4D Digital Context For Digital Twins

A Bentley White Paper

Pascal Martinez

Business Development Director,
Digital Cities

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Advancing Infrastructure

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Introduction

A digital twin is a digital representation of a physical asset, process or system, as well as the engineering information that allows to understand and model its performance. It can be continuously updated from multiple sources, including sensors and continuous surveying, to represent its near real-time status, working condition or position. It enables users to visualize the asset, check status, perform analysis and generate insights in order to predict and optimize asset performance.

A key component of a digital twin is the digital context which includes reality meshes, point clouds, terrain models, imagery, and GIS sources. In their journey to creating and managing a digital twin of their assets, infrastructure owner-operators are dealing with a fast-growing quantity of reality data, captured at an increasingly higher precision, scale, and pace.

Discover how Bentley Systems help owner-operators and engineering companies to capture, manage, analyze, and share their digital context.

4D Digital Context for Digital Twins

What is 4D Digital Context?

Any digital twin must reflect the actual conditions of a physical asset at any time, in order to allow stakeholders to virtually, effectively and collaborately operate it, cutting costs on field operations and enhancing safety.

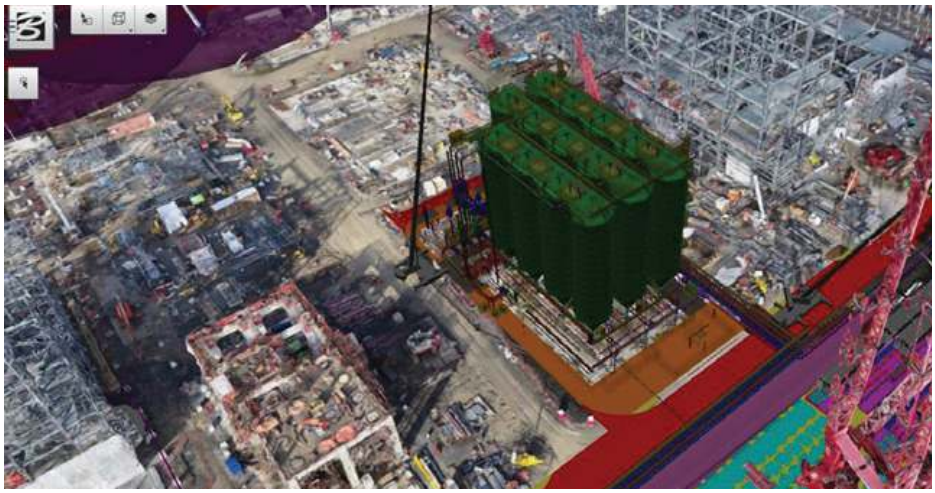
20%-30%

This is what companies implementing and operating a digital twin save on their development costs.

4D digital context is the aggregation of any 3D reality data captured on actual assets at different times, using a variety of techniques such as photogrammetry, laser scanning, trajectories, control points, 360 panoramas, and targets.

4D digital context reflects all geometrical, visual, and geospatial aspects of the actual asset at the time of capture, at any scale, and enables multiple new cost-saving workflows like online collaboration, remote inspection, virtual operations, in-context design, and mixed reality applications.

These highly-detailed reality models are used to provide precise real-world context for design, construction, and operations decisions for use throughout the lifecycle of an infrastructure asset.



Key Criteria for a Great 4D Digital Context

Precision and Trustworthiness

In order to reduce on-site visits, a digital twin must actually reflect relevant details of the asset. The precision and the exhaustivity of the modeling enable remote operations as well as decision-making processes. Digital context becomes a trustworthy information that stakeholders can use to collaborate upon, assess, annotate, and share. Such a level of confidence requires to control the entirety of the generation process, from the acquisition, by selecting the most appropriate capturing device and methodology, to the fusion of data and metadata into a single model.

Hybridity and Reality Data Convergence
In order to properly render all needed details and support multiple workflows, 4D digital context depends on various capturing techniques and reality data fusion. The combination of photos, providing a high resolution of information on the geometry and condition of an asset, point clouds, acquired at a high precision and density, and metadata like control points and trajectory, improves the quality of the reality models.

Time is of the Essence
Capturing reality content provides a 3D picture of the actual conditions at any given time enabling measurement and visual understanding, but the value of any data resides in its trustworthiness. 3D reality models regularly capture the latest conditions to truly enable remote and virtual operations, saving time and improving safety.

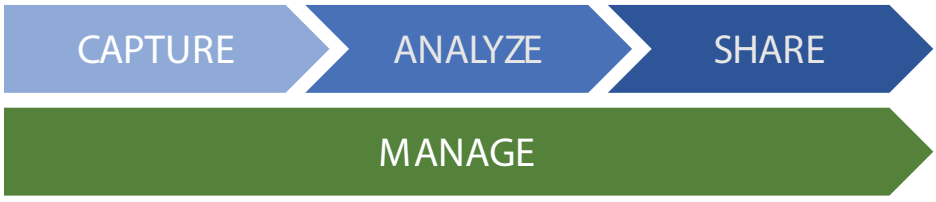
Moreover, archiving 3D reality models captured at various times during the construction or operation of an asset helps to better analyze and resolve issues, and improves collaboration across the entire lifespan of an asset.

This is where we introduce 4D. Particularly sensitive to the time dimension, construction companies are now implementing 4D planning and want to monitor their progress through the recurring, frequent capture of existing conditions on the construction site.

Asset management professionals also want to virtually inspect their asset at specific times to track changes and better plan maintenance operations.

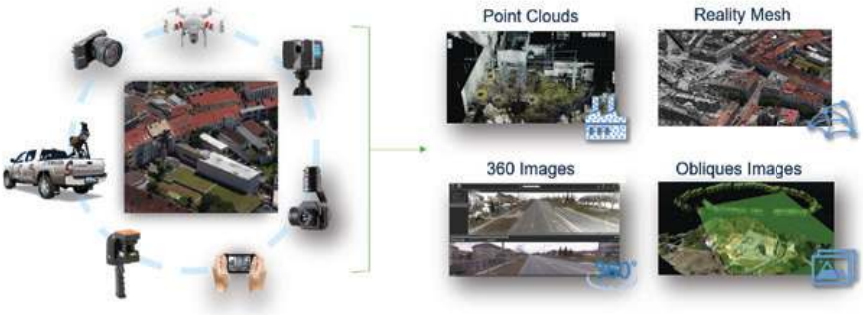
4D digital context also provides information on the condition of an asset at different times, providing valuable insights on its evolution. The time-stamped instances of the 3D model can be used for archiving, to resolve issues, for asset performance management, or for changes and progress monitoring on a construction site.

From Creation to Management
The creation of a 4D digital context model starts with the initial acquisition of reality data on an asset at the proper resolution and scale. Its continuous update and management along the lifespan of the asset requires multiple tools.



Capturing the context
Bentley reality modeling solutions, whether on premise or in the cloud, can convert drone and/or ground imagery, as well as any point clouds, into a broad range of reality content formats, from multiresolution meshes optimized for large scale models visualization and streaming to neutral geometrical exchange format to dense and massive point clouds.

Using photogrammetry and computer vision techniques, reality modeling solutions automatically detect the orientation and position of photos, georeference the model in thousands of possible spatial reference systems, and convert dense point clouds into highly streamable formats.



Managing Unlimited Volumes of Reality Data

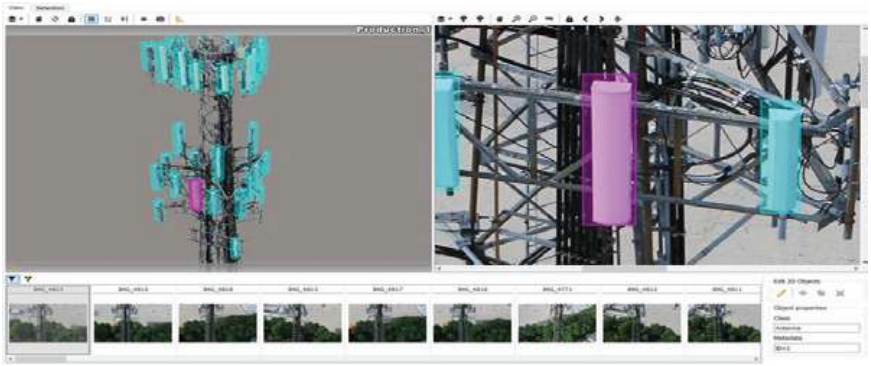
A digital twin must reflect all aspects of the actual asset. Therefore results are derived from the combination of multiple and recurring reality modeling operations. This implies storing, archiving, and managing a large quantity (terabytes or petabytes) of reality data, and providing an easy and constant access to stakeholders at any step of the asset's lifecycle.

Since a 4D digital context often results from the fusion of multiple reality data with various formats and acquired at different times, it is critical to rely on a management solution that is versatile enough and will scale with users' needs.

Adding Intelligence to the 4D Digital Context

Even though high accuracy, full scale, photorealistic digital context already provides a lot of value to users, more can be done to help improve operations. For instance, automated objects recognition can be used to quickly generate inventories, where equipments can be localized, georeferenced, and identified in the 3D model.

Through artificial intelligence, machine learning, and geometrical analysis techniques, as well as semi-automated processes, Bentley reality modeling solutions allow users to better understand the real-world context, extract insights from the reality model, and link it to other business information.



For instance, detectors trained through machine learning can automatically identify objects in photos and defects on a structure, then localize them in the model. It is very useful to automatically classify equipment like pumps or valves in a plant, lighting poles or street furnitures in a city or cracks on a dam or bridge.

Detecting cables or breaklines on a street or building can also be done very easily in a few clicks in order to vectorize key structures.

This technology can also be applied to the assisted 3D inventory of complex subjects like poles or trees.

Sharing and Collaborating

A digital twin is a single source of truth that all project stakeholders refer to, in order to make informed decisions. This means that beyond the intrinsic value of the digital context, it is critical to make the digital twin available to field and office workers, who will analyze it, annotate it and edit it, in collaborative workflows that improve communication, facilitate the preparation and execution of operations, and reduce risks due to misunderstandings. Bentley reality modeling solutions enable users to easily publish a 4D digital context on local or hosted servers and provide a secure access to the reality data and models all along the asset lifecycle.

The Advantages of 4D Digital Context

When appropriately created, managed and shared, a 4D digital context enables multiple digital workflows, like 'in-context' design, virtual asset construction monitoring and inspection, photorealistic training experience, and augmented reality/virtual reality. It truly helps users to improve the trustworthiness of their digital twins, reduce on-site visits, and improve the level of preparation, reducing the cost and risks of field operations.

"Bentley applications made a paradigm shift in our approach."

– Brijesh Dixit, Managing Director, Maharashtra Metro Rail Corporation Limited

Advancing Digital Twins Through Reality Modeling

For infrastructure project delivery, reality modeling captures the actual context of infrastructure projects through photos and/or scans, creating engineering-ready reality models for design, analysis, and construction workflows.

Better Design

The adoption of BIM has drastically impacted the way infrastructure assets are designed and built. Combining BIM with reality modeling techniques, which provide affordable solutions for capturing the context of a CAPEX project, takes it to the next level. Architects can better anticipate and integrate their projects into the existing landscape and surroundings. Structural engineers can influence design through in-depth simulation considering multiple parameters reflecting reality conditions. Eventually, the utilization of a 4D Digital Context helps achieve a better design, what also improves the constructibility of new assets.

Better Construction

Construction is of course largely benefiting from the implementation of BIM workflows and principles and from design-in-context approaches. These techniques enable 4D planning, help anticipate issues, and improve coordination and collaboration during construction. Considering reality conditions all along the building process allows contractors and owners to accurately track changes and issues, as well as actual progresses, against the planning. Resulting from any reality capturing techniques, those 4D reality models can be compared over time to detect changes, update the status of construction elements, and report and manage issues.

Better Operations

Improving operations on an infrastructure asset helps organizations better understand its actual performance through analytics and data extraction. Influenced by the model's accuracy, scale, and readiness, operations are strongly benefiting from new technologies like VR, AR, and even MR (mixed reality) that enable new applications, such asvirtual inspection, remote vizualisation, and online collaboration. 4D digital context, continuously updated and reflecting the actual condition of assets, augmented with analytical and eventually external data from Internet of Things devices, cameras, statistics, and simulation results, is the basis of any digital twin that is used to connect the office and the field, and saves many on-site visits during decision-making processes. Bentley has developed multiple solutions leveraging artificial intelligence and machine learning as well as assisted feature extraction and object recognition to extract more value from 4D digital context.

USD 57 Trillion

Spending on infrastructure by 2030

Better Collaboration

52% of project rework is caused by poor project data and communication during construction projects (FMI). 82% of infrastructure owners feel they need more collaboration with their contractors (KPMG). Collaboration inside a group or between parties is a key factor in any complex project. This is a multifold challenge that requires dealing with a great amount of data captured on any new projects, as well as with distant and multicultural teams. A digital context consists of a multitude of reality data that augment over time and require a scalable solution for their management and access by project stakeholders. Bentley now offers a unique solution to easily manage an unlimited quantity of reality data. Available on-premise and in the cloud, it allows user to manage and share petabytes of reality data, intuitively and securely.[1]

1. McKinsey https://www.mckinsey.com/industries/private-equity-and-principal-investors/our-insights/money-isnt-everything-but-we-need-$57-trillion-for-infrastructure#

Users' Words

Across multiple industries, users are now reporting benefits achieved through utilizing a 4D digital context to improve their design, construction, and operations processes.

CITY OF HELSINKI

Finland | Digital City

"The City of Helsinki, Finland has a long tradition of 3D city modeling dating back to the mid-1980s. As part of a three-year project, the City of Helsinki launched a EUR 1 million project to generate a 3D representation of the entire city using reality modeling and mapping solutions from Bentley Systems. "Future cities need advanced tools and innovative city models for creative design and well-grounded decisions."

– Jarmo Suomisto, Architect, Project Manager, Helsinki 3D+

PACIFIC GAS & ELECTRIC COMPANY

United States of America | Electrical Substation

"Having a complete 3D model at the time of constructability review allows us to measure electrical and physical clearance in real time, which helps eliminate costly conflicts during construction phases. With today's increasing substation complexity and decreasing substation footprint, having a 3D reality model is a must."

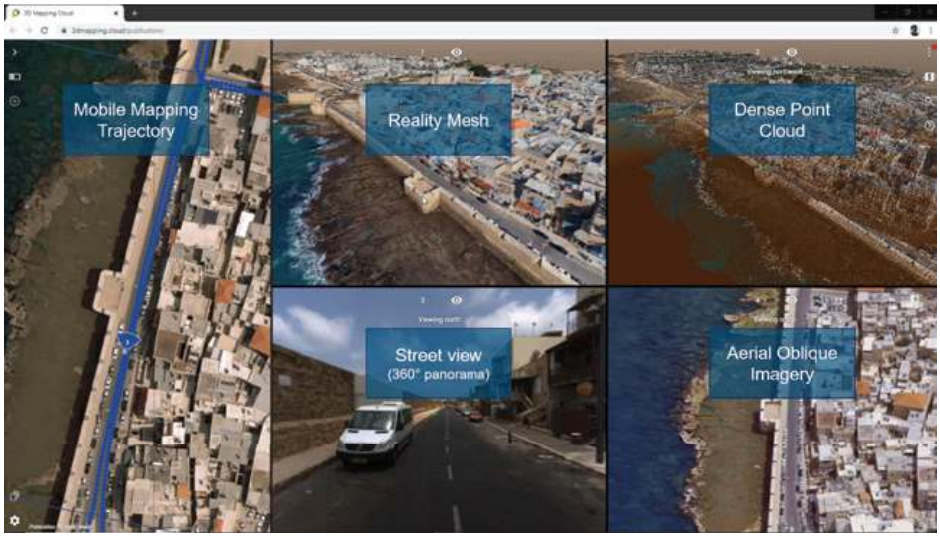
– Ralph Hansen, Construction Supervisor, PG&E

LEIGHTON ASIA

Hong Kong | Bridge Design

The team made Bentley's BIM technology the common platform to facilitate communications, and to anticipate and rectify construction problems. Solving more than 3,000 clashes before construction has largely reduced remedial work and hence saved time and cost. The survey team compared 3D design models to reality models to avoid discrepancies on site, then continuously updated the design model to create accurate as-built models.

FPO ASSET NEEDED



Bentley's Reality Modeling Solution

Leveraging two leading software products, ContextCapture and Orbit 3DM, Bentley's reality modeling solutions take the creation, management, analysis, and sharing of reality data and digital context to a new level.

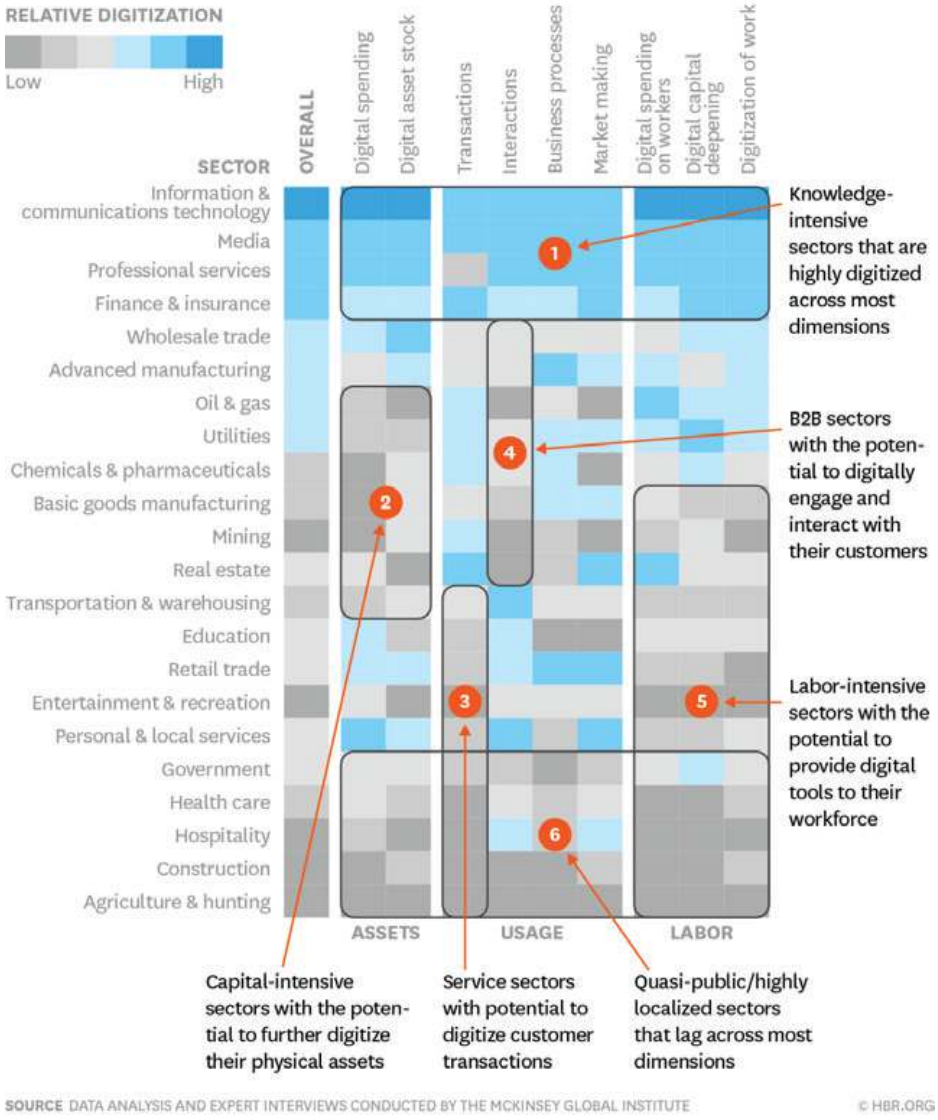
ContextCapture Creates engineering-ready reality models from point clouds and/or photos	This hybrid and scalable reality modeling solution automatically turns any reality data such as point clouds ground and/or aerial photographs into fully textured, multiresolution reality meshes, dense point clouds, or orthophotos. Process an unlimited quantity of reality data, on-premise or in the cloud, and collaborate online with your project stakeholders.
Orbit 3DM 3D and Mobile Mapping	Easily access and update your aboveground or belowground 3D city models with data acquired from street-level mobile, oblique, UAS, aerial, terrestrial, and indoor mapping. Orbit 3DM also allows you to access and update scanned data, imagery, 3D vectors, meshes, and 2D GIS/CAD data. Bentley's Orbit 3DM solutions help users manage, extract, and share vast amounts of imagery, point cloud, and 3D mapping data for use with reality modeling and digital twins.

Benefits for Your Industry

Not all industries have taken steps into digitalization, even though they can all expect huge benefits from it. Not surprisingly, IT-related sectors are more advanced in adopting those techniques, while more labor-intensive domains like construction are lagging.

How Digitally Advanced Is Your Sector?

An analysis of digital assets, usage, and labor.



SOURCE DATA ANALYSIS AND EXPERT INTERVIEWS CONDUCTED BY THE MCKINSEY GLOBAL INSTITUTE

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Surveying and 3D Mapping

Bentley's reality modeling software solutions automatically generate high-fidelity 3D reality models from simple photographs and/or point clouds. These photos can be taken from a variety of devices and techniques, including aerial LiDAR, drone photography, hand-held cameras, terrestrial laser scanners, mobile mapping systems, and even smartphones. The process brings new opportunities to optimize workflows to win projects.

Users can manage an unlimited number of high resolution photographs, dense point clouds, and panoramic images to gather the information needed to create high-fidelity georeferenced 3D models, reducing health and safety risks for works at dangerous sites. These 3D reality models are quickly generated for users to incorporate into their design, construction, analysis and operation workflows.

Provide digital context during design workflows

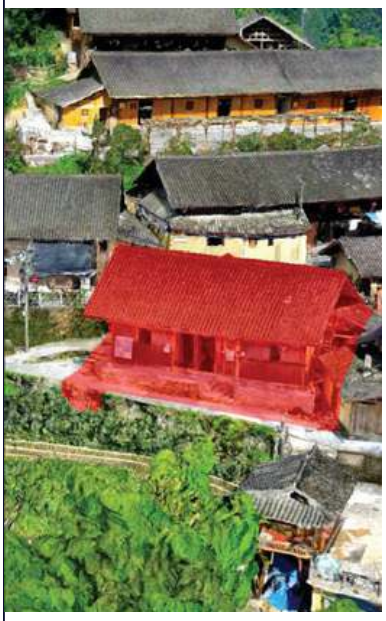
Reality modeling accelerates the decision-making process with advanced knowledge and insight into existing site conditions, helping you to:

- Carry out construction simulations to evaluate potential impacts.
- Uncover financial implications early.
- Optimize information sharing.
- Improve collaboration.

Accelerate project delivery during construction workflows

Reality modeling gives an accurate perspective of the job site, allows progress monitoring and evaluating, and enables verification of a job performance with the design. With reality modeling, you can:

- Ease collaboration between stakeholders.
- Provide up-to-date construction documentation and inspection.
- Allow the calculation of cut/fill quantities as often as necessary.
- Improve safety.
- Lower costs of as-built surveys.



POWERCHINA ZhongNan Engineering Corporation Limited
Xiangxi Autonomous Prefecture, Hunan, China

Application of Digital Platform for Targeted Poverty Alleviation in Shibadong Village

One of China's poverty alleviation targets in a remote area of the Hunan province, Shibadong Village is implementing a three-month construction renovation project. Faced with an eroding limestone landscape and lack of mapping data and engineering drawings, POWERCHINA ZhongNan Engineering Corporation was tasked with completing the renovation initiative within the required timeframe. The company needed to guide construction while facilitating village planning and management. The team used OpenBuildings Designer for BIM design, ProjectWise for project team collaboration, and Bentley's Reality Modeling to generate a 3D reality model of the site from more than 100,000 aerial and ground captured images processed within 15 days. The applications helped establish a web-accessible digital twin and streamlined planning, construction, and management to save 80% in time and 60% in costs, representing approximately CNY 1 million.

Improve the operations and maintenance of assets

Reality modeling helps to better manage assets by easily documenting assets in 3D and linking 3D-registered equipment to operations and engineering data. Better asset management enables you to:

- Optimize maintenance and service activities.
- Lower the cost of asset inspection.
- Reduce safety risks.
- Develop more repeatable inspection processes.
- Provide easier access of hard-to-inspect locations.
- Safeguard against asset downtime.

Bentley's reality modeling solutions allow you to securely manage, share, and stream 3D reality models across project teams and software applications, increasing team productivity and collaboration.

Oil and Gas and Manufacturing

Oil and gas owner-operators have quickly realized the advantages of digital twins, and most of them have already initiated dedicated going digital strategies. With remote sites, aging assets, health and safety challenges, and price pressure, oil and gas players have been looking for solutions to improve the productivity of their teams and cut costs at multiple levels.

"Constructing the plant of the future means embracing digitalisation. In construction, digital is about advancing the technology that helps us stay on top of progress and assure quality while keeping people safe. In that respect, the 3D reality mesh modelling technology has made a profound impact on ways of working on the project, rendering benefits above and beyond what we had imagined when starting the modelling program 18 months ago."

- Dmitry Gurevich, Shell's Information Technology Manager, Transportation & Heavy Civil

Shell Chemical Appalachia is constructing a multi-billion dollar, world-scale ethane cracking plant to create polyethylene in the western Pennsylvania region. To help monitor and manage construction of the facility, the organization used unmanned aerial vehicles to capture real-time, accurate data of the entire site and the surrounding areas, close to 450 acres total, and process the data into a high-resolution orthophoto and 3D reality mesh model. The 3D data provided a strategic perspective of the existing site conditions and served as a single source of truth for both future and retrospective progress analysis, optimizing collaboration and decision-making between the client and the EPC contractors, with over 500 multidiscipline end users across 10 companies.

On a weekly basis, the project team captured more than 8,000 images and processed the images as 2D and 3D deliverables within the required 72-hour window using Bentley's ContextCapture software. The high-speed processing engines of ContextCapture produced a dimensionally accurate 3D reality mesh, enabling the identification and resolution of potential construction problems before they impact operations on site. The 3D reality mesh models are expected to facilitate inventory control and improve emergency response management.

Transportation and Civil

Transportation is essential to sustaining economic growth and improving quality of life in a region. The daily movement of people and goods is constantly increasing, as is the size and complexity of projects being imagined, and assets operated. Owner-operators and their supply chains need effective and efficient solutions to design, build, and operate road and rail networks around the world, and are adopting reality modeling to improve worker safety, start projects faster, iterate designs more efficiently, and share information more effectively.

Reality modeling provides real-world digital context of existing conditions to accelerate design workflows by allowing you to:

- Simulate construction and evaluate the potential impact.
- Understand financial implications early.
- Accelerate and improve decision-making.
- Optimize collaboration and coordination.
- Leverage digital workflows.
- Manage and mitigate risk.

"Bentley's ContextCapture, along with LumenRT, provided a quick and realistic representation of ALDOT's design. Stakeholders and the public can see exactly how the project will look in real life. This is very beneficial to ALDOT and keeps projects moving!"

– Matt Taylor, Visualization Project Manager, Alabama Department of Transportation three

Reality modeling helps accelerate project delivery during the construction workflow to provide an accurate perspective of your job site, monitor and evaluate progress, and enable verification of performance against schedule. You'll be enabled to:

- Ease collaboration among stakeholders.
- Provide up-to-date documents for construction and inspection.
- Conduct calculation of cut/fill quantities as required.
- Improve safety and enable right first-time construction.
- Lower costs to perform as-built surveys.

Reality modeling helps improve operations and maintenance through easier capture and documentation of assets, which helps you:

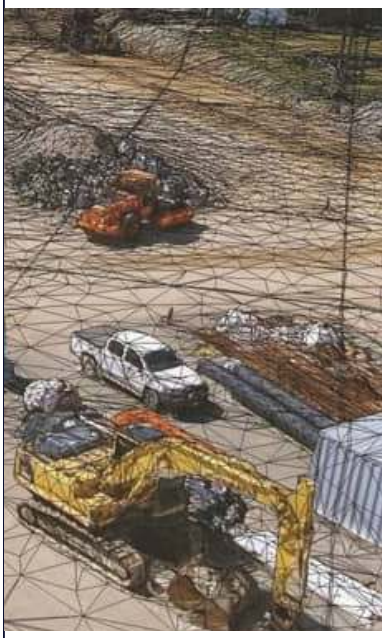
- Optimize maintenance and service activities.
- Lower asset inspection costs.
- Improve safety and coordination.
- Develop more repeatable inspection processes.
- Provide easier access in hard-to-inspect locations.
- Contribute to reducing asset downtime.

Alabama Department of Transportation, Centreville, Alabama, United States
Roundabout Bibb County

The Alabama Department of Transportation (ALDOT) initiated a USD 2 million project to improve the intersection at State Route 5 and County Road 58 in Centreville, Bibb County, Alabama. The proposed solution was a roundabout design that would connect all roads and elevate dangerous side road connections.

As a new design concept, the project faced public opposition, and ALDOT needed to incorporate public and stakeholder opinion and achieve buy-in. Upon completion, the new roundabout will reduce accidents by improving safe traffic flow in the area. ALDOT used Bentley applications to combine a 3D model of the proposed roadway, a drone-captured photogrammetry reality mesh, and real-time projected traffic into a rendered environment to visualize the project for better understanding.

Generating the reality mesh using Bentley Reality Modeling saved weeks, while LumenRT simplified the otherwise time-consuming incorporation of 3D features to significantly reduce costs.



Parramatta Light Rail Project
Aerometrex, Parramatta, New South Wales, Australia

To accommodate the projected 2036 shift of more than half of Sydney's population to the Greater Parramatta area, the Parramatta Light Rail Project will improve public transport in a very congested traffic area.

AEROmetrex was commissioned to create a 3D reality mesh of a 19.6-square-kilometer area that includes the proposed 12-kilometer rail route. The reality mesh will be used as a unifying data source for all aspects of planning, route selection, cost, and material estimations, and for community consultation.

The project team captured 60,000 photographs over a six-week period and processed the images in ContextCapture to generate a high-resolution, 3D model of the area in less than three weeks, with total data delivery reaching eight terabytes.

Using Bentley's reality modeling solution to create a 3D framework that can display disparate datasets significantly improved collaboration among the public and all stakeholders. The 3D model serves as the foundation for a holistic, interdisciplinary dataset on this long-term AUD 3.5 billion project, which is expected to reach completion in May 2023.

"The application of Bentley's ContextCapture to a large, expensive, and high-profile political project is a long step forward in the adoption of this technology for serious engineering applications. This is no longer a 'recent disruptor' technology. It is the future of mapping and surveying."

– Mark Deuter, Managing Director, AEROmetrex

Telecommunications

Inspecting communications towers typically requires shutting down the site and an expert rigging team climbing the tower – a costly, time consuming, and dangerous process. If the tower is non-climbable, an elevated work platform must be used to allow close-up inspection of the antennas and equipment. With numerous towers, often in hard-to-reach locations, this process makes it difficult to repeatedly record accurate data, leaving an incomplete understanding of the assets. Capturing imagery with drones can now go beyond just photographs and video. Reality modeling using ContextCapture automatically converts those images into an accurate 3D model of the tower or substation that can be measured, imported into existing engineering applications, or linked with asset and inspection records.

Reality modeling streamlines the operations and inspection of communications assets by:

- Enabling new designs to be incorporated into the existing environment for planning or expansion.
- Supporting the linking of data and geospatial information for asset management.
- Enabling comprehensive analysis and identifying equipment.
- Assessing corrosion or other problems before performing maintenance operations.
- Allowing for the capture of assets more frequently – with little or no asset downtime.
- Decreasing resource hours required for surveying on-site and improving work efficiency.
- Reduce health and safety risks associated with manual inspection.

"Delivering a vast and complete, verified accurate, up-to-date record of the current state and position of the client's tangible assets contained in an easily consumable source."

- Jake Lydick, Founder & CEO of Eye-bot Aerial Solutions

Springdale Monopole
Eye-bot Aerial Solutions, Springdale, PA, United States

Springdale Monopole is a reality modeling project for a cell tower antenna located in Springdale, Pennsylvania. Drone service company Eye-bot Aerial Solutions initiated this project to help achieve improved fidelity and workflows by modeling vertical monopole structures that feature transparent complex cross bracing. Because modeling these towers solely with UAV photogrammetry is extremely difficult, Eye-bot sought to incorporate LiDAR scanning as part of the data-capture process, and needed software to accommodate both survey methods.

The project team used Bentley's Reality Modeling solutions to process images from different data sources and generated a precise 3D reality mesh to share among stakeholders. The reality mesh helps eliminate risks associated with manual inspection, allows for precise measurements of the structure, and enables new designs to be incorporated into the existing environment for planning and expansion. The capabilities of reality modeling demonstrate tremendous potential for improved efficiencies in the telecommunications industry.

Ala Abdulhadi & Khalifa Hawas Consulting
Engineering Company

Reality Modeling for Al-Madinah
Al-Munawwarah

Al-Madinah Al-Munawwarah, Madinah,
Saudi ArabiaProject

Project

Al-Madinah Al-Munawwarah, Saudi Arabia is the second-holiest city for over 1.8 billion Muslims worldwide. Each year, pilgrims visit the city's three prominent mosques and other areas of religious and historical significance. The Kingdom of Saudi Arabia wants to accommodate more pilgrimages by increasing the number of people who visit the city annually from 8 million to 30 million by 2030. The plan includes building museums and planning routes to historical, cultural, and tourist sites. Ala Abdulhadi & Khalifa Hawas Consulting Engineering Company (AHCEC) was tasked with designing the plan, which also included expanding transportation systems and hospitality facilities while preserving historical sites.

Solution

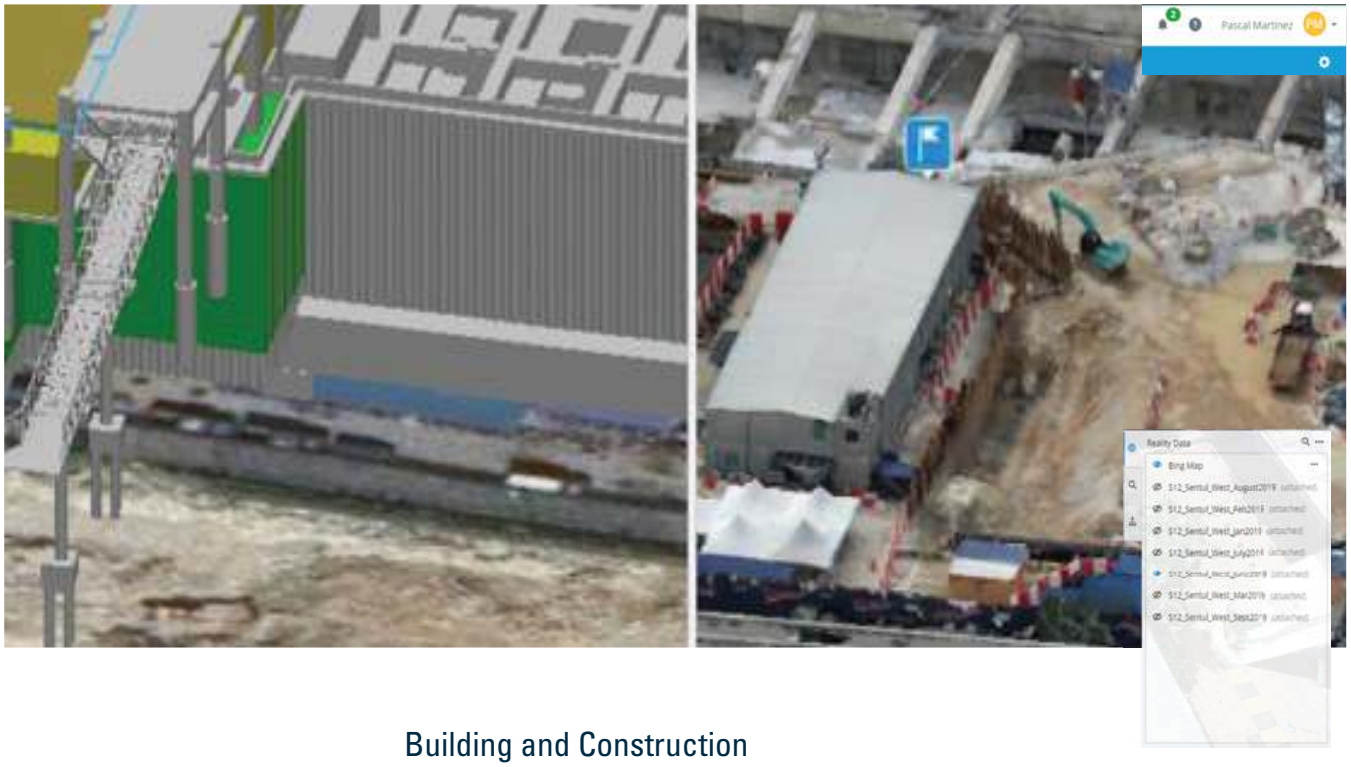
AHCEC established a reality model for planning and designing the infrastructure to accommodate the additional pilgrims. The model covered 55 square kilometers of the central region in Madinah, as well as 7,104 kilometers of streets. AHCEC also used a 3D mapping solution to manage the large amounts of mobile mapping data. The reality model was used to conduct multidiscipline site planning and design, providing a base model for future projects. The team also used the model to conduct a feasibility study for a 3-kilometer walkway between two important mosques. The model helped AHCEC conduct shade analyses, ensuring maximum walking comfort both at the mosques and to the surrounding facilities.

Outcome

AHCEC's reality model has helped complete the project 15 months ahead of schedule while still creating a design that facilitates more pilgrim's access to Al-Madinah. The team used ContextCapture and Orbit 3DM to complete the objective in nine months, saving over a year in surveying time and more than SAR 42 million. The interoperability of the applications allowed the model to be exported in web-ready formats for easier approvals from the government and other stakeholders. This project was the first of this scale in Saudi Arabia to use consumer unmanned aerial vehicles in such a short timeframe.

Software

ContextCapture helped process the UAV-captured images to create a realistic 3D model of the city. Orbit 3DM, Bentley's 3D mapping solution, helped effectively manage and feature extract content, as well as publish mobile mapping data. These applications implemented data from existing point clouds. Reality modeling provided the team with a reliable survey technique that minimized modeling time and costs while streamlining decision-making and visualization.



Building and Construction

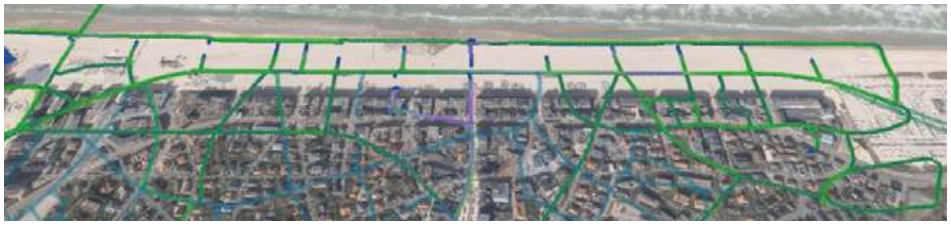
Whether for CAPEX projects like the construction of a new stadium or for the renovation of a group of existing buildings, capturing the context is key to achieve a better design, plan for construction and improve collaboration. When 9% to 12% of costs of construction projects are due to rework, embracing BIM and digitalization techniques becomes a necessity for owner-operators and contractors.

The unique combination of 4D planning, reality modeling, reality data management, BIM, data exchange and online visualization enables the creation of advanced solutions to detect and monitor changes and progress on construction sites in 4D.

A project manager, Virtual Design and Construction manager or a field engineer, can easily compare the reality data, captured from photos and or point clouds, and processed into 3D reality meshes or point clouds, with BIM models or even "4D schedules", adding a time sequence to each component of a BIM model. This helps to check the condition and presence of a component, update its status in the planning, what contributes to the generation of a consolidated up-to-date dashboard that keeps track of actual construction progress.

Moreover, through simple measurement analysis, the user can verify the compliance of each built component with the design model, and help keep track of deviations and defects.

Finally, the tracking of the latter in 4D, thanks to the creation and management of 4D Issues, that can easily be shared with stakeholders in standard formats, drastically improves the communication between contractors, owners and designers, and reduces disputes and related costs.



Utilities

Stakeholders in utilities require the most up-to-date site information throughout their assets' lifecycles, allowing them to make informed decisions. With reality modeling technologies and solutions, utilities owner-operators can monitor onsite asset conditions while reducing costs, saving time, and lowering risks of injuries to workers.

Assets can be easily documented and 3D-registered infrastructure can be linked to operations and engineering data. These capabilities provide a complete, up-to-date representation of the asset as a single, digital source, which can be easily shared and streamed in other software applications for better asset management. All involved parties—from remotely located stakeholders, to engineers in the office, to workers in the field—can be connected to assist in the asset design, construction, operation, and inspection workflows.

Pacific Gas and Electric Company (PG&E) owns and operates more than 1,000 transmission and distribution substations, spanning two-thirds of California. With 95 percent of its USD 1 billion substation budget spent on brownfield locations, PG&E had been manually converting existing 2D drawings to 3D models for use on retrofit projects. That time-consuming process has been replaced by reality modeling based on image capture and processing. The Substation Engineering Department has reduced the cost of substation modeling by 50 percent with the use of UAV imagery and processing with ContextCapture. Taking one-third less time than previously used methods to create, the highly accurate 3D reality models are referenced into Bentley Substation to model the existing substation in 3D for use in substation design. Using ProjectWise to share the models among design teams, PG&E now has one source of information in a centralized location.

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