Building better infrastructure with digital twins

Paul King, Bentley Systems

Bentley® Advancing Infrastructure

Project Controls EXPO Melbourne, Australia

Bentley Systems | Global Top 100 software company

Innovative software and services for the enterprises and professionals who **design, build, operate and maintain** the world's infrastructure – sustaining the global economy and environment for **improved quality of life**

The largest software company focused solely on **infrastructure**

>$1bn annual revenue

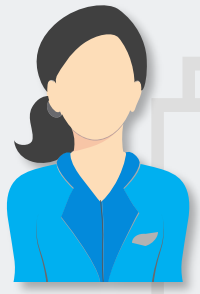
>$1bn R&D investment over the past 5 years

35% of global project spend is burned up in disputes

Annual *CRUX Insight Report*, 2022

Industry | Construction is challenging

Internal challenges



Data transparency

Talent management

Reinventing the wheel

Not adapting to new technology

Problems utilising resources

External challenges

Fragmented value chains

Extensive subcontracting

Broad project portfolios

Competitive pressure

Coping with complexity

Industry | Construction is challenging - and affected by COVID

F*%#c$!!

Data transparency

Talent management

Reinventing the wheel

~~Not~~ adapting to new technology

Problems utilising resources

S*!#c$k!

Fragmented value chains

Extensive subcontracting

Broad project portfolios

Competitive pressure

Coping with complexity

 |

Industry | What our customers are telling us

Workers **waste two days** project data and resolving

One-quarter of project da

One-third of poor decisio ta

FMI

Resource Availability

Data

Industry | The opportunity to do things better '*than average*'

20% Longer than scheduled

&

80% Budget overspend

Source: McKinsey & Company, for the average large project

People collaborating	Companies	Countries	Documents	Actions
1,140	182	6	2,280,397	6,406,736

 |

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Industry | The opportunity to do things better '*than average*'

How do we need to change?

- Reshape regulation
- Change the contractual framework
- Improve procurement and supply-chain management

- **Rethink design and engineering processes**
- **Improve on-site execution**
- **Infuse digital technology and advanced automation**
- **Reskill the workforce**

McKinsey & Company

Industry | The opportunity to do things better '*than average*'

This would be really interesting sh*t if I wasn't in the middle of it

Barack Obama, during 2008 financial crisis

 |

Industry | Construction of [<*railways*>] is complicated

Asset Information Management

Capital Project CDE & Collaboration

Reality Modelling

Visualisation & Animation

Overhead Line

Corridor Mapping & Analysis

Geospatial Information

Bridge Design and Analysis

Drainage Design and Analysis

Rail Network Design

Rail Predictive Maintenance

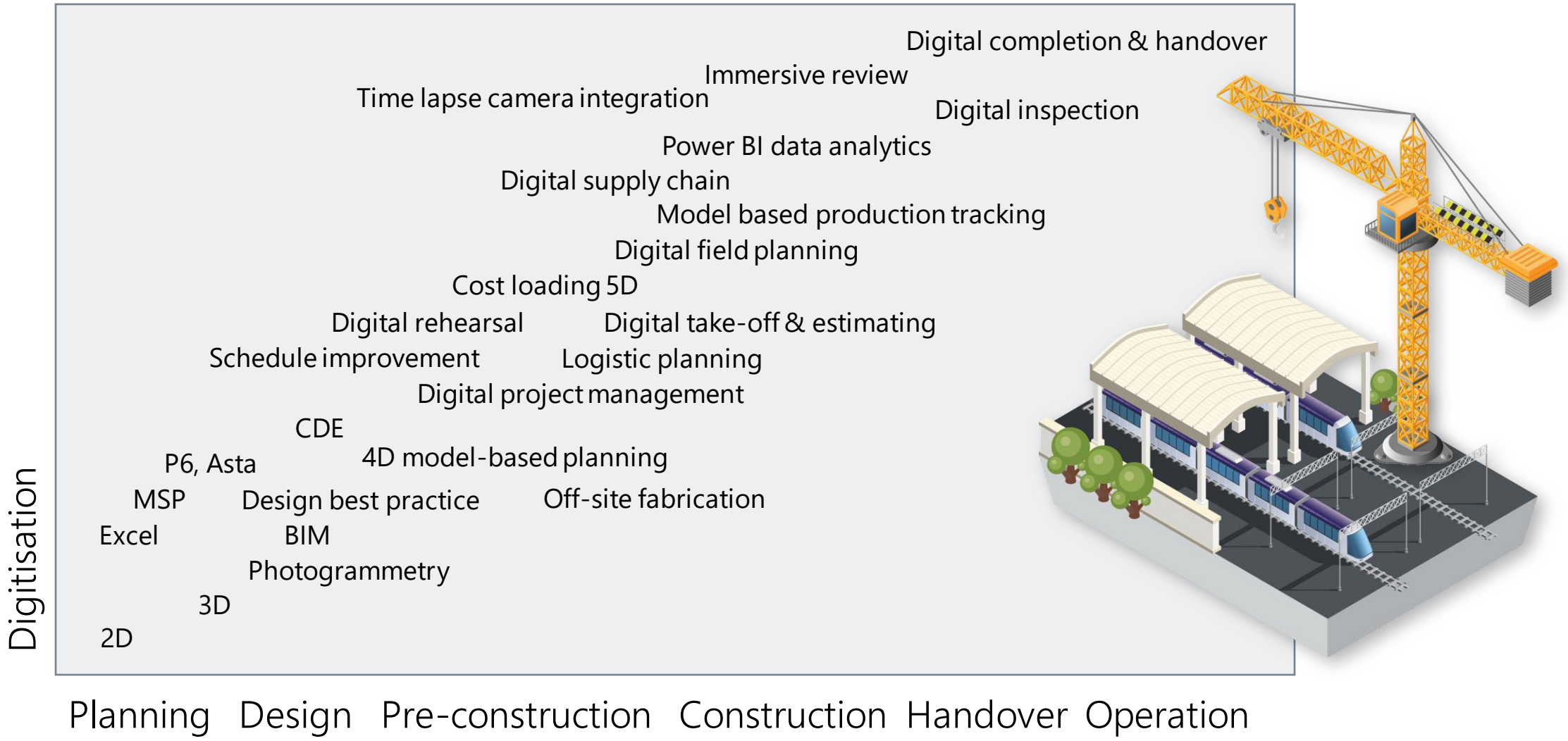
Station/Platform Design & Analysis

Bridge Inspection

Tunnel Design and Analysis

Road Design & Analysis

Going digital | Technology to support change



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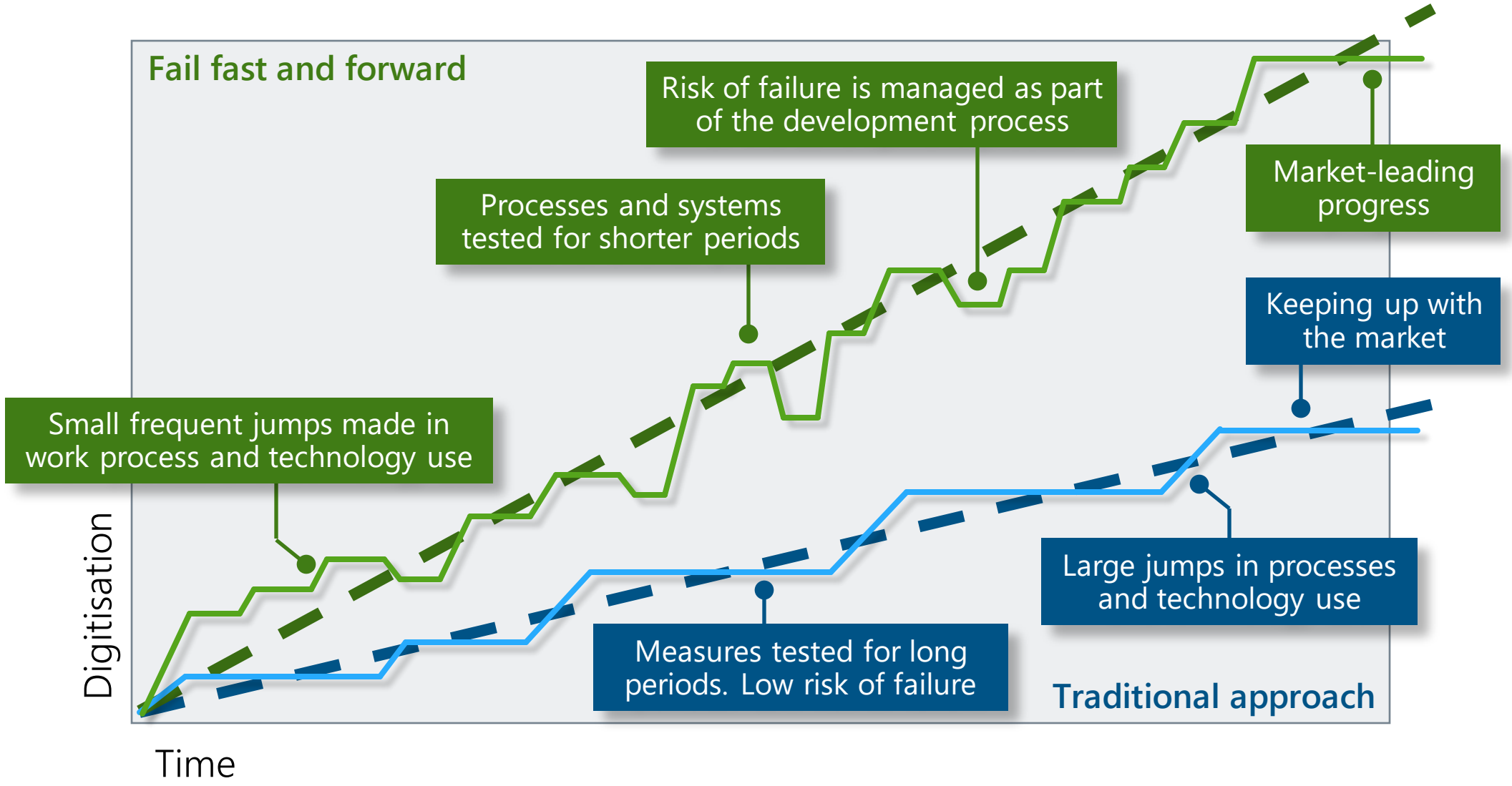
Going digital | Technology is changing your competitors



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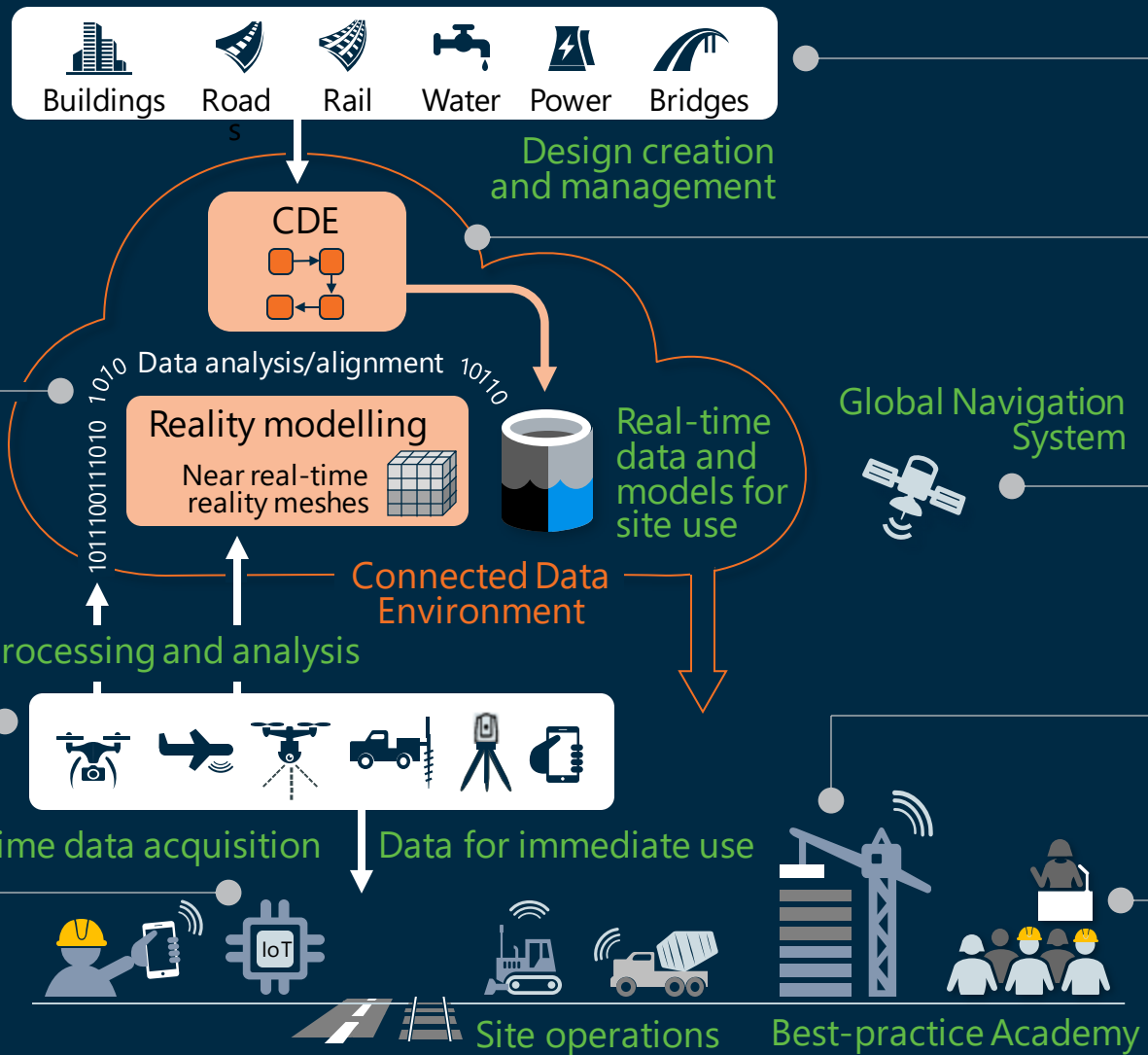
Going digital | Technology is changing your competitors

Many projects create and share 3D models and 2D drawings, without using ISO 19650

Gathering and using high-quality data improves cost control, decision-making, risk management, site safety, and helps to spot trends

Survey data from drones and scanners enhance the quality of can update 3D/4D models, track progress and manage site logistics

Sensors track and analyse real-time data from equipment, crews and materials, for multiple uses



Good design is the foundation of a digital twin

Connected data environments exploit large-scale data use, enabling better collaboration

Positioning systems and photogrammetry produce high-fidelity models quickly

Autonomous machines raise utilisation rates, lower costs and improve safety

Transferable learning legacies, performance benchmarking, and R&D

Next generation BIM | Digital collaboration | Near-perfect data capture | Internet of Things | Autonomous navigation

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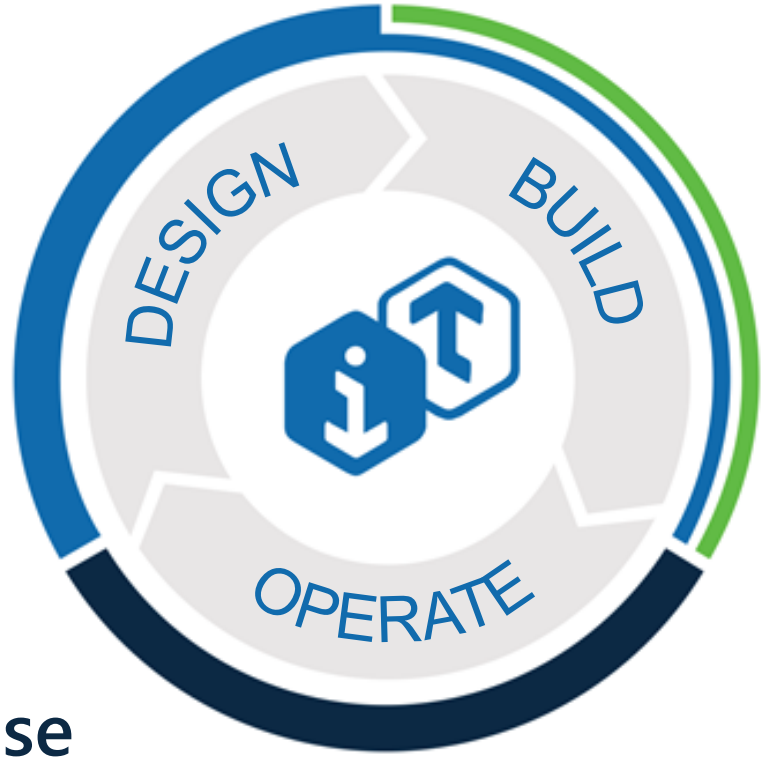
Going digital | Bentley Infrastructure Cloud

SYNCHRO

ProjectWise

Leverage digital design delivery, portfolio intelligence, data governance, and enhanced work-in-progress capabilities



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Manage construction projects with virtual model-based workflows between the office and field, and always know the performance and financial health of projects

AssetWise

Transform data into real-time insights with advanced analytics capabilities to improve operational performance

 |

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Going digital | Bentley growth and innovation in construction

SYNCHRO

SYNCHRO

2008 — Advanced work packaging & modelling: ConstructSim

2015 — Program construction management: eadoc

2016 — Progressive assurance: ComplyServe

2017 — Procurement: ProcureWare

2018 — 4D scheduling & simulation: SYNCHRO SOFTWARE

- New construction team and strategy launched
- iTwins open-source iModel.js APIs launched
- Digital Construction Works (DCW) established with TopCon

2019 — Enterprise CDE: bc business collaborator

2020 — Field notes: NOTEVAULT

- **Jan 2020 SYNCHRO Construction Launched as a complete construction platform**
- $100M iTwins Venture Fund launched

2021 — Field performance management: E7

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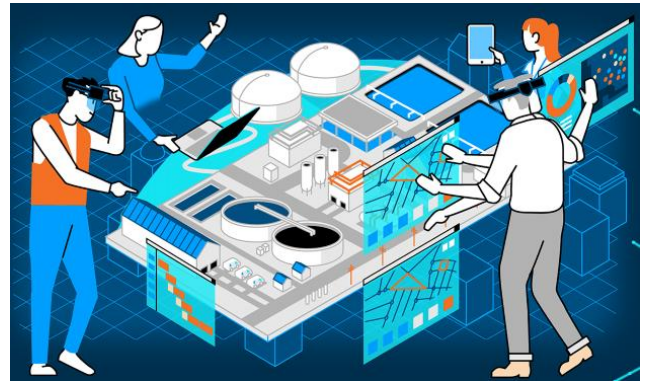
SYNCHRO

Designed to help construction firms to
win better projects, deliver them efficiently, and improve their profitability

Integrated digital construction environment

In the field, in the cloud, in context



The construction digital twin

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It’s easier to get into a hole than out of it

Ancient proverb

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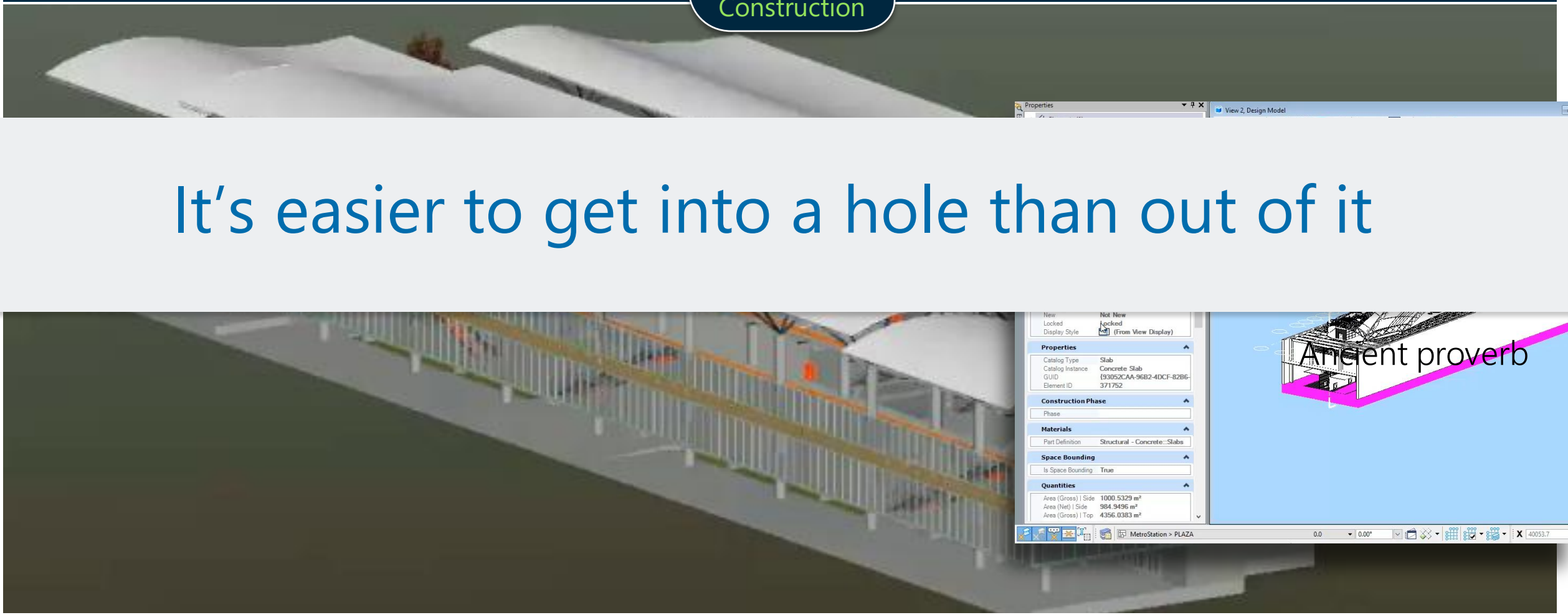
Best-Practice Project Delivery

Construction

Construction Digital Twins



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Connected Data Environment

Digital Components

Digital Workflows

Digital Context

iTwin Services

Project Digital Twin

 |

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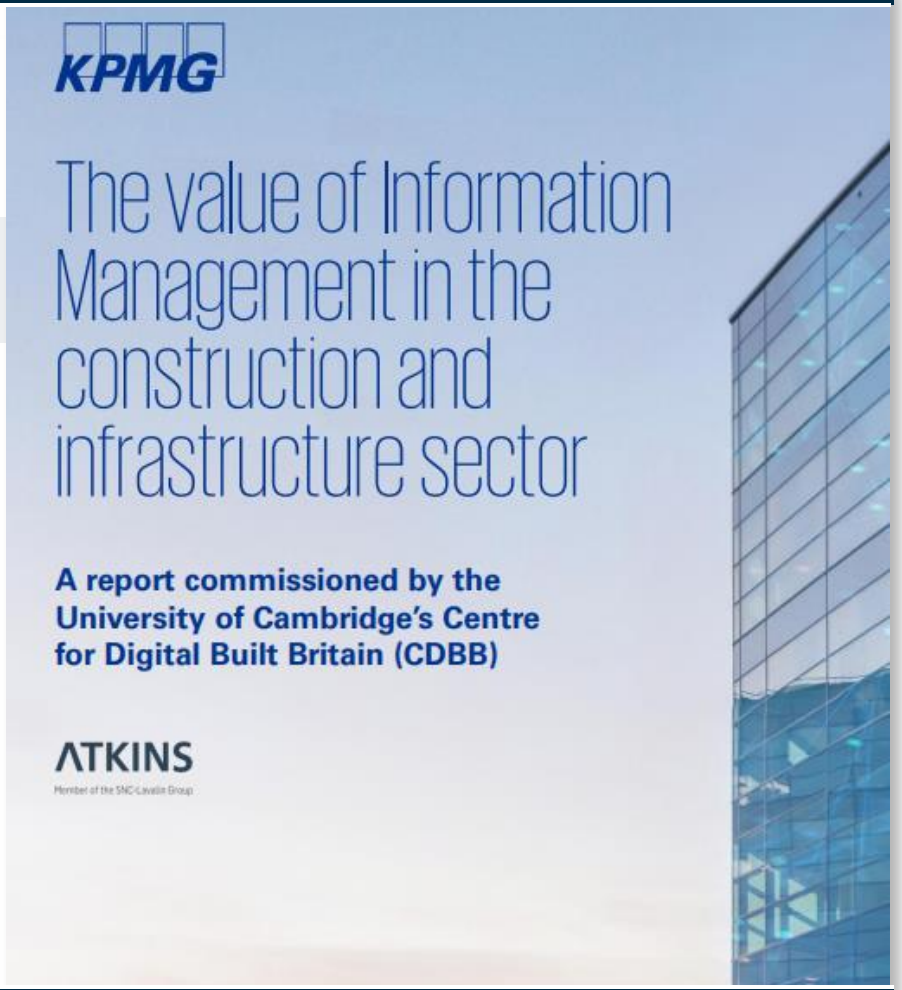
For every $1 invested

Up to $6.00 return in labour productivity

+

Up to $7.40 savings in delivery time, labour time, and materials



Connected Data Environment | Digital Components | Digital Workflows | Digital Context | iTwin Services | Project Digital Twin

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Our **CDE** reduces the **OTFU**

Australian tier 1 contractor, 2019

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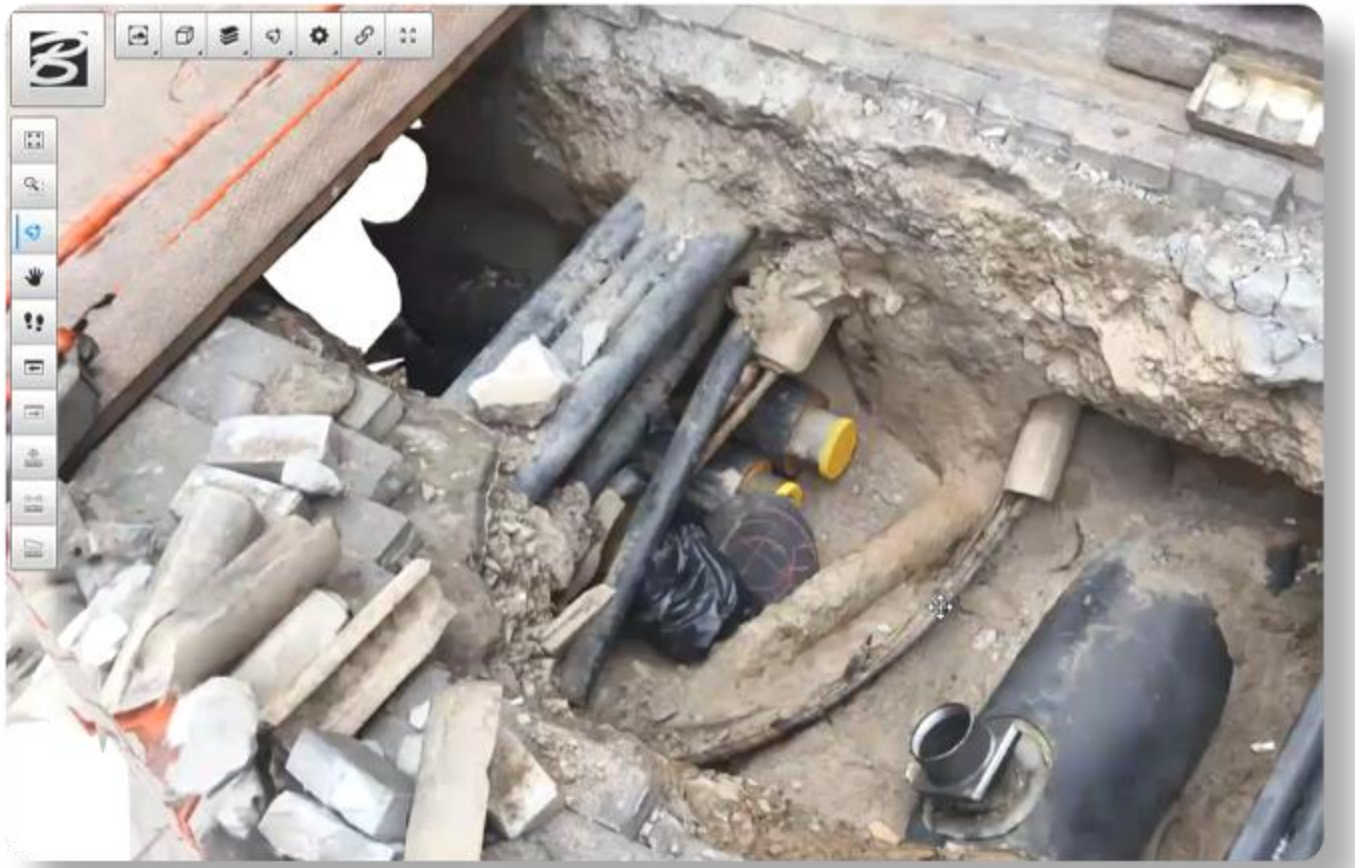

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But my data comes from incompatible formats, different data sources, and different vendors

Alignment Accountability Accessibility

Source: everyone, on every project, everywhere

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iTwins - infrastructure digital twins

Documents, data, models, photos, IoT feeds, and other data sources

iModels

Specialised container for infrastructure information

- Digital components assembled from many sources
- Backbone for iTwins

iModelHub

Control centre for iModels

- Coordinates concurrent access to iModels
- Maintains managed sequences of changes across users

iModel.js

Open-source libraries and model viewer

- API libraries for digital twin access, visualisation, and synchronisation
- Cloud architecture

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Courtesy of EarthCam

iModel.js

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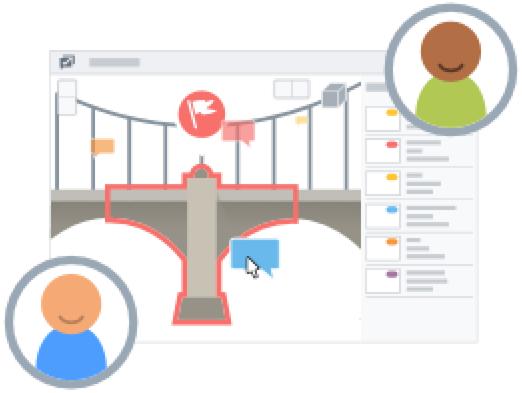
iTwins - infrastructure digital twins

Access and integrate data from both Bentley and third-party repositories



Manage digital components

Organize, stream, and visualise reality data

Exchange content and collaborate

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Bentley design applications

- AutoPLANT Modeler
- MicroStation CONNECT Edition
- MicroStation V8*i*
- OpenBuildings Designer
- OpenPlant Modeler
- OpenPlant PID
- Open Bridge
- OpenRail Designer
- OpenRoads Designer
- OpenSite Designer

Third-party design applications

- 3D Studio (.3ds)
- AutoCAD
- AVEVA Diagrams
- AVEVA E3D
- AVEVA PDMS
- AVEVA PID
- Rhino (.3dm)
- Intergraph Smart 3D
- Intergraph Smart P&ID
- Revit
- Civil 3D
- SketchUp

Interchange formats

- ACIS (.sat)
- CGM
- DXF
- FBX
- i-model
- IFC
- IGES (.igs)
- JT
- Land XML
- OBJ
- MIF/MID
- Parasolid
- Shape files (SHP)
- STEP (.stp)
- STL
- VUE

Connected Data Environment

Digital Components

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SYNCHRO Construction | iTwin enabled | Web | Mobile | Desktop | Cloud

SYNCHRO Field	SYNCHRO Control	SYNCHRO Perform	SYNCHRO Cost	SYNCHRO 4D
Mobile	Web	Web | Mobile	Web	Desktop | Web
Mobile field management	Project management & document controls	Project performance insights	Cost & procurement management	Planning & estimating
Tablet and phone workflows	Task- & model-based workflows	Optimised site operations	Project- & portfolio-level costs	Model-focused workflows

Connected Data Environment

Digital Components | Digital Workflows | Digital Context | iTwin Services | Project Digital Twin

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Digital representation

of a physical asset, process or system

Continuously synchronised

from multiple sources to represent real-time status, condition or position

Data driven workflows

to predict and optimize project outcomes and performance

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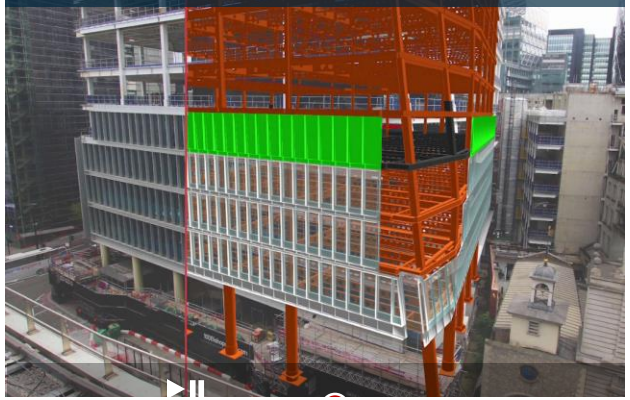
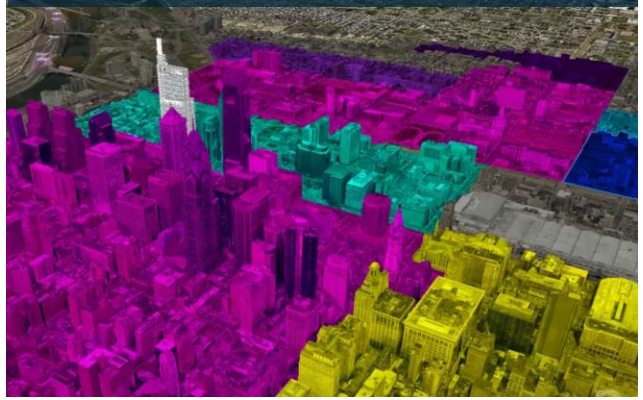
3D/4D execution

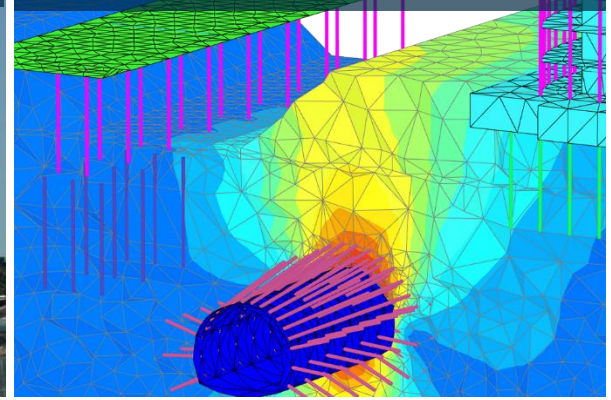


Reality modelling



Robotics

Geotechnics



Mixed & virtual reality

Sensors

Machine learning

Artificial intelligence

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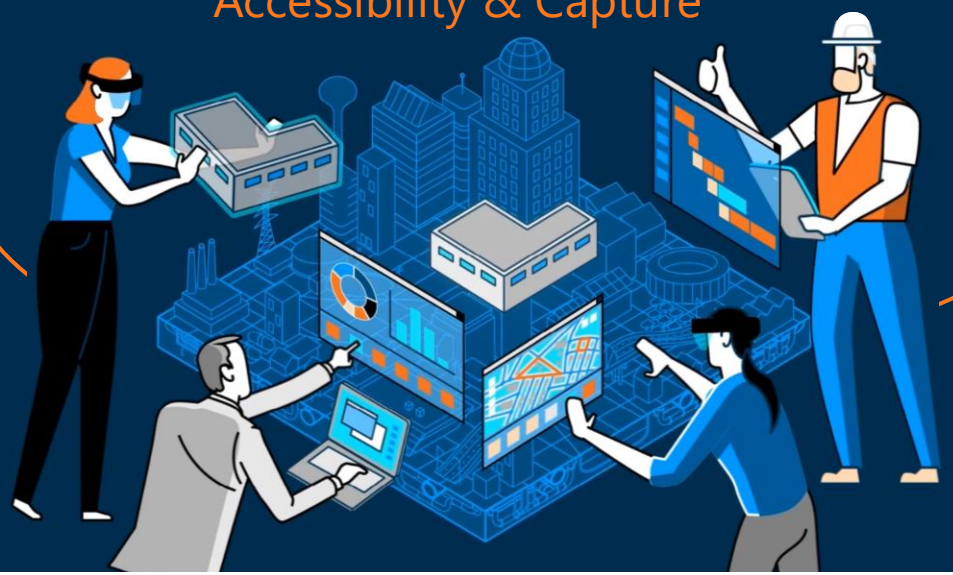
Design Data
Drawings, models, surveys, etc

Construction Data
WBS, costs, schedules, photos, etc

Field Feeds
IoT, reality data, forms information, etc

Data

Alignment & Coordination
Accountability & Change Management
Accessibility & Capture



4D Scheduling & Simulation

5D Estimation & Cost Management

Task & Document Management

Field Performance Management

Connected Data Environment

Digital Components

Digital Workflows

Digital Context

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Create

Step 2

Connect the model, aggregate & transform

- Design and reality models
- Construction components
- Construction data
  - WBS
  - 4D schedule
  - quantity take-off
  - costs, etc

Connect

Step 2

Construction live digital twin

- IoT sensors
- Construction survey
- Equipment telematics
- Mobile field data

Step 3

Model-based planning & operational efficiency

Consume

- Analytics & visibility
- Enhanced workflows
- AI and ML
- VR and AR

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Step 1

Construction model, aggregate & transform

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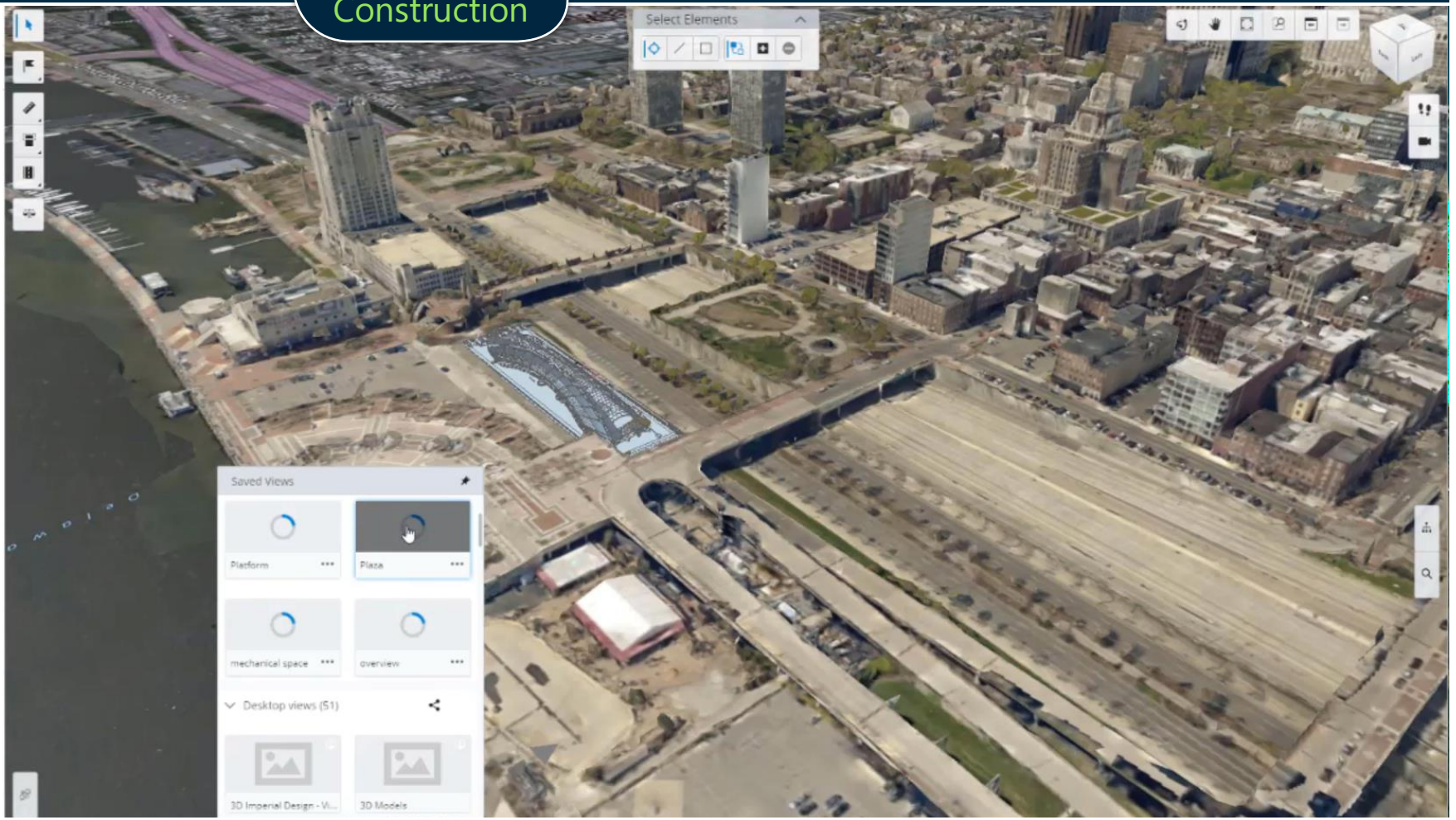
  - costs, etc



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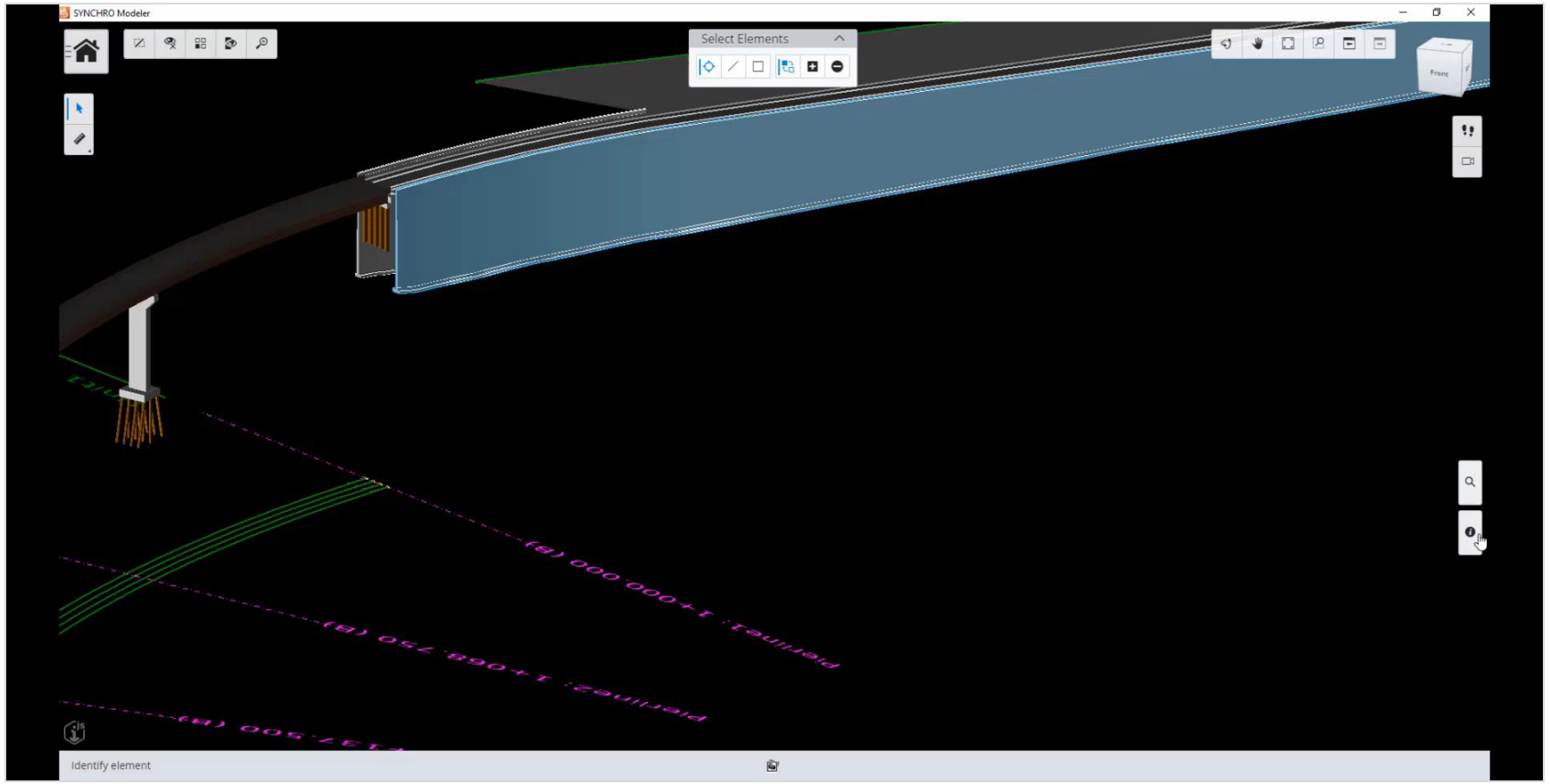

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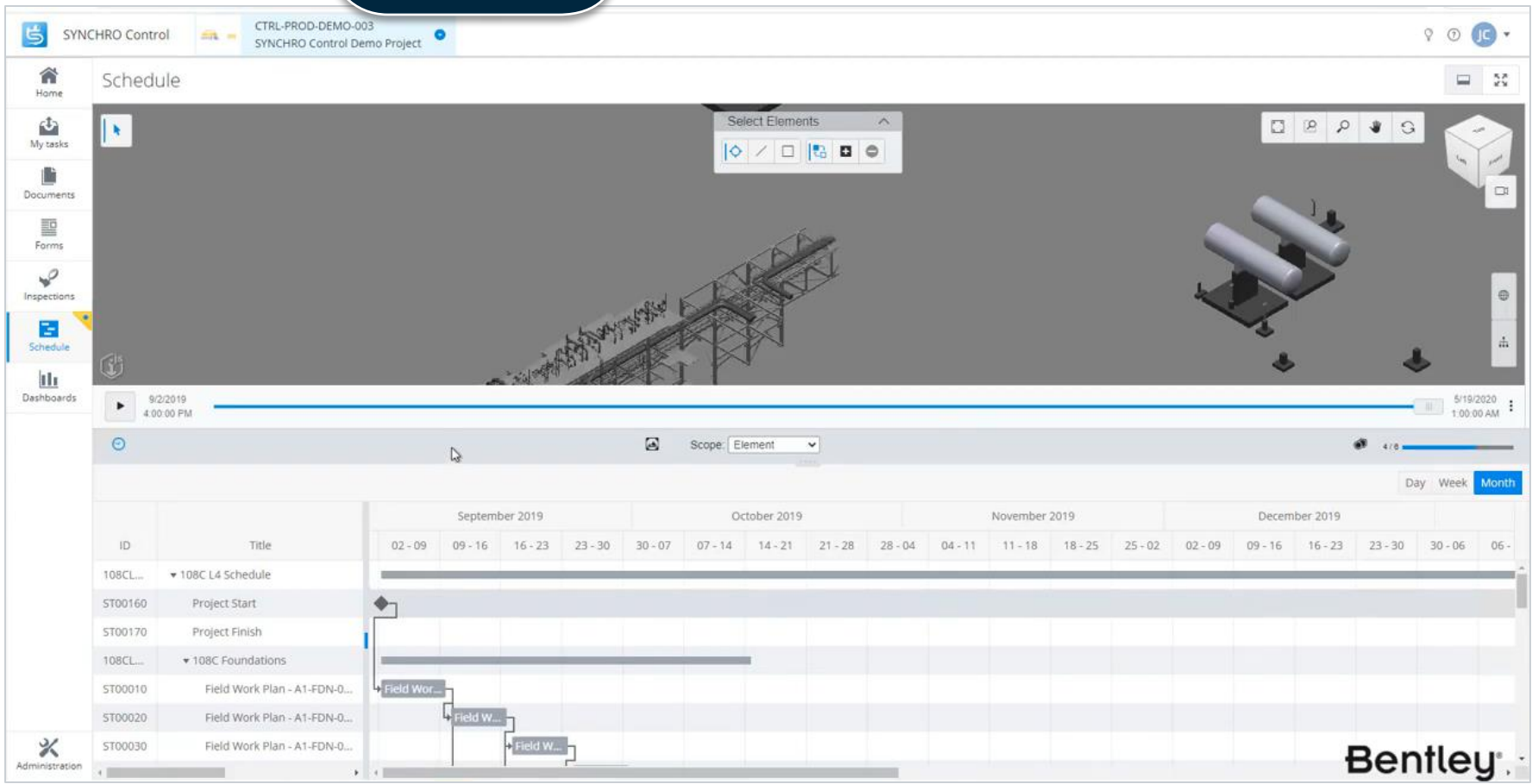

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Step 2

Connect the live digital twin

- IoT sensors
- Continuous survey
- Equipment telematics
- Mobile field data

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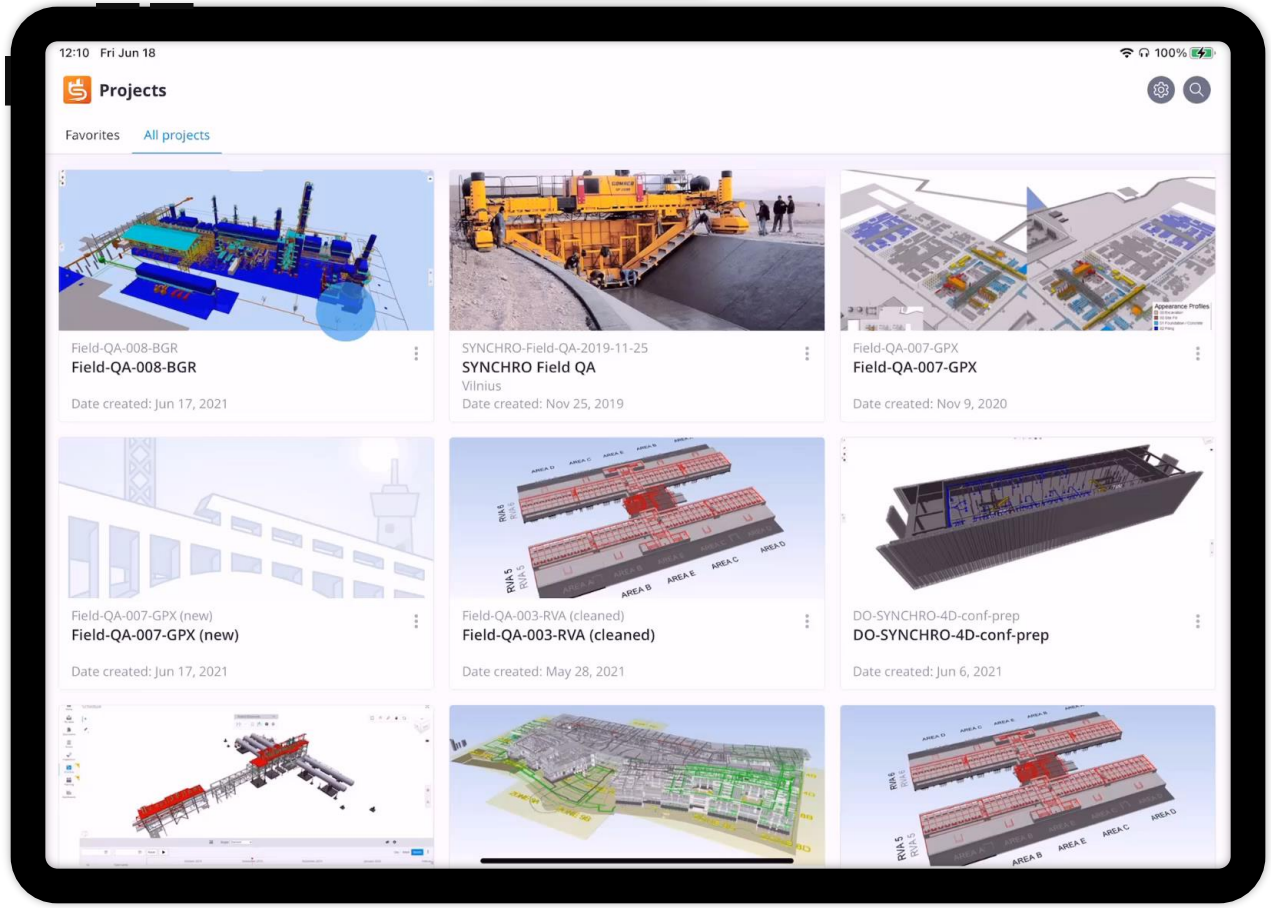

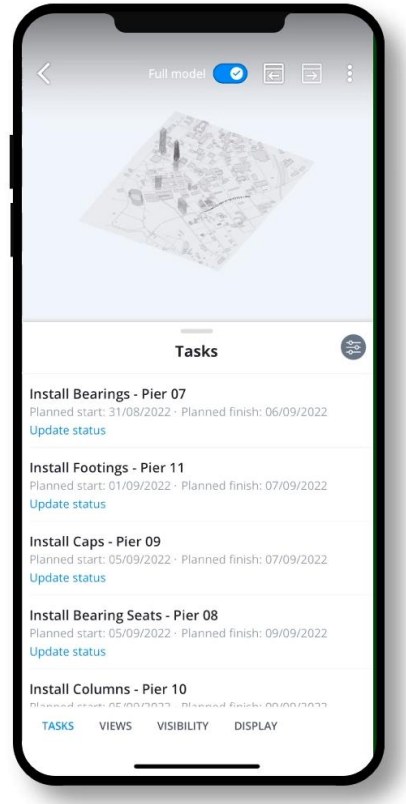

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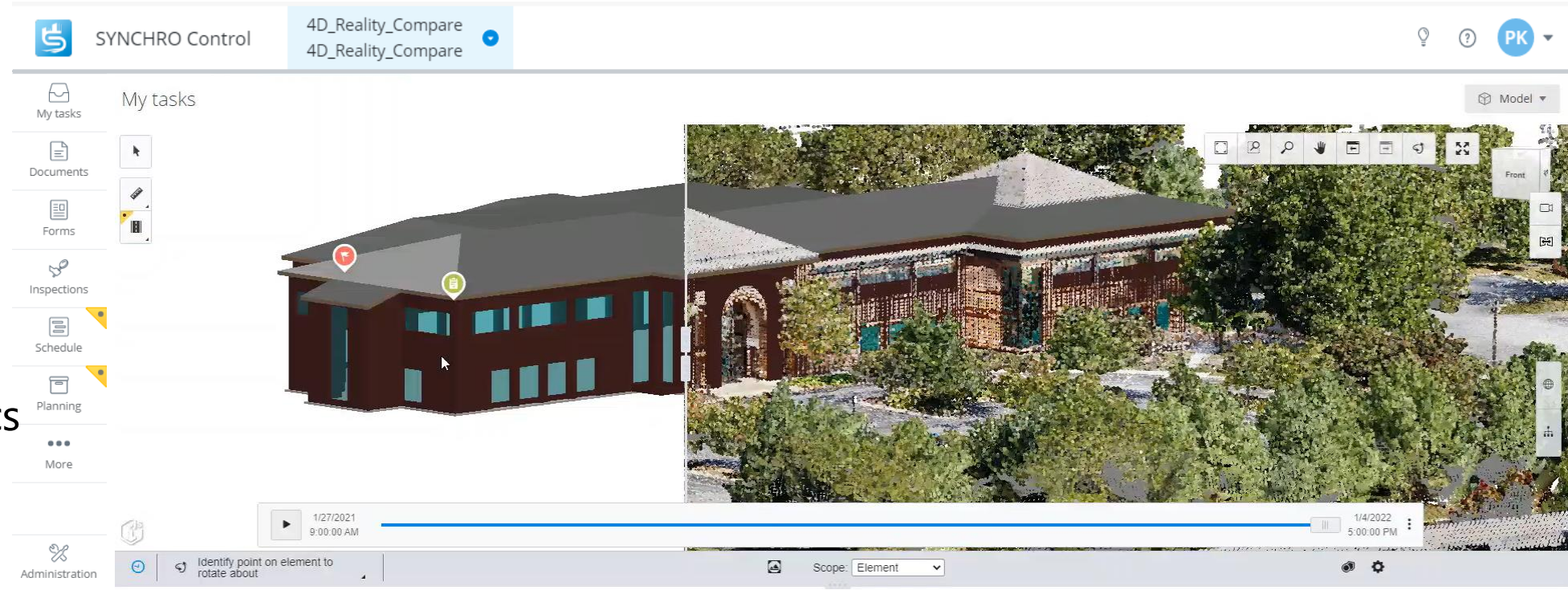

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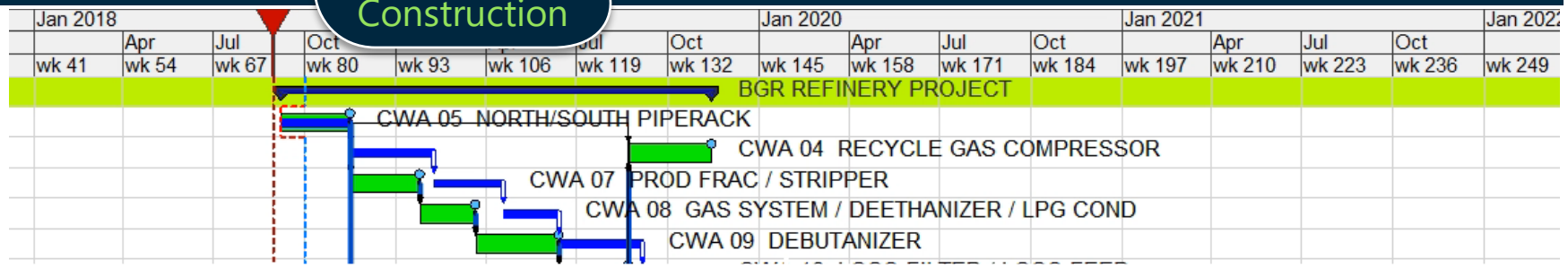
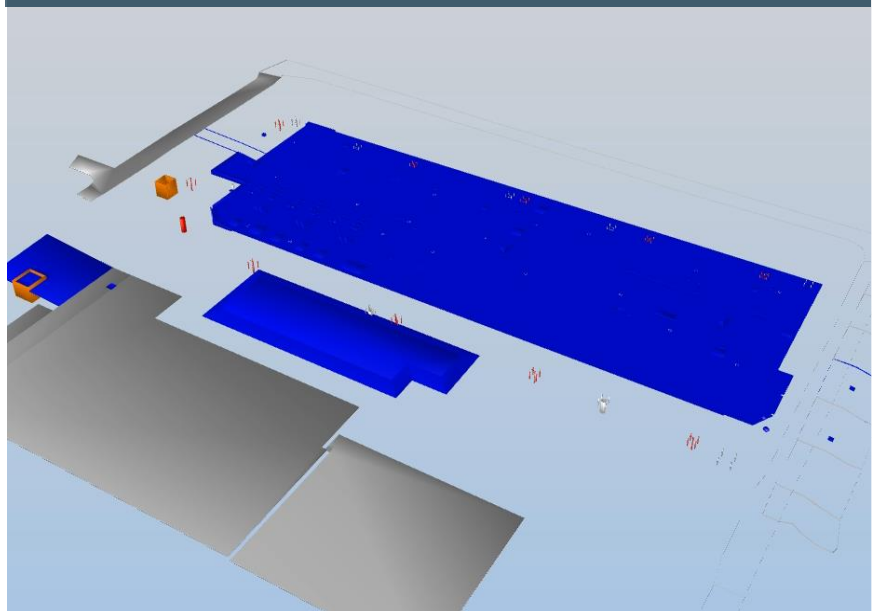
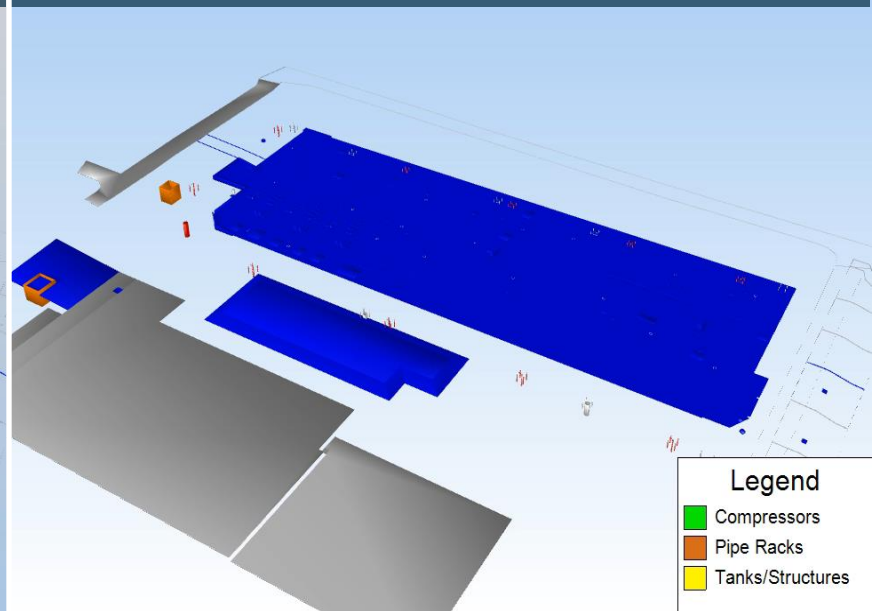


Baseline schedule



Alternative scenario for comparison



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Southern Program Alliance
Level Crossing Removal Project

The Year in INFRASTRUCTURE and GOING DIGITAL AWARDS

WINNER

67% cut in ...
and validating staging plans

8... requests

75% cut in the time to distribute information to construction personnel

LEVEL CROSSING REMOVAL PROJECT | SOUTHERN PROGRAM ALLIANCE

Connected Data Environment | Digital Components | Digital Workflows | Digital Context | iTwin Services | Project Digital Twin

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SYNCHRO digital twins provide . . .	**So that . . .**
- Real-time data visibility in context - A single source of truth	Everyone is on the same page at all times
- 4D planning and simulation - 5D cost estimation	Resources are optimised, risks are mitigated, and projects are on time
- Operational efficiencies - Businesses intelligence	Teams make better, faster decisions and work with more time

Connected Data Environment | Digital Components | Digital Workflows | Digital Context | iTwin Services | Project Digital Twin

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Conclusion | Going digital with the construction digital twin

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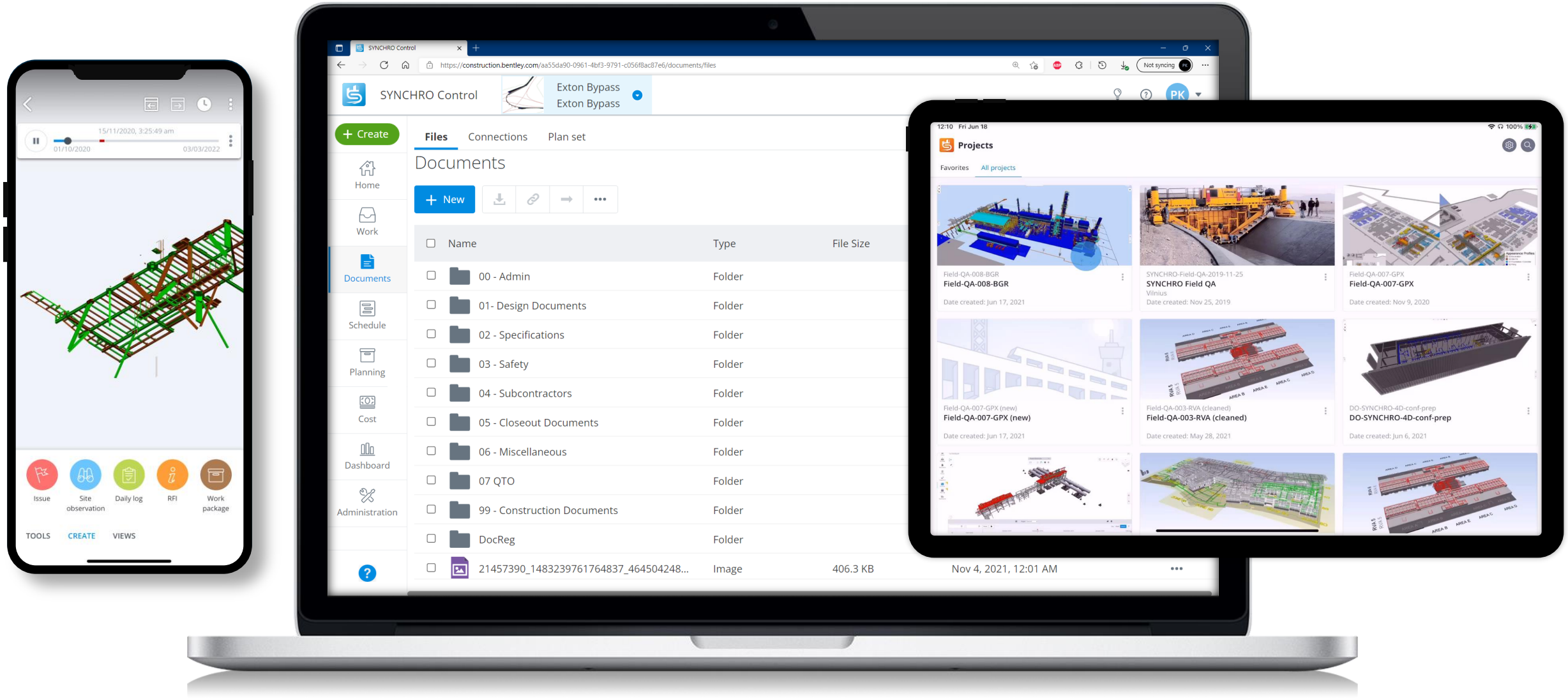

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