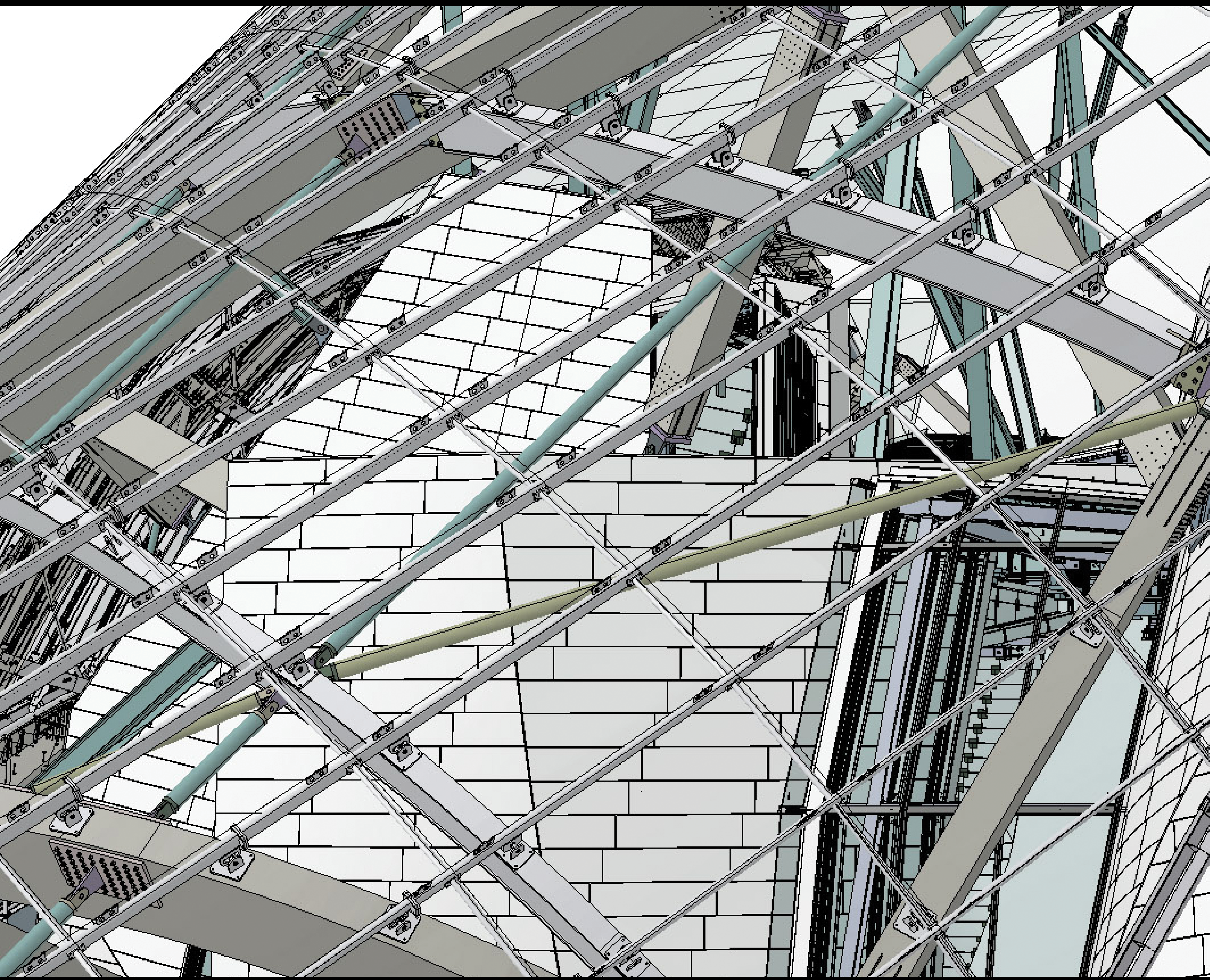
JBIM

Journal of Building Information Modeling

An official publication of the National Institute of Building Sciences buildingSMART alliance™

National Institute of Building Sciences: An Authoritative Source of Innovative Solutions for the Built Environment

Fall 2012



BIM Really Can Be a Team Sport

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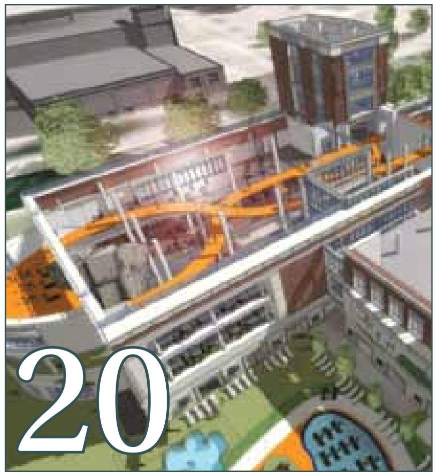

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On the cover: The Fondation Louis Vuitton, a new art museum in Paris, is pushing the limits of BIM technology and demonstrates how BIM, enabled by a cloud-based file management and project collaboration platform, can help large distributed teams work together. The 3D cover image, produced by Digital Project™, shows the façade of the Fondation Louis Vuitton.

Integrating Technology and Process in Cathedral Hill Hospital Project

By Baris Lostuvali and Michelle Hofmann

AS BUILDING INFORMATION MODELING (BIM) SPREADS IN THE architecture, engineering and construction (AEC) industry, designers, engineers, contractors and owners are exploring how to best utilize it to improve the way they do business. This fundamental change is further accelerated with the emergence of collaborative project delivery methods such as integrated project delivery and lean construction. In this "perfect storm," how do teams integrate, process and utilize BIM to its best extent?

Sutter Health's Cathedral Hill Hospital (CHH) project is a 1.2 million square foot urban replacement hospital in San Francisco, California. It is not just designed to be a state-of-the-art hospital but also to break new ground in multiple areas of design, construction and operations. As the CHH integrated project delivery team (IPDT) nears completion of the preconstruction efforts, this paper aims to outline some of the key ideas and tools practiced in this phase.

ADAPT BIM TO FIT A COLLABORATIVE DELIVERY PROCESS

At the start of any collaborative project delivery, project teams go thru a phase of "fuzzy front end" where they work to validate the initial design assumptions, optimizing and influencing design to validate the cost and schedule, and to analyze constructability issues. This integration phase is full of uncertainty and ambiguity **(FIGURE 1)**.

In this uncharted area, design professionals that traditionally took the role of design manager now find themselves participating in previously unforeseen contexts, working in multidisciplinary teams led by contractors and dealing with new responsibilities at the design stage. At the same time, supply chain members, not previously involved during the early project definition phases, are engaged at the earliest phases of the project life cycle.

In this design phase, BIM was at the center of the discussion. Questions asked were:

- What should be modeled in BIM and/or in 2D?
- How much detail is required and needed in the BIM model?
- What is the right content in the BIM?
- What is the cost/benefit analysis of modeling a component weighed against the effort required?

Discussions led to the conclusion that these open-ended questions needed to be continually revisited so BIM could be used effectively. The IPDT developed a "scope matrix" for the entire project to outline all elements of design and the production of information flow between players and tools. In addition, the team put a strong focus on a well-defined, "level of detail" (LOD) matrix for BIM.

GAUGE THE MATURITY OF BIM

In an environment of complex information flow, with multiple iterations, it is highly crucial that the IPDT understand the maturity of BIM. The IPDT needs to figure out a way to gauge the information that goes into BIM and know when it is good enough to hand the information to the next team in the production line. At CHH, major work streams are: architectural; medical planning; structural; mechanical, electrical, plumbing/fire protection (MEP/FP); and exterior. These groups constantly share incomplete information, which helps them to understand the maturity of the information within the BIM.

When IPDT finds that information is not good enough for a release/hand-off and/or identifies a conflict that can't be resolved, the production line is stopped. A task force is assembled to assess and resolve the issue and no work resumes in the BIM until the issue has been completely resolved.

It is important to state that the IPDT at CHH benefited tremendously from being co-located in a single floor of a building. This enabled high-quality, face-to-face interaction between the design and trade partners.

ENHANCE BIM THROUGH SIMPLE AND VISUAL COMMUNICATION

To tackle the challenges of making the design and BIM processes transparent, IPDT used process maps and "swim-lane" diagrams as a way of collecting information and aligning the team members **(FIGURE 2)**. The simplicity of the swim-lane diagrams

Continued on page 30

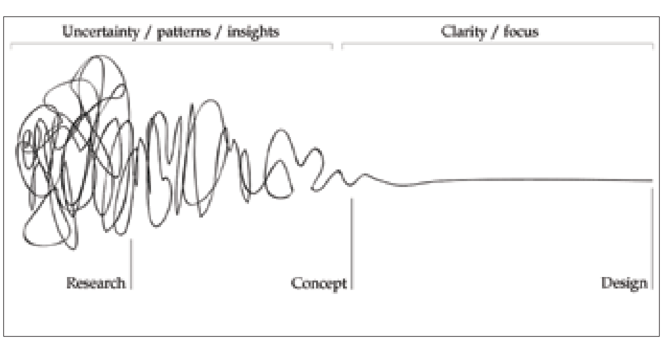

Figure 1. The Process of Design Squiggle, by Damien Newman.

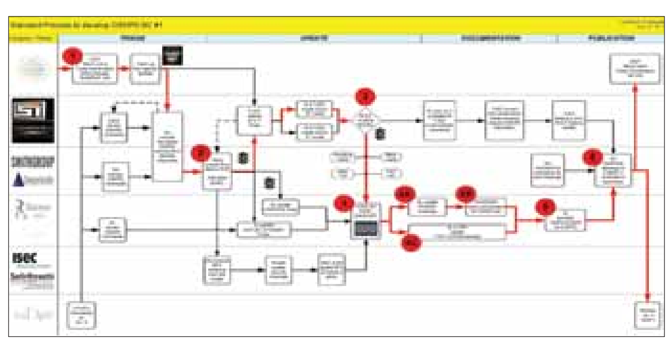

Figure 2. A "swim-lane" process map for MEP/FP coordination.

IFC4: Evolving BIM

By Tim Chipman

IN RECENT YEARS, THE INDUSTRY Foundation Classes (IFC) standard for building information modeling (BIM) has seen widespread adoption, supported by approximately 150 registered software applications. This article describes the next evolution of this standard, IFC4, and related efforts for achieving wider and deeper interoperability across software applications.

The goal of IFC has always been to describe how building information can be leveraged across applications within and across vertical industries, supporting the vast array of disciplines encountered in the building industry. To be useful across such a large ecosystem, such standards must capture necessary detail to describe how a building is to be built, along with the many non-physical aspects describing who is doing what, when, how and why. Meanwhile, many downstream applications are only concerned with subsets of this information. Another aspect to address is the format of information, which must accommodate changing technology and diverse platforms, such as phones, tablets, desktops and servers. For basic applications, XML provides ease of integration; compact formats such as STEP Physical Format (SPF) are more practical for representing buildings in detail; spreadsheets such as Excel provide access to a wide range of users without custom software; and databases of various forms may support collaboration among concurrent users.

Meanwhile, as more applications adopt IFC, customers have asked for deeper integration to capture more detailed information across applications in a consistent way. To support this growing usage, IFC has evolved with initiatives on multiple fronts.

Data model: A number of enhancements have been introduced in IFC4, with a focus on system-wide improvements while maintaining backward compatibility.

Parametric design: While buildings are ultimately made of discrete components, during the design process it is often desirable to use higher-level representations reflecting the design intent, so that changes can be made in one place, where the composition and layout of components, can be automatically updated to reflect the change. IFC4 introduces the concept of material profiles, where axis-based components, such as beams, pipes and ducts, can be described by paths and cross-sections of materials, along with offsets relative to the axis and end points. Similarly, a concept of material constituents has been introduced where components, such as doors and windows, can have various parts (for example, framing and glazing) defined by geometric aspects and corresponding materials. Material layers allow flat components, such as slabs and walls, to be described by material thicknesses and boundaries with offsets.

Geometry: IFC4 expands geometry to support more complex shapes as well as simplified geometry. Complex shapes may be exactly described using Non-Uniform Rational B-Spline (NURBS) curves and surfaces. Simplified shapes may be described using tesselated surfaces with compact lists of vertices and triangles, providing the closest mapping to GPUs and more efficient processing as may be suitable for mobile applications.

Libraries: IFC4 supports capturing templates of products, processes, resources and property sets. These files can be referenced by other IFC files that include instances of such templates.

Ports: Ports provide the capability for MEP elements to connect through pipes, ducts or wires. IFC4 extends the capability for defining ports at product templates and standardizes ports on objects according to product type. For example, a water heater may have ports for gas or electricity as input, cold water in and hot water out. This enables products from different manufacturers to be intelligently connected according to system type and connection geometry.

Processes: IFC4 expands the process model to support scheduling of tasks, procedures and events, with expanded detail as found in leading scheduling applications and 4D simulations. Process templates allow common processes to be captured in libraries and re-used.

Resources: IFC4 expands the resource model to track costs and environmental impacts of materials, labor, equipment and other project resources with expanded detail. Resource templates allow common resources to be captured in libraries and re-used.

Constraints: The constraint model has been formalized so that requirements may be directly validated on any object attribute, either directly or along a graph of objects and collections. For example, a requirement may indicate that the height of a space must exceed a certain length. Constraints may also be used to indicate mapping of data to external files, conflicts when multiple versions of a model are merged, formulas based on calculations from other attributes and tables of values that apply for parametric modeling.

Documentation: Published as ISO 16739, the documentation for IFC had to undergo rigorous adaptation to meet requirements for formatting and content. At the same time, documentation was expanded to provide real usage examples for hundreds of product types, while eliminating redundancy by organizing common concepts in a central place. Documentation is now multi-lingual, with translations in five languages as of this writing.

Definitions: IFC, along with hundreds of other engineering standards, is defined using the EXPRESS data definition language, where the rich semantics allow virtually any other schema representation to be derived. The IFC4 documentation now includes a simplified XSD-based representation for all data types, enabling XML to be used in a more compact form with better readability.

Diagrams: Instance diagrams are now included for all data types. Because building

components in the real-world have a vast number of relationships (for example, how connected, where placed, when constructed, who is responsible and what changed). Relationships must also be captured in data model, where diagrams make it more clear how the various objects interact.

Examples: Sometimes it is easier for software developers to understand new concepts by seeing tangible examples rather than sifting through definitions. The IFC4 documentation now includes a comprehensive set of examples in various domains including: architectural; structural; mechanical, electrical and plumbing scheduling; and estimating.

Model views: While the IFC specification defines how to represent BIM electronically, it does not indicate what should be included for particular scenarios. The concept of a model view definition (MVD) has evolved to fulfill this role, describing exactly what information must be included for a handoff, such as for a building maintenance request. Contracts may be written to require information at a particular stage using the referenced model view, where submissions may be electronically validated and enforced.

mvdXML: In parallel with IFC4, the MVD approach has been formalized so that requirements may be defined in a way that is computer-interpretable, yet human-readable in resulting documentation, using a format called "mvdXML." MVDs may also define mapping formats for translating information into general-purpose applications such as spreadsheets. The electronic encoding of MVDs now also makes it possible for a new class of software applications to adapt data to conform to the MVD without prior knowledge.

Tools: buildingSMART International has provided a new tool called ifcDOC for authoring model view definitions and producing resulting schemas, documentation and diagrams. This same tool is used for generating IFC documentation, the Construction Operations Building information exchange (COBie) specification and a growing population of MVDs.

To take advantage of new BIM capabilities and much-improved software interoperability, visit www.buildingsmart-tech.org to find the growing list of applications supporting IFC4. ■

Tim Chipman is deputy leader of buildingSMART International's Model Support Group and develops software at Constructivity.