As urban populations grow and governments struggle to improve their aging infrastructure, digital cities are the solution for managing and mitigating risks associated with changing environments. To connect people with the processes, data, and technology they need to interact with their environment, city planners are adopting a going digital strategy, a phrase that is quickly becoming part of the infrastructure lexicon.

City governments are leveraging innovative new technology for reality modeling to capture existing site conditions through the use of digital photography or point-cloud data. These 3D reality models can be easily shared and streamed to accelerate the decision-making process and improve collaboration with outside agencies and services.

Bentley’s ContextCapture application generates 3D reality meshes to create engineering-ready and city-wide contextual models, ensuring your information is always up to date to support design, construction, and operations.

The 3D reality models can be used for a variety of purposes, including urban planning, illustrated by Helsinki 3D+ for the city of Helsinki, to detailed engineering design and construction workflows, utilized by Huadong Engineering Corporation Limited for the city of Shenzhen. The following projects in this e-book demonstrate how you can leverage reality modeling to advance your going digital strategy and realize your digital city goals.
The capital city of Amaravati is planning to build a world-class river walk community along the banks of the Krishna River in Andhra Pradesh, India. Clove Technologies was tasked with providing a virtual 3D model that combines existing data with planned environmental development and facility designs, as well as highly precise models for engineers, architects, designers, and city officials to use for conceptual planning and cost analysis. The project team faced challenges capturing the 14-kilometer project along the river, which was set amid islands and hills.

Using ContextCapture, the project team created a 3D reality mesh from UAV images and DGPS data with 3.2-centimeter accuracy. It used LumenRT to animate the proposed solution for beautifying the shores, and created flood simulations for flood management planning. Bentley’s integrated and automated technology saved significant time generating the reality mesh compared to traditional survey and modeling methods and improved collaboration among stakeholders. The model facilitated detailed planning and analysis for this INR 1.5 million project.

**Project Playbook:** ContextCapture, LumenRT, MicroStation®

ContextCapture and LumenRT have fulfilled the dream of a landscape designer during the planning of the riverbed of Amaravati. The creativity in a virtual world was presentable to government officials, ministers, and other project stakeholders. The government was able to [receive] pre-estimates of the budgets required, and understand the impact of floods on the landscape and settlements.

— KKVNRaju, Managing Director, Clove Technologies Pvt. Ltd.
Bentley’s 3D digital technology platform eliminated the tough problems of overall technical and management planning for the Qianhai infrastructure construction project. By dealing with the error, omission, clash, and deficiency problems at the project planning and design stage, and by carrying out construction simulation in advance, we avoided the management and control risks and investment waste caused by imperfect design. We achieved digital engineering construction, laying a solid foundation for building Smart Qianhai.

– Jinfeng Wang, IT Director, POWERCHINA Huadong Engineering Corporation

Huadong Engineering Corporation Limited, POWERCHINA Huadong Engineering Corporation Limited
Shenzhen, Guangdong, China

Application of BIM Strategy for Shenzhen Qianhai Municipal Infrastructure

In Shenzhen, Guangdong, China, the Qianhai Cooperation Zone is undergoing intense development, with nearly CNY 390 billion of dense construction covering 14.92 square kilometers. The planned activity includes more than 180 kilometers of roads and 32 kilometers of rail lines aboveground and belowground, as well as CNY 68.2 billion in infrastructure. Huadong Engineering Corporation (PowerChina) is responsible for the infrastructure and other major projects.

Huadong Engineering’s daily management and coordination of BIM implementation ensured the team leveraged the technology to solve numerous challenges. A 3D reality model of the zone, used with the project’s multidiscipline 3D design models, created a GIS-based view for resolving errors, omissions, collisions, and deficiencies. The 3D collaborative design helped save more than CNY 21 million in rework alone.

Project Playbook: Bentley Raceway and Cable Management, ContextCapture, Descartes, LumenRT, MicroStation, Navigator, OpenBuildings Designer, OpenRoads™ Designer, OpenRoads Navigator
The Yangzhou Municipal Planning Bureau retained Haiwei Spatial Information Technology to perform data acquisition and reality modeling services to establish an accurate 3D city model for decision-making, planning, and the development of Yangzhou, China. The resulting model gave government officials and planning designers the ability to visualize potential development initiatives and served as a basis for using reality modeling for urban development in other Chinese cities.

Using ContextCapture, the project team processed 800,000 photos captured with UAVs and generated a 3D reality mesh in 20 days, compared to 10 months using manual processes. Descartes® enabled the team to edit 400 surface models in three days. MicroStation provided the interoperability needed to integrate multi-sourced data and produce a digital, urban 3D GIS platform. Bentley’s integrated applications allowed the team to deliver the project 10 days ahead of schedule and save an estimated CNY 1.2 million on this CNY 4.5 million project.

Project Playbook: ContextCapture, Descartes, MicroStation

[Bentley technology]…reduced the time costs of data conversion and the delivery costs of the project.

– Ming Zhang, Director of Marketing, Haiwei Spatial Information Technology, LLC
Bentley’s ContextCapture enhances efficiency by several times. The computing capacity for the modeling in an individual machine can reach 30 gigapixels per day. It reaches 120 gigapixels per day if we use four machines to process data interactively. The traditional methods cannot keep up.

– Dan Guo, 3D Modeling Technology Processor, Shanghai Hangyao

Shanghai Hangyao
Qinghai, China

Xining Smart City Initiative

In 2014, Xining began its smart city initiative by capturing 40,000 images of 7,600 square kilometers of its city. Shanghai Hangyao, experienced with digital city projects, was tasked with completing this reality modeling initiative. Using ContextCapture, the project team generated the city’s first intuitive and informative 3D reality mesh, a true 3D digital asset. The land authority and police agencies used the 3D reality mesh to detect unauthorized construction, perform real estate registration, and confirm land ownership. Other agencies across the government can stream the data over an internal network, overlaying it with their theme layers to conduct professional analysis locally.

The parallel computation architecture and automatic reality modeling capabilities of ContextCapture empower the ambition of the large city mapping project. Compared with the traditional modeling workflow, ContextCapture efficiently realized reality mesh production for large-scale mapping, and saved CNY 10 million in project costs.

Project Playbook: ContextCapture
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 completed in 2017, the city of Helsinki launched a EUR 1 million initiative to generate a 3D representation of the entire city. The model is now provided as open data to involve the public and encourage commercial research and development.

The team used OpenCities Map® to create accurate base maps and geo-coordinate utility networks. ContextCapture was used to generate a 3D mesh representation of the city and Pointools was used to model the surface and terrain. LumenRT enlivened designs. Lastly, the team used ProjectWise® to collaborate and manage all the data that would be uploaded to a web portal for distribution and general access. As part of its digital city initiative, the 3D model improves Helsinki’s internal services and promotes smart development. The project also showcases the technology and promotes its use in higher education.

**Project Playbook:** ContextCapture, Descartes, Pointools, LumenRT, OpenCities Map

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**Future cities need advanced tools and innovative city models for creative design and well-grounded decisions.**

— Jarmo Suomisto, Architect, Project Manager, Helsinki 3D+
Maharashtra Metro Rail Corporation Limited
Nagpur Metro
Nagpur, Maharashtra, India

For this INR 86.8 billion urban mass transit project in Nagpur, India, Maharashtra Metro Rail Corporation Limited (Maha-Metro) implemented a comprehensive BIM approach with a consortium of engineering consultants from conceptual design through construction, operation, and maintenance. The project team used ProjectWise and AssetWise® to create a connected data environment and improve design integration and collaboration among the design teams.

Using Bentley’s integrated design applications to produce the entire infrastructure model enhanced collaboration, accelerated design time, and improved project reliability, which helped save 50 percent in engineering time and costs. Implementing BIM methodology enabled real-time collaboration and simulation, which minimized changes and avoided rework. The intelligent BIM model allows for asset management throughout operations and maintenance for full lifecycle infrastructure management.

Project Playbook: AssetWise, MicroStation, Navigator, OpenRail™, ProjectWise

Bentley software helped us make a paradigm shift in how we approach an engineering project. It allowed us to switch from a 2D to a 3D design platform. We see the upside throughout all phases of the project lifecycle.

– Brijesh Dixit, Managing Director, Maharashtra Metro Rail Corporation Limited
The Pope’s visit to Philadelphia in September 2015 was the largest public event held in the United States that year. Attracting more than 1 million people, the Papal visit required extensive preparations. AEROmetrex developed a 3D reality model of the city to assist in planning. Accurate to within 5 centimeters, the photo-realistic 3D model included every stationary object in the area including landscaping, sculptures, and buildings.

In a four-week period, the team obtained and processed more than 28,000 images using ContextCapture, saving an estimated 200 hours of survey time and AUD 24,000 in costs. By providing perspectives from any vantage point, the model's utility extends beyond its original use for facility and security planning, and will be used in the future for urban planning, and disaster and transport management.

Project Playbook: ContextCapture

This project was not only a technical and financial success but was also a showcase of the capabilities of ContextCapture for realistic, comprehensive, 3D reality modeling. We believe this is the mapping system of the future.

— David Byrne, Technical Director, AEROmetrex
As part of an urban planning initiative, the Shenzhen Survey and Research Institute retained Shanghai Hangyao Information Technology to capture aerial photos and use them to produce a 3D smart city model. The CNY 2.8 million project covers 210 square kilometers of the Longgang district of Shenzhen, China. With many high-rise buildings on the project site, image acquisition took longer than expected, compressing the 3D modeling time while creating greater demand for efficient modeling technology.

The survey team used two aerial cameras to obtain oblique, high-resolution photos of the site. By processing the images with ContextCapture to generate a 3D model, the team accurately reflected the terrain and site features. The team accommodated a variety of 3D formats supported by different output platforms, accelerating model production by 70 percent. The software’s automated processing features minimized labor resources, saving hundreds of thousands in costs.

**Project Playbook:** ContextCapture
To help the city of Grenoble obtain a “City of Art and History” certification, Geomatics Services proposed digitizing a physical 19th century model commissioned by Napoleon Bonaparte. The model is part of a unique collection of 150 models preserved at the Museum of Plans Reliefs in Paris and was in Grenoble for three months. After several attempts to process and broadcast the 3D model to the public, Geomatics Services decided to implement reality modeling.

The team used ContextCapture to automatically generate a textured 3D mesh from photos. Using the software’s editing features along with Descartes, users could correct the errors in the automated processing. Bentley’s reality modeling software helped complete the 3D rendering four times faster than other methodologies and preserved a heritage work, which is now integrated into the city of Grenoble’s digital terrain model.

**Project Playbook:** ContextCapture, Descartes, LumenRT, MicroStation
Located in Shanghai, China, the Caohejing Development Zone is an intelligent park that cultivates and supports technology-intensive enterprises. The administrative committee needed to manage the information and technical demands of the 2,500 park enterprises and help attract more investors. Soarscape Technology Development was retained to provide data acquisition and modeling services for the site. The CNY 1.6 million project also required the development of a platform for the 3D geographic information system.

The project team processed the collected park data to create the 3D models. The team integrated the models, vector attributes, and other data in OpenCities Map, based on uniform formats and platforms. This practice helped realize the 3D GIS and enable 3D information management of the park. ContextCapture saved one week of modeling time and CNY 100,000 compared to other software. Bentley’s interoperability eliminated incompatibility issues, which reduced time and costs.

**Project Playbook:** OpenCities Map, ContextCapture, Descartes, LumenRT, MicroStation
Yancheng Municipal Planning Bureau retained Soarscape Technology Development to deliver a 3D digital city model of Yancheng. The project required Soarscape to obtain oblique photography data at a 3-centimeter resolution, covering a 40-square-kilometer area. The team needed to produce the reality mesh within one month. With approximately 400,000 high-resolution photos to process and topography models to modify, it was difficult to load data onto the existing GIS platform.

The team used ContextCapture to process the photos, Descartes to modify the models, and MicroStation as the browsing platform to support 160 gigabytes of 3D reality meshes. The team produced the 3D reality meshes for the entire area in 20 days, compared to six months with manual modeling. Descartes enabled three employees to revise 400 water surface models in three days. Overall, Bentley’s integrated solutions saved approximately CNY 400,000 in labor and data acquisition costs.

**Project Playbook:** ContextCapture, Descartes, MicroStation

Bentley software guarantees seamless connections between Bentley and third-party software, saving time and money.

— Mingming Li, Technical Director, Soarscape Technology Development (Shanghai) Co., Ltd.
The 3D city model will be used by an expert panel to select the best architectural solution for the Stasys Eidrigevičius Center of Arts in Panevėžys.

– Rytis Mykolas Račkauskas, Mayor of Panevėžys City Municipality

The Panevėžys City Municipality approved 14 development projects to establish the Integrated Territory of Panevėžys. The city contracted UAB IT logika to develop a digital 3D city model for the EUR 40,000 digital city initiative. The project required data collection over an 11-square-kilometer area and integration of 3D models from a variety of sources into the reality mesh. The entire city model needed to be accessible via a personal computer and through a web-based application.

Using consumer-grade unmanned aerial vehicles, the team captured more than 50,000 photos in six days. Users processed 100 gigapixels of images in less than three months with ContextCapture. ContextCapture’s interoperability helped integrate more than 20 city development models imported from different sources and publish a unified model on an open-source, 3D-web platform for public viewing. With Bentley’s reality modeling software, UAB IT logika delivered a high-resolution city model within a limited budget.

Project Playbook: ContextCapture, Descartes
As part of a coordinated development plan, Zhong-Guan-Cun will integrate the resources of Beijing, Tianjin, and Zhong-Guan-Cun to build a science and technology city. The CNY 2.2 billion project includes the design and construction of roads, utility pipelines, a 174,000-square-meter park, and green roadsides spanning 477,000 square meters. The project consultant, CCCC Water Transportation Consultants, implemented a collaborative BIM process to coordinate the many engineering disciplines to deliver the new digital city.

The team generated a comprehensive 3D model of the entire city with Bentley software. Performing construction simulation improved construction management, shortening the construction period by 64 days and saving CNY 6.6 million in costs. By integrating ContextCapture to generate a reality mesh from UAV terrain data collected on-site, the team facilitated earthworks planning, saving approximately CNY 40 million.

**Project Playbook:** ContextCapture, LumenRT, MicroStation, Navigator, OpenBridge Modeler®, OpenRoads, ProjectWise, ProStructures

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**Using Bentley software solutions for our construction project, we easily shared information among stakeholders, improving collaboration and saving time.**

— Zhiqiang Lu, Deputy Chief Engineer of China Waterborne Transport Research Institute
Bentley’s reality meshes and the open data policy of the city of Helsinki together with Umbra’s real-time 3D technology create completely new opportunities.

– Otso Makinen, CEO, Umbra Software Oy

In 2016, the city of Helsinki released its reality mesh city model, created using Bentley reality modeling applications. Recently, the city of Helsinki partnered with Umbra Software to expand and optimize the city model and its data usage beyond engineering, architecture, and construction uses. Together, the organizations are pioneering the world’s first 3D city model as easily accessible open data.

Helsinki continues to update the 3D city model with Bentley software, creating new and more accurate area project reality meshes. The ability to integrate Bentley models with Umbra’s fully automated optimization and delivery platform makes the 3D city model available to anyone through cloud-based services. This innovative joint venture opens new collaborative possibilities between Helsinki and businesses, creating a new ecosystem around city data ranging from gaming applications to public transportation.

Project Playbook: Bentley Map, ContextCapture, Descartes, LumenRT, MicroStation, Pointools
To accommodate the unprecedented demand for access to historical imagery for all available epochs in rural and urban New South Wales, Australia, DFSI Spatial initiated the Historical Aerial Photography Enhancement (HAPE) project. While a digital repository of high-quality, scanned images already covered the entire state, DFSI was faced with a labor-intensive manual process to make these historic images discoverable, viewable, and downloadable to stakeholders and the community through a web-based service. Upon completion, the HAPE project will enhance environmental decision-making and land-use assessments, resulting in significant advancement to sustainability across New South Wales.

The project team used ContextCapture to process the historic imagery and generate accurate, 2D/3D mosaic models in a format than can be delivered to the NSW LiVE web-based server. The automated capabilities of Bentley’s reality modeling solution substantially reduced the costs of manual processing and optimized functionality of historical images through a searchable, open data server.

Project Playbook: ContextCapture
To improve the return on investment and reduce operation and maintenance costs, we comprehensively used BIM technology to control and manage the implementation and funds for this project.

— Xuyuan Liang, Vice-general Manager, Heilongjiang Long Jian Road & Bridge Engineering Co., Ltd.

The PPP Urban Road Project is a CNY 1.12 reconstruction and extension initiative in China’s Yuncheng County in the old city of Heze, which includes 21 urban roads, two bridges, auxiliary drainage, and green works. The area presented the multidiscipline team with site constraints and a tight schedule. The organization used Bentley’s 3D BIM and reality modeling applications to minimize the impact of demolition and construction on traffic flow and the surrounding city, meet the delivery timeline, and integrate lifecycle operation management.

The team used ContextCapture to generate a 3D reality mesh of the construction site and LumenRT to simulate traffic diversion plans that reduced traffic jams during construction by about 80 percent. This also lowered demolition and relocation costs by 25 percent. Bentley’s integrated technology for modeling and simulation enabled simultaneous design and construction, saving about 1.5 percent of overall project costs.

**Project Playbook:** ContextCapture, LumenRT, MicroStation, Navigator, OpenRoads, ProjectWise, Subsurface Utility Engineering
Ulanqab City Planning Bureau commissioned Shanghai Hangyao Information Technology to establish a 58-square-kilometer 3D reality mesh of downtown Ulanqab. The reality mesh will provide digital management and planning for city development. Because the City Planning Bureau will use the model as the foundation for a 3D information platform and the time to capture the aerial photography was extended to accommodate the geographic solar elevation, the timeframe to produce the reality mesh was short.

Shanghai Hangyao Information Technology used ContextCapture to automatically generate an accurate 3D reality mesh of the entire city from aerial photographs. The interoperability of ContextCapture eliminated the need for file conversion during the editing process, which streamlined workflows and improved efficiencies for model creation in other formats by 70 percent. The automated processing capabilities in ContextCapture minimized manual labor, saving hundreds of thousands in project costs.

**Project Playbook:** ContextCapture
Bentley’s ContextCapture makes data acquisition simpler and more efficient, and has fully automated data production. This saved 80% of our time and 60% of our costs for our 200 square-kilometer multi-source data fusion modeling project.

— Deputy General Manager, Soarscape Technology Development (Shanghai) Co.

Soarscape Technology Development (Shanghai) Co., Ltd./IFA Technology

Xiamen, Fujian, China

Realistic 3D Data Collection and Modeling of 180 Square Kilometers of Xiamen City

Xiamen City Planning and Design Institute retained Soarscape Technology Development (Shanghai) Co., Ltd. to produce 3D reality data and models based on oblique photography for 200 square kilometers of Xiamen City. The CNY 4.5 million project required fusing large amounts of high-resolution data and images from multiple sources to accommodate the restricted ground and air space amid a tight timeline.

The team used Bentley’s reality modeling applications, including ContextCapture, to seamlessly process all the images from numerous data capture sources into a high-precision, 3D reality mesh of the area in 90 days. Using mesh editing functions in Descartes and ContextCapture, five designers finished revising models for 1,200 water surfaces in seven days. Compared to 10 months required for manual modeling tasks, it took only four days to perform automated modeling. The integrated reality modeling solution saved approximately CNY 1.25 million in labor and data acquisition costs.

Project Playbook: ContextCapture, Descartes, LumenRT, MicroStation
About Bentley Systems
Bentley Systems is the leading global provider of software solutions to engineers, architects, geospatial professionals, constructors, and owner-operators for the design, construction, and operations of infrastructure, including public works, utilities, industrial plants, and digital cities. Bentley’s MicroStation-based open modeling applications, and its open simulation applications, accelerate design integration; its ProjectWise and SYNCHRO offerings accelerate project delivery; and its AssetWise offerings accelerate asset and network performance. Spanning infrastructure engineering, Bentley’s iTwin Services are fundamentally advancing BIM and GIS to 4D digital twins.

Bentley Systems employs more than 3,500 colleagues, generates annual revenues of $700 million in 170 countries, and has invested more than $1 billion in research, development, and acquisitions since 2014. From inception in 1984, the company has remained majority-owned by its five founding Bentley brothers.

For additional information, visit [www.bentley.com](http://www.bentley.com).

About ContextCapture
ContextCapture is Bentley’s reality modeling software that can quickly produce 3D models of existing conditions for infrastructure projects of all types, derived from simple photographs and/or point cloud. Without the need for expensive or specialized equipment, ContextCapture enables users to quickly create and use these highly detailed 3D engineering-ready reality meshes to provide precise real-world context for design, construction, and operations decisions throughout the lifecycle of projects. Project teams can easily and consistently share reality modeling information, consumable and accessible, on desktop and mobile devices, in many formats, including native use within MicroStation for any engineering, operations, maintenance, or GIS workflow.

For additional information, visit [www.bentley.com/ContextCapture](http://www.bentley.com/ContextCapture).

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