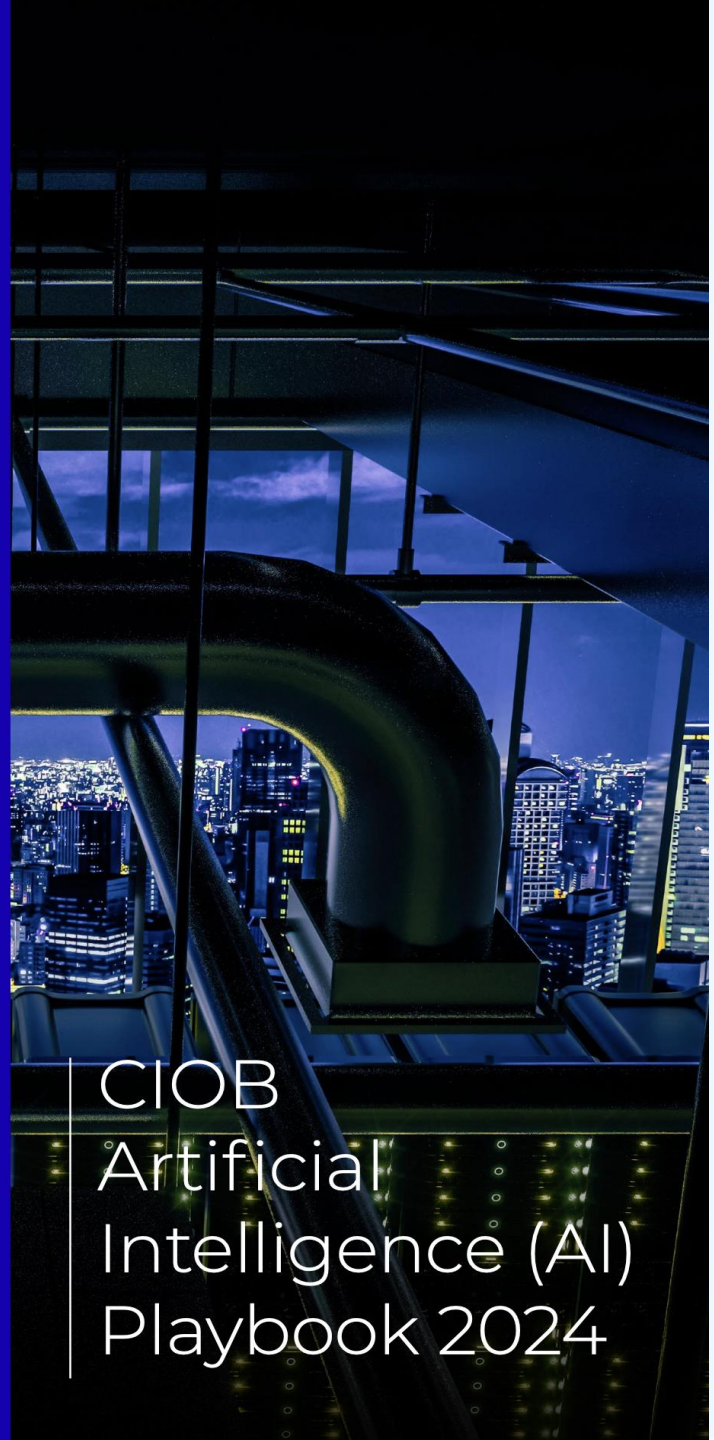


CIOB Artificial Intelligence (AI) Playbook 2024

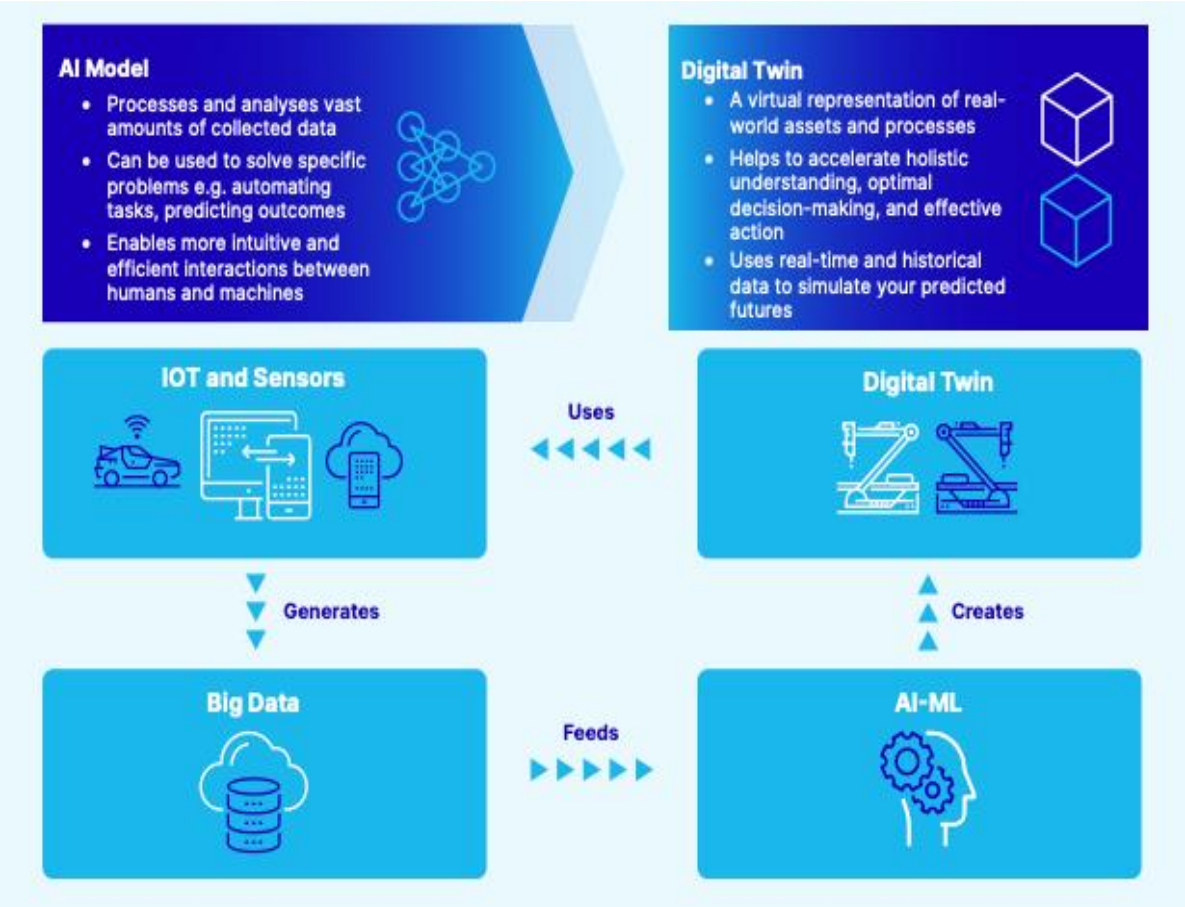
Relationship between AI and Digital Twinning

Loughborough researchers behind "first of its kind" AI tool that aims to cut time needed to survey and maintain RAAC

11 October 2023

Engineering | Research | Research success

A "first of its kind" AI tool, that aims to cut the amount of time and resources needed to survey and maintain Reinforced Autoclaved Aerated Concrete (RAAC) in buildings nationally, has been developed by researchers at Loughborough University.



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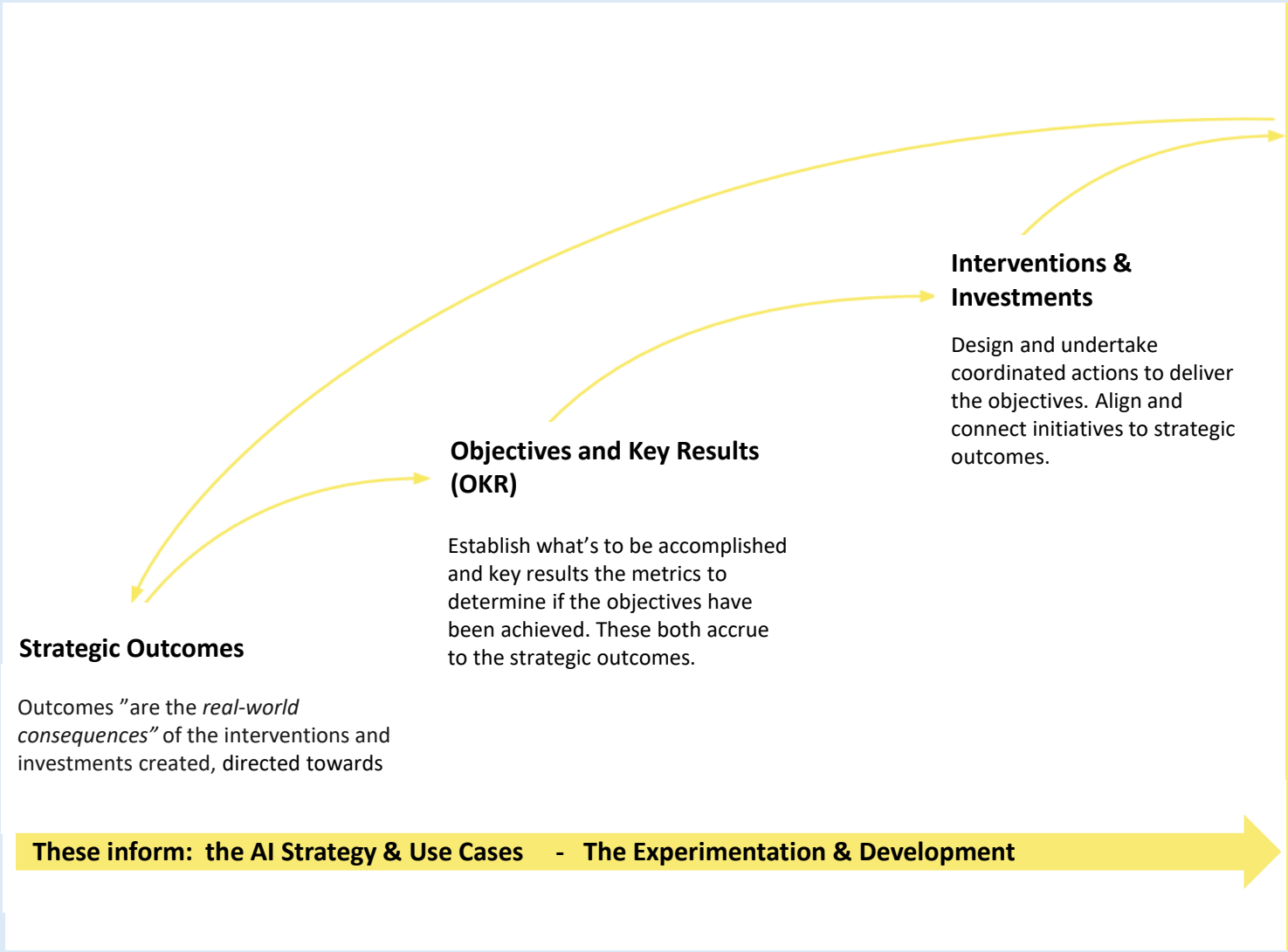
AI Vision & Strategy



Organizational & AI Vision

The vision(s) should be tightly aligned and describe the desirable destination (the north star) short-mid and long term where AI is a key enabler.

Our job is to back cast and work out the interventions and AI investments needed to get there.

We need to make the destination ever clearer as we move forward with AI implementation and use case deployment.

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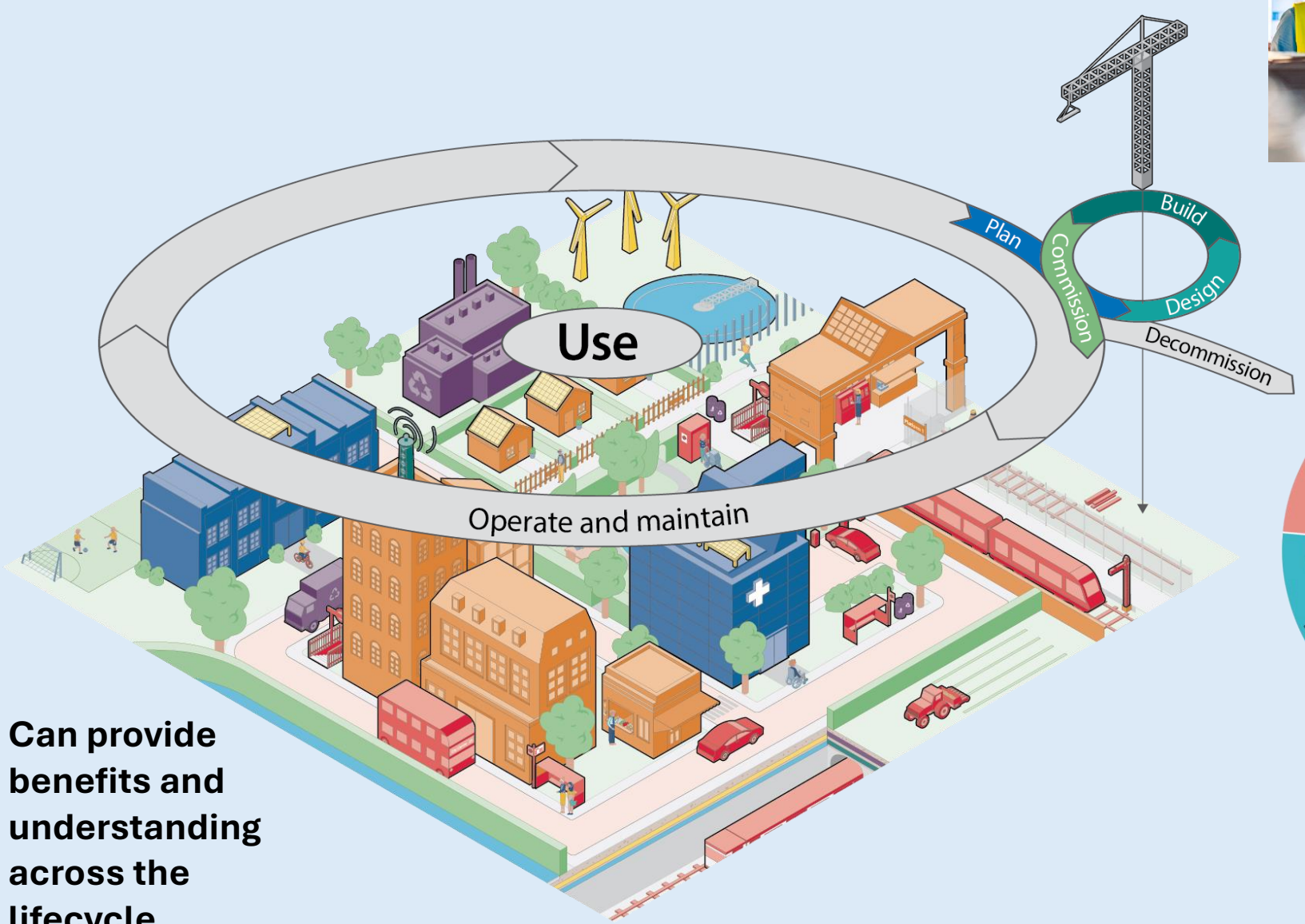
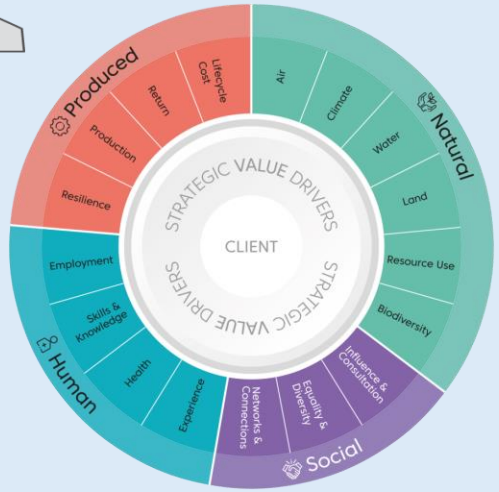
High Impact, Precise AI Use Cases

Can be easily adopted and sustained



Can provide benefits and understanding across the lifecycle



Value and Ethic Driven

AI Opportunities

Other Sub-field AI Components

Natural Language Processing

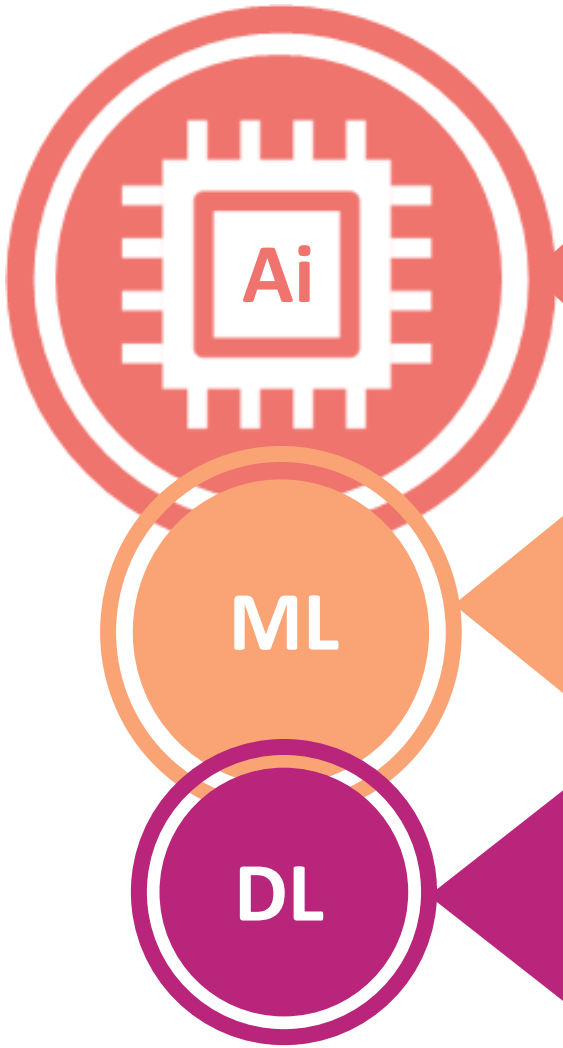
The ability to understand speech, understand and analyse documents

Robotics

Machines that can assist people without actual human involvement

Computer Vision

A field of AI that trains computers to capture and interpret information from image and video data



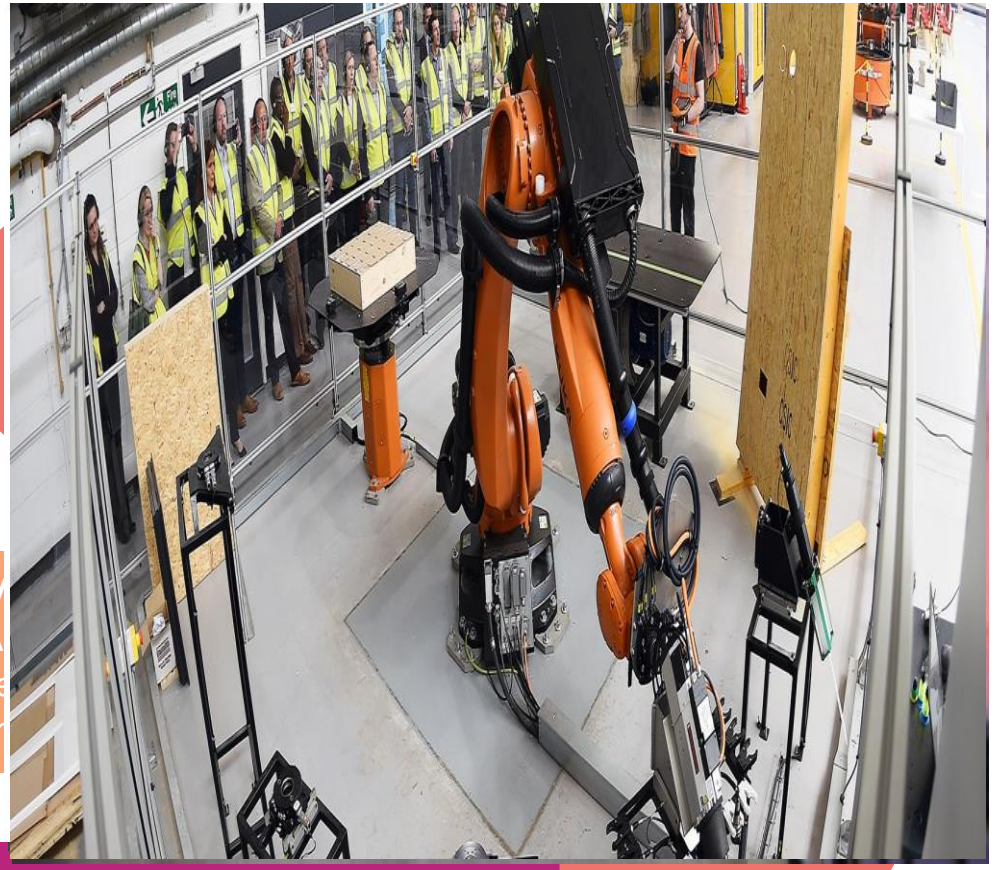


Image: Plugger.ai

Deep Learning

A subset of Machine Learning, which significantly enhances the automation of training AI models

Benefits of Generative AI and Digital Twins

The integration of Digital Twinning and AI offers powerful tools to enhance project planning, quality control, maintenance, sustainability, and overall efficiency. These include:

Project Planning and Management

Optimised scheduling

Use Case: By creating a Digital Twin of the construction project, construction managers can simulate different scheduling scenarios to find the most efficient timeline.	**AI Integration:** AI algorithms analyse historical data and current project variables to predict potential delays and suggest optimal resource allocation.

Resource Management

Use Case: Digital Twins provide real-time insights into the availability and usage of materials, equipment, and labour.	**AI Integration:** AI can optimise resource allocation, ensuring that materials and labour are used efficiently to minimize waste and cost.

Quality Control and Safety Management

Real Time Monitoring

Use Case: Digital Twins can monitor the construction site in real-time, identifying deviations from the planned design and quality standards.	**AI Integration:** AI algorithms detect anomalies and potential safety hazards, allowing for immediate corrective actions to prevent accidents and ensure compliance with safety regulations.

Automated Inspections

Use Case: Digital Twins can automate the inspection process by continuously capturing data from the site.	**AI Integration:** AI analyses this data to identify defects or areas that require attention, prioritising tasks for quality assurance teams.

Predictive Maintenance and Asset Management

Maintenace Scheduling

Use Case: Digital Twins of building systems (e.g., HVAC, electrical) can monitor performance and condition in real-time.	**AI Integration:** AI predicts when maintenance is needed based on usage patterns and performance data, scheduling maintenance proactively to avoid breakdowns and extend asset life.

Lifecycle Management

Use Case: Digital Twins track the entire lifecycle of building components, from installation to replacement.	**AI Integration:** AI provides insights into the optimal timing for upgrades or replacements, balancing costs with performance and reliability.

Sustainability and Energy Efficiency

Energy Management

Use Case: Digital Twins can monitor energy consumption patterns in real-time, identifying inefficiencies and areas for improvement.	**AI Integration:** AI optimises energy use by adjusting systems dynamically based on real-time data, reducing energy costs and carbon footprint.

Sustainable Building Design

Use Case: Digital Twins simulate different design options to evaluate their environmental impact and sustainability.	**AI Integration:** AI proposes design modifications to maximise energy efficiency and minimise environmental impact, supporting sustainability goals.

Construction Process Optimisation

Process Simulation

Use Case: Digital Twins can simulate various construction processes, from foundation laying to final inspection, to identify potential bottlenecks and inefficiencies.	**AI Integration:** AI analyses these simulations to recommend process improvements, optimising workflow and reducing project timelines.

Supply Chain Management

Use Case: Digital Twins provide a comprehensive view of the supply chain, tracking materials from supplier to site.	**AI Integration:** AI predicts supply chain disruptions and suggests alternative sourcing strategies to ensure timely delivery of materials

Infrastructure Health Monitoring

Structural Health Monitoring

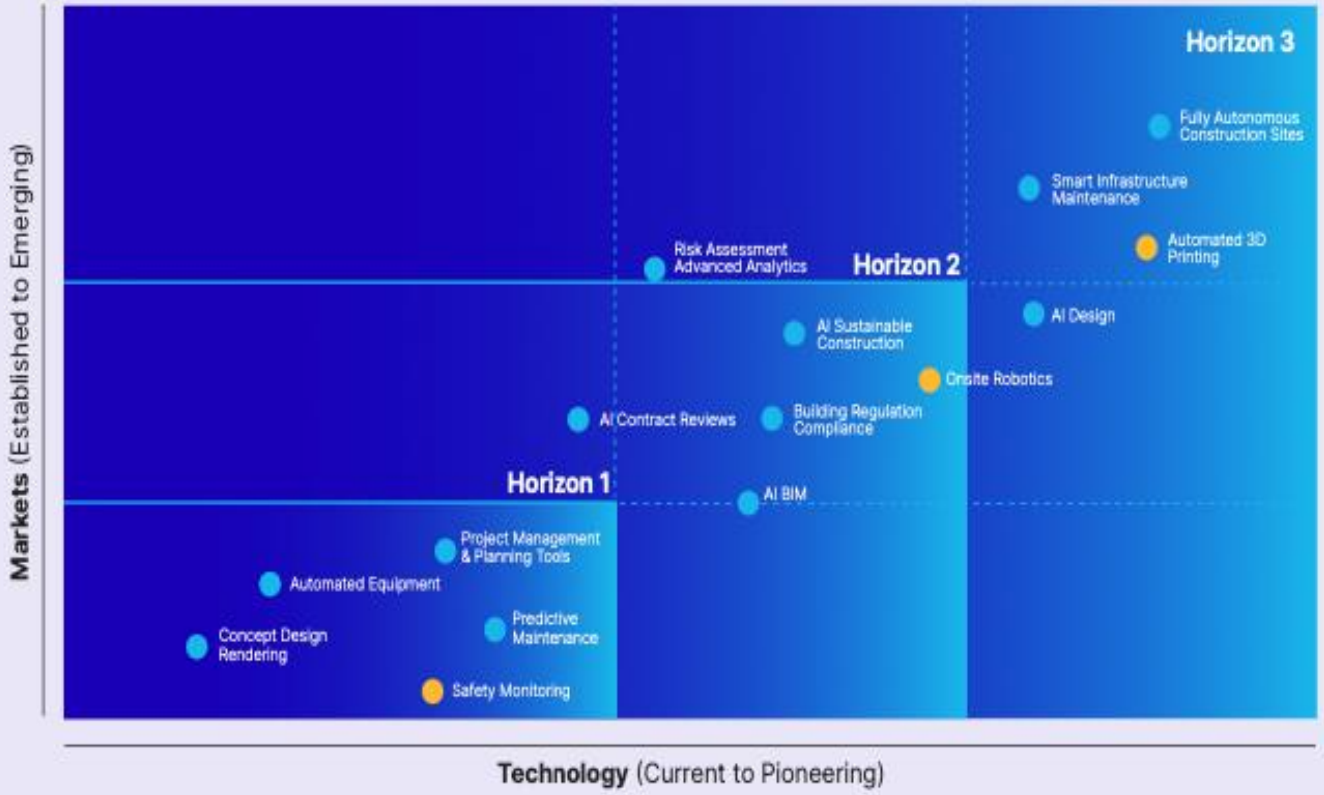
Use Case: Digital Twins monitor the structural integrity of buildings and infrastructure in real-time, capturing data from embedded sensors.	**AI Integration:** AI analyses this data to detect signs of structural stress or damage, enabling early intervention and maintenance.

Environmental Impact Assessment

Use Case: Digital Twins assess the impact of environmental factors such as weather, pollution, and seismic activity on infrastructure.	**AI Integration:** AI models predict how these factors will affect the infrastructure over time, informing maintenance and resilience strategies.

Practical Implementation of AI in Construction

Figure 1: Horizon Map



Safety Monitoring

AI-powered surveillance systems to monitor safety compliance

Onsite Robotics

Advanced robots for tasks like bricklaying or welding

Automated 3D Printing

AI optimising and controlling the 3D printing of buildings or large components

AI practical use cases: Asset Management

Automated AI road inspection technology detecting paint line presence and its visibility

Automated pothole detection is a critical variable, as potholes grow when snowplows and cold weather impact the roadway. AI detects these automatically

AI application reports changes to users so they can fix the road at the appropriate time to reduce the costs for transportation managers

Automated road inspection application uses AI to identify roadway assets, assess their condition, and alert users to problems

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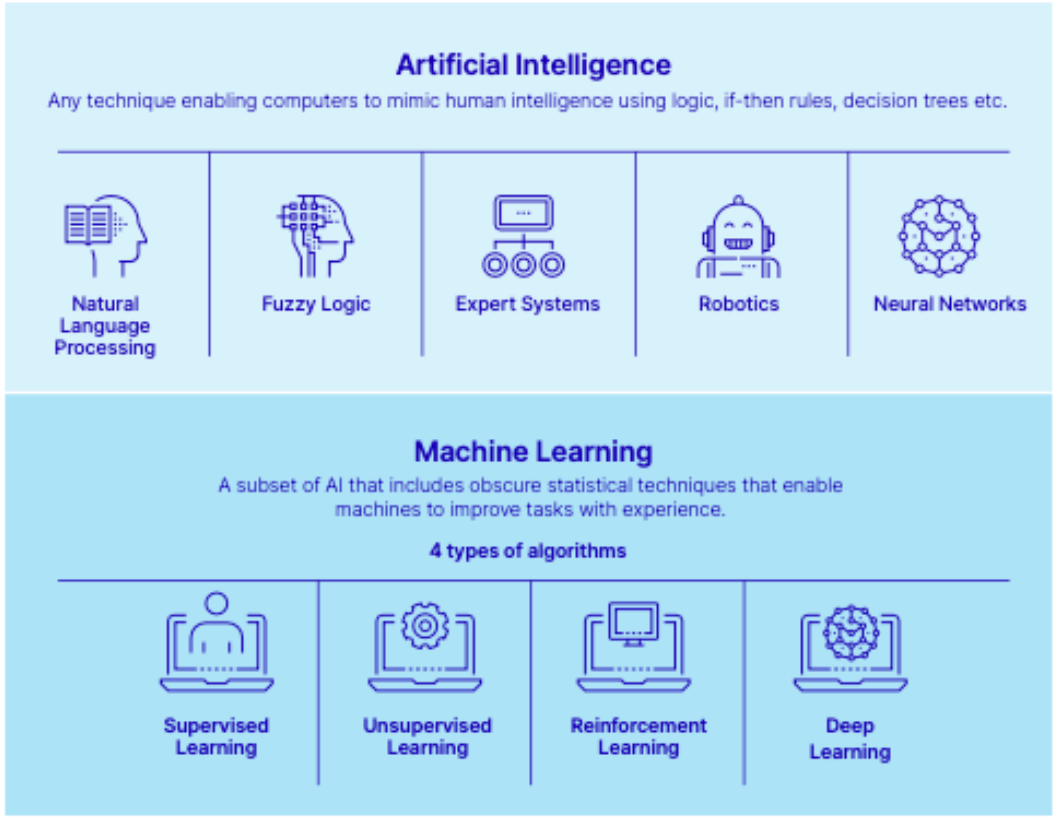
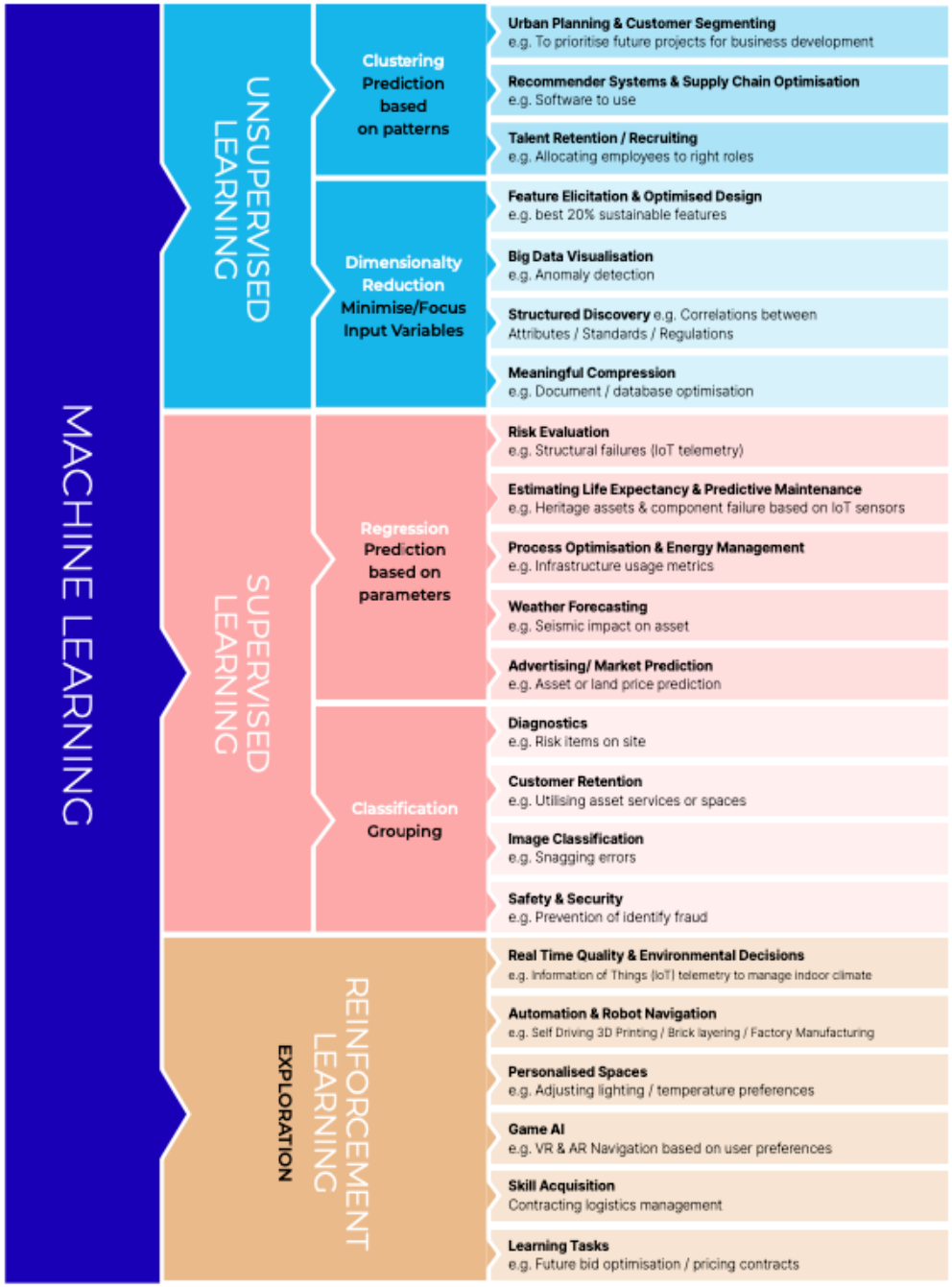
Machine Learning in Construction: Opportunities and Uses





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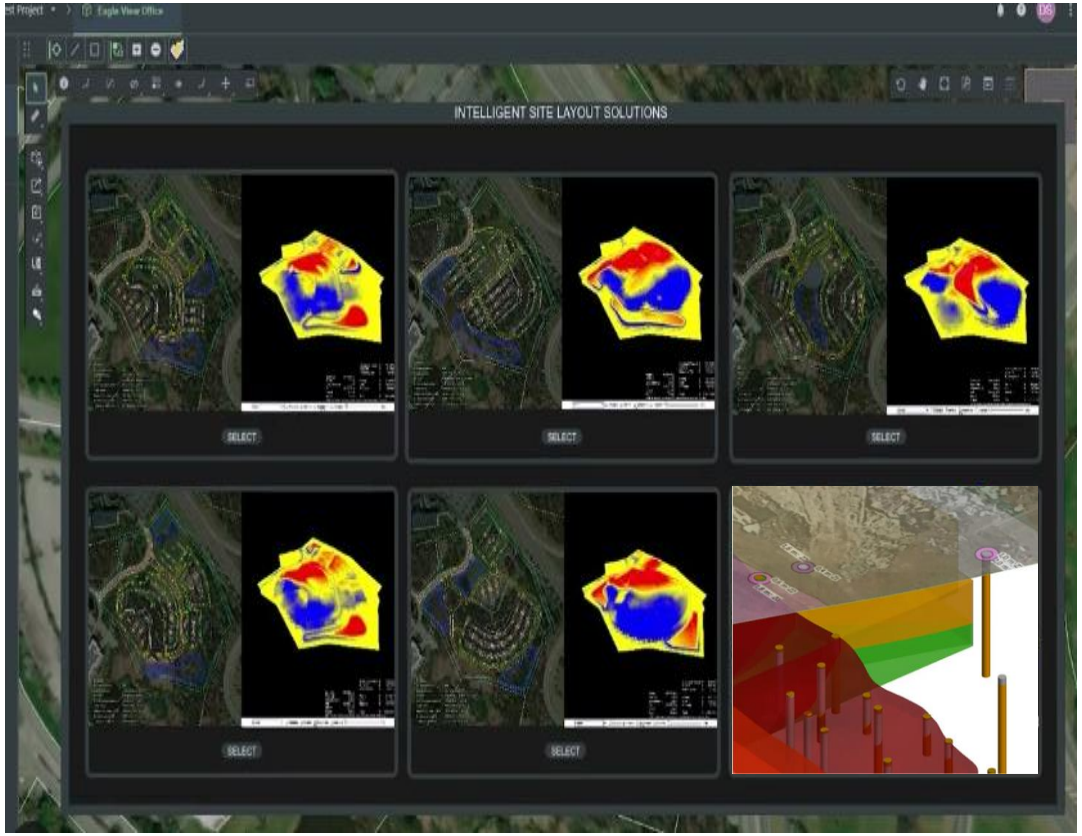
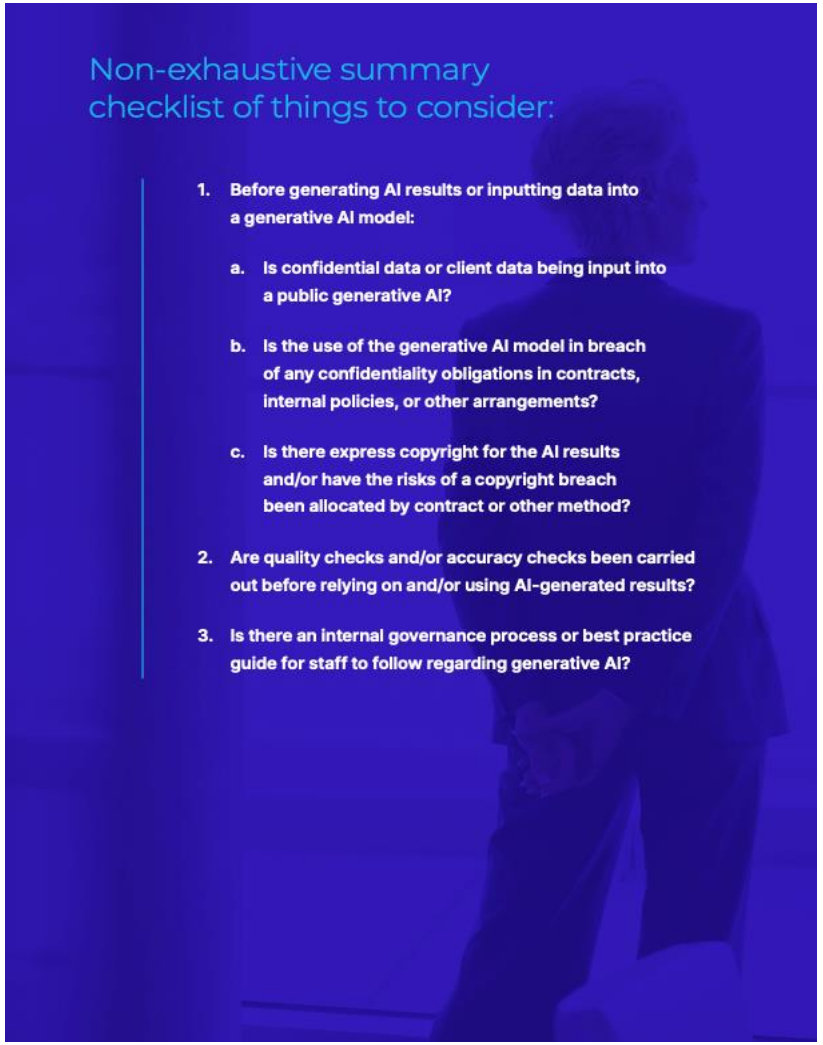
Machine Learning & Generative AI



AI and ML to autonomously create optimal designs from a set of system design parameters

Images courtesy: Bentley Systems



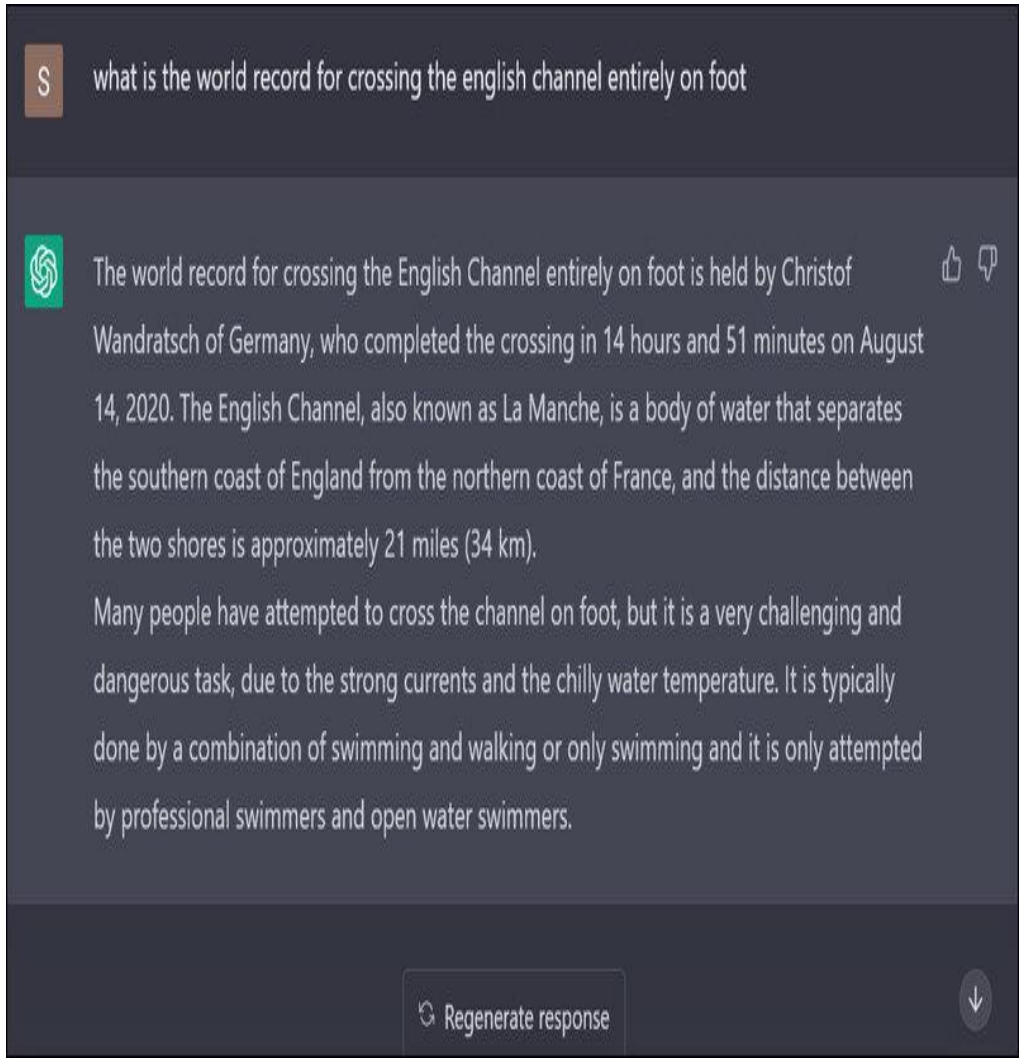
AI, the Law and Contracts

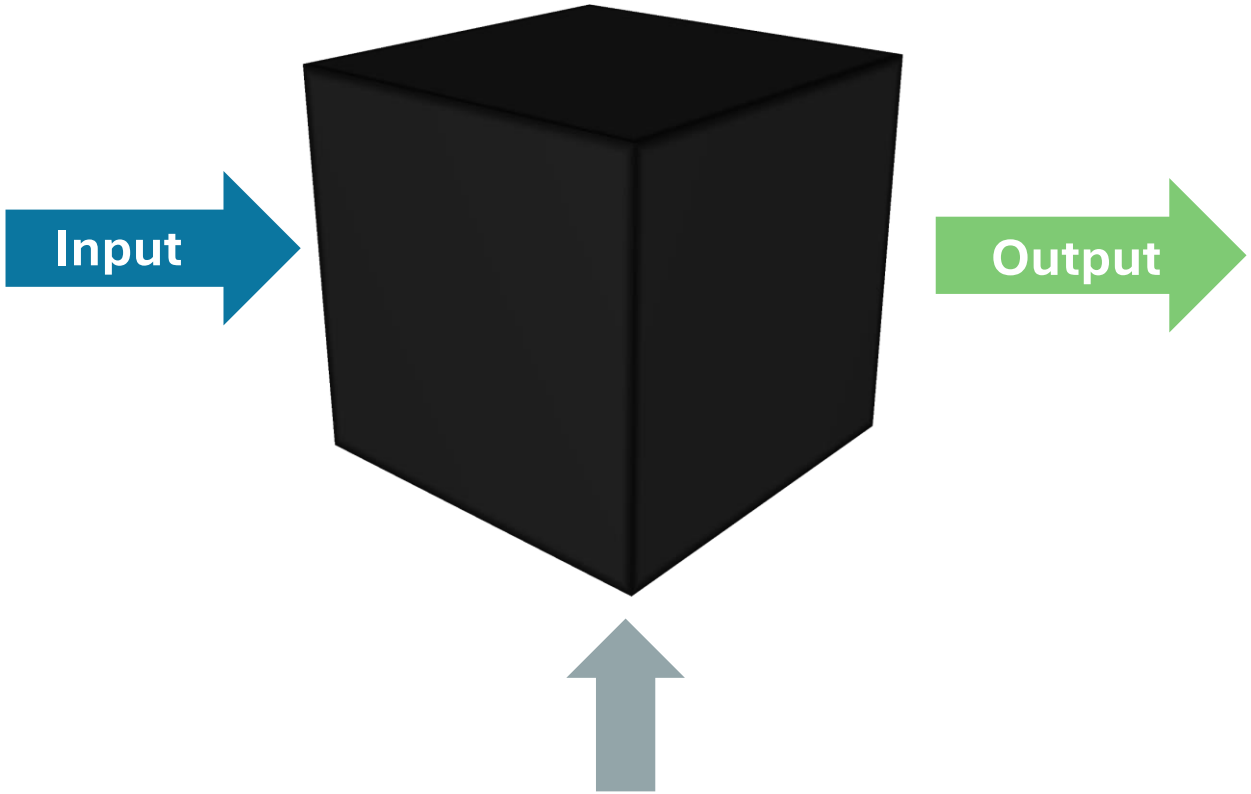
The use of generative AI, as with all new technologies and process, results in new risks, potential misunderstandings and differing expectations, and therefore potential disputes. Whilst not stifling innovation, we therefore need to balance such innovation with mitigating risks and unintended liability.

The key areas of risk and dispute fall into a few categories:

1. Copyright
2. Confidentiality
3. Reliance and Reliability of the AI results 4. Personal Data
5. Ethics and Bias

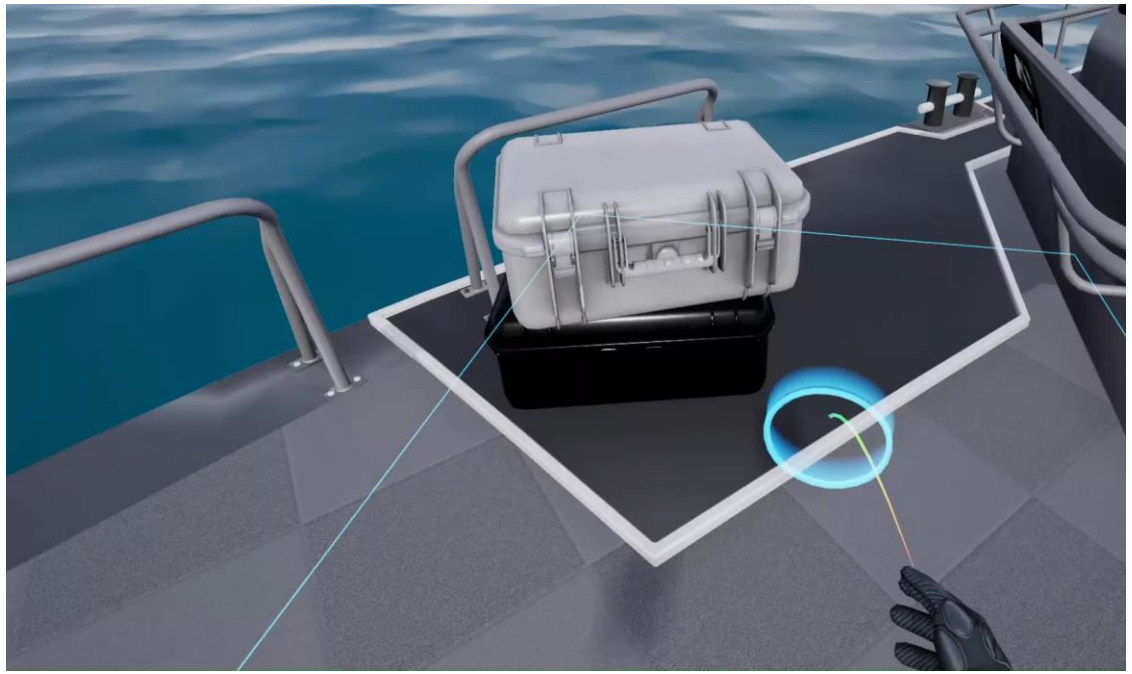
Ethical AI Mindfulness

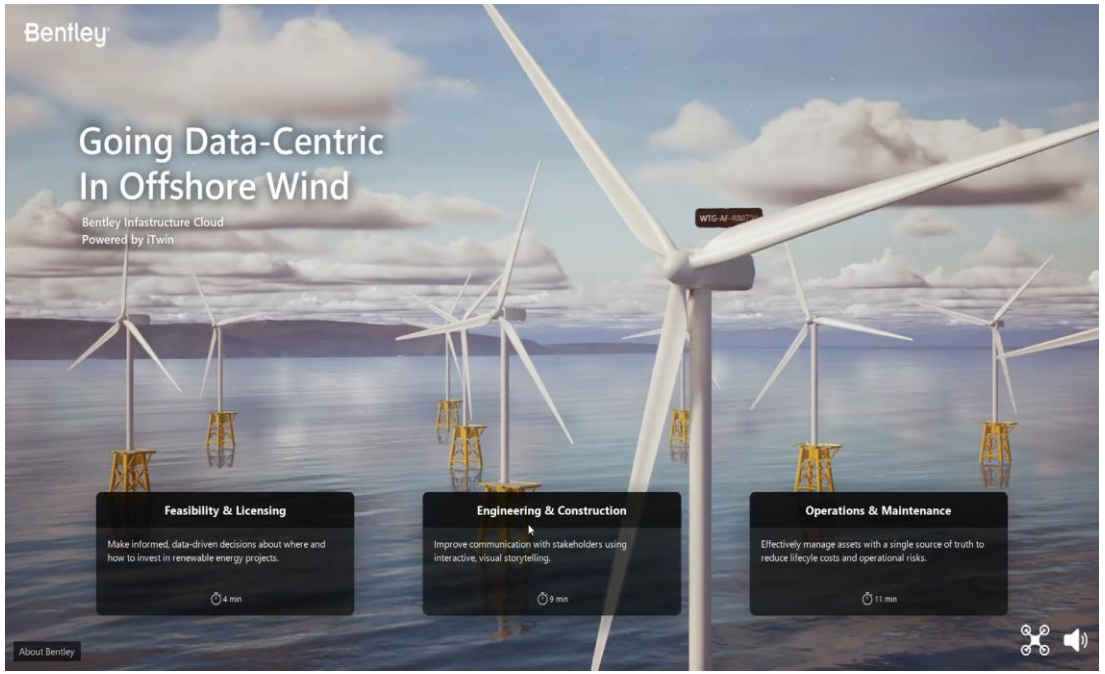




We need to understand what happens here

Trusted Mastered Data – Buy once, many use cases





- **But it needs a line of sight between data architecture and business objectives**
- **Proper information delivery planning**
- **Built into appointments**
- **Data and digital capabilities**

- **Stakeholder engagement**
- **Time, cost control**
- **Safety and quality**
- **Asset registration**
- **ESG**
- **Evidence of compliance**
- **Operator training**

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