Bentley® Education

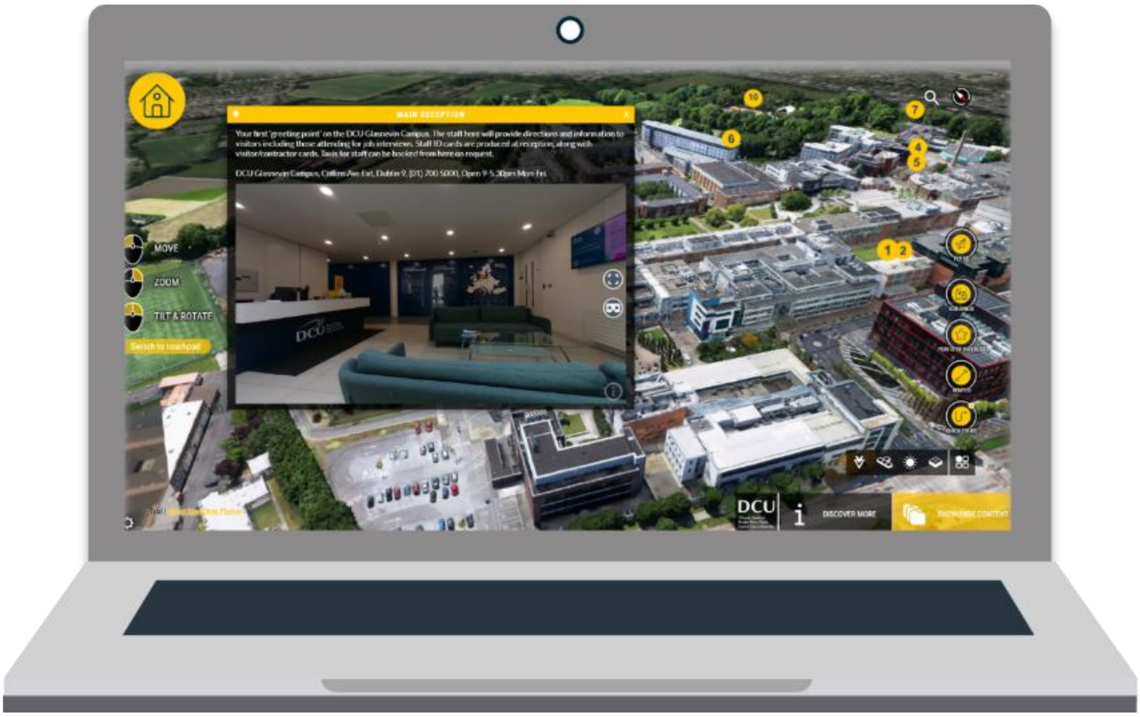
Case study: Smart DCU

Institution: Dublin City University

Partners: Insight Research Ireland Centre for Data Analytics, Bentley Systems, Dublin City Council, Kaunas University of Technology

Focus: Supporting an autism-friendly campus through immersive digital twin integration

Bentley tools featured: iTwin Capture Modeler, OpenCities Planner, AssetWise 4D Analytics (4DA)



Overview

The Smart DCU example illustrates a modular, Bentley-enabled approach that can be adapted to suit an organization's existing infrastructure, capabilities, and goals. The project demonstrates how a layered methodology, starting with photogrammetry, progressing through cloud-based visualization, and integrating real-time data streams, can deliver meaningful outcomes, even without perfect data coverage.

DCU's goal was twofold: to enhance operational efficiency and to support its ambition to become the world's first autism-friendly university. With a user-first philosophy, particularly for neurodiverse students, the digital twin was designed to help users assess space suitability in real time before physically entering a room.

Data acquisition: Indoor and outdoor capture

The methodology used a combination of drone surveys, handheld photogrammetry, and available BIMs to model indoor and outdoor spaces.

Outdoor capture

A DJI Mavic 2 Pro drone was flown over DCU's four campuses (Glasnevin, All Hallows, St. Patrick's, and Alpha) using DJI Ground Station Pro for automated, grid-based flight plans at 30–100 meters. This generated over 5,600 high-resolution geotagged images (e.g., 1,749 for Glasnevin), forming the base reality dataset for the digital twin.

The following drone flight parameters were used.

Drone flight parameters – DCU Campus survey					
Campus	Altitude (m)	Resolution (sm/px)	Overlap (f/s)	Flight time (mins)	Area (ha)
Glasnevin	60	1.4	70% / 70%	103	31.51
St. Patrick's	50	1.2	75% / 75%	53	7.06
All Hallows	42	1.0	80% / 80%	108	6.34
Alpha	47	1.1	85% / 85%	74	3.15

These values were generated using DJI Ground Station Pro flight planning software and a DJI Mavic 2 Pro. Overcast conditions were chosen to reduce glare.

Indoor capture

For indoor environments, which drones can't easily access, an iPhone 14 Pro Max equipped with LiDAR was used to take handheld photos. Polycam processed this imagery into 3D meshes, suitable for smaller rooms with standard lighting. However, for complex environments with glass, glossy surfaces, or high ceilings, this method proved less reliable.

Where available, 3D BIMs (such as those for the Polaris building) were incorporated directly. For older buildings with only 2D floorplans, a hybrid approach was used: Polycam-generated shell models were enhanced in Twinmotion, where missing objects and textures were manually added. For example, objects like sensory pods, student art, and furniture were modelled separately and placed into the space.

Category	Element	Description
Rooms	Tools used	iPhone 14 Pro Max + Polycam (LiDAR + image capture)
	Simple rooms	Quiet rooms and interfaith centers scanned handheld; Polycam produced textured 3D meshes or plain BIMs

	Complex rooms	Spaces with glass, glossy surfaces, or dense objects were scanned with Polycam to create shell models. Retouched in Twinmotion with manual edits
	Benefit	Method enabled realistic, semantically meaningful room models without requiring perfect scan conditions
Objects of interest	Approach	Small items with complex textures (e.g., Lego flowers, chess sets) captured using image-only photogrammetry
	Larger outdoor feature	Larger outdoor features (e.g., benches, the Labyrinth) scanned with both LiDAR and photos for full geometry + texture capture
	Conditions	Photos taken from multiple angles and heights in uniform, soft lighting (ideally overcast conditions)
	Processing	Polycam auto-processed data and exported to formats such as OBJ and GLTF for use in Twinmotion and Unreal Engine

Indoor rooms

Reality modeling and publishing

iTwin Capture Modeler was used to process drone imagery into textured 3D meshes and point clouds, exported in formats suitable for real-time rendering and integration.

For publishing and stakeholder engagement, OpenCities Planner provided a lightweight, browser-based interface. Digital twins could be accessed via simple URLs, and the platform supported the creation of Points of Interest (POIs), each of which could link to external dashboards, 360° images, or live sensor data. This proved especially useful for showcasing autism-friendly features such as quiet rooms and wellness areas.

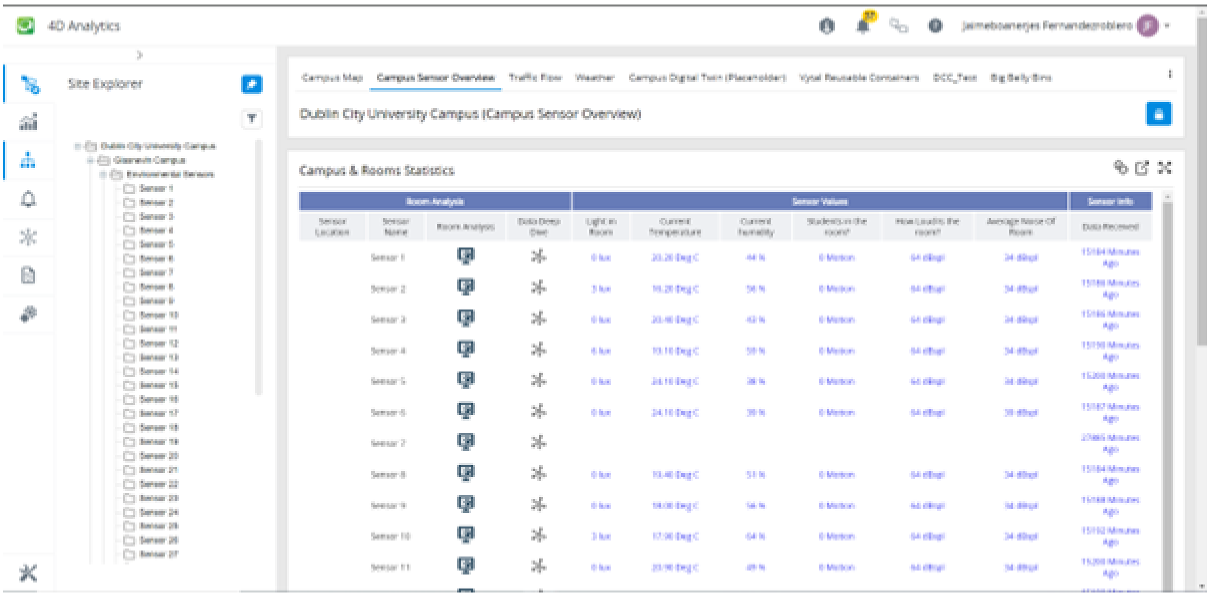
Sensor integration and real-time monitoring

To make the twin dynamic, real-time IoT data was integrated using Bentley's 4D Analytics (4DA) platform. Data could be streamed directly or linked from third-party APIs and dashboards.

Sensors installed on campus included:

- **WIA:** 40 devices monitoring room occupancy, temperature, humidity, noise, and lighting
- **HiData:** 2 edge devices using computer vision to measure occupancy and environmental conditions
- **CIVIC:** Radar sensors at campus entrances tracking pedestrian, vehicle, and cyclist movement
- **Bigbelly:** Smart waste bins providing live waste collection data

Each sensor type had its own dashboard and API, but 4DA unified the data, allowing fusion and temporal analysis. For instance, Sensor 16 in the U Building could display historical temperature, noise, or occupancy across selectable date ranges—useful for both students and facilities teams.



WIA: 40 sensors reporting light, temperature, humidity, room occupancy, and noise level.

HiDatai: Two computer vision-based sensors reporting room occupancy, light, and noise level

Data visualization and accessibility

The team used different platforms for visualization depending on the audience and goals:

- OpenCities Planner was used for rapid, low-barrier access via web browsers. POIs provided real-time context for users navigating the 3D model.
- Unreal Engine was explored for immersive digital experiences. The team developed interactive spaces such as the Interfaith Centre, Wellness Room, and the Polaris building with live IoT overlays. These were enhanced with realistic assets and textures using Twinmotion and then deployed via Unreal Engine.
- For added accessibility, the team prototyped a wayfinding system. Users could select a destination room, and a digital avatar would guide them via two modes: either showing a video-like path or allowing the user to follow the avatar themselves, like in a video game.

Tool selection and integration overview

The table below provides a quick reference for common campus modeling scenarios, reflecting a combination of Bentley and third-party tools as used in real-world implementations such as Smart DCU. This layered approach ensures that each asset (whether a room, building, or object) is captured, refined, and integrated using the most appropriate method. Each workflow was tailored to the specific needs of the asset, balancing speed, accuracy, realism, and interoperability with Bentley tools.

Physical Assets	Data Collection	3D Modeling (Processing)	Library of Digital Assets	Type of Assets	Virtual Environment Integration
DCU Campus (Outdoors)	Drone Photography (DJI Mavic II PRO, DJI Ground Station Pro) 	iTwin Capture Modeler	Glasnevin, St. Patricks, All Hallows, Alpha	3D reality data meshes	
Rooms (Indoors)	Hand-held photos (Iphone 14 Pro Max)  48 Pix Cam. LiDAR Cam.	polycam	Interfaith Centre, Quiet Room	3D reality data meshes	OpenCities Planner Bentley
Buildings	BIMs (DCU)	Twinmotion	Polaris Building	3D realistic BIMs	
Complex Rooms (Indoor)	Plain 3D BIMs (Iphone 14 Pro Max)  48 Pix Cam. LiDAR Cam.	polycam Twinmotion	Wellness Room, Henry Grattan Entrance, U Building	3D realistic BIMs	UNREAL ENGINE
Objects of Interest	Hand-held photos (Iphone 14 Pro Max)  48 Pix Cam. LiDAR Cam.	polycam	E-Bikes, E-Scooters, Labyrinth, Benches, Lego flowers, Chess game, Bigbelly bins, Prayer furniture.	3D reality data meshes	

Challenges and workarounds

- **Photogrammetry indoors** struggled with reflective surfaces, cluttered rooms, and large spaces. The team either modelled rooms empty or created a clean shell and manually placed digital objects.
- **Sensor placement** required university approval, highlighting the need for institutional support early on.
- **Visualization tools** varied in capability. OCP was ideal for quick publishing but lacked native graphing; 4DA supported dashboards and integration but required configuration; Unreal offered immersive potential but came with higher complexity.

- Modeling vegetation and glass produced distorted meshes, even with LiDAR. Realistic replacements were added using high-fidelity assets from Twinmotion or Unreal Engine.
- Importing large BIM files (e.g., the Polaris building) caused performance issues in Twinmotion. Files were optimized by collapsing by material type to reduce system load while maintaining editability.
- Institutional buildings lacked consistent BIM or CAD records. Drone photogrammetry and mobile scans were used to fill gaps with new reality meshes.

Tips for implementation

- **Start with what you have:** Drone imagery and free tools like Polycam can go a long way.
- **Use a layered approach:** Reality mesh → contextual data → real-time data → immersive experience.
- **Combine formats:** Integrate BIMs where available and fill gaps with photogrammetry or modeling.
- **Match tools to audiences:** Use OpenCities Planner for public access and Unreal Engine for deeper interaction.
- **Build incrementally:** DCU started with a few key spaces—interfaith centers, quiet rooms, classrooms—before scaling.
- **Prioritize inclusivity:** Design for neurodiverse users from the outset, not as an afterthought.
- **Optimize large BIMs:** Collapse elements by material to improve usability in visualization tools.
- **Scan in modules:** Capturing individual rooms or buildings reduces complexity and supports iteration.
- **Replace complex materials digitally:** Use asset libraries to substitute vegetation and reflective surfaces when mesh quality is poor.
- **Engage stakeholders early:** Secure approvals and access by involving estates, IT, and facilities teams from the start.