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# Building Information Models and Model Views – Part 2

By Richard See, Managing Director – Digital Alchemy

**PART 1 OF THIS** article (published in the Fall, 2007 issue of JBIM), provided some history about Building Modeling and Building Information Modeling (BIM), and ended by introducing Information Delivery Manuals (IDMs) and Model View Definitions (MVDs) as parts of a process for realizing software interoperability in targeted building industry processes. This part will provide more detail about a standard process and toolset for developing BIM based solutions for the building industry.

## CHALLENGES ON THE ROAD TO INTEROPERABILITY

Interoperability across all disciplines, phases, and software tools used in a building industry project is a lofty goal. The International Alliance for Interoperability (IAI) began pursuit of this goal in 1994 and developed the Industry Foundation Classes (IFC) as the information model schema for sharing BIM information across these boundaries. In only a few releases, the IFC model schema was very large and quite complex. Software companies looking to support the standard needed a strategy for phasing their implementations and for ensuring they delivered something useful and valuable to their customers at each milestone in building support for IFC.

To address this need, in 2000, the BLIS Consortium introduced a process and toolset to bring focus to software support for IFC data exchange based on end user use cases. The process involved identifying building industry processes in which sharing BIM data would deliver maximum value to the project. The goal was to reduce complexity for software vendors by giving them specifications for the subset of IFC that would fully support the targeted end user exchange scenario (e.g. early design stage architectural design to HVAC design). Nearly 60 software products by 35 organizations developed support for one or more of the BLIS Views of IFC in the 2000 to 2003 timeframe. About half of these were certified through certification

testing that included data validation similar to what is discussed below.

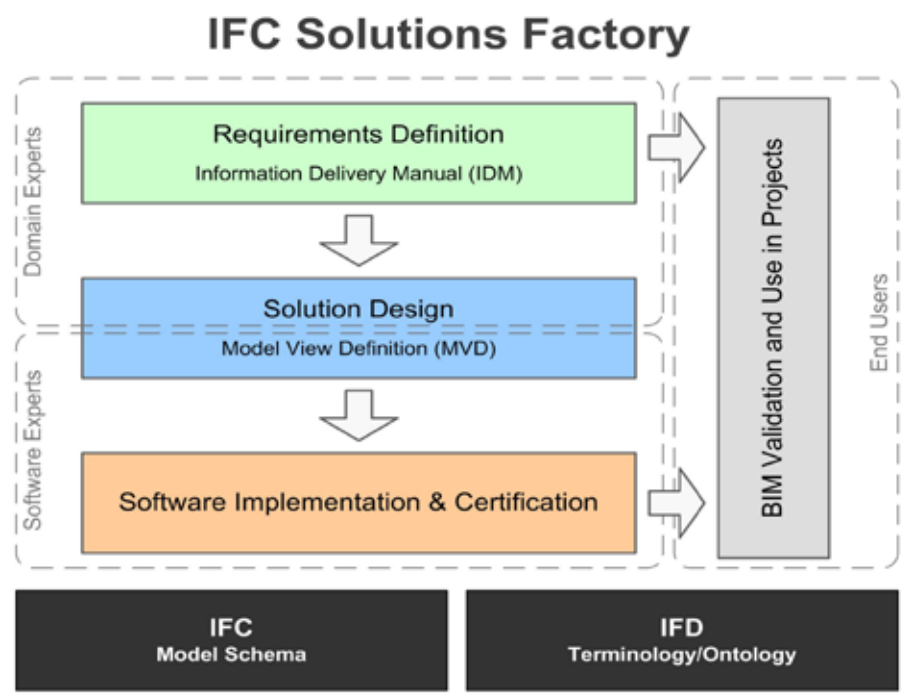
In 2005 timeframe, two processes were initiated which extended these ideas: Information Delivery Manuals and Model View definitions.

Frustrated by a lack of reliability in IFC data exchange in products at the time, the Norwegian chapter of IAI (later renamed to buildingSMART) funded development of a process and documentation formats for Information Delivery Manuals (IDMs). Their goal was to enable “contracted data exchange.” That is: to enable sufficient specificity in the requirements for data exchange in building industry projects that these requirements could be included in project contracts. The approach taken extended and enhanced the process for capture of such requirements that had been used by IAI since 1994. End user domain experts (the architect and the HVAC engineer in our example above), facilitated by an information modeling expert,

documented an existing industry process (in the form of one or more process diagrams) and the information exchanges that occur in that process (in a spreadsheet).

In parallel, the Finnish chapter of the IAI set out to update the model view definition process and tools used by BLIS in the context of their Virtual Building Laboratory at Tampere University of Technology. As with IDM, the proposed standard for MVDs involved both a process and standard documentation formats. In addition, a software toolset to was developed to support Model View diagramming and a web site was established to support coordination across MVD definition projects. The MVD process and format was proposed as a standard for use by the IAI/buildingSMART in late 2005 and was adopted as the standard in early 2006.

Both the IDM and MVD processes and templates have been used in several projects over the past few years, but generally separately.



There was a need to see these two complimentary systems integrated into a single process and toolset for defining and developing BIM solutions for interoperability.

### THE IFC SOLUTIONS FACTORY

In the summer and fall of 2007, an integrated process for defining end user BIM data exchange requirements, IFC based technical solutions for those exchanges, software certification, and end user BIM data exchange validation was proposed to the US National BIM Standard (NBIMS) committee, IAI/buildingSMART international, and several organizations using IFC based BIM data exchange. The name of the integrated system is the IFC Solutions Factory. It includes 4 sub-processes, toolsets, and templates (see Image 1).

The IFC model schema and International Framework for Dictionaries (IFD) are used as resources in the design of IFC based solution, certification testing, and BIM Data Validation.

### IFC SOLUTIONS FACTORY TOOLS, TEMPLATES, AND WEB SITES

This section will provide a very brief introduction to the subcomponents for each of the 4 phases of the IFC Solutions factory. More detail and examples will be provided in a 3rd installment to this series.

### REQUIREMENTS DEFINITION

- **Process Map** – Documents the end user process(es) using Business Process Mapping Notation (BPMN).
- **Exchange Requirements** – Documents the data (objects, properties, and relationships) that must be exchanged at a point in the end user process.
- **Generic BIM Guide** – Provides instruction to end users for the subject process and exchange(s). This can range from what must be included in the BIM, to exchange tips, to reference standards that must be used (e.g. a classification system).
- **Exchange Requirements Model (ERM)** – Entity/relationship diagrams for each exchange. These are generic and not yet related to IFC or any other information schema.
- **Coordination Web Site – IDM page(s)**  
– A web site will be established for coordination across all phases of the Solutions Factory. This will foster coordination, sharing, and re-use of common concepts all four phases of the factory. The basic building block for these solutions is called a Concept (e.g. the concept of assigning classification to a product or assembly).

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## SOLUTION DESIGN

- **Model View Definition** – Documents the purpose and scope of a Model View, including the project participants, the applications types (from/to) and the end user processes/exchanges supported. Note: a Model View integrates requirements for one or more ERM (typically more than one).
- **Concept Definitions** – Documents a data concept included in the Model View. Typically these correspond to end user concepts defined in supported exchanges, but often an end user concept will translate into more than one concept in software data exchange.
- **Generic Model View Diagrams & Software** – Entity/relationship diagrams for the single model that satisfies all exchange requirements for the target end user processes. These diagrams are still independent of any particular information model schema. These diagrams are created using a software toolset that supports diagramming in Microsoft Visio and re-use of existing concepts on the coordination web site (through web services).
- **IFC Model Binding View Diagrams & Software** – Entity/relationship diagrams for an implementation of the Model View using a specific version of the IFC model schema. This is the 'solution' for exchange of BIM data in the target end user processes using IFC. Together with the Implementation Guidance, these specify software implementation requirements for both export and import of the model view. These diagrams are created using the same software toolset and coordinating web site as for the Generic Model Views.

Project Name	Lead Organization	Project Objective	Timeframe
SMARTcodes	International Code Council	Automated building code compliance checking	Q3-07 through Q2-09
Qty Takeoff for Building Services	buildingSMART Norway	BIM driven takeoff and cost estimating for building service (MEP) systems	Q2-08 through Q1-09
Concept Design BIM 2009	US GSA, Statsbygg (Norway)	Spatial Program Validation Energy Performance Analysis Circulation & Security Analysis	Q4-07 through Q4-09
COBIE	US Army Corps of Engineers	Handover of information from Construction to Building Operations	Q2-08 through Q2-09 (est.)
NBIMS	buildingSMART Alliance	National BIM Standard	Q4-08 through Q4-09

- **Implementation Guidance** – These document software implementation requirements at the concept level. They include data instance diagrams, implementer agreements, and any reference data sets (e.g. reference standards, look-up tables, or industry enumeration data). They are intended to address any and all ambiguities as to how a software product will support the Model View.
- **Coordination Web Site – MVD page(s)** – The same web site described above will include all the concepts used in existing MVDs. The software toolsets described allow the MVD developer to use pre-existing concepts in their MVD and to upload new concepts for use in future MVDs. The goal is to avoid re-inventing any wheels (i.e. one good way to support assignment of classification, not many similar ways).

## SOFTWARE IMPLEMENTATION AND CERTIFICATION

- **Certification Test Cases and Test Suites** – Historically, test cases using in IA1 certification testing have been very geometry centered. This will change over the next few years, so that testing is expanded to other important data & relationships in IFC model Views. In general, test cases should be developed to independently test each concept included in the Model View. For leaf node concepts (leaf nodes in the MVD diagrams), these can be thought of as Unit Tests. Testing for higher level concepts can be thought of as Integration Tests.
- **Product Specific Certification Testing Reports** – Certification test reporting will be improved using the Model View diagrams. Concepts that are correctly supported will be shown with solid lines and no notes. Concepts that are not correctly

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supported will be shown with dotted lines and include keynotes to an exceptions section in the report. This will make it easy for end users to review test results, product by product. A data representation of these results can also be used to compare the results from two products (e.g. one exporting and the other importing the IFC BIM) so that the end user knows exactly what concepts will be correctly exchanged.

- **Coordination Web Site – Implementation & Product Certification page(s)** – As for Requirements (IDM) and IFC based Solution (MVD), there will be a section of the coordinating web site dedicated to documenting the tests that were run for software product certification and the results for each product tested. This will give end users unprecedented access to both the scope and results for these tests.

### BIM DATA VALIDATION

- **Product Specific BIM Guides** – These will be product specific adaptations of the generic BIM Guide (above) which show the user how each requirement is completed for a particular application (i.e. screenshots and application specific guidance).
- **IDM/ERM Specific Validation Rules** – Business rules in the original requirements definition (i.e. use of UniFormat classification in one exchange and MasterFormat classification in another) are mapped to the constraints branch of the IFC schema in the same way as exchange concepts are mapped to the product and resource branches. The result is a constraint (or requirements) model that can be used to check data in a BIM claiming to meet all exchange requirements. Such BIM Data Validation can be done by any end user or by a consultant using a data validation software application. Examples include the Solibri Model Checker and Xabio—each using an exchange specific plug-in.
- **Coordination Web Site** – BIM Data Validation page(s) – Finally, the coordinating web site will include one or more pages dedicated to providing end users with ERM specific constraint models and instructions for BIM validation in their projects.

### PILOT PROJECTS USING THE IFC SOLUTIONS FACTORY

While IDM and MVD have been in use for awhile, the IFC Solutions Factory has integrated them into a seamless process and

augmented them with improvements to certification testing and reporting and with the addition of BIM data validation, which is probably the most important aspect of the Solutions Factory for end users. It is this ability to confirm BIM data as being fully conformant to requirements for an exchange that allows project team members to require use of such exchanges in their project agreements. This is an important and necessary milestone.

Because of these changes, the IFC Solutions Factory is being tested in several projects. The projects outlined on Table I will be using and providing feedback for improvement of the IFC

Solutions Factory processes, tools, templates, and web sites over the next 18 months.

*Part 3 of this article series will walk through examples for each of the IFC Solutions Factory phases and deliverables.*

*Richard See is Managing Director of Digital Alchemy, Chairman of the BLIS Consortium, Leader of the Models and Implementation Guidance committee in the NBIMS initiative, member of the Technical Advisory Committee for buildingSMART International, and member of the Technical Committee for the buildingSMART Alliance (North America).*

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