The buildingSMART openBIM Awards Yearbook 2022

Extraordinary projects from the buildingSMART International openBIM Awards Program 2022

buildingSMART International

About buildingSMART

buildingSMART is the worldwide industry body driving the digital transformation of the built asset industry, committed to delivering improvement by the creation and adoption of open, international standards and solutions for infrastructure and buildings. buildingSMART is the community for visionaries working to transform the design, construction, operation and maintenance of built assets and is an open, neutral and international not-for-profit organization.

The buildingSMART Awards program was established in order to recognize exemplary projects that have used buildingSMART standards and solutions to effectively overcome interoperability challenges. The first awards were presented in Toronto in October 2014, and the program continues to grow year on year.

In 2022 the final round of the program saw projects compete in 9 categories, with 9 Award winners being announced as well as 3 special mentions.

2022 Highlights

Categories

The program was divided into four broad categories: Project Delivery, Operations, Research and Technology. Each category has its own sub-categories, providing the basis for the Awards program.

Jurors

This Awards program was supported by 153 jurors across 21 chapters. The primary role of the juror is grading project submissions against a strict criteria, designed to ensure the highest quality of submissions. This year there was once again a triage team to help reduce the amount of work on all jurors.

Submissions

The program has received over 100 submissions for each of the last three years, this year with 121. Of those, 51 passed reviews by the technical triage team spread over 11 categories. The breakdown for those that passed triage is as follows:

- Asset Management: 3
- Construction for Buildings: 10
- Construction for Infrastructure: 5
- Design for Buildings: 5
- Design forInfrastructure: 3
- Facilities Management: 1
- Handover: 2
- Professional Research: 6
- Student Research: 5
- Sustainable Outcomes: 2
- Technology: 9

Special Mentions

Due to the high volume of quality submissions, there were a number of projects deemed a high enough standard to warrant a special mention. These projects scored exceedingly highly by the jury rating, but fell slightly short of being deemed an Award winner.

Contents

Asset Management

Construction for Buildings

Design for Buildings

Design for Infrastructure

Facilities Management

Handover

Professional Research

Student Research

Technology








WINNER - Asset Management

ChorusLife: Creation and maintenance of an openBIM Digital Twin for asset management

Engisis, Minnucci Associati and COSTIM - Italy

Project Description

The ChorusLife smart city project is designed and constructed by real estate developer COSTIM on around 150,000 square metres of abandoned land in Bergamo, Italy. The backbone for management and development of the city will be a digital twin which has been developed as a living lab working proof of concept for the system integration developed during the design development phase by a specialist team made up from IBN, Minnucci Associati and Engisis.

Core Objectives

The objective of the living lab working was to:

- understand the role played by the openBIM models in the creation of the digital twin of ChorusLife,
- maintain the digital twin over time, and
- define the asset information requirements for the delivery of the openBIM models for the digital twin.

About the Project

The ChorusLife project is a new smart district currently under construction on former industrial land in Bergamo, Italy. The project will create a new commercial area with retail, food court, service stores and others, restaurants, parking spaces, a wellness centre and sports palace plus a residential area with apartments, hotels, concert arena, communal gym and park.

The Smart District will be underpinned by technology to provide residents with building-as-a-service. Using COSTIM's integrated digital platform called GTM, users will fully interact with the district to book and pay for services, monitor consumption and participate in events.

Smart City

GTM is a digital environment that collects, transforms and integrates data from a range of IOT sensors and other range stores, digital infrastructure and plant engineering systems.

COSTIM is using the ChorusLife project as a living lab to promote and experiment with research and development activities to develop a digital twin that can be integrated into the GSM infrastructure and provide the basis for rolling out new expanded future services.

Strategic openBIM

The use of openBIM was the strategic choice for several reasons. First, the BIM model needed to be integrated into several applications: a model viewer, a Building Management System (BMS), the Azure Digital Twin (ADT), a Computer-Aided Facility Management system (CAFM), and others. is contained in the BIM models and proprietary formats would require specific integrations an add cost to the project;

These systems share part of the information that is contained in the BIM models and proprietary formats would require specific integrations and add cost to the project;

Second, the approach had to be easily replicated across other projects. A closed approach would have limited the applicability of the solution to the same software context;

Finally, the project required a long-term approach to ensure that the maintenance of the digital twin would be possible in 5 to 10 years without the risk that any specific supplier would no longer be in business.

Thus, within the ChorusLife living lab an approach was developed a digital twin based on IFC.

Highlights

Specifically, for the proof of concept the following approach was adopted:

- A two-room apartment was modelled to map all assets to IFC and the BIM model data was exported in proprietary (BIMx) and in an open (IFC) format. The bulk of full ChorusLife IFC model was provided by the client prior to this activity;
- The ADT Data Model (so-called creation of Digital Twin instances) was created based on IFC and the REC ontology.
- An openMAINT (CAFM) was prepared by creating the data model in the software, starting from the IFC model import; integrations between the ADT with openMaint and BIMX were specified along with integration between BIMX and openMaint.
- The GUIDs (globally unique identifier) of the objects in the IFC models were used as parameters of the web services developed to integrate the IT systems.

buildingSMART Tools Used

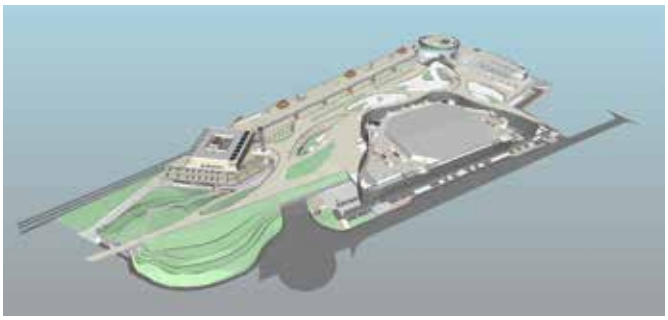
IFC 4, IDM

Result

The ChorusLife proof of concept project listed and described all the scenarios and the use cases that had to be supported by the digital twin. For each scenario, we defined if an openBIM model was useful, noting that some scenarios didn't need BIM models at all. The work enabled the project to understand and formalise the relationship between the information contained in openBIM models – which was mainly spatial structure, systems and elements - and the rest of the digital twin information, such as sensors data, and maintenance activities. A Microsoft Azure Digital Twin was configured to IFC, and its APIs were tailored to retrieve and update the representation of the objects coming from the IFC models. This IFC data model was linked to other data models.

> "An asset is, by definition, an item that has value. In our project, we looked at the digital twin as an asset itself, and openBIM was a way to increase its value. First, openBIM guarantees value over time: it ensures the maintenance of the digital twin for 5 to 10 years. Second, openBIM decreases the investment cost for a digital twin: no specific integrations are to be developed. Third, openBIM defines a replicable approach: the creation of the next digital twin will cost less. And all this, while driving innovation! openBIM was a winning choice."

Giulia Minnucci, Engisis



FINALIST - Asset Management

BIM, Asset Management & Safety

Terna SpA - Italy

Project Description

Terna is one of Europe's main electricity transmission grid operators and manager of the Italian high voltage transmission grid. Working with technology partner ACCA software, the project is the first large-scale implementation of BIM solutions in the Italian power transmission industry and has enabled Terna to digitise its existing and new assets using openBIM and so begin to transform and improve asset management across its entire transmission system infrastructure.

Core Objectives

The project objectives are twofold:

- 1. Rapidly and reliably digitising existing power plants in openBIM.
- 2. Using the results of this digitalisation process to increase the efficiency and effectiveness of the asset management processes through increased automation of existing activities and the introduction of new techniques supported by the power of openBIM and digitalization.

About the Project

Terna's BIM implementation journey was triggered by a change in Italian national laws and standards, making the use of BIM mandatory on all public projects above 100M Euros from 2019.

This project is a proof of concept that represents a baseline for the rollout of similar openBIM projects as Terna continues to invest in innovation and digitalization and a key part of its digital asset management strategy; to prove that with openBIM technologies and methodologies a secure business case can be established for the use of digital technology.

The project has also used the capability of openBIM to create a BIM Object Library for the Energy market with classes and information aligned to the IFC standard. This way, it is possible to communicate through standard protocols (APIs) and support open and interoperable formats across the industry.

However, the foundation of the project is the process of digitising existing and new assets. A dedicated BIM Tool called "Stazioni" has been created to enable the rapid digitization of existing assets in IFC based on this BIM Object Library and the client's needs and requirements. This produces not only the IFC model but also holds all deliverables produced in a Common Data Environment with connection between the IFC model and all related information and documentation to create a Digital Twin of the asset.

The use of openBIM, also makes it possible to acquire models created from external operators

and share deliverables produced so as to manage BIM tenders in line with the ISO-19650. Using open data and being able to request the desired model and related information using the specific requirements in the IFC openBIM format, allows Terna to collaborate with any stakeholder involved in the BIM Tender process with maximum transparency.

Highlights

The project has three main elements:

The BIM object library

Consisting of 1500 modelled objects, built to meet Terna's requests and needs including:

- Custom geometry.
- Information level derived from the shared technical data sheets of object classes.
- Types are differentiated for information content rather than for geometric detail.
- Construction details and/or specifications available from the object as attachments.

Tool Station

A development of a specific BIM Tool which allows a quick design of a new electric high voltage substations, ensuring appropriate level of detail:

- All configurations have been developed taking into account different voltage levels, seismicity and short-circuit current.
- Technology allows a new substation to be model quickly.
- Digital models detail level is appropriate for projects objectives.
- The same workflow is applied when modelling existing substations.

The Common Data Environment (CDE)

Allows the reporting of information directly from the BIM model of electrical high voltage substations:

- The last updated data / information is always available on any device via the cloud-based system.
- Time and effort required to cross-check the current status of the project is reduced.
- A point of contact is established for all the specialists preventing the risk of inconsistency.

buildingSMART Tools Used

IFC 2x3, IFC 4, BCF

Result

The project has proven itself in several key areas:

Time saving: The BIM methodology allows an improved, faster design process with a reduction in errors.

Optimization and standardization: Adopting a standard, centralised design process and open-sources files allowed the full integration of systems with the company's existing software environment.

Reduced loss of information: The risk of losing data was managed and reduced by ensuring that information flowed seamlessly from the design stage to the maintenance phase. The ability to save information while on-site in near real-time is possible due to the digital twin synchronization.

Enabling new technologies: The use of digital twin technology to optimise asset management is just a first step on a journey towards adopting a range of new innovative technologies.

> "Throughout the life cycle of an asset, openBIM helps to connect people, processes, and data to achieve asset supply, operation, and maintenance goals. In this case, openBIM, applied to safety, certainly represents a key element in order to reduce the risks associated with field operations."

Domenico Luongo, Terna

WINNER - Construction for Buildings

The Henderson - an "Office for the Future"

Henderson Land Development Company Limited, Hip Hing Construction Company Limited - Hong Kong

Project Description

The Henderson is a new 34-storey office tower located in the heart of Hong Kong's central business district designed with a curvaceous glass façade by London-based Zaha Hadid Architects as an "office for the future". Design, construction operation and maintenance will be underpinned by BIM and digital facilities management tools made interoperable and sustainable by embracing the openBIM philosophy throughout the design and construction process and then across the entire lifecycle of the project.

Core Objectives

The vision for the Henderson project is to create a truly smart building. A comprehensive openBIM standard and data exchange strategy to interface between BIM and FM tools has been established from the start with a steering team consisting of different project stakeholders guiding progress. The use of openBIM thinking is vital for the project to achieve interoperability, traceability, reliability, and sustainability, and depends not only on the management, standardization, and software tools, but more importantly on the openBIM mindset and capability of project participants.

About the Project

The complex Henderson Tower building design features a high-tensile steel structure to provide a wide floor span of up to 26m with 5-metre floor-to-floor height, a rooftop Banquet Hall with panoramic views of the city skyline, and a vast glazed roof and façade. Realizing this design created unprecedented challenges for the international design team.

The need for a deep basement to fulfil car-parking demands, and the constraints of a congested site with sensitive live tunnels in close proximity, meant the project was constructed with a top-down construction approach, which in itself adds challenges in construction planning.

Full lifecycle openBIM information management was adopted as part of the solution to these technical challenges. This required early involvement among a wide array of project parties, using more than 20 openBIM parties and 15 proprietary BIM software suites. Data interoperability during coordination was vital to avoid compromising the native data framework and solutions delivered by each speciality and was achieved by using an openBIM approach.

The use of Design for Manufacturing and Assembly (DfMA) techniques meant the project features more than 60% cylindrical or double-curved glass panels, together with the assembly of 16,000 tons of prefabricated steel.

An openBIM project environment allows different project parties to coordinate without resorting to a single particular software solution and enables high-quality data exchange and cost-effective design.

By embracing an openBIM approach the Henderson Tower project team created a digital framework that enables interoperable data exchange that is:

- Traceable: Embracing an ambitious project goal, the Henderson was designed by international architects, and involved specialized project parties using numerous software and practice.
- Reliable: BIM Execution Plan and ISO 19650 govern the information management process and production standard amid different practices and interpretations of BIM in this international project.
- Sustainable: With traceable and reliable data, a sustainable openBIM digital twin ensures that data is interoperable across software and along the project lifecycle.

Highlights

In design:

Spatial coordination was completed 2-weeks before steel fabrication; office headroom maximized by incorporating 90% MEP routings into the steel framing zone; generative design rationalized 30% façade panels; automated model checking, and headroom demarcation reduced workload.

In procurement:

Early openBIM phase planning gives evidence to top-down construction approach; quantity take-off from Revit or Trimble Connect via open format saves 25% time; openBIM for steel enables engineers to illustrate installation progress directly in the CDE.

In assembly:

Over 4000 façade panels and over 16,000 tons of steel for pre-fabrication are digitized; the buildability study via openBIM trims 45% of the time for basement capping beam installation and saves 80% of steel for underslung support.

In operation:

Over 20 organizations participate in openBIM. Site workers are trained to view BIM via smartphones on-site; maintenance access is openly coordinated in CDE before site installation; steel installation quality guaranteed via 3D-laser scanning on-site against BIM model; under the progressive agreement of COBie methodology, asset value will eventually be brought to operation stage.

buildingSMART Tools Used

IFC 2x3, ifcXML, bSDD, BCF, IDM, mvdXML, COBie

Result

The vision for the Henderson Tower project is to create an urban oasis in the central business district of Hong Kong through unprecedented architectural design, that provides an internationally accredited green and high-performance building for occupants and the neighbourhood. These objectives are driven by innovative technologies, engineering excellence and embracing openBIM philosophy which enabled data exchange across the team and the seamless transfer of information from the design, modelling, simulation and analytic software used by different designers, specialist consultants and constructors. The open, sharable digital infrastructure and building information platform allows the building asset and information to become available for use in the building operation, enabling the genuine digital transformation of the current practices in the building industry.

> "openBIM, is the key to materializing the aspiration through unprecedented cutting-edge technologies and project team members' intensive collaborations. openBIM enables effective data exchanges and information dissemination from the design, modelling, simulation and analytic software used by different designers, specialist consultants and constructors. The open sharable digital infrastructure and building information platform facilitate the building asset and information carry forward to the building operation, that enables the genuine digital transformation of the current practices in the building industry."

Cheuk Hei Wong, Hip Hing

WINNER - Design for Buildings

Department for Education: Gen Zero

Bond Bryan Digital - UK

Project Description

The Gen Zero project is a research and development project for the Department for Education, which used best practice information management to assess the delivery of new ultra-low carbon building standards for schools. This project has two designs for new schools, one on an urban site and one on a rural site. Information management on the project was led by Bond Bryan Digital as part of an overall project delivery team led by Mott MacDonald.

Core Objectives

The project looked to use BIM and information management tools specifically to support, automate and accelerate the carbon assessment process during the design of two new schools for the Department for Education and to determine the cost uplift to meet new ultra-low carbon building standards.

About the Project

The Department for Education (DfE) initiated the project as part of the school's design process. As Information Manager on the project, Bond Bryan Digital developed the information requirements collaboratively with the DfE. This included a range of requirements to support the use-cases of:

- carbon analysis
- coordination
- quantification (to support cost analysis)
- visualisation, linking to cloud-based specifications
- data for transfer to the operational phase to support the management of the buildings post-handover

The information management resources were developed in alignment with the UK BIM Framework including the ISO 19650 suite of standards in advance of any of the designers being appointed to the scheme. This provided the opportunity to set the project up for success from the very outset and follow a compliant process.

The information requirements were developed fully around open standards and documented using the IFC 2x3 schema. This was supplemented with additional properties required by the COBie schema and then further enhanced with additional client requirements.

The use of classification references was important and this included Uniclass 2015 as the primary classification as well as NRM1 (to support quantification and costing) and a bespoke classification to allow the DfE to define and assess spatial design information. This was all captured within the structure of IFC.

All information requirements were documented in an Information Management Platform (IMP), which was a combination of technology solutions including Notion, Airtable and Whimsical. Collectively this approach was referred to as the project's 'Information Hub'.

The Information Hub is integrated with other cloud-based technology, such as 3D Repo (cloud-based model viewer) and links to other technology used on the project (e.g., Asite as the project's common data environment).

Work also involved developing processes to support the design team tender process and carrying out capability and capacity assessments of each prospective designer using online forms and reports. This process included an assessment related to the use of open standards.

Upon the appointment of the designers, the team developed resources including a BIM Execution Plan, Detailed Responsibility Matrix, and Master Information Delivery Plan. These lead-appointed party information management resources were then included within the Information Hub directly alongside the DfE's information management resources. This provided a single location for all the resources to be stored, accessed, and managed throughout the life of the project.

The use of open standards as part of the DfE's Exchange Information Requirements meant that designers could be selected irrespective of their software. This resulted in the design team using four different authoring tools to suit their specific requirements.

Highlights

- This research & development project focused on the design/ and affordability of carbon zero schools and was key to informing the future of DfE's approach to information management.
- The project includes two theoretical school designs in urban and rural sites focusing on RIBA Stages 0-4 (design only).
- Seven disciplines (architecture, building services, structures, civils, landscape, ff&e & catering) were involved.
- ISO19650 information management was a key component of R&D aspect.

buildingSMART Tools Used

IFC 2x3 schema (ISO16739:2005), IFC-SPF

Result

The Information Hub was developed as a live site to document the information requirements around open standards, including a database of requirements aligned to the IFC Schema. This approach left no room for ambiguity in delivery, supporting a process that was repeatable, reusable, and reliable.

The approach has now evolved and will now allow it to develop so that Acceptance Criteria, as required by ISO 19650, can be documented, and automatically generate model validation in checking tools.

> "The use of open standards for the Gen Zero project demonstrated that the Department for Education's purposes could be satisfied for this specific project. This has given me confidence to further integrate more of this approach into all future projects with the knowledge that the data requirements can be delivered irrespective of the authoring tools. This, therefore, allows the delivery of best value to continue for all projects by allowing the best teams to be selected."

Department for Education (Client)

SPECIAL MENTION - Design for Buildings

Life-cycle openBIM at Norwegian Viking Age Museum

Statsbygg and AEC3 Deutschland - Norway

Project Description

The Viking Age Museum (VTM), is a prestigious project managed by Statsbygg, the Norwegian Government body responsible for the operation and maintenance of 2300 government buildings. The project adds new exhibition areas, education facilities and a café to the existing museum. The project is challenged by complex building geometry, advanced technical installations, and integration of the extension into the existing building which requires movement of a fragile Viking ship exhibits. The use of openBIM processes was central to overcoming these challenges and to enable efficient project management and as-built handover.

Core Objectives

Four openBIM workflows were required by the project to assist delivery:

- 1. Setting up openBIM requirements and model checking (alpha-numerical information).
- 2. Project dashboard including:
  a. Cost estimation. Pivotal design management information.
  b. Project status. Pivotal project management information.
- 3. Simulated Viking ships transportation. To address a specific project challenge and demonstrate possibilities for innovation.
- 4. As-built digital FM handover. Important information to maintain the value of the building in its lifetime.

About the Project

Workflow 1. Working in collaboration with consultant AEC3 Germany, Statsbygg developed a standardized workflow for all its projects to quality assure all model deliverables. Central to the workflow is the specification of information requirements.

The solution checks the existence of information items within the required property sets. To check allowable values deeper, Regular Expressions (RegEx) have been developed for the most important information such as naming and classification. While the buildingSMART standard mvdXML can be used, deeper check using RegEx require the enhancement of mvdXML.

All quantitative alphanumerical information requirements at object level are documented in the requirement database BIMQ, developed together with consultant AEC3. Statsbygg developed an information standard in collaboration with other large public Norwegian client organizations, with a generic requirement set describing the need for an “average commercial building”.

The BIM delivery agreement process follows the methodology described in ISO 19650-2 and CEN/TR 17654. The requirements can be reported as human-readable requirements, PDF or ODT as required for each discipline and project stage.

Workflow 2. Project cost control is the pivotal factor when deciding whether a project can be executed or not. openBIM-based cost estimation is precise and efficient. Norwegian cost estimation is based on standards for building specification, classification, and production quality, making it more streamlined.

Workflow 3. Simulating the Viking ship's transportation was one of the most challenging activities of the project. During the construction, the ships will be stored in the existing building with as little physical transportation as possible required to relocate them into their new permanent location. Each ship is scanned and modelled as IFC files and transportation simulated using the IFC objects created.

Workflow 4. As-built digital FM handover is critical to enable Statsbygg to manage, operate and maintain all 2.300 of its buildings based on digital, standardized information. This requires projects to handover models for FM and building operation, updated with design changes during the construction stage. The digital twin handover is an integral part of the building documentation and uses a common openBIM, solution, Dalux FM for building operation. A Norwegian implementation of ISO 81346 is used to identify systems and objects allowing automated linking between the models and documentation.

Highlights

Hundreds of successfully executed projects since 2011 have demonstrated that it is possible to work efficiently with openBIM workflow. Several successful local and regional openBIM applications have been developed to support different parts of project execution.

Standardized openBIM requirements across all projects makes the development of the industry more predictable. When large client organizations and the National standardization body are coordinated and pull in the same direction it makes investments into streamlining openBIM worth the effort.

The project identified that openBIM requires a relatively high level of competence among clients, architects, engineers, and contractors, including both an overall understanding of the importance of delivering standardized structured information and more specific technical competence on how to set the chosen authoring tools to deliver according to buildingSMART standards.

buildingSMART Tools Used

mvdXML, RegX, IFC

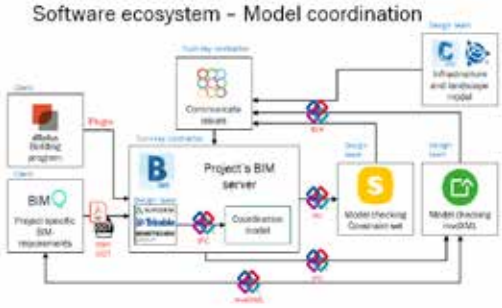
Result

The project has demonstrated that integrating openBIM into project execution and facilities management, operation and maintenance of buildings is the way forward. However, changing the industry to become digital, automated and sustainable requires major changes in business culture, and motivation of individuals.

It has also highlighted that owners must initiate and finance development to help drive industry standards and software and deliver to openBIM standards. As such dialogue with local software vendors must be increased to increase support and deliver to requirements.

> "Use of buildingSMART standards have has provided Statsbygg with the opportunity to specify relevant, project specific requirements based on a common information standard. We have developed a common workflow resulting in high quality information models. We can provide all our projects with a low-threshold project dashboard with live management information. This results in cross-discipline coordination, design-to-cost and to user requirements, safe-guarding of Viking artifacts and handover of information model linked to documentation to operation and maintenance."

Steen Sunesen, Statsbygg



WINNER - Design for Infrastructure

Application of openBIM in the Design and Delivery of Guangzhou-Zhanjiang High-speed Railway

China Railway Design Corporation - China

Project Description

The new 400km Guangzhou-Zhanjiang high-speed railway is being constructed in South East China just north of Hong Kong for the Guangdong Guangzhan Railway Company and runs from Guangzhou Railway Station west to Zhanjiang.

The line passes through eight new stations at Foshan, Shinkansen Airport Station, Xinxing South Station, Yangchun East Station, Yangjiang North Station, Mata Station, Maoming South Station, Wuchuan Station, before terminating at the new Zhanjiang North Station. The project is expected to be completed in 2025.

Core Objectives

The use of openBIM technology throughout the design and construction process should improve design efficiency, and ensure that quality and safety are increased during construction. By establishing a “one model; the whole life cycle” digital approach across all domains and phases, the project will achieve benefits in design, optimization, construction, management, operation, and maintenance. In the longer term, this foundation will aid further research into the technical and management issues around the accelerated use of BIM in railway design and construction.

About the Project

The need for this new high-speed rail line was established by Guangdong Guangzhan Railway Company in 2020. The China Railway Design Corporation was appointed as designer and general contractor for the project and established a BIM Execution Plan (BEP) for the project in 2021, a plan developed and based on ISO 19650 and openBIM standards.

This plan was applied throughout the whole process of design, review and delivery to realize a fully digital exchange of design information enabling design to start rapidly in 2021 and move to implementation in 2022. Construction started in 2023 for a rapid two-year delivery program.

Construction is being carried out by a joint venture of construction contractors, formed between the China Railway Guangzhou Engineering Group Company, the China Railway 14th Bureau Group Corporation and the China Railway No.2 Engineering Group Company. The project features 400km of twin 350km/h high-speed track, of which some 56% is constructed on bridges and 22% in tunnels.

In the planning phase, the ISO 19650 process was adopted to collect the information requirements of the main stakeholders such as the appointing party, the general contractor and the construction contractors. One key information requirement stipulated that the contractor

should establish “a BIM and information system in accordance with the relevant requirements of the developer or the supervisory parties”. BIM and information system in accordance with the relevant requirements of the developer or the supervisory parties”.

As such, a two-level CDE platform for design and construction was developed to meet the requirements of collaboration while ensuring that BIM data can be compatibly transferred to the construction phase and the construction management platform.

Based on the IFC standard and Model View Definitions theory, an IFC data review tool was developed to visually analyze the IFC types, properties, and relationships. This was implemented using automatic semantic completion and correction of the data of IFC 4 and IFC 2x3.

The software was developed based on the BIM Collaboration Format (BCF) standard to capture and manage design issues was developed to enable the collaborative review of BIM models between multiple parties and software platforms.

Highlights

- In the planning phase, the ISO 19650 process was adopted to collect the information requirements of the main stakeholders.
- A two-level CDE platform for design and construction was developed to enable collaboration and easily transfer BIM data.
- An IFC data review tool was developed to visually analyze the IFC types, properties, and relationships, and enable automatic semantic completion and correction of data.
- The software was created to capture and manage design issues and allow the collaborative review of BIM models.

buildingSMART Tools Used

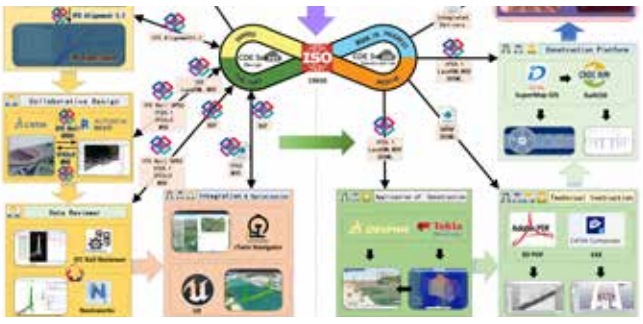
IFC 4, IFC 2x3, MVD, BCF, LandXML MVD

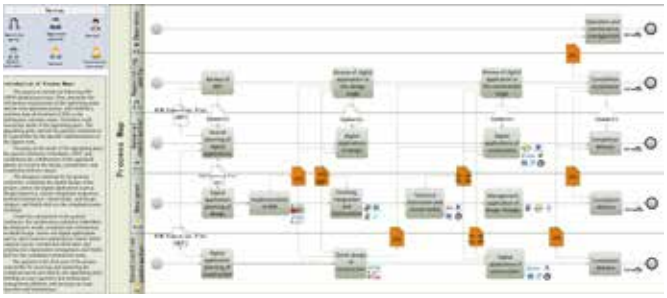
Result

The use of openBIM technology based on ISO 19650 standard has enabled information requirements, responsibility matrix, project information delivery planning and milestones to be established and communicated early. This led to the establishment of a BIM execution plan and two level CDE, incorporating IFC standard extension, deployment and application and ease of information generation and model review. The use of BCF BIM collaboration format aided the identification and optimization of design clashes and enabled efficient model checking and information transfer. Design and construction have been aided through the use of virtual reality engineering visualization and enabled intelligent management during tunnel construction.

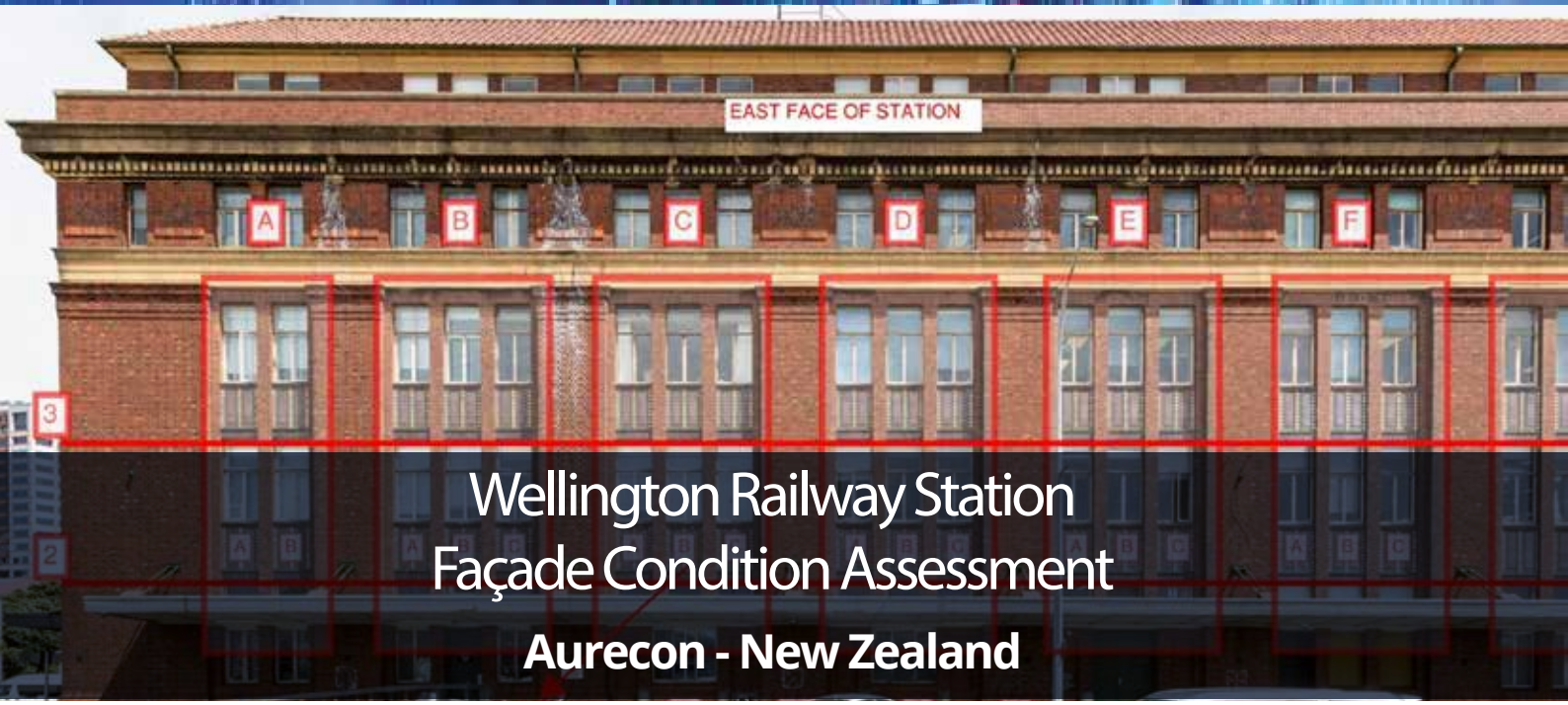
> “China Railway Design Corporation (CRDC) has actively participated in the development of the IFC standard, and has developed a corresponding software system based on the standard. The system has been applied in many projects, and significant benefits have been seen in the aspects of design quality, risk management and control, and construction progress of the EPC project. In the future, CRDC will continue to deeply participate in the development of buildingSMART standards, and to iterate and upgrade the software system continuously.”

QI Chunyu, China Railway Design Corporation





WINNER - Facilities Management



Wellington Railway Station Façade Condition Assessment

Aurecon - New Zealand

Project Description

Consultant Aurecon was engaged by KiwiRail, New Zealand's railway owner and operator, to provide a system that enables a heritage architect to conduct a condition assessment of six of the Wellington Railway Station façades made up of 168 panels with 5,562 tiles in varying conditions and at risk of failing due to their age and design. With many of the panels being out of direct line of view or high in the air, and with the Covid pandemic lockdowns preventing physical inspection, the project provided an ideal opportunity for remote assessment.

Core Objectives

This project enabled consultant Aurecon to successfully conduct a virtual condition assessment of the Wellington Railway Station façade tiles and for KiwiRail's Heritage Architect to review the spatial layouts provided to better understand the relative risks for the different tile damage types identified. A visual report or model enabled the inspection data to be presented and provided an opportunity to detect trends of tile damage.

About the Project

The Wellington Railway station is a neoclassical building, constructed from a steel substructure, with reinforced concrete slabs and panels, with brick cladding. Underneath most window casings are the panels of terracotta tiles in different states of condition, which are the subject of this project.

Remote assessment of the facades was carried out using point cloud with LiDAR and high-resolution photography. This data was then referenced to a sophisticated location-based asset tagging structure governed by a spatial hierarchy such as façade orientation, level, panel, and tile position, and tile type, plus other predefined tags such as damage types and severity.

Due to the number of tiles, a novel approach to data entry and automation was required. Blender3D was chosen early to receive condition data as the model generator, which was anticipated to be able to connect to Blender's internal rendering tools to provide these insights throughPython scripting and access to materials and lighting systems.

Remote access to the model allowed the heritage architecture organisation to navigate through the panels and identify damaged areas. The model also enabled damage replication to be flagged, enabling the heritage architect to collect adjacent rows and columns of tiles, with a linear, diagonal or area pattern via simple integer fields in BIM360. This was mapped to the tagging standard to ensure the correct collection of tiles

for the particular damage issue.

The use of IFC as a receiving schema and the Python connectors provided by this early version of BlenderBIM meant that a high degree of automation was achieved.

A script to perform colourations based on both severity and damage type was run to create visual output reports on a façade-by-façade basis. This output also identified the number of tiles in severity groups and generated a report for damage triage and any procurement necessary.

Sophisticated scripting helped to prioritise the highest damage severity for a tile and identify how different damage issues can affect more than one tile. With this process the team was able to provide insight on a large volume of assets.

Highlights

- 'Computational' thinking was used in the configuration of BIM360 locations, issue types and replication options that were anticipated to be used by digital model data structures. This enabled 'future proofing' and provided automation through data standardisation.
- The connection of the locational data to the model via CSV files andPython scripting, enabled the generation of BIM elements, with correct tagging and naming standards to be regenerated and injected with data with the click of a button.
- Approximately 80 hours of manual elevation creation were eliminated by reading tables and shading individual tiles according to severity and damage type.
- Asset information thinking, in the form of a lean approach to damage as assets, enabled the focus of the condition assessment team to capture only the data required, enabling them to focus on 2,449 damage issues rather than an assessment of all 5,562 individual tiles.
- The ability to accumulate a programmatically produced bill of materials based on severity level, eliminated the requirement for manual counting and reduced the potential for error.

buildingSMART Tools Used

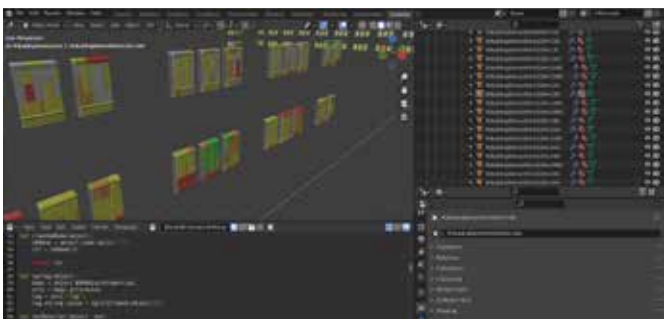
IFC 4

Result

The project demonstrated the long-term benefit of connecting structured data to building elements, especially in relation to emerging facilities management practices for existing structures. The use of remote monitoring reduced the cost of site visits and eliminated the health and safety risks of working at height. Computational thinking and openBIM also helped eliminate manual data handling, improved data reliability and enabled the perpetual storage of asset and condition information, recorded against assets tagged according to location hierarchies.

> "IFC provided benefit through a comprehensive and ready-to-use schema, which enabled the connection between coding libraries, visualisation and spreadsheeting tools for the aggregation and summarisation of quantities. This then enabled the client and project team to remotely collaborate on digital outputs instead of being constrained to the production of many duplicated versions of physical, 2D documents where the number of tile assets and issue mapping would have prohibited timely delivery of the project."

Matt Randell, Aurecon



WINNER - Handover

Handover to FM with openBIM - Marshal's Office, West Pomerania

Mostostal Warszawa S.A. - Poland

Project Description

Mostostal Warszawa's Facility Management platform is a new product that was designed and developed in close cooperation with the client and future users of the platform during the design and construction of the Marshal's Office, a new passive House standard government office complex in West Pomerania, northwestern Poland. The project included the development of a BIM viewer and an asset register that communicates with the other modules of the FM platform and Building Management System and allows the facility manager to get real-time data about energy usage, critical equipment work hours and connect this information to a specific BIM element serving as a digital twin.

Core Objectives

The strategic goals for BIM implementation on the project included the need to extend openBIM into the handover and FM stage of the new government office building. That means designing and implementing a fully operational FM platform from day one. To underpin this the team committed to implementing an openBIM framework across entire project and supply chain, incorporating best practices throughout this process and to engaging the client in the outcome.

About the Project

The new Marshal's Office is a €44 million design and build government office complex in the West Pomeranian province of northwestern Poland. The buildings are designed and certified to Passive House standard.

The project aim was to build a modern government office complex consisting of two buildings Z1 and Z2. Building Z1 needed to be deeply renovated and thermo-modernized to minimize heat loss and significantly reduce operating costs in the long run and was handed over in January 2022. Building Z2 is a new construction built to Passive House building standard.

From the start of the design process the client required the design and implementation of a new FM platform that would simplify and increase the efficiency of the future building operation and management.

Involving the client team in the solution was a vital first step and so during the design and implementation of this platform 15 representatives from all departments of the Marshal's Office were engaged along with the future Facilities Manager.

By working closely with future users of the FM platform and listening to their feedback the client information could be adjusted requirements and allowed changes to be made to the way

information was collected from the supply chain. It also sped up the migration process of asset information to the FM platform.

An AIM module was developed from scratch which included a BIM viewer and IFC importer. The IFC importer leveraged all the built asset geometry and information gathered from the design and construction stages and brought them into the O&M stage.

From the beginning of the project, a strong emphasis was placed on quality assurance and control of design, BIM models and data. Multidisciplinary coordination, clash detection and model quality checks were based entirely on IFC models and the IDS. All issues were communicated with BCFs via issue management platform.

Highlights

The project had a number of distinct phases:

BEP and mobilization phase: This phase helped us to test software, exchange procedures, develop an Information Delivery Specification (IDS) and deepen key project participants' understanding.

Multidisciplinary coordination, model, and data quality control: Multidisciplinary coordination, clash detection and model quality checks were based entirely on IFC models and the IDS. All issues were communicated with BCFs via issue management platform.

As-built changes and model validation: It is challenging to deliver an as-built model that is coherent with reality, but it was even more so on this site due to the fast pace of the project and the number of subcontractors involved.

Design and implementation of the facility management platform: The Client required the design and implementation of an FM platform consisting of 4 modules: AIM, CAFM, CMMS, EMS.

Data acquisition: Hundreds of documents including the information extracted from them as well as information coming straight from site, needed to be associated with BIM components, classifications, systems, and types.

Digital commissioning: Helped to register and manage all the defects and forward them to our subcontractors.

buildingSMART Tools Used

IFC 2x3, BCF , IDM, IDS, mvdXML, COBie

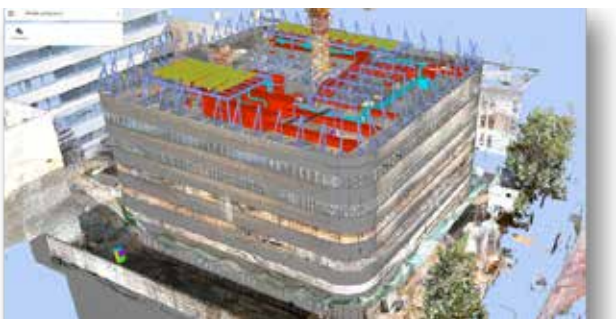
Result

Following the development work carried out on the Marshal's Office project, the new FM platform and AIM module has now been made available to more users. This includes 100 clients – 80% of which are public sector organisations - who can now use the new openBIM functionalities of the FM platform. This means that some 2500 buildings are already operated using the platform.

The project is still a work in progress and continues to promote the use of IFC and COBie standards for the industry with increasing client awareness of the benefits.

> "The openBIM approach gave us the possibility of using BIM models at every stage of the project. As a core component of the AIM module on the FM platform, BIM documentation prepared in the openBIM standard will ensure that the BIM models will be easy to use and manage throughout the course of facility operations."

Project Client



SPECIAL MENTION - Handover

bSI Information Delivery Specification (IDS) for integrated openBIM and openGIS Platform

Strategic Building Innovation - USA

Project Description

The Hong Kong Lands Department's (LandsD) project to assure and control the quality of the government data repository is central to its five-year roadmap for the development and implementation of the new Open Standards Government BIM Data Repository (GBDR) to store and serve 300,000+ IFC models in the future. The main tasks for the initial stage of the project were to develop Information Delivery Specifications for the data, IFC guidelines for meeting the IDS, and an IDS checker for checking IFC models to be stored. LandsD also coordinated efforts among several other government agencies that will supply BIM files to LandsD. These included Drainage Services Department, Water Supplies Department, Civil Engineering and Development Department, Highways Department, Architectural Services Department, and Electrical and Mechanical Services Department.

Core Objectives

As government agencies around the world increasingly use Building Information Models to improve the efficiency and effectiveness of city management, the number of models stored in central data repositories is growing. Hong Kong foresees collecting 300,000 and this number will grow as road and bridge models are added to repositories. The challenge identified by Hong Kong's Lands Department (LandsD) was to help government agencies to assure and control the quality of this growing number of models and ensure that they consistently meet thr required specification.

About the Project

From 2021, the Hong Kong Lands Department (LandsD) has been developing a five-year roadmap for the Open Standards Government BIM Data Repository (GBDR). The vision of the roadmap was to integrate openBIM and openGIS data and create a data repository that is scalable, serviceable, and shareable. After a pilot study with around 260 native models collected from seven government contracts, LandsD quickly realized this could not be done without a "neutral" format, information requirements, and harmonization.

With a mix of proprietary formats, the data repository will suffer from inconsistency and lack of required entities, properties, or property values. For the data to be scalable, serviceable, and shareable, the data repository had to be developed based on open standards.

LandsD's project meets this challenge by supporting the streaming of integrated data to GBDR using Information Delivery Specifications and a new IDS Checker tool. It was achieved

by bringing together openBIM and openGIS expertise from the US, Asia, and the European Union.

To enable the proof-of-concept study, LandsD developed a written IDS set based on use cases, converted them into machine-readable files (idsXML), and developed an IDS Checker that reads the files and checks the IFC models uploaded to the GBDR.

The IDS Checker was tested with 149 IFC models and the results were quantified. The IDS Checker will eventually be used to validate IFC models handed over to LandsD before they are stored in the GBDR.

The project team contributed to the development of bSI's IDS standard by sharing examples and code sets, providing feedback, suggesting improvements, and responding to requests and collaborating with bSI's IDS group. At bSI's invitation, the project team have presented project experience and openBIM+openGIS knowledge during a number of bSI events.

Highlights

- Information Delivery Specifications (IDSs) were defined to support the use cases of the Open Standards Government BIM Data Repository (GBDR), including a key use case: integration of openBIM and openGIS for creating a city model.
- IFC entities, attributes, properties, and property values were identified to be checked based on the IDS sets.
- The IDS Checker was developed based on the latest version of IDS, version 0.5, on buildingSMART International's GitHub website.
- The IDS Checker was validated with IFC models stored in the Open Standards GBDR. The validation involved running 149 IFC models (47 building IFC models and 102 infrastructure IFC models) through IDS Checker and generating metrics, showing the quality of IFC models.
- IFC models stored in the Open Standards GBDR were validated for a number of use cases including a 4D-based decision support system at an urban scale.

buildingSMART Tools Used

IFC 4, BCF, IDM, IDS

Result

One of the advantages of using buildingSMART International's (bSI's) new Information Delivery Specification (IDS) standard is that IDS will be transferable between BIM tools when software vendors adopt bSI's IDS standard and develop functions or plugins for reading machine-readable IDS files. However, there are some downsides to IDS:

(1) the checks are usually limited to the schema (data structure) level or, more specifically, checking the information related to IFC entity type, classification, property, attribute, material, and range of values,

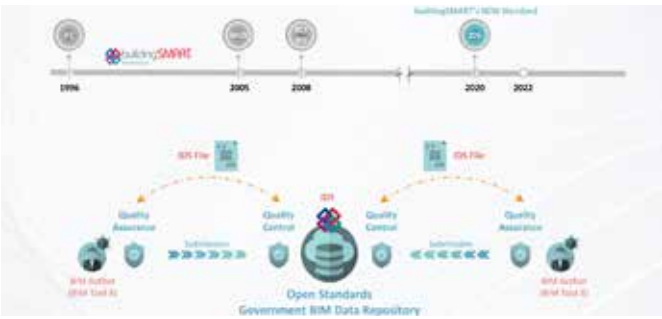
(2) the checks are not applicable to geometric information, such as dimensions, and

(3) the checks requiring complex logical assessment, such as if statements, are difficult to implement.

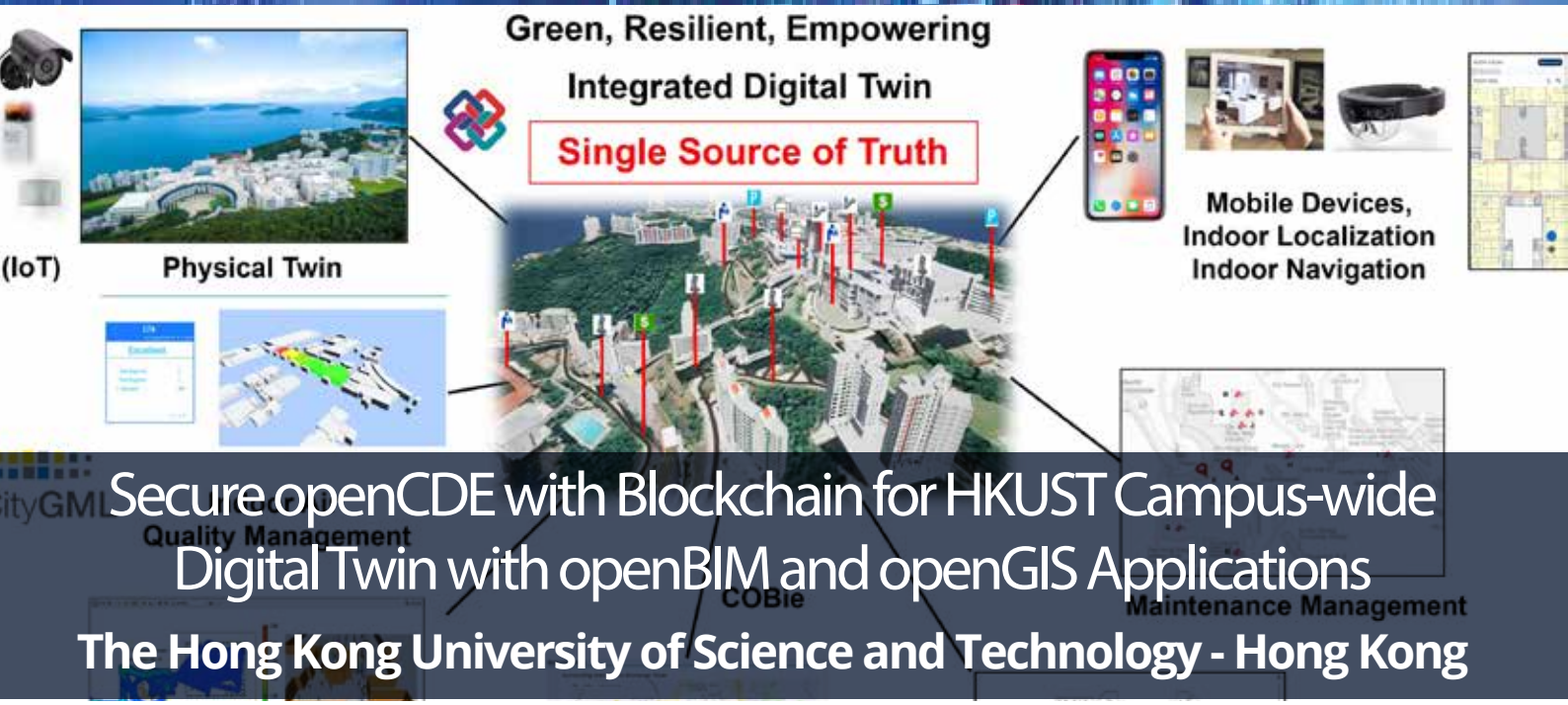
To address these limitations, LandsD's project teams have categorized information specifications that can be expressed with bSI's IDS standard and so can be used with the IDS Checker. It is recommended that other project teams in our bSI community to take a similar approach and encourage solution providers to adopt IDS and develop plugins or functions for reading idsXML files.

> "The project was one of the first and largest implementation of IDS at this scale with the repository being designed to store around 300,000 project models in the future. By using openBIM, it provides a reproducible process that can be adapted by others."

Min Song, Strategic Building Innovation



WINNER - Professional Research



Secure openCDE with Blockchain for HKUST Campus-wide Digital Twin with openBIM and openGIS Applications

The Hong Kong University of Science and Technology - Hong Kong

Project Description

This research project by Prof. Jack C.P. Cheng of the Hong Kong University of Science and Technology (HKUST) used the university campus as a testbed to create a digital twin to transform and improve facilities management (FM) activities. The project "Digital Twin for HKUST Campus" created 3D BIM models in Autodesk Revit based mainly on CAD drawings and field survey but was also supported by laser scanning technology. It will eventually model the entire HKUST campus, including the academic buildings, student/staff halls and the landscape. The model brings together diverse data sources that are traditionally scattered across different databases and has successfully made information retrieval more efficient and useful, significantly speeding up and reducing the cost of facilities management activities.

Core Objectives

A digital twin which integrates BIM models and IoT networks to represent a physical building in real-time is central to modern facilities management activities. However, the existing common data environments (CDEs) lack adequate data security and data integration which is seen as a crucial part of the process. It is also vital to balance the need to constantly update the digital twin with the need to retain access to historical data, vital in the FM process for tracking the lifecycle of the FM processes and official audits.

About the Project

The Hong Kong University of Science and Technology (HKUST) has a vision to create a campus-wide digital twin to assist the facilities management operations by integrating all assets and systems into a single hub. This means digitizing over 60 buildings covering a total floor area of about 500,000 m^2. The aim of the project is to demonstrate how this technology can transform FM practices to be more efficient and able to deliver occupants higher levels of comfort and enjoyment of the campus.

Routine facilities management activities require information such as spatial layout plans, historical maintenance records and real-time sensing data, to be accessed from a variety of locations and from multiple data sources. However, these sources are traditionally scattered among different databases or systems.

This research aims to meet this goal by addressing four main challenges:

(1) Integrating multiple BIM sub-models of an area into a single platform: BIM focuses on detailed components inside an individual building; Geographic Information System (GIS) stores the geospatial data and their topological

relation in a wide area. Integrating BIM and GIS data without information loss is crucial.

(2) Integrating IoT data with BIM-GIS to support facility condition monitoring: While BIM/GIS stores a digital model of the facility, IoT data from remote sensors are isolated and scattered.

(3) Integrating BMS information with BIM data to support HVAC system monitoring: A uniform schema is needed to support the integration of data from different sources, including BIM, BMS and IoT.

(4) Managing all the facility data securely for FM practices: Once the BIM, GIS, IoT and BMS data is brought together, a methodology is needed to ensure secure data management. Currently, common data environment (CDE) is used to store and share data among different parties. However, the existing CDEs lack adequate data security to enable safe sharing across multiple end-users.

Highlights

- Project time shortened by 38 days.
- Project cost reduced by around HK$430,000.
- Indoor sustainability analysis based on openBIM model and eQUEST allowed total energy consumption and operational carbon to be cut by 32%.
- HKUST Digital Twin mobile app was developed by integrating openBIM & Unity game engine and meant that the BIM models file size was reduced by 43% for visualization, space & IAQ query.
- IoT data was integrated into the ArcGIS web app for better visualization and query allowing six types of IoT data integrated.
- A virtual tour was enabled with 360 degree panoramic images created from 85 panorama stations to provide a more intuitive understanding of the actual indoor environment.

buildingSMART Tools Used

IFC, MVD, IDM, openCDE, openCDE APIs

Result

The research achieves four key outcomes:

(1) The use of and openBIM, a IFC data model enabled seamless BIM-GIS integration, and a realistic 3D topology of the entire HKUST to be captured in rich detail. The IFC schema is interoperable with Esri ArcGIS platform, where an online dashboard for web-based model interaction and query was developed.

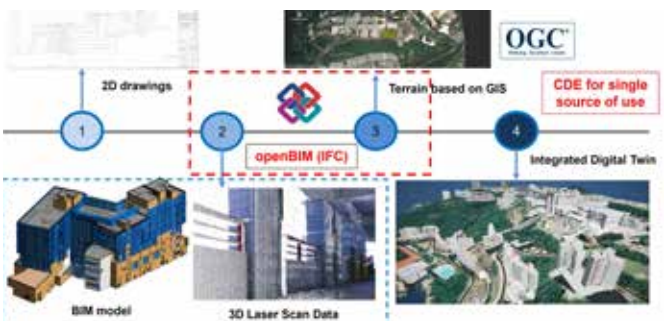
(2) The BIM-GIS model is integrated with distributed IoT data based on openGIS. An extended CityGML model incorporates real-time IoT data, which are parsed from other HKUST portals with a Python API. A mobile app enables the general public to see operational performance of, for example, indoor air quality.

(3) The BMS data is integrated into the BIM-GIS model, including air-conditioning system performance. With an open ontology called Brick schema, the interaction between the BMS and the surrounding geometry is captured.

(4) A secure openCDE has a blockchain model which encrypts FM data and authenticates staff permission level before granting access privileges. This gives high integrity, authentication, and transparency of data sharing among different FM parties.

> "The openBIM (with extended IFC schema) allows seamless BIM-GIS integration, preserving building attributes when geo-referenced into GIS landscape. Furthermore, the openGIS (with extended CityGML schema) integrates IoT data into the BIM-GIS model, supporting IAQ and walkability monitoring. Open ontology correlates HVAC operation from BMS with IFC geometry, IDM and MVD for energy usage estimation towards sustainable asset management. Eventually, our blockchain model (with openCDE Documents API) ensures secure and authenticated access control."

Prof. Jack C.P. Cheng, HKUST



FINALIST - Professional Research

State of Preservation Domain to Document Existing and Historic Buildings

University of Naples Federico II - Italy

Project Description

The research team from the University Federico II in Naples set out to create a new standardised digital workflow to help document the condition of historic buildings and support on-going conservation planning activities. This so-called HBIM (BIM for Historical / Heritage Architecture) uses advanced openBIM methodologies and technologies to define the structure to assess the vast and complex technical requirements for maintenance and preservation of historic assets.

Core Objectives

To date, there are no BIM tools designed specifically for the specific characteristics of historic buildings. Although some BIM authoring software provides functions to document graphical degradation data, there are critical issues regarding the way non-graphical information is structured which hinders the full sharing across different users and skills. The project addresses this challenge by creating a new operational HBIM workflow for historic buildings and a standardised way to organize and structure data, based on the architectural heritage and condition of materials and the historical value and architectural interest of artefacts.

About the Project

The project creates a new domain standard for documenting the condition of preservation of historic artefacts. This captures the type of material and the different conditions found during on-site inspection and specifies the documentation needed to support decision-making processes required for any preservation intervention needed.

The workflow was originated in Italy as historic structures are deeply rooted in the national fabric. Naples, for example, has some 393 historic churches plus another 112 closed churches, all requiring regular inspection and maintenance.

The project standardizes workflows and uses openBIM formats to ensure higher quality, shareability and reliability of data. The aim is to develop a common language in openBIM, supporting AEC operators, helping public administrations and contractors to validate an HBIM product.

Information is structured through a precise codification that makes it interpretable even by artificial intelligence, thus enabling and optimizing the entire information mapping process.

The project has a number of stages in the workflow:

- Create a bSDD document ‘‘stato di conservazione’’ to document the historic building’s condition,
- Add a classification and all the relative information (Synonyms, country, data, relations),
- Add specific properties with all the information required,
- creates relationships between classes and properties and assigns permitted values,
- Upload the IFC file on usBIM,
- Start usBIM.bSDD and choose the created bSDD classification,
- Select the IFC elements on the model, find their classification and add to it the elements,
- Download the IFC file edited with usBIM. bSDD,
- Open the IFC file with any IFC viewer and read the information.

The entire project has been implemented with openBIM standards and methodologies, using exclusively non-proprietary open formats, to guarantee an interoperable and collaborative workflow that free of any technological constraints or limitations related to the use of specific software or formats.

The workflow has been applied as a trial to document the preservation of the Church of San Pietro in Vinculis in Naples, Italy. This building is a typical example of the artifacts and assets of historical interest known to be maintained and safeguarded and that would benefit from digital intervention.

This validation has made it possible to devise a “state of conservation” classification structure that will be able to suggest to professionals how to intervene on an artefact, taking into account the conditions affecting the structure and drawings

Highlights

The HBIM project workflow consists of the following steps:

- 3D graphical mapping of decays and alterations in a BIM model using ACCA’s BIM Authoring software ‘Edificius’,
- export of the model in IFC format,
- in-depth study of existing prescriptions and indications concerning the documentation of the state of preservation of building materials,
- identification of typical materials of buildings of historical interest (stone materials, wood, metals),
- identification of pathologies divided into alterations and decays,
- identification of the properties and parameters required to define individual alterations and decays,
- systemisation of information into classes, subclasses, properties and property sets,
- export of the .json file and validation in bSDD,
- application of the “Conservation State” domain to the IFC model through the usBIM cloud and the specific tool usBIM.bSDD,
- verification of results with an IFC viewer.

buildingSMART Tools Used

bSDD, IFC, IFD standard ISO 12006-3

Result

This project has created a useful tool to help designers exchange survey information on historic structures and the simplify the identification of required interventions.

By following the bSDD guidance on .json files and using the “editor” functionality of usBIM.bSDD it was possible to create the classification and

FINALIST - Professional Research

TPF-5(372) BIM for Bridges and Structures Transportation Pooled Fund

HDR - USA

Project Description

The TPF-5 (372) BIM for Bridges and Structures project is to develop a standard way to exchange 3D models and other digital data for conventional workhorse bridges in the United States based on the Industry Foundation Classes (IFC) standard. Workhorse bridges in the US are defined as those with spans of less than 300 feet and are generally constant girder-type structures assembled from standard structural components and systems. The work is being performed by a distributed project team with members working virtually from the USA and Germany. The project is led by consultant HDR on behalf of the American Association of State Highway and Transportation Officials (AASHTO) Committee on Bridges and Structures (CBS) Technical Committee on Technology and Software (T-19).

Core Objectives

The US has been increasingly using BIM for project delivery with the ultimate goal of using the design intent model as the key contract document. The US bridge community vision is for the design intent model to replace today's 2D contract drawings, which are currently exchanged as PDF files. The model will be the reliable source of digital information for design and construction and the contractual binding document. The challenge today is that the US bridge community is locked into proprietary digital data files that make it difficult to exchange information between design and construction teams. An information delivery standard that will define the requirements for the exchange of model-based information to execute the construction of highway bridges in the US, specifically to aid construction teams in preparing bid packages and initiating fabrication.

About the Project

This research is being funded by a Transportation Pooled Fund sponsored by 24 state transportation agencies and the United States Department of Transportation (USDOT) under the Federal Highway Administration (FHWA) program.

Although some fabricators have begun employing BIM tools in the fabrication of bridge components, their use in transportation infrastructure is severely limited due to the lack of standardization. It became obvious that in order to take advantage of the efficiencies associated with the use of BIM in transportation structures, a comprehensive strategic plan was needed.

The scope of the TPF-5(372) BIM for Bridges and Structures project is to develop the standards for exchanging bridge information required from design to construction.

The work is based on the buildingSMART International IFC 4x3 schema and the Alignment Based Reference View.

Specific activities to achieve the objective of this project have included:

- Development of an Information Delivery Manual (IDM)
- Development of a Model View Definition (MVD)
- Development of a U.S. Bridge Data Dictionary
- Engagement activities with software vendors to support the development of the Industry Foundation Classes (IFC) 4x3 schema and the MVD being produced under this initiative
- Development of a unit test suite for software developers to test their commercial products functionality to import and export files using the IFC 4x3 schema
- Stakeholder engagement and communication to promote the use of IFC 4x3 to support the exchange of workhorse bridges information from design to construction.

Highlights

The project has now reached substantial completion, having established IDM, thr development of bridge data dictionary, Model View Definition (MDV) and the test suite for software vendors in progress. Highlights and schedule achievements include:

- 2019 - 2024 (Years 1-5) Industry Involvement and Stakeholder Education and Engagement
- 2019 - 2020 (Year 1) Investigation and Exploration
- 2020 - 2022 (Years 2 and 3) Development of IDM and MVD
- 2022 - 2023 (Year 4) Economic Analysis Return on Investment (ROI)
- 2023 - 2024 (Year 5) Software Certification and Technical Support

buildingSMART Tools Used

IFC 4x3, IDM, MDV

Result

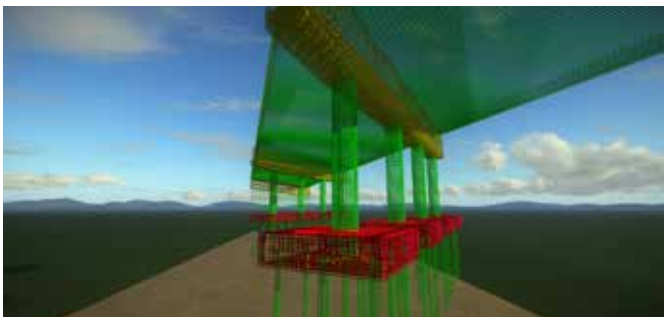
The project is still ongoing, but it is expected that the IDM/MVD will be validated through the unit test suite. The team is also continuing to work collaboratively with software vendors to produce authoring tools for 3D modelling of bridges and structures.

To date, the response from the vendors has been very positive. There have been some preliminary demonstrations from software vendors to show progress and six software vendors have signed letters of intent to support the BIM for Bridges and Structures IDM/MVD into the software, including: All Plan, Autodesk, Bentley Systems, LUSAS, Midasoft.

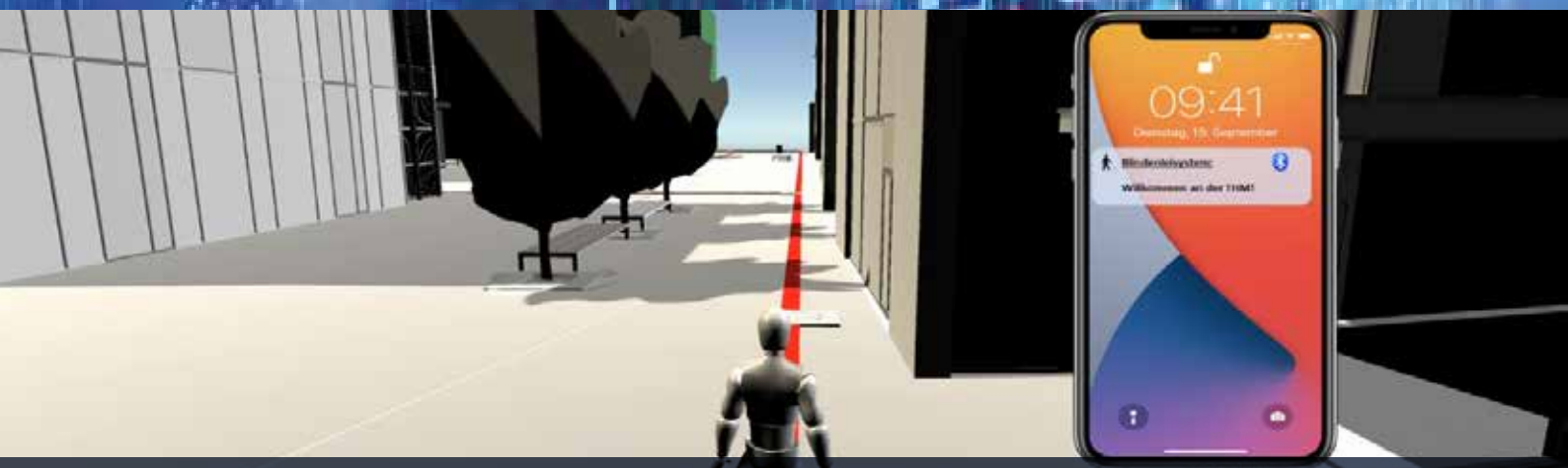
The Technical Committee T-19 will be voting to adopt and publish this IDM as the AASHTO Information Delivery Manual: Guide Specification for Design to Construction Data Exchange for Highway Bridges. When adopted, this standard will serve as the US National Standard for exchange information requirements to support model-based delivery and for the design intent model to become a legal document replacing 2D drawings.

> "The BIM for Bridges and Structures project is unique because its resulting products will provide the key components for enhancing interoperability and enable all State Departments of Transportation in the US to share one common data standard for bridge design and construction of highway bridges."

Alexa Mitchell, HDR



WINNER - Student Research



Implementing passive RFID technology into BIM models in combining them with open-source software applications

THM (University of Applied Sciences Mittelhessen) - Germany

Project Description

This Master's thesis by Abduaziz Juraboev, Research Associate at the Faculty of Civil Engineering, University of Applied Sciences Mittelhessen in Germany, focuses on the implementation of passive RFID technology into BIM models and combining them with open-source software applications to monitor and manage physical structures (buildings, roads, sewer systems and such others) and building materials (e.g. textiles, mineral and plastic floor coverings, concrete components).

Core Objectives

Connecting the parametric BIM models with the physical building elements by using RFID and wireless IoT technologies in a multiplatform application enables the BIM building models to be actively used throughout the life cycle of a building, not only by the facility management, but also by the public for various use cases The challenge was to read the RFID tags in different installation scenarios. Depending on the installation situations (under, over or in the material), various requirements were specified for RFID tags and readers and further hardware developments identified.

About the Project

The integration and installation of Radio Frequency Identification (RFID) tags in combination with wireless Internet of Things (IoT) technologies in Building Information Modelling (BIM) can create connectivity between the physical- and the virtual world.

This research project demonstrated the value of this link, beyond the identification of physical objects, to make further asset information available to different user groups during the entire life cycle of the building structure. By scanning the tagged building elements, complete associated information can be accessed and presented to users via applications, in visual and audio form.

This Master Thesis investigated software and hardware solutions for the integration of RFID and wireless IoT technologies into BIM systems based on two use-cases:

Use Case 1 - Centimeter accurate pedestrian guidance system for the blind and people with limited mobility.

Use Case 2 - Infrastructure Objects in Urban Water Management.

The project aims to find practical applications for bringing these technologies into open BIM processes and provide the preliminary work for these defined applications based on BIM systems and soft- and hardware components.

The aim was to develop a prototype application

as a proof of concept by using the Industry Foundation Classes (IFC STEP 21) data exchange format in the building industries for navigation, tracking, and information systems.

The research of RFID and wireless IoT technologies and their integration into BIM building models were methodically and practically investigated using the following questions:

- What is the current state of the art and research of integrating RFID and IoT technologies in BIM projects?
- Can we use the model-based data in the operating phase of the structure over its life cycle, and would this provide additional value?
- Can digital BIM models be linked to the physical structures in real-time using RFID technology as a digital twin, for example setting up a navigation and positioning system?
- What opportunities are provided by RFID and wireless IoT technologies based on BIM systems for barrier-free mobility and physical infrastructure objects?
- Which software and hardware components can we use to implement RFID and wireless IoT technologies in BIM building models?

Highlights

- RFID technology offers high accuracy in determining the position of objects and battery-free tags are largely maintenance free and have a long service life of 20 to 50 years.
- Passive RFID tags can be easily integrated indoors and outdoors, linked to database information, and integrated into new buildings and existing infrastructure to offer significant added value.
- Interdisciplinary cooperation, model-oriented planning, and model-based communication play an important role in the development and practical implementation of the RFID and wireless IoT technologies in BIM.
- Resources over the entire life cycle of a building can be tracked, and the product and object data made transparently available for further use.
- The integration of RFID and wireless IoT technologies into BIM models adds value by bringing together people, tools and processes during the life-cycle of structures.

buildingSMART Tools Used

IFC

Result

The research results show that by integrating RFID tags as BIM objects into building elements during the planning phase, the physical objects can be linked to digital BIM models with the help of “RFID tag” component families, using a serial number to specific coordinates. The developed application is available for connecting BIM models with RFID technology.

The selected software applications are freely available as an open source for proof of concept and can be freely installed in any platform, such as Microsoft Windows or Mac PC operating systems.

A complete digital building model was exported into the opensource in .ifc format. Then the database system (MongoDB) and a JavaScript server (MeteorJS) were set up as a “backend”. The IFC models, including all their information, can then be visualized in common browsers and mobile devices, by connecting the RFID reader.

At the THM Giessen Campus, RFID tags are already installed in the test site. Therefore, these can readily be used, for example, for the development of the first BIM-supported navigation and positioning system using the openNaviBIM app via Bluetooth.

SPECIAL MENTION - Student Research

AR-supported Teaching

TU Wien (Vienna University of Technology) - Austria

Project Description

The AR-supported Teaching project was carried out by TU Wien, the Vienna University of Technology. The project has developed an augmented reality (AR) platform that bridges the gap between AR and Building Information Modelling (BIM) for the education sector. Three applications were developed as vital components of the project: the AR editor, AR viewer and a web application. These allow the creation, viewing and administration of AR teaching scenes and are all based on the openBIM principle.

Core Objectives

At first glance, teachers who want to implement AR in their lessons have a wide choice of software solutions. But a closer look reveals that most of them are not suitable. On the one hand, most AR software manufacturers demand financial compensation. And while some BIM authoring software does provide a number of solutions free of charge, this can lead to a dependency on software manufacturers through proprietary formats. In addition, longer workflows or programming skills are often required leading to high barriers to entry and use.

About the Project

In the AR-supported Teaching project, an AR platform was developed that enables teaching scenes to be created and without specialist programming knowledge. The aim is to make it possible to implement AR in the classroom and to do this the team created three applications, the AR editor – which allows models to be created, the AR viewer – which allows models to be viewed, and the website – which allows interaction to be managed. All applications are functionally separate but interconnected.

Create: With the help of the AR editor, teachers can create AR teaching scenes using IFC files, which they import into the AR editor. The teaching scene can then be adapted or extended with annotations, animations, layers, and buttons while the IFC remains intact. The AR editor saves the contents of a teaching scene in a database, which improves data access and keeps data up to date.

View: The AR viewer enables users to view the created teaching scenes using the device of their choice. Buttons enable self-directed, exploratory learning and speed which is freely selectable to prevent cognitive overload. The “Live Session” function makes a live connection between AR editor and AR viewer. This allows communication between learners and teachers when carrying out remote learning. The user of the AR editor can set markers in the live session and expand it with media files such as images and videos, and an integrated voice and message chat system also supports communication.

Website: A web application is used to administer users. This mainly involves defining user roles and assigning groups to regulate which AR-supported Teaching applications a user can use. Teaching scenes are not user-specific but always refer to groups and can also be created in the web application and downloaded by anyone in the AR viewer.

Highlights

AR-supported Teaching uses three applications:

AR editor

- Imports multiple IFC files
- Enables the addition of didactic elements like: animations, annotations, buttons and layers

AR viewer

- For Android devices
- View the scenes created in the AR editor
- Live session to AR editor and other AR viewers (chat, voice, live pointer)

Website

- Link between AR editor and AR viewer
- Group management
- Project management
- Teaching scene overview

buildingSMART Tools Used

IFC

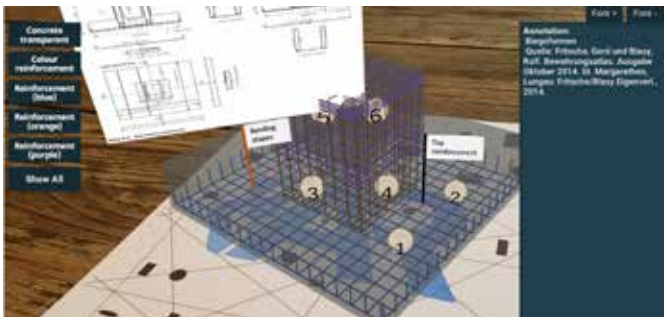
Result

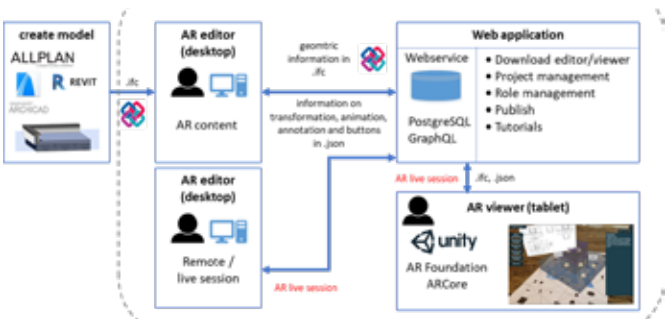
AR-supported Teaching should be freely available to all educational institutions. However, free refers not only to software and training costs) but also to the choice of software. Therefore, the open format IFC is used which allows this vital free selection of the BIM authoring software in educational institutions. openBIM file formats also ensure the longevity of data as the BIM models needed for the teaching scene can also be used in the future. This also means that ongoing adaptation of the import process in the AR editor is not necessary.

The file formats used in AR-supported Teaching (IFC, JSON) are human-readable. Hence, advanced users can develop their own applications to create more complex teaching scenes. Modelling for the teaching scene is done in native software. The model information comes exclusively from the IFC. Therefore, modelling for the teaching scene can take place in any buildingSMART-certified software. This brings openBIM into the classroom and is a clear, visually easy to view introduction for young, interested pupils/students.

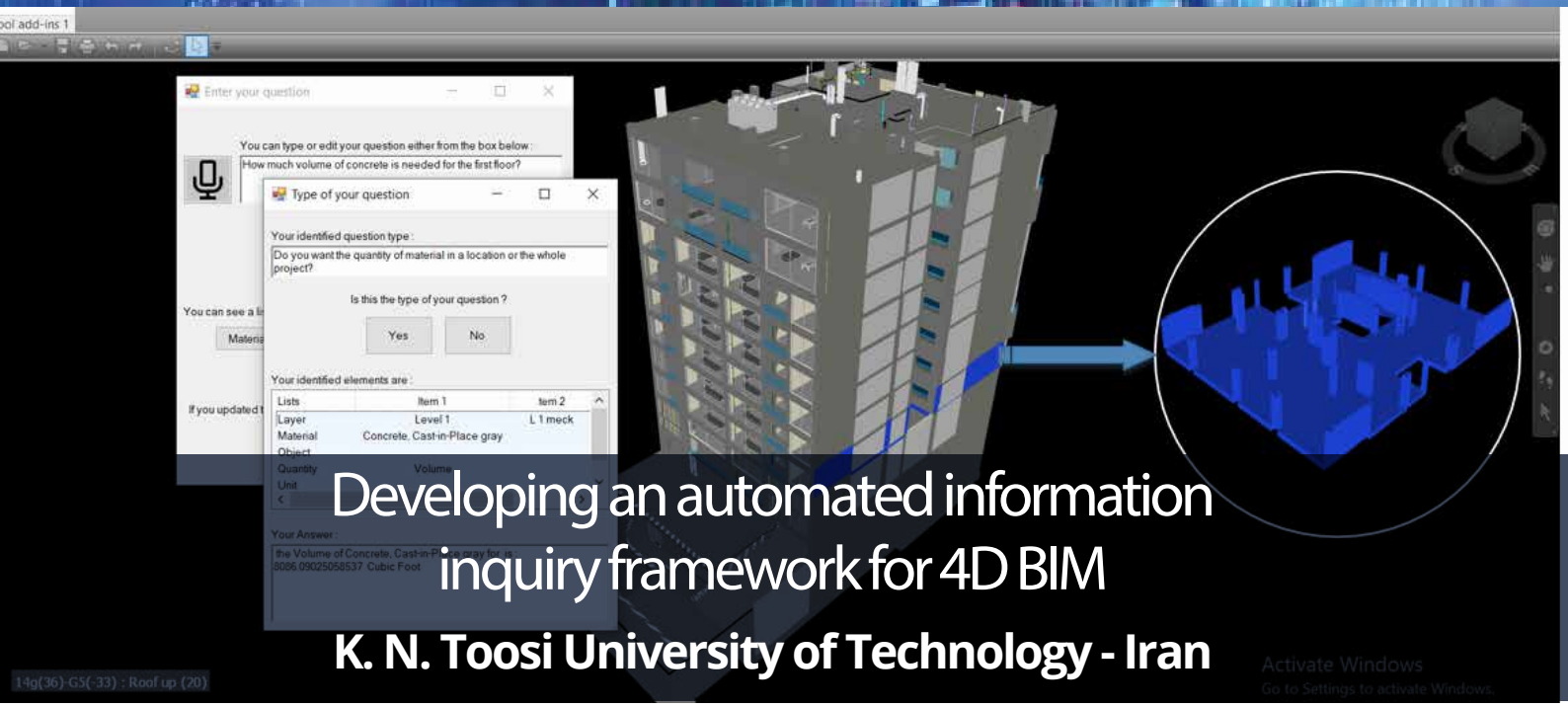
> "IFC acts as the foundation of our AR-supported teaching platform, which allows the free selection of BIM authoring tools while creating educational material. openBIM file formats guarantee the longevity of these efforts. Future edits and adaptations can be carried out with any standard-adhering software and our import process is streamlined by focusing on a single input format. Additionally, students become familiar with IFC as a key technology in their future professions, while exploring problems and challenges in building processes."

Konstantin Höbart, TU Wien





FINALIST - Student Research



Developing an automated information inquiry framework for 4D BIM

K. N. Toosi University of Technology - Iran

Project Description

This project, led by Armin Nabavi, a researcher at the KN Toosi University of Technology, Iran, has developed an automated information inquiry tool for extracting information from 4D BIM models. The project's goals are to accelerate this query and retrieval process and enable non-technical users to have access to the valuable information held in these models. The framework and software create a Siri-like experience allowing users to ask questions in a natural language and receive the answers in just a few seconds. The authors used ifcOWL- a web ontology language presentation of the IFC schema- to semantically understand the input questions and their parameters.

Core Objectives

The project set out to assist, ease and accelerate the process of retrieving information held in BIM models. Current methods of accessing this information can be tedious and time-consuming, particularly for non-technical users, who might have limited or no knowledge of working with BIM software. This project aims to remove any need for specialist skills to access information from BIM models.

About the Project

The use of Building Information Modeling (BIM) technology is key to increasing efficiency throughout the construction process and enabled huge amounts of practical information to stored within BIM models and updated throughout the project lifecycle. However, accessing this information is often a tedious and time-consuming process, particularly for non-technical users.

This research proposes an Artificial Intelligence-based framework to enable the automated retrieval of information to help in BIM models to accelerate and simplify the process.

The project identified a number of challenges both in the way that the search terms are used to seek the right information and in the way that answers are returned to the user - text-based answers may need to be visualized in the model, for example.

This project focuses on accessing 4D BIM information that is important and common in the construction phase, but the goal is to create a BIM assistant that is applicable and available for all BIM models, capable of automatically answering any users' questions during the construction phase.

The proposed framework automates the information query process and includes the following steps:

Step 1: the user's question type is determined through a Support Vector Machine (SVM) algorithm.

Step 2: the question is analyzed with a Natural Language Processing (NLP) algorithm to extract keywords.

Step 3: understanding the user's purpose is critical for the question answering system. Keywords extracted from the last step are expanded through a domain ontology and a general ontology.

Step 4: the identified keywords and expanded terms are mapped to lists of objects, materials, and tasks in the BIM model.

Step 5: an API is called to employ the identified question type and the target terms, find the answer in the BIM, and display them to the users.

One significant advantage of this platform is that anyone can ask questions and achieve responses directly, regardless of their BIM skills, knowledge or experience, so it enables non-technical users to benefit from BIM without intermediaries. Implementation of the platform on the web will increase the accessibility and versatility of the platform, avoiding the need for specialized software or hardware.

Highlights

- The process of answering essential question types in the construction phase is automated.
- Access to 4D BIM information is simplified for non-technical users.
- A more user-friendly environment for Navisworks application is created.
- 4D BIM essential information was accurately discovered.
- Time-consuming manual search of BIM models is eliminated.
- The time taken for the question-and-answer process is significantly reduced.
- The system is able to understand the exact purpose of the user using NLP and openBIM.

buildingSMART Tools Used

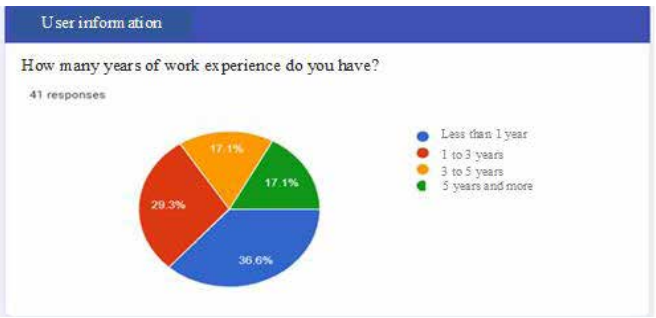
IFC

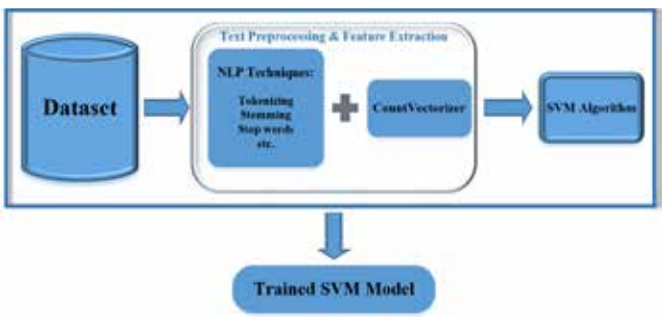
Result

Evaluation of the platform shows that the voice assistant outperforms manual methods of interrogation in five out of six questions investigated in the case study with high accuracy and precision in answering. The platform can correctly recognize the type of user questions and can also understand the exact purpose of the inquiry by using natural language processing (NLP) and ifcOWL ontology and so return the related elements or requirements from the model. Testing has also shown that for five out of six question types, the speed of information retrieval is two to five times faster than manual Quantity Take Off (QTO) in Navisworks.

> "Understanding the user's purpose of their question is a critical part of a question-answering platform. Keywords of the query alone cannot achieve the user's purpose. IfcOWL, which provides a web ontology language representation of the IFC schema, is used to add semantic concepts to the user's query. The query will be expanded utilizing the relationships between concepts in IfcOWL."

Armin Nabavi, K. N. Toosi University of Technology





WINNER - Technology

Implementation of BIM-based building permit process in Estonia

Future Insight - The Netherlands

Project Description

Dutch engineering software consultant Future Insight has designed and delivered a new online building permit checking process for the Ministry of Economic Affairs and Communications of Estonia. The highly automated platform uses information drawn from submitted BIM models and is designed to be used by both the permit applicant and by the permitting authority.
The project is now fully implemented across Estonia and available for use by all civil servants, providing all parties with savings in cost and time plus improvement in the quality of outcome.

Core Objectives

The goal of this project was to build on a proof of concept carried out two years ago and roll out a fully operational, nationwide BIM-based building permit checking service within the Building Registry for the Estonian government.

About the Project

BIM models are increasingly becoming the norm rather than the exception among contractors, developers, and architects and in Estonia is an integral part of the e-construction strategy to create more efficient public services and to provide open access to public data related to the built environment. This project created an easy to use, flexible and scalable BIM checking service within the national Building Registry for the Estonian government and is one of the first steps in this strategy and will help implement BIM in organisations and increase efficiency of public services related to construction.

Estonia will now be one of the first countries in the world to have a nationwide BIM service at its disposal as an aid in permit processing, so that everyone involved can get used to and reap the benefits of using BIM. In the longer term the project will increase the use of BIM and construction digitisation in Estonia, which ultimately should lead to the reduction of building lifecycle costs. It should also improve the efficiency and quality of public services related to the building lifecycle.

The work was built on a proof of concept carried out two years ago and, given the innovative nature of the project and the many external dependencies, the project was approached in an agile way. As BIM will be used more widely in work processes across the built environment, knowledge and support will increase and it will be possible, step by step, to work towards a possibly fully automatic BIM-based permit process in the future.

The following preconditions were the foundation for creating this product and are now standard for every project Future Insight project and activity:

1. The product operates on the basis of open standards. Open standards that enable interoperability and communication between the various components of the system architecture. IFC should be used for the BIM data, according to the international ISO standard 16739: 2017 which is widely supported and often used as a standard.

2. City GML is used for the 3D Digital Twin in accordance with the ISO TC211 components. This is also a standard that is widely supported and used, as it is an international OGC standard that models all characteristics of the built environment. The solution also supports the ISO 19152: 2012 LADM implementation.

3. To enable scalable and easy use, a web-based solution was adopted with a simple user interface. Data storage and transfer are based on online databases. Open API's and web services. The product is in principle scalable, flexible, both vertically and horizontally. This makes it possible to deploy it throughout the Netherlands on a very large scale and very widely. By using open standards the system can easily exchange data with other databases and systems.

While all governments receive various formats of BIM models, the usability and accessibility are not always obvious and so often a missed opportunity, since these models and data have great potential for improving processes the lifecycle of objects and buildings. This project is a step towards helping organisations to utilise that potential.

Highlights

- Provides a user-friendly online solution to review IFC files with the ability to share it internally and externally and store it in a central database.
- Gives the ability to link relevant information to BIM models and provide insight into zoning plans and cadastral maps in the project environment.
- Enables data to be displayed as 2D sections or floor plans, but also visualized as a 3D Digital Twin environment.
- The solution is based on open standards which, partly thanks to the API connection, makes BIM models accessible and sustainable for many applications and personnel within an organisation.

buildingSMART Tools Used

IFC 2x3, IFC 4, bSDD, BCF, IDS

Result

The service is currently being implemented nationwide in Estonia, allowing access to the service for all users for whom BIM design is relevant within Estonia. Both within the government and applicants for permits such as architects and project developers. Since it is a web-based solution that is built using open APIs and international open standards, it is highly scalable and replicable. The service is now being made available nationwide within Estonia and the same web-based basic technology is also being used in projects in the Netherlands, Germany, Hong Kong and the United States. This ecosystem will also be part of the Horizon Europe Accord project in which various parties from the industry, buildingSMART International and the OGC will collaborate on an open standard for BIM-based permit checking.

> "As a government, our goal is to provide efficient public services that are easy to use, transparent and vendor-neutral. openBIM is a key enabler for this because IFC is a widely adopted open standard for digital data exchange in the construction industry. This allows us to build innovative digital services that can quickly be integrated with existing and future workflows in the industry."

Jaan Saar, Ministry of Economic Affairs and Communications Estonia

FINALIST - Technology

AR-supported Teaching

TU Wien (Vienna University of Technology) - Austria

Project Description

AR-supported Teaching is an augmented reality (AR) platform designed to assist teaching in the Architecture, Engineering and Construction (AEC) sector by bringing openBIM into the classroom for young, interested students. It enables teachers to create individual AR teaching scenes without programming knowledge and without the need for expensive subscriptions to software packages. Instead, the basis for this system is a BIM model as IFC, which can be expanded as required with additional content such as annotations, animations, buttons, and layers.

Core Objectives

Teaching currently relies almost exclusively on two-dimensional representations of three-dimensional problems. The goal of the AR-supported Teaching project has been to combine the advantages of Augmented reality (AR) in teaching with those of openBIM so as to better support student learning and help to teachers to instruct how to work with openBIM tools and embrace the “Construction 4.0” environment.

About the Project

The new AR-supported Teaching suite enables three-dimensional teaching scenes to be projected into the environment and experienced by students and teachers in the classroom, helping them to embrace these new technologies as a central part of the engineering design and construction process.

The connection between AR and BIM in the context of teaching is a novel step. The focus is on the intuitive usability of the applications and creating low entry barriers for new users. By using open, standardized formats (IFC and JSON), the BIM model on which the AR teaching scene is based is software-independent.

As such, the full immersive experience of interactive AR teaching scenes can be delivered by simply using smartphones in the classroom without the need for expensive hardware or subscriptions to software suites.

Students views the AR-supported Teaching scenes with the AR viewer through which they can initiate self-directed, exploratory learning, exploring the model and learning at their own speed.

The “Live Session” function makes a live connection between AR editor and AR viewer. This allows communication between learners and teachers even when not together in a classroom. A web application is used to administer users.

Teaching scenes are not user-specific but always refer to groups and can also be created in the web application. Modelling for teaching scenes is done in native software with model information

coming exclusively from the IFC. This gives modelling taking place in any buildingSMART-certified software.

The file formats used in AR-supported Teaching (IFC, JSON) are also human-readable so that advanced users can develop their own applications to create more complex teaching scenes.

Highlights

- For the university assistant, the AR teaching technology enables a clear representation of complicated structures but enables different teaching contents to be displayed and linked centrally in one model.
- For students, complicated geometries are easier to understand, particularly early in learning when experience of spatial thinking is limited. Being able to view real situations in 3D can help to define problems.
- For the BIM operations manager the use of AR teaching tools simplifies the perception of spatial dimensions. The viewer has real reference objects and so can more easily understand relative sizes, making it possible to display scenes that would otherwise be too small, too large or take too long.

buildingSMART Tools Used

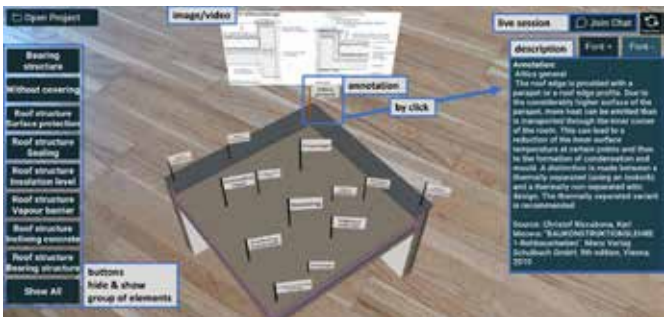
IFC 2x3, IFC 4, ifcXML

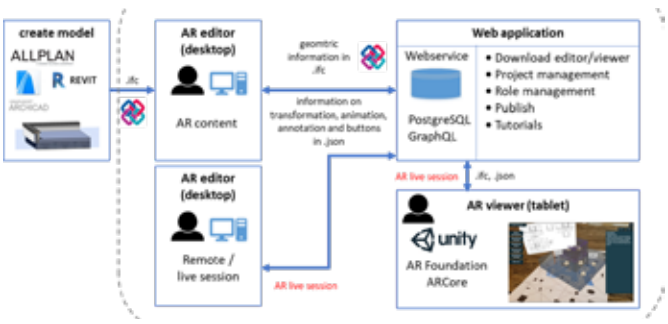
Result

This novel bridge between openBIM, AR and AEC education should change the way future engineers are taught, enabling students to experience and embrace the power of 3D modelling and design tools early in their careers and help teachers to focus on their teaching rather than on technology challenges. The rapid evolution in the technology behind AR will impact the speed of this teaching change. Putting simple ubiquitous devices such as smart phones at the heart of this solution helps alleviate this challenge but has required on-going work to overcome the physical difficulties of using small devices to view large teaching scenes.

> "IFC acts as the foundation of our AR-supported teaching platform, which allows the free selection of BIM authoring tools while creating educational material. openBIM file formats guarantee the longevity of these efforts. Future edits and adaptations can be carried out with any standard-adhering software and our import process is streamlined by focusing on a single input format. Additionally, students become familiar with IFC as a key technology in their future professions, while exploring problems and challenges in building processes."

Konstantin Höbart, TU Wien





FINALIST - Technology

BEXEL Manager - Smart integrated openBIM approach

BEXEL Consulting - Slovenia

Project Description

BEXEL Manager is the new BIM platform that integrates the most important 3D/4D/5D/6D BIM analyses into a single openBIM solution. It integrates hundreds of separate IFC models into the federated BIM model along with updates of each and supports the import and export of BIM models into IFC2x3 and IFC4. The platform has been successfully used on complex projects and BIM models with up to 2 million BIM model elements.

Core Objectives

The vision of BEXEL Manager technology is to automate repetitive project planning and management tasks, freeing time and resources for creative and value-adding project management activities. The platform offers advanced engines for data verification, data enrichment, clash detection, quantity takeoff, cost estimation, smart 4D/5D schedule planning, progress input, monitoring, and reporting. All features are integrated into efficient openBIM workflows that enable full control over the project execution.

About the Project

BEXEL Manager address the issue of fragmented and limited BIM implementation and workflows on construction projects. Despite advancements in BIM technologies and digital construction technologies, there are significant challenges in BIM implementation due to being too often rolled out without a comprehensive approach that acknowledges the need for incremental project development.

The project seeks to break BIM out of its siloed working environments, allowing projects to successfully transfer data and open up the advantages of learning from past experiences and activities. By utilizing and developing existing openBIM standards, it has enabled the smooth exchange of data and BIM analyses between various BIM tools.

BEXEL Manager's approach is comprehensive, seeing BIM as an integrated process where every domain is a piece of a puzzle that forms a big clear picture of the entire project – understanding where data integrated into one module is visible and could serve as the basis for further project development in the next module and where a change in one place is reflected throughout the whole project.

The technology supports an integrated BIM workflow that:

- Starts from the BIM model federation process using multiple IFC files,
- Goes through an automated Data Validation process using open Excel and .JSON templates

- Continues with Automated Data Enrichment workflow based on IFC data templates as well as through the bSDD integration,
- Allows for quality control of model geometry through the use of a robust clash detection module,
- Automatically creates Cost Classification based on data previously integrated in the model plus naming and Rules of Measurements templates that rely on IFC properties,
- Uses an Intelligent Scheduling approach, to automatically generate a construction schedule using methodologies based on previously created or imported Cost Classification system and spatial zones defined through the utilization of spatial data layer.

This process upgrades BIM from a basic 3D model to a fully integrated 4D/5D model that can track progress, provide close monitoring of KPIs and support operation and maintenance after the project completion.

Highlights

- Automation: The software allows data management, automated BIM data checks and BIM data enrichment, enabling the automatic generation of QTOs, schedules or cost estimations.
- Change management: BEXEL Manager enables propagation of project changes into BIM models with an automated update of all conducted analyses.
- Customization: BEXEL Manager enables integration of any classification system within BIM model and can produce customized reports.
- Integrated 4D/5D: Task dependencies and links to 3D elements are stored, allowing seamless interoperability with traditional scheduling applications. Data exchange is performed using openBIM formats.

buildingSMART Tools Used

IFC 2x3, IFC 4, ifcXML, bSDD, BCF, IDM, IDS, mvdXML, COBie

Result

BEXEL Manager helps to unlock the benefits of BIM benefits to project stakeholders, and project delivery roles. The template-based automated workflows allow rules and expert knowledge to be imported as simple spreadsheets enabling a range of engineering staff to contribute to the BIM project management process. Feedback from clients confirms the potential of BEXEL Manager and underlines the value of further development and improvements related to openBIM. The main lesson learned during the implementation of the tool was the need to understand client requirements and their doubts related to digital transformation and implementation, especially around all possible uses of data and more specifically various ways to save, preserve and exchange data using openBIM.

> "We believe that technology has to keep up and enable openBIM workflows, with full interoperability, and flexibility of digital ecosystems. That way, BIM users can provide real project benefits through a holistic openBIM approach having a federated model of hundreds of IFC sources, IDS-based metadata verification and enrichment using bSDD integration, BCF collaboration, openBIM construction planning, and management workflows."

Veljko Janjic, BEXEL Consulting

FINALIST - Technology

Artificial Intelligence for BIM

Plans2BIM

WiseBIM - France

Project Description

The Plans2BIM project is an online cloud-based openBIM solution that uses artificial intelligence to transform 2D building floor automatic plans into a 3D BIM database. The resulting models are in openBIM IFC format, allowing users to enhance the model using BIM software and extend the benefit of BIM through open and interoperable workflow to increase collaboration between project members.

Core Objectives

The goal of the Plans2BIM project is to encourage more building owners to move towards the use of BIM by reducing the cost and accelerating the time taken to digitalise the design and construction layouts of existing buildings and to create reliable and accurate BIM models.

About the Project

This solution aims to help existing building managers owners and operators to move from traditional 2D layouts and towards the use of 3D BIM models to increase the efficiency of maintenance, renovation and dismantling of their building assets.

The current process of creating BIM models from existing building layout drawings is very costly and time-consuming. This new tool uses artificial intelligence algorithms to address the problem and offer clients a saving of up to 50% in modelling time by using existing information rather than having to invest in new 3D point cloud captures of buildings and on-site visits.

Plans2BIM has been developed following three years of PhD research and 5 years of further development. The process is simplified by implementing openBIM standards to create a simple and reliable first data capture step on the BIM project journey. Users can access results in openBIM IFC format, as well as the metrics in CSV/XLSX files.

The software includes specific functionalities to manually check or modify the result. A viewer (2D & 3D) is provided to help the user to analyse and validate the model before exporting it in IFC format. An editor tool allows users to modify the geometry or to add properties to all building elements within a single IFC file.

Plans2BIM's main target customers are engineering offices, facility/property managers, construction companies and architects seeking an automatic process to digitalize existing building into openBIM in a fast and simple way. The software is distributed online as a SaaS (Software as a Service) for ease of updating and to enable customers to be serviced quickly.

Highlights

Plans2BIM accelerates the modelling process, by automatically generating the openBIM model using algorithms and simple tools to edit the model online. The solution rapidly generates interoperable openBIM output files from existing 2D images just in seconds which can then be finalized and enriched using BIM editors to get a complete model. Plans2BIM enables modelers to quickly transform online their 2D plans into BIM with:

- universal input
- fast recognition
- tools to assess the BIM quality
- collaborative platform
- standard openBIM output
- metrics in CSV/XLSX files

buildingSMART Tools Used

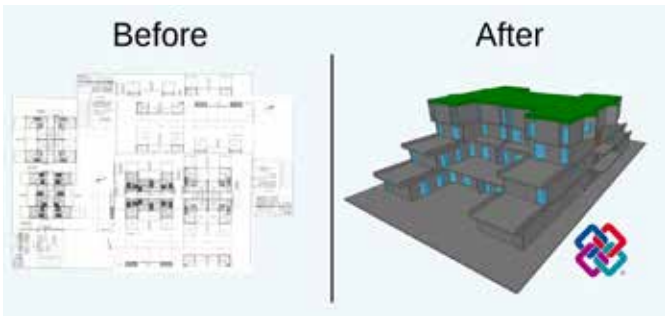
IFC 2x3, IFC 4

Result

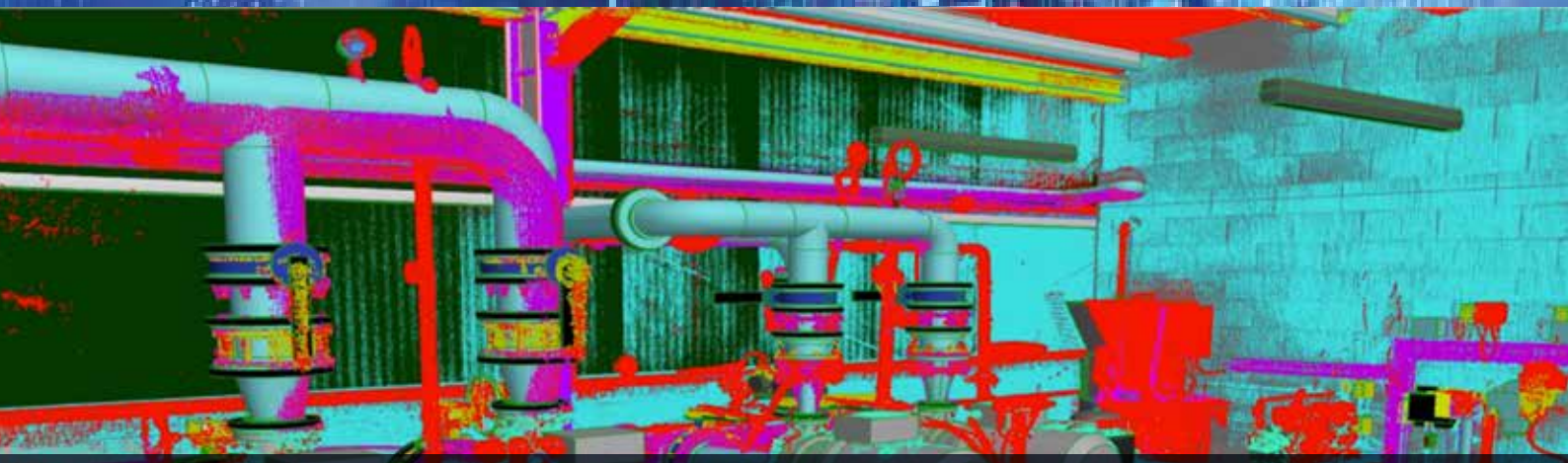
The Plans2BIM solution was tested on a project to digitalize several social housing buildings, and the modelling was completed using BIM software – a process that took some 32 hours overall. As a comparison, the plans were also processed manually with regular BIM software, taking some 66 hours for the job to be done manually – almost twice as long. This 50% saving in time allows the BIM modellers to focus on the data and model enrichment processes, providing clients with better outcomes and reinforcing their added value.

> "Our decision to integrate openBIM standards has played a key role in our technology. We have developed a cloud-based solution, Plans2BIM, that provides users an online access to unique Artificial Intelligence technology, that they can automatically transform their 2D plans into a 3D BIM database. This empowers them to maximize the benefits of BIM in an open workflow. Most importantly, the results are 100% interoperable and accessible with different software. Through openBIM, our customers can execute their projects in the most efficient way, take control of their data and combine the best software solutions for their needs."

Tristan Garcia, WiseBIM



FINALIST - Technology



The BIM & Scan openBIM Cloud Platform: AutoCorr and AutoGen - Validation and Reconstruction Tools

BIM & Scan - Ireland

Project Description

This software development project has created two new algorithms designed to accelerate and improve the process of aligning point cloud scan data with existing BIM model data. AutoGen automatically creates IFC CV 2.0 MVD files from open standard E57 point clouds to speed up the Scan-to-BIM process. A second cloud-based software known as AutoCorr is a Scan-vs-BIM solution that checks the AutoGen models and can also be used for manual Scan-to-BIM checking, as-built handover BIM checking and construction monitoring - creating automatic BCF messages of all issues found.

Core Objectives

The project set out to speed up and improve the process of checking point clouds compared to BIM data and, by doing so, assist in the creation and verification of digital twin models that better match reality.

About the Project

Combining point clouds with BIM models is central to the digitization of construction. However, the ability to compare point clouds with models created in the past using old drawings is now also a vital part of the design and construction process as clients increasingly need to understand the differences between the model data and the current reality.

This project set out to move beyond the current focus on Scan-to-BIM data management software solutions to address the growing and critical area of interest around Scan-vs-BIM data solutions and the comparison of actual recorded data with that contained in the BIM model.

This new application brings a new level of reality to digital twins and is critical to support construction progress and quality control, the generation of as-built BIM models and in the process of asset monitoring.

The AutoGen and AutoCorr software algorithms are built on ISO 16739 data model/schema. Using the software, model-data from different designers and from different stages in the lifecycle of a building, can be validated against the IFC coordination models with the help of open standard E57 scan-data.

BIM & Scan AutoCorr highlights any variations between the point cloud and coordination model using a user specified tolerance and automatically generates BCF reports and camera views when planned objects deviate from the built assets. These deviations are serialized automatically in a new semantic point cloud enriched by correspondence colour coding of the IFC type itself.

The software has already been used on many real-world projects and has enabled dramatic

improvements in speed, efficiency, quality, and value across the data management processes. This has also enabled faster quality assurance decisions to either modify the as-built BIM or correct the construction on site.

Building these software tools based on IFC has brought many advantages, including the ability for users to utilise the software through whichever design app or viewer they already have.

Highlights

- AutoGen creates LOD 200 Architectural and Structural Models to speed up the Scan-to-BIM process,
- While AutoCorr not only checks AutoGen models, but is used for manual Scan-to-BIM checking, as-built handover BIM checking and construction monitoring,
- AutoCorr creates automatic BCF messages of all issues found and automatic camera viewpoint too.

buildingSMART Tools Used

IFC 2x3, BCF, IDM, MVD

Result

The project has demonstrated that, due to the scale of the data management challenge when comparing point cloud with BIM models, without the ability of AutoCorr to highlight and categorise the deviations, humans could not actually solve the problem. There are simply too many objects and assets on most modern complex infrastructure sites for humans to investigate all issues. This solution enables the verification of point cloud data sets but more importantly, enables clients to actually take the action needed to solve the issues identified.

> "Utilizing bSI supported openBIM ISO standards allows us at BIM & Scan Ltd to develop engineering solutions with confidence in regard to interoperability, and assuring quality information exchanges that are extensible and flexible when specifying them from project to project. bSI facilitates and maintains the standards needed to assure lean business processes can be integrated with delivering real objectively testable solutions in practice that further enable real value-add assessment during the life cycle of built environment projects. ."

Dr Shawn O'Keeffe, BIM & Scan

FINALIST - Technology

usBIM.extender

ACCA software - Italy

Project Description

The usBIM.extender product is a collection of BIM Tools that operate on the IFC and BCF file format and allows greater collaboration during the management and operation of built environment assets. By using standardised open formats and services, the tools underpin the openBIM principles of interoperability, openness, reliability, collaboration, flexibility, and long-term sustainability.

Core Objectives

This new collection of tools and applications has been designed around open BIM principles to help built environment professionals solve real building data management problems. The design of each tool is based on real use-cases and will evolve and expand in response to growing user need in the future. The range of tools is designed to covers any aspect of the BIM management process using the open formats now deployed across the buildingSMART community.

About the Project

The usBIM.extender solution is a suite of tools based on openBIM standards, designed to evolve over time with the day-to-day changes that typically happen during all the phases of the construction.

At its foundation is usBIM, the BIM management system for the digitisation of constructions and infrastructures and usIFC.server, which allows for dynamic editing of IFC models. Tools then overlay this technology with specific functions allowing users to create any kind of workflow that involves the use of openBIM data.

The entire suite of tools is mounted in the cloud and only a web browser is required, enabling any member of the project team to contribute to the enrichment of the models, using any tool of their choice to update models in real-time to ensure the digital twin always reflects the actual state of the asset it represents.

The 12 tools making up the usBIM.extender collection are as follows:

1. usBIM.editor: Tool for editing BIM models directly in IFC format.

2. usBIM.classification: Tool for editing classifications of an IFC model entities and to generate a new IFC model with the updates.

3. usBIM.refactor: Tool for refactoring and/or merging of IFC models.

4. usBIM.ids: Tool to verify the properties of the entities of a BIM model in IFC format, manually with filtering and advanced functions or automatically with the use of IDS standard files.

5. usBIM.bSDD: Tool to create new data dictionary for the buildingSMART Data

Dictionary (bSDD) online service and to enrich IFC models with classifications and properties using bSDD with a standardized workflow that ensures data quality and information consistency.

6. usBIM.openCDE: Tool for connection to and from other Common Data Environments (CDE) for seamless documents exchanges and data workflow.

7. usBIM.clash: Tool for clash detection that highlights geometries conflicts between federations of BIM models in IFC format with the generation of check reports and BCF files.

8. usBIM.compare: Tool for comparing different versions of a BIM model to catch immediately any differences in IFC files.

9. usBIM.reality: Tool to navigate BIM models with virtual reality or with real-time rendering.

10. usBIM.render: Tool to create professional photorealistic and real-time renderings of BIM models in IFC format directly online in your browser.

11. usBIM.bcf: Tool to manage project communication with the use of BIM Collaboration Format (BCF) to discuss and solve issues in BIM models in IFC format.

12. usBIM.reclass: Tool to change IFC entities classes in order to add semantic meaning to BIM models in IFC format.

Having these tools all in the same place enables users to try out new tools to optimise and improve their workflow and ultimately produce better quality models and data.

Highlights

- Any software can be used to produce, read and manage data, and can be changed or upgraded as needed,
- Client/Stakeholder is real owner of the data, because access is not dependent on any software,
- Software is very specific for each need, but data model is common to anyone. The use of open format means that ata access is guaranteed over time, without software license,
- Workflows are independent of the software used,
- Data aggregation and analysis from different models is always possible because data is in open format. Data can be cross-checked and verified to improve outcomes,
- Productivity increases, as users have access to specialised tools for every aspects of the work. Software and tools will improve as competition stimulates development.

buildingSMART Tools Used

IFC 2x3, IFC 4, bSDD, BCF, IDS

Result

usBIM.extender is delivering many solutions for common use-cases in the sector and will increase as open data strategies are adopted by clients. Models are increasing in complexity from geometrical and informational point of view and, as such, open data strategies bring new possibilities and benefits to businesses from the use of data. As microservices, the existing usBIM.extender tools are highly accessible to professionals from the micro enterprises that constitute most of the construction supply chain, enabling the benefits of openBIM to be accessed by a wider range of stakeholders.