Building Information Modeling & Facility Management

Louise Sabol

IFMA World Workplace, November 2008.

Contents

Abstract

Building Information Modeling is the latest software technology being introduced throughout the AEC profession. A complete 3D digital representation of a building system or subsystem, this sophisticated technology is both a visually accurate model of a building and a database for recording the breadth of information developed and associated with building components.

Beyond being a drawing and documentation tool, BIM offers a platform for enhanced interdisciplinary collaboration, the capability to manage change, and the ability to extend information support throughout the building lifecycle.

Building Information Modeling Arrives

Building Information Modeling (BIM) is the latest software technology being introduced throughout the AEC profession. A complete 3D digital representation of a building system or subsystem, this sophisticated technology is both a visually accurate model of a building and a database for recording the breadth of information developed and associated with building components. Beyond being a drawing and documentation tool, BIM offers a platform for enhanced interdisciplinary collaboration, the capability to manage change, and the ability to extend information support throughout the building lifecycle.

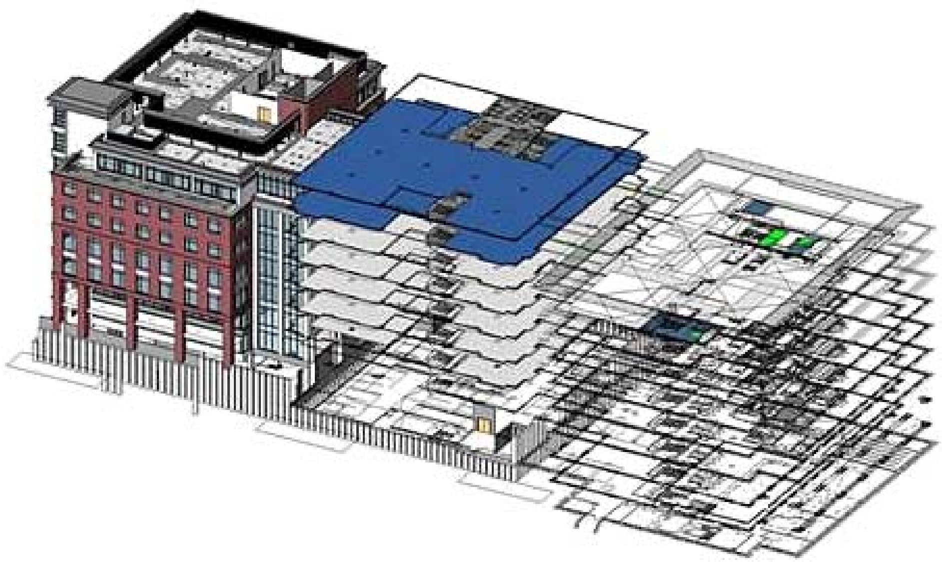

Figure 1: A Building Information Model

BIM is not simply 3D CAD. CAD applications have been in use for over 20 years, and are also capable of producing 3D models. CAD files are simply geometric data, comprised of primitive drawing elements: lines, arcs, solids and surfaces that represent the physical location and configuration of building components. Certain CAD applications allow building elements to be tagged with supplemental information, but the technology is not sophisticated enough to provide users with significant data of a model's component parts or relationships between objects

In a BIM, elements are virtual simulations of building components. A wall exists as a wall, a boiler is a boiler, and all objects have an identity and attributes. As a data application, BIM can track the types and quantities of materials, equipment and spaces. Major building systems may be represented in distinct and separate BIM models which can be integrated into a single master model. A BIM application typically has the capability to extract information in 2Ddocument form (akin to CAD drawing sheets) to enable use by various project stakeholders.

Quantities and shared properties of materials can be easily extracted. Scopes of work can be isolated and defined. Systems, assemblies, and sequences are displayed in a relative scale with the entire facility or group of facilities. Information can be attached to building components during the design process - from manufacturer's specifications to maintenance instructions- thus offering the potential for an integrated information base available to building owners and operators at project turnover.

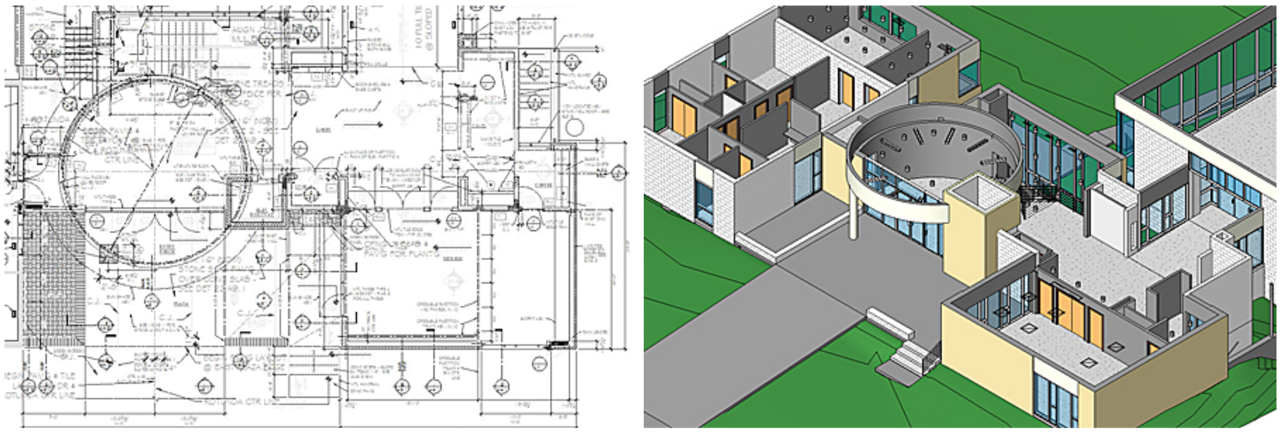

Figure 2: Traditional CAD documents (left) are difficult to interpret. A 3D BIM (right) provides an improved means of finding conflicts and supporting component data, leading to improved process efficiencies. (Model by Design + Construction Strategies)

Aside from being a powerful data application, BIM technology has the potential to enable fundamental changes in project delivery, promising a more integrated, efficient process. As a highly collaborative, data-rich environment, BIM has the inherent capability to reduce costs and promote efficiencies in the following manner:

- It accelerates the processes so that decisions and changes can be made early with a reduced impact to time and costs.
- The accuracy of the model, and its ability to communicate effectively to the diverse parties involved in building projects and management, reduces miscommunication and reinforces understanding visually.
- Quantities and data can be automatically generated by the model, producing estimates and workflows much more quickly than conventional processes.
- Data delivered at project turnover is more complete, more structured.

Bridging the Data Gap: BIM for Facilities Management

Facility Managers are continually faced with the challenge of improving and standardizing the quality of the information they have at their disposal, both to meet day-to-day operational needs as well as to provide upper management reliable data for organizational management and planning. An alphabet soup of data systems - CAFM, CAD, IWMS, EAM, CMMS - service the wide range of needs in the facilities arena, but there are no one-size-fits-all applications since FM practices are widely diverse in their requirements.

An emerging technology, Building Information Modeling is poised to offer a new level of functionality for the management of buildings and the physical assets within them. Asset and facilities management have primarily relied on data-centric applications for their information support tasks. Graphic capabilities in CAFM and IWMS applications have primarily focused on space management. Rework is often required to make CAD files delivered from project construction documents useful for facilities management. Not being inherently graphic, FM applications are often not seamless in managing changes, requiring tedious synchronization when building configurations and affiliated data attributes change.

BIM provides a unified digital repository of all building components, and as a full 3D model it is capable of displaying views with a clarity that are typically eludes users not schooled in interpreting standard 2D building drawings. The application's capability to attach an infinite range of data to components of the model, either within the application or in an external database such as Oracle, creates a potential data repository that is useful beyond construction documentation. For example, BIM space components can be supplemented to track information such as room numbers, area calculations, and occupant censuses. Equipment objects can record manufacturer, room location, equipment specifications, reference URLs, among many other attributes. As a relatively new technology, the capabilities of BIM have not been fully exploited in commercial FM systems as of yet.

Building Information Modeling, however, is a complex application and not suited to the casual user. More complex or technologically savvy organizations may have the resources to employ BIM specialists or consultants to maintain models for their facilities, as the Sydney Opera House did for their geometrically complex facility. (See Case Study to follow).

Standards and Data Exchange

To support the full building lifecycle, new standards for data exchange in the AEC-FM industry will need to be developed. The National Institute of Building Sciences (NIBS) formed a committee in early 2006 to create a National Building Information Model Standard (NBIMS) - to provide a common model for describing facility information. Several organizations in the building industry are also pursuing efforts to standardize and define BIM technologies, including:

- Construction Specifications Institute (www.csinet.org) - Developing the International Framework Dictionary (IFD) Library for buildingSMART which will be an open, shared, international terminology library for structuring object-oriented information exchange.

- OSCRE (www.oscre.org) – Organization directed towards developing global standards for exchanging electronic real property information.
- FIATECH (www.fiatech.org) – Organization working to accelerate the development and adoption of technologies that automate integration for capital intensive projects.

In the area of BIM data exchange standards, IFCs (Industry Foundation Classes) are an open, (vendor neutral, format developed by the International Alliance for Interoperability (IAI) to facilitate interoperability in the building industry. The IFC format facilitates the transfer and integrity of information between intelligent building models and the information systems that play a role in building management. IFCs offer a means to transfer data from a BIM application into affiliated software programs that are capable of cost estimating, CMMS, or space management.

Large organizations are beginning to require BIM deliverables for their building projects. In the U.S. Federal Government, BIM is a requirement for projects at GSA, the U.S. Army Corps of Engineers, and the Department of State. One goal of GSA's BIM requirement is to better manage its space by automating spatial validation of A/E designs. GSA uses this information for program validation, cost recovery and move management.

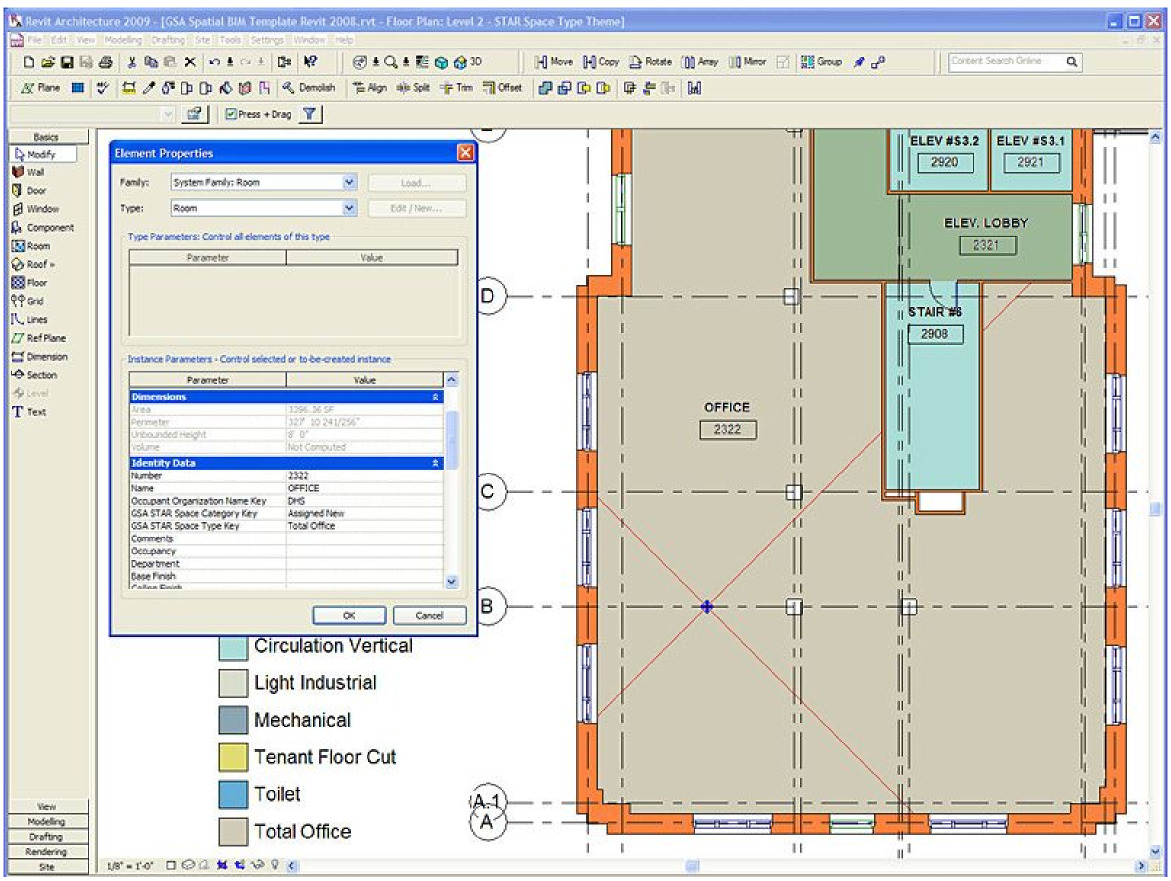

Figure 3: Revit model of GSA space. GSA requires spaces greater than nine square feet to have a specific set of non-graphic data attributes
(described in Section 2.1.1 of the GSA BIM Guide for Spatial Program Validation).

The Construction Operations Building Information Exchange (COBIE) is being developed by the Corps of Engineers Research Lab (CERL) to create both a format and standardized template for information handover to operations and maintenance entities. The COBIE approach envisions capturing information incrementally throughout the planning, design and construction processes and providing a framework for robust information organization for facilities management.

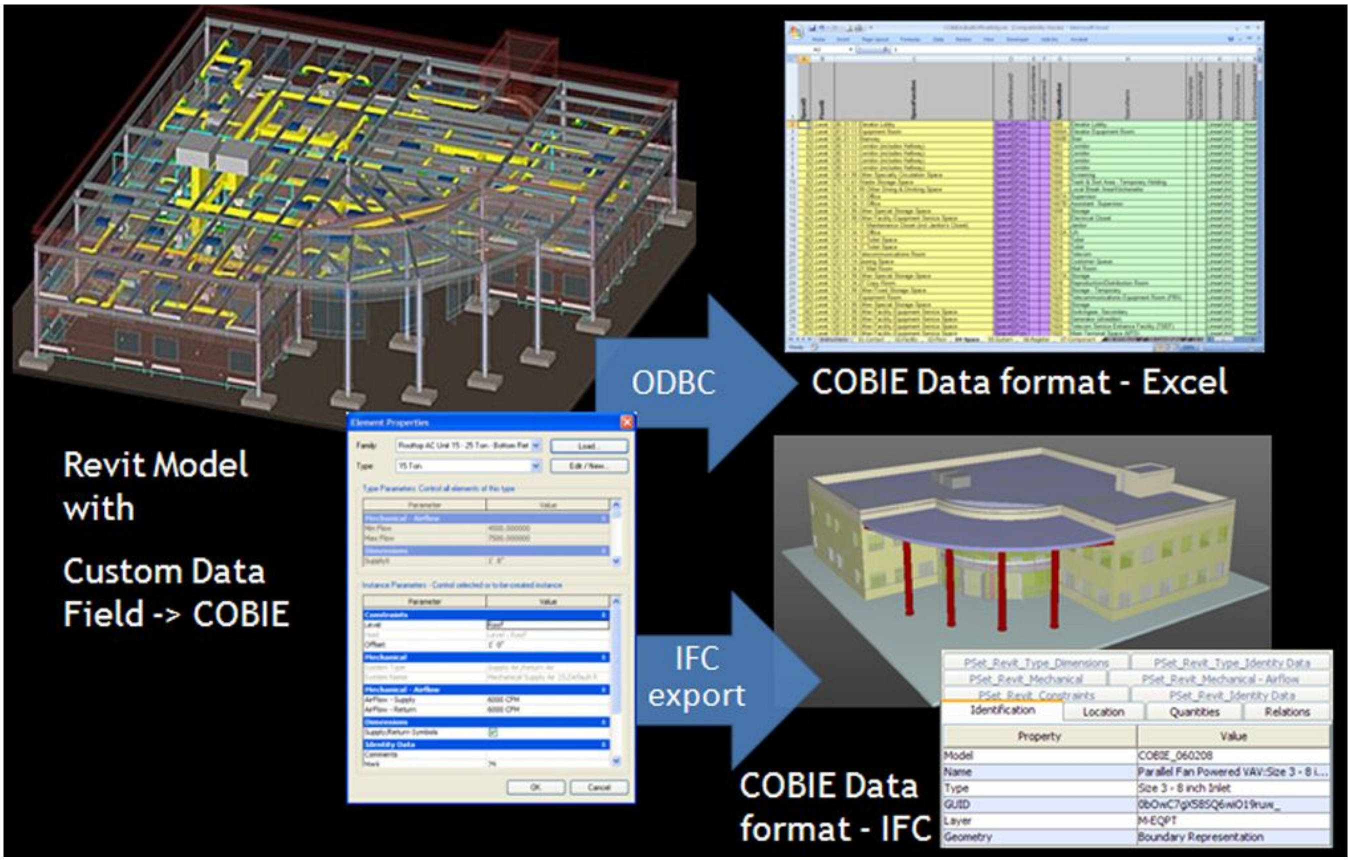

Figure 4: Revit model with custom data fields for COBIE data, export paths to COBIE in both Excel and IFC formats [Design + Construction Strategies]

Case Study: Using BIM for FM - Sydney Opera House FM Exemplar Project

In 2005, the Australian Cooperative Research Centre for Construction Innovation embarked on the Sydney Opera House (SOH) FM Exemplar Project to identify Facilities Management industry best practices. Along with researching procurement and benchmarking, the two-year study also investigated digital modeling – BIM. The lack of consistent data in a single source has become an on-going issue to the management of the facility, one that the project hopes to resolve. Preliminary research suggests that a 3D digital model of Sydney Opera House, populated with the appropriate data, will save time while improving the operation of the facility through consistent, accurate and current data that enables faster and more effective management.

Why the Sydney Opera House needed a Building Information Model

Sydney Opera House is a large, very complex structure, housing equipment and activities that are equally complex. Commencing in 1958, the original documents were hardcopy paper and pencil/ink drawings. While excellent paper archives exist, this documentation did not adequately describe the building that was ultimately completed in 1973. The final, complete building varies from the architect's original drawings, and unfortunately no definitive set of plans or documentation incorporating the changes existed. CAD drawings of the existing facility were created in the late 1980s, but proved unreliable and uncoordinated.

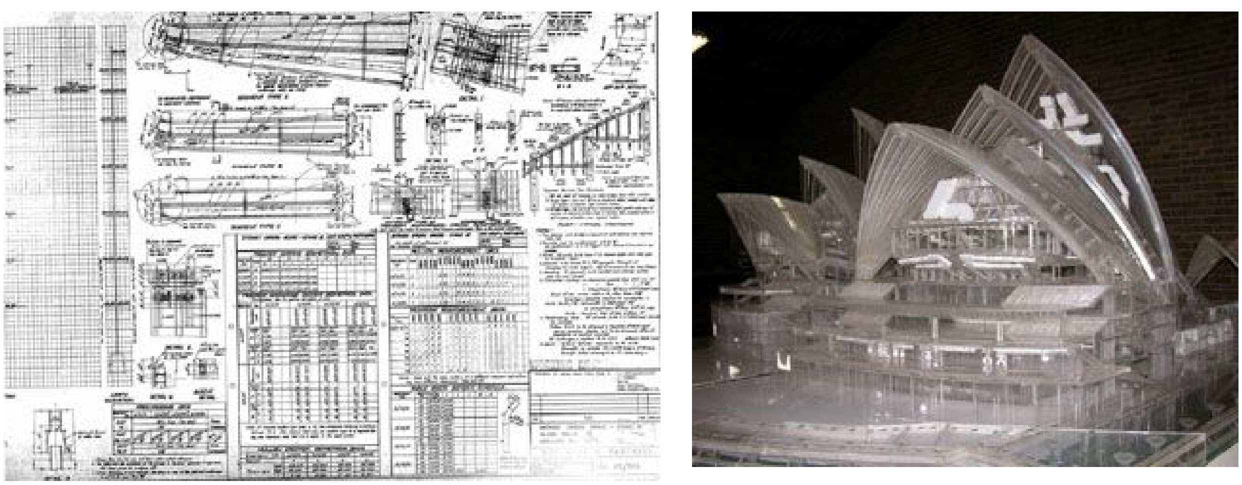

Figure 5: SOH Construction Drawing (left) and Physical Model (right)

The building has reached a milestone age in terms of the condition and maintainability of key public areas and service systems, functionality of spaces and longer term strategic management. Major building upgrades are being planned that will put considerable strain on existing Facilities Portfolio services, and their capacity to manage them effectively.

The facility does not have one unified facility management system, currently relying on several different and incompatible systems to manage functions as diverse as building maintenance, accounting, building presentation and asset value management. The organization’s multimillion dollar annual budget for

O&M and large technician (40 to 50 personnel) and contractor group (over 200 workers per week) demand a more integrated system that accommodates the constant changes occurring in the facility and its complex conditions.

Building an FM Data Model

The SOH developed a building information model to be used for full lifecycle management of the facility. The creation process did more than record the physical structure of the building; it also incorporated huge amounts of service, maintenance and cost information. The model includes all information about objects within the building, such as lifts, ventilation and fire systems, and importantly the relationship between them, in a single repository.

The modeling was divided into a master model and logical discipline-specific sub-models (architectural, structure, mechanical, electrical, and others). A 3D structural model created by Arup, SOH's consulting engineers, was used as the basis for model development. The master model supported different spatial hierarchies: location zones, functional spaces, rooms and places to organize interior space for multiple purposes. The master model integrates GIS data (via IFCs) to provide a site underlay replete with data about utilities, underground utilities, terrain, and other site attributes.

Model entities (or objects) that have asset maintenance requirements were populated with data fields (e.g. name, location, maintenance task, and schedule). General data attributes for operations and maintenance were also applied, notably a set of data fields for Building Condition Index that included sixteen fields to track the general appearance, tidiness and cleanliness of functional spaces of the building.

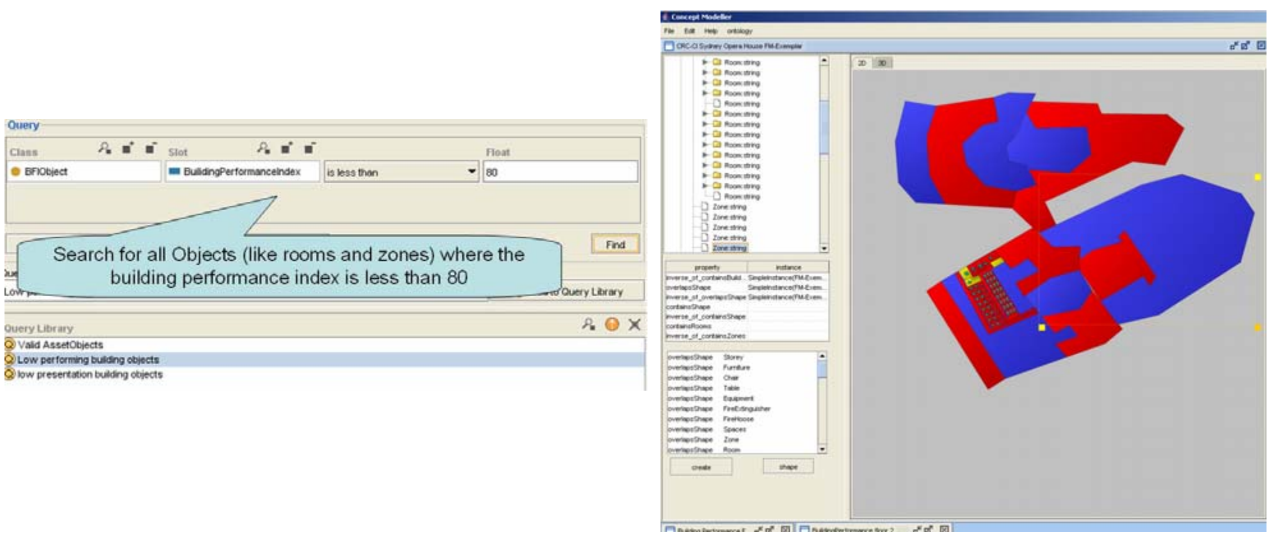

Figure 6: The SOH data model can be queried (left, search on BPI < 80) and the results returned in a graphical form (at right, red indicated rooms that meet the query constraints)

The Industry Foundation Class (IFC) data model was an integral part of the SOH model development. The model development used IFCs to transport Arup's structural design in (Bentley Triforma) model to their BIM application (ArchiCAD) for further modeling, with further exports to their FM software via IFCs.

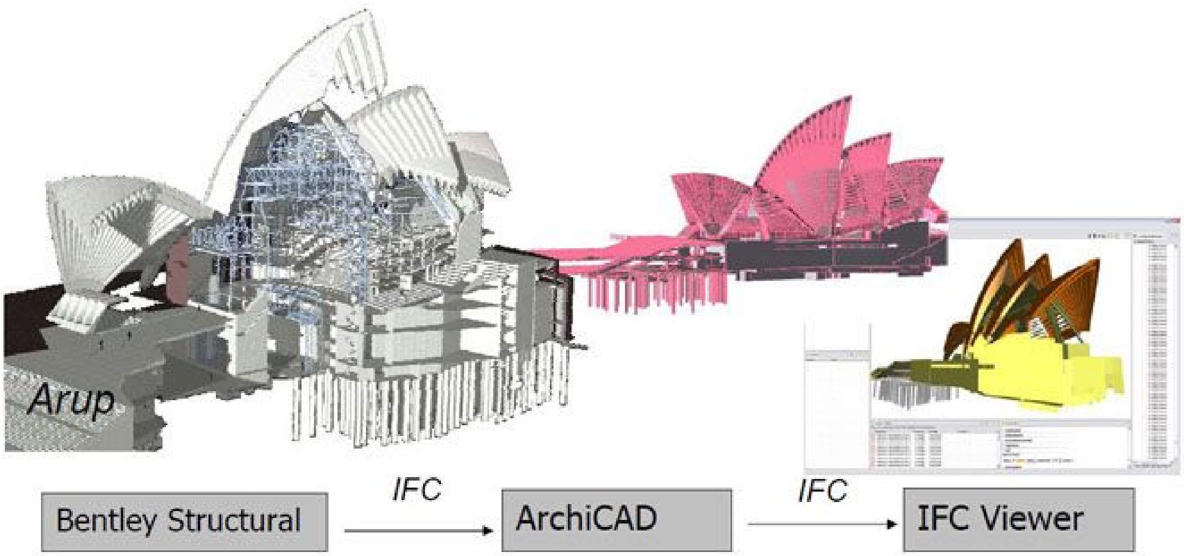

Figure 7: Migration of data via IFCs from engineering model to develop main BIM and export to FM software.

The integration of FM applications and IFC-compliant BIM is in its infancy. To support the FM processes using the IFC at the Sydney Opera House, the team developed guidelines and modeling practices and formalized them into a specification. The document describes how information and conventions specific to Sydney Opera House were incorporated in BIM and enabled the organization to develop a BIM with consistency.

Major Findings and Conclusions

The FM Exemplar Project has established that building information modeling is an appropriate and beneficial technology enabling storage and retrieval of integrated building, maintenance and management data for Sydney Opera House.

In the technical review, using this approach yielded several advantages such as consistency in the data, intelligence in the model, multiple representations such as two- and three dimensional (2D and 3D) reports, an integrated source of information for existing software applications, and integrated queries for data mining. The standardized building model acts as the main data structure which can be extended with other data sources as each element of the model such as a wall, furniture, a room, or a grouping of elements has a unique identifier. This unique identifier can be used as a basis for correlating different datasets, thereby opening up query capabilities across different datasets.

To support the FM processes using IFC exchanges from a BIM, a Sydney Opera House specification was developed, which will be critical to final development. Tests with partial data demonstrated that a complete BIM was realistic, but reliant on support of exchange standards by participating -and still evolving, software applications.

Specific benefits of BIM to Sydney Opera House Facilities Management include:

- Fostering faster and more effective facilities management by providing information that is easily shared and reused by the variety of contractor and staff employed in the organization.
- For upgrade and refurbishment projects, the capability to analyze the designs thoroughly, and perform simulations easily.
- Ability to control whole-of-life costs and environmental data leads to predictable building performance and tighter budget planning.

It is only a matter of time before a protocol is fully established to export the valuable data in BIM models to FM applications. Data formats, vocabularies and data exchange policies need to mature before such an application is useful for the average facility manager. However, the experience of the Sydney Opera House FM Exemplar Project demonstrates the value of developing standards to organize this information exchange, and integrating new information technologies into an FM practice.

Glossary

AEC	Architecture, Engineering, and Construction
BAS	Building Automation System
BIM	Building Information Model (software application)
CAD	Computer Aided Design (software application)
CAFM	Computer Aided Facilities Management (software application)
CMMS	Computerized Maintenance and Management System
COBIE	Construction Operations Building Information Exchange
FM	Facilities Management
GSA	U.S. Government Services Administration
IAI	International Alliance for Interoperability
IFC	Industry Foundation Classes
IWMS	Integrated Workplace Management System (software application)
NBIMS	National Building Information Model Standard project
Polyline	In CAD, a continuous line composed of one or more line segments that is treated as a single object. Used in space management applications (CAD or CAFM) to represent a space or room.

References

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About Louise Sabol

Louise A. Sabol is a registered architect with more than 25 years of experience in the building and technology professions. At Design + Construction Strategies, LLC, Ms. Sabol serves as Director of Technology, providing overall technical planning for the firm's technology integration projects for organizations involved in complex capital projects.

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