Interoperability for precast concrete building models

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- The precast concrete National BIM Standard (NBIMS) initiative has been used to facilitate information exchanges and improving interoperability among exchanges.
- Two demonstrations were conducted to showcase the functionality that the software companies are developing in support of the standard and to provide an example of the potential of open BIM.
- These demonstrations revealed the importance of full validation testing and certification for achieving smooth, effective, and reliable workflows.

Building information modeling (BIM) interoperability among different stakeholders in construction projects may be seen as a modern version of the Tower of Babel. For centuries people have designed, built, and maintained facilities. However, with the increasingly costly and inefficient processes used, the time, cost, material, and labor expended result in disappointing quality, value, and financial returns.

Construction projects today are complex and involve highly specialized and fragmented professional services. They require strong interdisciplinary teams, with stakeholders willing to collaborate, including clients and their representatives, designers, contractors, and the range of specialist consultants with their deep domain knowledge and experience. Individual BIM applications, which are used in the construction industry, store information in their native formats, imposing challenges for reusing the data in subsequent applications downstream in the workflow.

There is no single software platform or system that can support all functionalities required for the construction industry. A study conducted by McGraw-Hill states that 8 in 10 users of BIM software tools in the United States consider lack of interoperability among software applications to be a limiting factor in achieving the full potential of BIM.[1] To make the information available to various project stakeholders that use different BIM applications, the software applications need to have a facility for accurate and reliable data exchange.

This paper provides a short description of the Industry Foundation Classes (IFC) schema and certification procedures and reports on the current status of the National BIM Standard[2] (NBIMS) for precast concrete. It includes precast concrete engineering and fabrication workflows and demonstrations of precast concrete interoperability and compliance with the latest precast concrete NBIMS conducted at the annual PCI conventions in October 2011 and September 2012.

The paper argues that rigorous validation testing against domain-specific model view definitions (MVDs) and certification are required for achieving reliable IFC exchanges and improving the overall interoperability of BIM authoring tools. The target readership includes engineers in precast concrete producer companies and precast concrete design firms who are engaged in BIM, software companies that support the precast concrete industry, and academic and industry researchers in construction interoperability.

Industry Foundation Classes

The initial specification for IFC[3] was created in 1995 to address the sharing of information to facilitate and support more efficient workflows and information exchanges. IFC was developed by buildingSMART.[4] It is a publicly defined data schema for storing building information over the building life cycle and exchanging it among software applications used in construction. IFC objects represent geometry, relations, processes, materials, performance, fabrication, and other properties needed for design and production using data modeling language.[5] It is in the process of becoming international standard ISO 16739.[6]

The IFC schema is widely recognized as the common data exchange format for interoperability within the construction industry.[7] It is a rich product modeling schema, but it is highly redundant and lacks formal logical rigidness, offering different ways to define objects, relations, and attributes in support of various data uses. Thus, data exchanges that select from the redundant data representations have had unacceptable problems of mismatch due to misinterpretation between exported and imported data. This has posed a barrier to the advancement of BIM.[8,9] These inconsistencies have led to the conclusion that domain-specific MVDs are needed to define precisely how building model exchanges should be expressed using IFC.[10]

IFC certification procedures

For MVDs to work, the software applications that export and import building model information according to the MVDs must be tested for conformance. This requires independent certification. In 2010, buildingSMART developed the new IFC Certification 2.0 procedure for the IFC 2 × 3 Coordination View Version 2 (CV 2), which is an MVD intended to promote consistent and reliable implementations of the IFC specification by many software vendors across multiple software platforms. CV 2 is part of the open BIM initiative, which is a general approach for collaborative design and realization of construction projects based on open standards and workflows. It supports a transparent, open, and smooth workflow, allowing different project stakeholders to participate regardless of software tools used. It is supported by buildingSMART and several leading software vendors.

CV 2 targets the coordination among the architectural, mechanical, and structural engineering tasks during the design phase. It contains definitions of spatial structure, building elements, structural modeling elements, and building service elements that are needed for coordinating design information among these disciplines. It includes parametric shapes for a limited range of standard elements and the ability to also include nonparametric shapes for all other elements. Property sets, material definitions, and other alphanumeric information can be assigned to those elements.[11] The certification process verifies export and import of IFC files conforming to the IFC 2 × 3 CV 2 and general conformance requirements. The workflow of the IFC Certification 2.0 procedure is supported by an online database and test center known as the General Testing and Documentation Server (GTDS) at http://gtds.buildingsmart.com.

National BIM Standard

The NBIMS initiative[12] proposes facilitating information exchanges through MVDs.[10] A model view is a subset of the IFC schema that satisfies the requirements for a particular industry model exchange. This NBIMS methodology defines the appropriate information entities from the IFC schema for a particular use case. The differences between the model schemas, designed to store building models for BIM applications, and the model schema of exchange models, arise from the different functions they support. The authors' experience in developing the precast concrete BIM standard,[8] as one of the earliest NBIMS dealing with a broad domain of exchange information and requirements, has given insights into the advantages of the MVD approach and enabled us to identify areas that require more attention, such as full validation testing of target IFC base exchanges.

The following sections introduce the idea of MVD and analyze the issues related to the semantics of IFC in developing MVDs. Studies on data exchanges, by reducing or simplifying the information, show that without well-defined exchange model views, the current approaches are vulnerable to errors, omissions, contradictions, and misrepresentation.[13] The results of the exchange scenarios between BIM applications have been shown to contain information loss or distortions.[14] Most of these problems can be related to the lack of semantic uniformity in the way BIM tools map their internal objects to and from IFC entities and properties. For example, there has been no standard procedure by which a precast concrete architectural facade is modeled and mapped to and from the IFC schema.[15] Performance studies of BIM databases, to create partial models and run queries, show a strong need for both identifying model views for specific exchanges and for specifying the exchange protocols in a stricter manner.[8,16] Venugopal et al. analyzed a need for a more formal definition of IFC concepts.[17] A layer of specificity for selecting and specifying information entities, their attributes, and rules over the top of the IFC schema needs to be provided for effective exchanges. This layer is a subset of IFC schema and when used for a particular exchange it is called a model view. A more generic definition of an MVD is "a subset of a building product model schema that provides a critical representation of the information concepts needed for a particular information exchange in construction workflow."[18]

Overview of the NBIMS process

This section provides a brief overview of the methodology for developing MVDs. More details can be found in Eastman et al.[19] Exchange requirements are derived from the scope and context of use-case exchanges and structured in an information delivery manual (IDM). Then, these requirements are combined into a set of information modules, called MVD concepts, which form a model view. The MVD concepts are shared through an open website, IFC Solution Factory, and serve as MVD specifications. Implementation of model views by software companies is supported by test cases for small groups of related MVD concepts. Finally, guidelines for documenting model views within each of the supporting applications are developed. The following sections explain these steps as they were conducted within the precast concrete context.

Engineering workflows in the precast concrete industry

The process models for the four different process maps (architectural precast, precaster as general contractor, precaster as subcontractor, and precast fabrication) were identified as necessary by the domain committee because of the different workflows involved. The result of the four distinct workflows was to identify 51 exchanges: 11 for the architectural precast concrete front-end process, 15 for the precaster as prime contractor, 9 for precaster as subcontractor, and 16 for fabrication and erection.

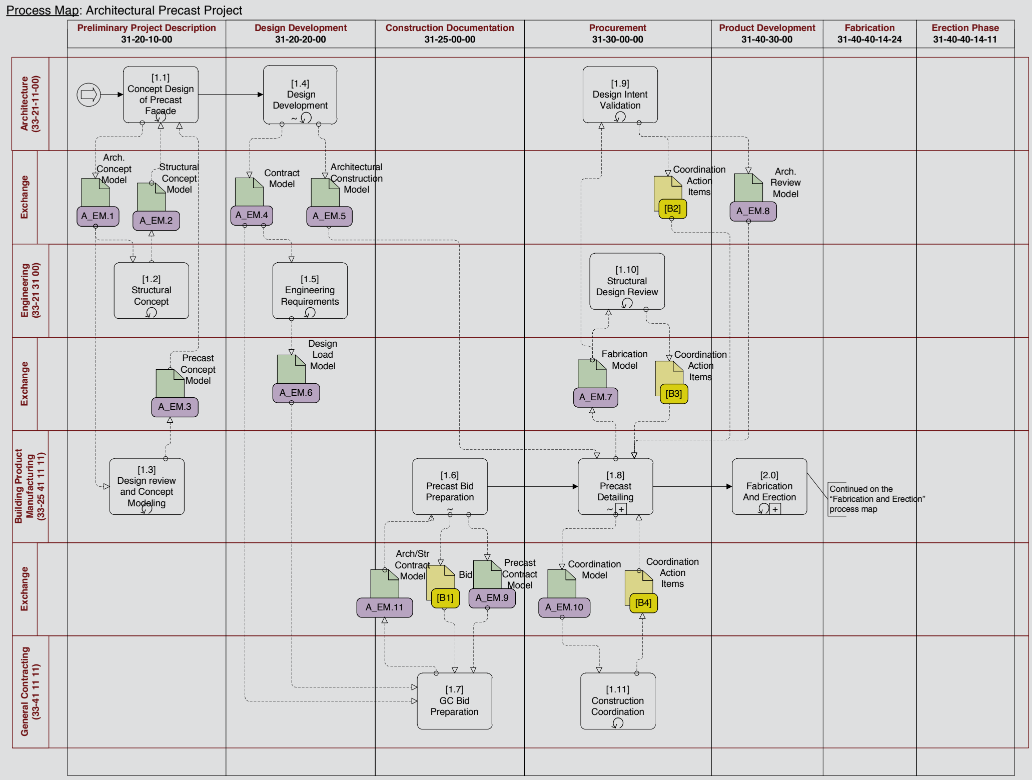
This was an ambitious task addressed by four subcommittees identified for the tasks. Business Process Modeling Notation (BPMN) representation was used to describe the different workflows.[20] BPMN is organized according to project phase (columns) and project roles (rows) (**Fig. 1**). White boxes are tasks, green boxes (with purpose identifications) are model exchanges, and yellow boxes designate nonmodel exchanges.

The next task was to identify the exchange requirements of each of the 51 exchanges. The information constructs include the degree of detail needed, connectivity, aggregation and nesting relationships, type of geometry representation, and others used in different workflows.

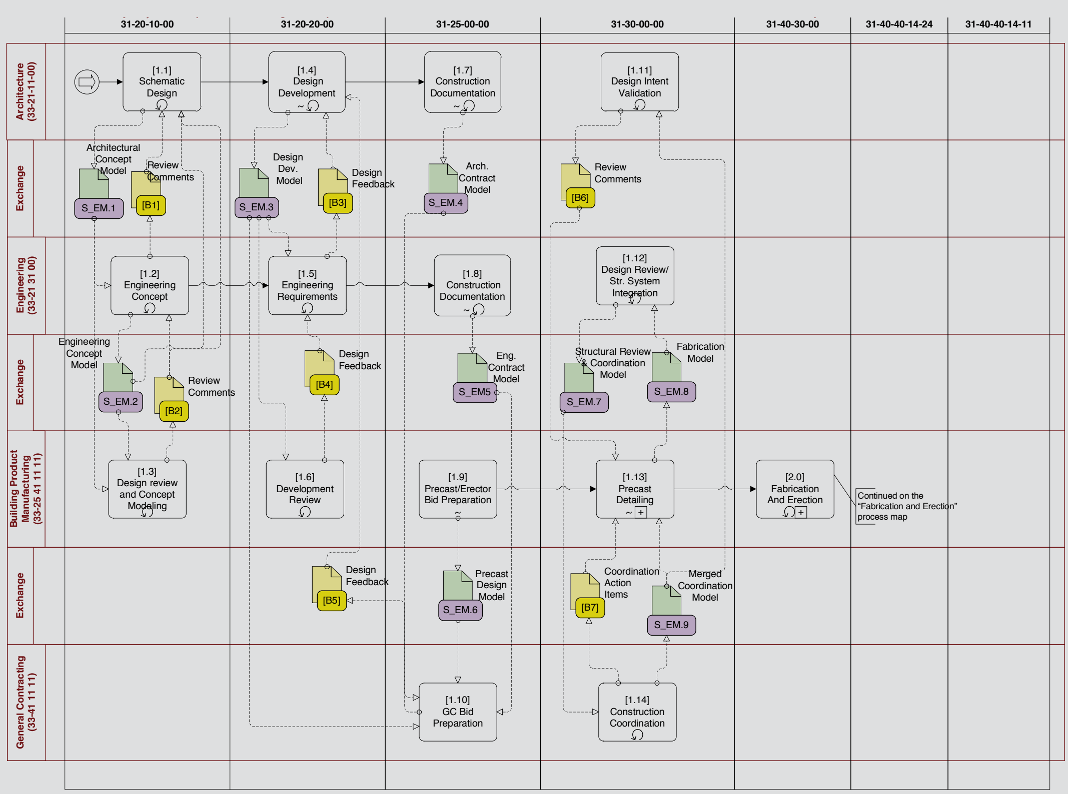
The next step in developing an IDM in the NBIMS methodology is to define the high-level information categories. For example, in the case of precast concrete, these information categories can include reinforcement elements, joints, plant- and field-applied connections, and slabs. These information categories are then divided into different subcategories. For example, slabs can be divided into hollow-core, double-tee, and diaphragm slabs.

This method continues to reach the appropriate granularity in which each category of information is basic enough to refer to a well-defined set of information, guided by the structure of IFC. These information items are called exchange objects and refer to data structures of interest for each of the information categories needed to be shared in the exchange models. Extruded shapes or solid forms and dimensional tolerance in the shape information category are examples of exchange objects (**Fig. 2**). These technical attributes are derived by analyzing the constituents of the collaboratively provided exchange models' contents. These exchange objects are detailed non-IFC binding attributes and properties of different information categories, which make them different from earlier efforts (that is, the functional parts defined by buildingSMART guide for IDM development).[21] Using nontechnical language facilitates the collaboration of industry domain experts in developing an IDM and communication of methodology and objectives.

The exchange requirements were documented in a large spreadsheet. Figure 2 illustrates a segment of the spreadsheet used during the knowledge elicitation process, through which the detailed information requirements were specified for each exchange identified in the process maps. The column headings at the right side of the figure represent the different exchange models. As shown, each information item is used in several exchange models with different levels of detail, geometric representations, functions, and degrees of accuracy. The main characteristic of exchange objects is that they are specifically defined to be reusable within several exchange models. Therefore, it is important to balance the granularity of exchange objects and not to define them to be so context specific that they lose the possibility for multiple applications in different exchange models.



Architectural precast concrete workflows



Precaster as subcontractor

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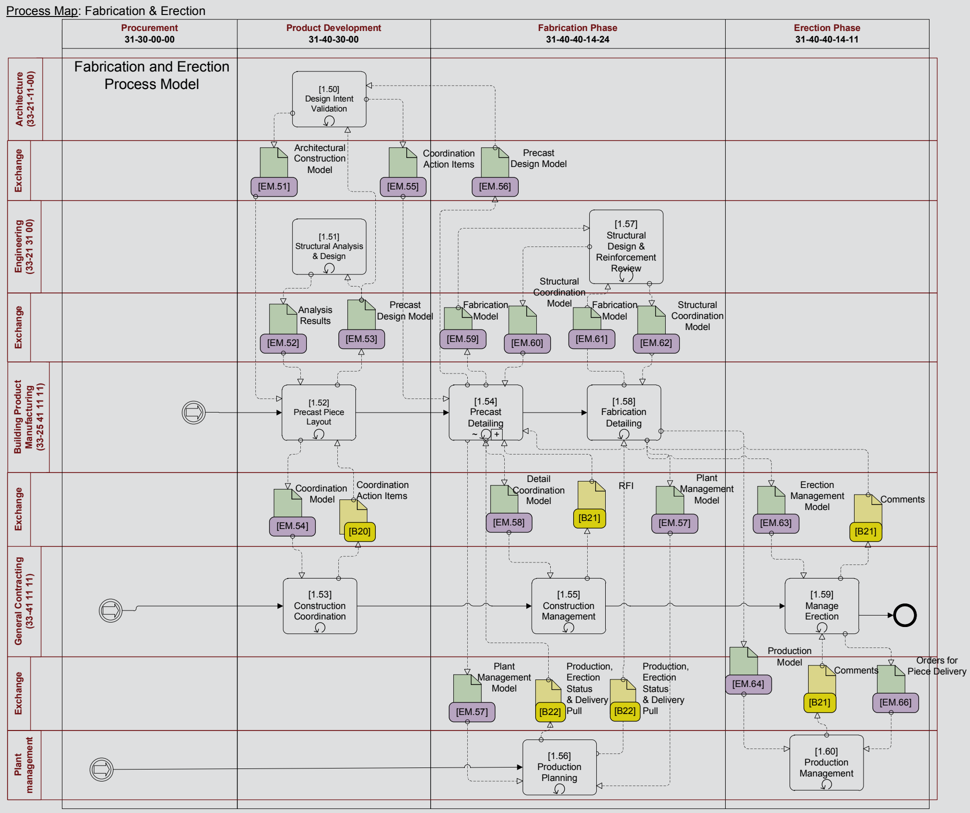
Figure 1. Business process model notation representations.



Precaster fabrication and erection processes for all three project delivery roles

Figure 1, continued. Business process model notation representations.

Accordingly, technical expression of an exchange model can be obtained by compiling the relevant constituent exchange objects and their associated business rules. This provides specifications for information exchanges and can be used as a basis for a data exchange standard. The detail, precision, and representation type of exchange objects may vary in exchange models in different stages of the project life and are determined based on the business rules and with participation of industry experts. Also, the level of detail in the provided and exchanged models for each information unit can vary based on the project stage, purpose of model exchange, model recipient, and local practices.

Further, different project delivery methods impose changes in roles and responsibilities of project parties, which considerably change project deliverables at each stage for each discipline involved in the project. This variation can even determine the presence or absence of an item in a model. Hence, finer adjustments in exchange objects are necessary to make them applicable in different exchange models and localities. Therefore, IDMs should permit application of IFC schema in national, local, or even project contexts.

In the work presented here, exchange objects were fine-tuned by providing four main categories of control functions, applying business rules to particular exchange objects in different exchange models. So the business rule variations show the change in context of the project. Developing the specifications for the 51 model view exchanges led naturally to several insights:

- The same information structures are needed in multiple exchanges. In fact, almost all of the exchanges used some shared information. The building model exchanges only varied in some aspects: detailed type and level of detail of geometry and nominal shape, as-cast, as erected.

- The attributes associated with pieces varied according to the use-case intention. The level of detail regarding reinforcement, embeds, and other details varied according to stage of design and the use case.

We investigated the commonalities by comparing the exchange objects across the different exchange models using a comparison macro to identify duplications of content with a view to consolidating the exchange models into a subset that would be capable of serving the purposes of all of the original 51 models. The models were first checked for consistency and then for consolidation.

Consistency check The exchange models were prepared by the different members of each of four subcommittees of the PCI BIM Advisory Committee. Naturally there

Information Group	Information Items	Attribute set	Attributes		P_EM.1	P_EM.2	P_EM.3
Foundations	Grade Beam, Pier Cap, Spread Footing, Slab on Grade, Stem Wall, Retaining Wall, Drilled Pier, Cassion, Pile, Pile Cap	Shape	Geometry	Required?	R	R	R
				Deformations?	A	A	D
				Function?	V	F	E
				Level of Detail?	L	M	
				Accuracy?	P	P	C
			Dimensional Tolerance Info	Required?	O	O	R
		Type	Structural Type (CIP Concrete/Precast)	Required?	R	R	R
		Supplier	GC/Contractor/Fabricator type/name	Required?	O	O	O
		Material	Material type	Required?	R	R	R
			Quantity	Required?	O	O	R
		Assembly relations	Part of structural system (slab, floor, façade, frame)	Required?			R
		Nested relations	Contains rebars/tendons...	Required?			O
			Contains connection hardware....	Required?			O
		Connection relations	.. to Precast	Required?			O
			.. to CIP	Required?			O
			.. to Steel	Required?			O
		Metadata	Author, Version, Date	Required?			O
			Approval Status, Date	Required?			O

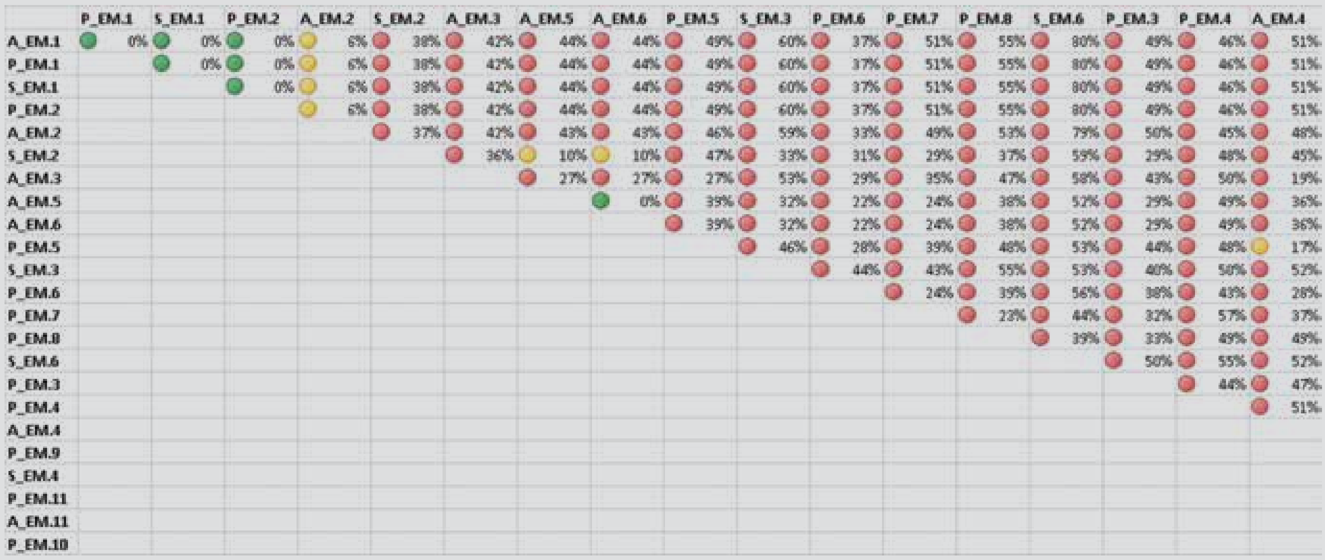
Figure 2. Example of the developed information delivery manual, including the business rules.

were some inconsistencies among exchange models. The research team then edited the models and submitted them for review by the BIM Advisory Committee. By reviewing the overlaps, inconsistencies, and redundancies in the exchange models, the team derived and used the following assumptions to guide the edit:

- The metadata of an object, which provide "information about the information" (such as the name of the author, version number, and last edit date), must be required wherever the object itself is required. Where the object is optional, the metadata must at least be optional.
- Generic project information (names and addresses of participants, etc.) is optional throughout.
- The site location can be optional in all exchanges; the site does not need to be geo-located anew in every exchange.
- Nesting relationships are only required after design development. They are optional during design development and required thereafter.
- Areas and volumes of pieces are not usually required until design development.
- Structural engineering information such as live loads and analysis results (moments, shears, displacements, reactions, and deformations) should not appear in exchanges with the architectural function.
- The geometry of external systems is always reference objects only and applies in design development and subsequently.
- The geometry for contractor coordination in all cases is referenceable (boundary representation). Relations in objects and systems other than precast concrete are not editable in precast concrete views.
- Material quantities and dimensional tolerances are optional in early exchanges, required for contract stages, and at least optional after that.
- Reinforcing bar, connection hardware, and lifting equipment are not of interest at all in the concept phases and should be blank. Similarly, they are blank through design development for all exchanges with the architectural function.
- Production information (such as production control number) can appear only after fabrication.

Consolidation of exchange models Once the consistency review and edit were complete, the exchange model comparison macro was run again. Wherever the number of differences found divided by the total number of fields was less than 10%, the exchange models were compared critically with a view to unifying them. If merging was viable, any additional changes were made and the exchange models consolidated. The guiding principle of the merged changes was to enhance exchange capability.

This analysis led to great simplification and efficiencies in specifying the exchanges and the needed variations among them. **Figure 3** shows a portion of a model comparison matrix, which maps the differences among exchange models. Cells of the map represent percentage differences among exchange models. Each field of each exchange model was compared with a parallel field of every other exchange model. Green, yellow, and red represent 0%, $<$10%, and $\geq$10% differences, respectively. **Table 1** details the relationships between the resulting consolidated exchange models and the key original exchange models that each covers. Eleven exchange models were defined in the resulting IDM, of which six were used for the subsequent demonstration exercises. When fully implemented,



	P_EM.1	S_EM.1	P_EM.2	A_EM.2	S_EM.2	A_EM.3	A_EM.5	A_EM.6	P_EM.5	S_EM.3	P_EM.6	P_EM.7	P_EM.8	S_EM.6	P_EM.3	P_EM.4	A_EM.4
A_EM.1	0%	0%	0%	6%	38%	42%	44%	44%	49%	60%	37%	51%	55%	80%	49%	46%	51%
P_EM.1		0%	0%	6%	38%	42%	44%	44%	49%	60%	37%	51%	55%	80%	49%	46%	51%
S_EM.1			0%	6%	38%	42%	44%	44%	49%	60%	37%	51%	55%	80%	49%	46%	51%
P_EM.2				6%	38%	42%	44%	44%	49%	60%	37%	51%	55%	80%	49%	46%	51%
A_EM.2					37%	42%	43%	43%	46%	59%	33%	49%	53%	79%	50%	45%	48%
S_EM.2						36%	10%	10%	47%	33%	31%	29%	37%	59%	29%	48%	45%
A_EM.3							27%	27%	27%	53%	29%	35%	47%	58%	43%	50%	19%
A_EM.5								0%	39%	32%	22%	24%	38%	52%	29%	49%	36%
A_EM.6									39%	32%	22%	24%	38%	52%	29%	49%	36%
P_EM.5										46%	28%	39%	48%	53%	44%	48%	17%
S_EM.3											44%	43%	55%	53%	40%	50%	52%
P_EM.6												24%	39%	56%	38%	43%	28%
P_EM.7													22%	44%	32%	57%	37%
P_EM.8														39%	33%	49%	49%
S_EM.6															50%	55%	52%
P_EM.3																44%	47%
P_EM.4																	51%
A_EM.4																	
P_EM.9																	
S_EM.4																	
P_EM.11																	
A_EM.11																	
P_EM.10																	

Figure 3. Matrix for analysis of degree of similarity between exchange models showing the first 17 of 51 models.

the eleven model views are expected to fulfill the needs of all the workflows reviewed in this undertaking.

MVD concept definitions and IFC bindings

Once the IDM is complete, the requirements are formulated as a set of information modules, called MVD concepts, which form a model view. The concepts are first defined in generic terms, but they are given sharp definition through "binding" to the syntax of IFC exchange or implementation schema. **Figure 4** shows an example of an IFC binding for a precast concrete MVD concept that represents a hollow-core or double-tee slab. The physical slab consists of individual precast concrete pieces that are mutually spatially disjointed. These pieces are represented by the IFC entities IfcSlab and IfcBeam, which are related using the IfcRelAggregates relationship. The unique nature of this concept for precast concrete is that a single slab is an aggregation of individual precast concrete pieces, which is represented by one-to-many relationships. The precast concrete–specific aspects, which narrow the ways in which the generic IFC objects can be used, are provided in the form of business rules. For example, for the slab aggregation, the PCI concept defines that an IFC exchange file the RelatingObject field of the IfcRelAggregates relationship instance must point to an IfcSlab instance. It refers to a slab entity with geometry, material, possibly embeds that are within the slab itself, but not in its other components. Embeds in double-tee or other components are not to be part of the slab except through inheritance.[22] Similarly, the RelatedObjects field must point to one or more instances of IfcBeam. It references each of the component beams in this slab. Slab component pieces are assumed to be mutually spatially disjoint, without overlaps. They may overlap the slab geometry.[23]

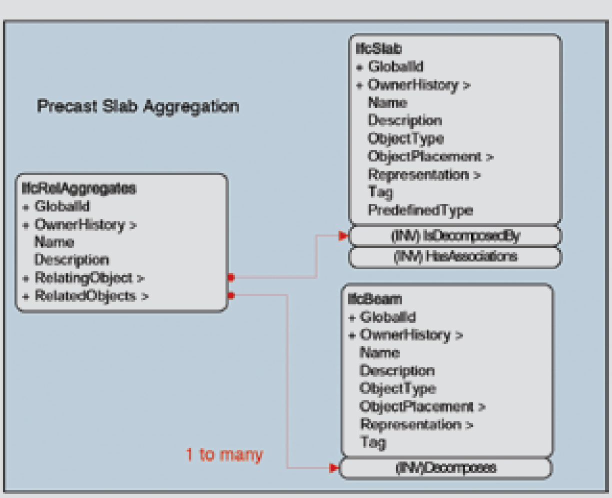


Figure 4. Industry foundation classes 2 × 3 specific concepts description: precast concrete slab aggregation.

The full set of PCI MVD concepts contains 25 main concepts and 135 node (or *leaf*) concepts. The full set can be seen at the PCI MVD browser page of the IFC Solutions Factory website.[22]

Demonstrations

On October 25, 2011, at the PCI Convention in Salt Lake City, Utah, and on September 30, 2012, at the PCI Convention in Nashville, Tenn., initial exchanges based on the precast concrete NBIMS were demonstrated. A number of vendors of software systems participated. Six exchanges at the PCI Convention in Salt Lake City and seven exchanges at the PCI Convention in Nashville were made among these applications using IFC as the data exchange format. Two additional applications were used to visualize the data exchanged.

Table 1. Consolidated exchange models derived from analysis of process map exchange models.

Consolidated exchange models	New exchange model codes	Original process map exchange model codes
Building concept	BC_EM	AEM.1, PEM.1, SEM.1, PEM.2, EM.3
Engineering concept	n/a	AEM.2, SEM.2, SEM.3
Precast concrete concept	PC_EM	AEM.5, AEM.6, SEM.3
Engineering design development	n/a	PEM.4, PEM.5, PEM.6, PEM.7, PEM.8
Architectural	AC_EM	AEM.4, PEM.9, PEM.11, SEM.4, SEM.6, AEM.11, EM.51
Engineering contract	ECO_EM	PEM.10, SEM.5
Precast concrete detailed coordination	PDC_EM	AEM.7, A_EN.8, AEM.9, AEM.10, P_EM.12, SEM.9, EM.53, EM.54, EM.55, EM.60
Structural review and coordination	(SRC_EM)	SEM.7, EM.61, EM.62
Engineering analysis results	(EAR_EM)	EM.52, EM.55, EM.56
Precast concrete	PF_EM	SEM.8, EM.58, EM.59
Production data	PR_EM	EM.57, EM.64, EM.65

Note: The exchanges in parentheses were not included in the demonstrations below. AC = architectural; AEM = architectural exchange model; BC = building concept; EAR = engineering analysis results; ECO = engineering contract; EM = exchange model; n/a = not applicable; PC = precast concrete concept; PDC = precast concrete detailed coordination; PEM = precaster exchange model; PF = precast concrete; PR = production; SEM = semantic exchange model; SRC = structural review and coordination.

More software vendors took part in the demonstration at the PCI Convention in Nashville than in Salt Lake City. The number of direct IFC exchanges was also increased. These demonstrations offered an important insight into the potential of open BIM, showing a sequence of exchanges over a significant portion of the precast concrete workflow.

While the projects were small and simple (**Fig. 5** and **6**), the demonstration showed the functionality that precast concrete software companies can provide to support smooth and effective workflows. It also showed how exchange interfaces can support on-the-fly adjustments of exchanges regarding geometry, detail, and properties.

Although the demonstrations revealed the potential benefits of data exchange for precast concrete design and fabrication, they also revealed the limitations of existing exchanges. Even software applications that have been certified against the IFC Coordination View do not meet all of the specific requirements of the precast concrete NBIMS for smooth, effective, and reliable workflows. A strict validation procedure of target information exchanges, specifically against the precast concrete MVD requirements laid out in the precast concrete NBIMS, is needed.

Validation

There is no universal BIM data exchange. Certified software products do not guarantee successful IFC-based data exchanges. Therefore, testing of target exchanges for conformance to requirements defined in the original IDMs and MVDs is needed for reliability. This is called validation. Validation tests should be conducted on IFC files exported from a BIM modeling application according to the schema of an exchange requirement or IFC MVD. Test cases can be defined for checking data exchanges against rules for data structures and data values. Ideally, a third-party validation tool checks a candidate IFC exchange file against requirements that are defined in a set of MVD concepts. The tool produces a validation report, stating what does or does not comply with the requirements.

Current status of the precast concrete NBIMS

At the time of writing, the PCI National BIM Standard Committee had about 20 members. This group addresses interoperability issues principally between the major precast concrete BIM applications and other applications using the precast concrete BIM data. These include structural analysis, reinforcement bar bending, quantity takeoff, material tracking, and plant management. The newly developed precast concrete NBIMS supports all of the major exchanges for precast concrete design, engineering, production, and erection, and addresses a range of contract delivery methods with different up-front workflows.[23] Exchanges for reinforcing hardware are under development.[24]

The PCI NBIMS has been polled in the PCI software committee for both the IDM level of definition and the

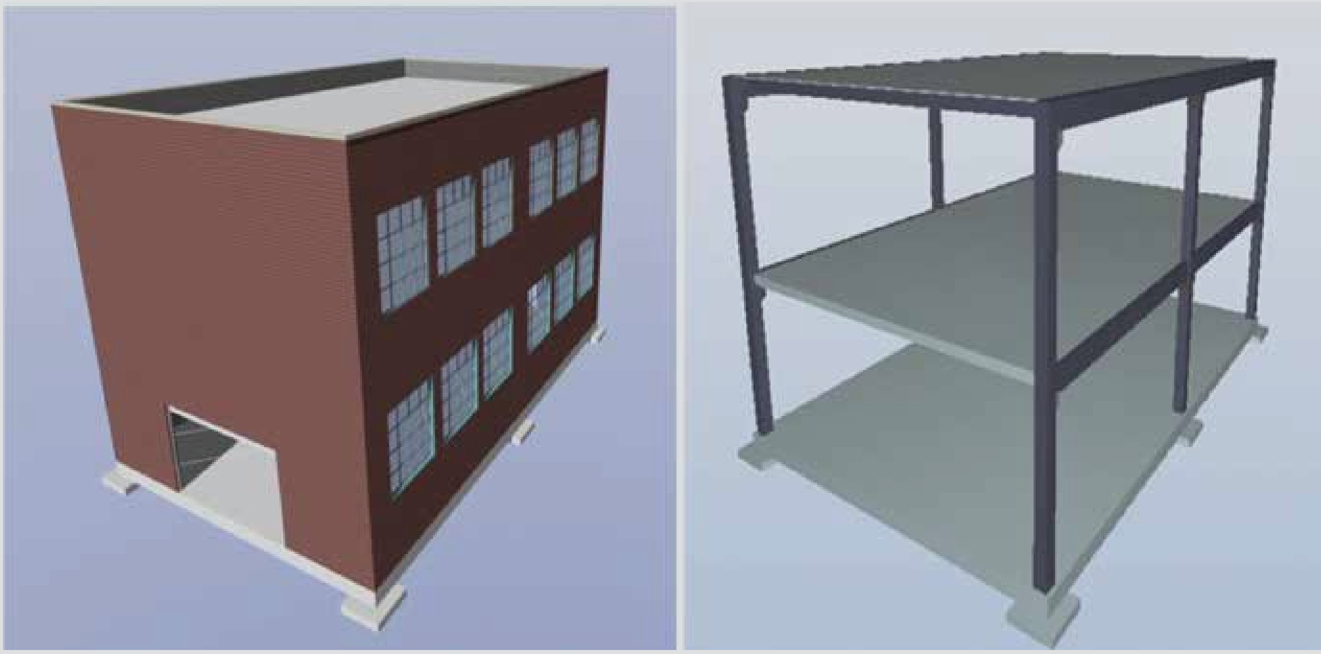


Figure 5. Precast concrete test model. Brick-walled, two-story building.

MVDs and was approved by the PCI Research Committee on April 14, 2010. It is also a candidate for approval by the National Institute of Building Sciences (NIBS)/buildingSMART committees.

Summary

The reliability of IFC-based information exchanges in the construction industry and in the precast concrete industry in particular should be reconsidered for interoperability. The precast concrete NBIMS effort, which aims at facilitating information exchanges and improving interoperability, has achieved a certain degree of success and recognition. Given the mature status of the precast concrete NBIMS, software companies should be encouraged to provide data exchange functions that conform to the standard. PCI members have an essential role to play in bringing this message to their software vendors.

However, the effort also has a number of limitations. Some model views duplicate modules of information specification, dealing with objects, embeds, geometry, properties,

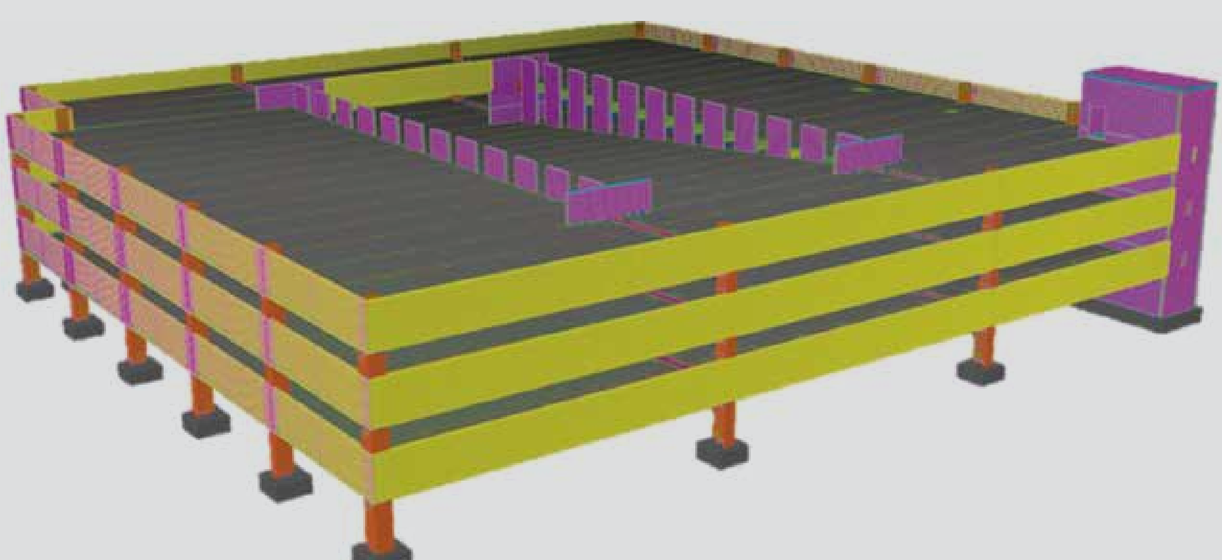


Figure 6. Precast concrete parking structure model. Precast concrete–specific functional coverage included double-tee and hollow-core slabs, precast concrete columns, spandrels, sandwich wall panels, discrete accessories, precast concrete stair and ramp, slab, topping, external finishes, camber and batter on beams, precast concrete properties. Non–precast concrete–specific functionality included reinforcing details, foundations, and material properties.

finishes, etc. Consolidating the exchanges based on the defined criteria can reduce their number. Some MVD concepts are defined incompletely or informally and are not reusable. Many of them can be combined for testing without eliminating flexibility. MVD development is time consuming, and the resulting MVDs are rigid and unsuitable for collaboration. As a result, software companies are reluctant to support many MVDs and would prefer to support a smaller set that could be reused in numerous domain applications.

Multiple efforts are underway to address the challenges of MVD specification and implementation. The MVDxml[26] and ifcDOCs undertaking[26] has developed good tools for documenting MVDs. MVDxml is a method for publishing concepts and associated rules. ifcDOC is a specification development and documentation tool. To address the effort of MVD implementation, a new approach for development of model views based on object-oriented, testable, and reusable modules of information called semantic exchange modules (SEMs) is being developed.[27] An SEM is a structured, modular subset of the objects and relationships required in each of the multiple BIM exchange model definitions. The goal is to reduce the model view generation-implementation time by allowing software companies to reuse modules across different domains. This would also reduce the time and effort required for validation and certification, as testing for conformance to requirements defined in an original MVD is shortened where some of its constituent SEMs have already been certified for other MVDs.

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Notation

BIM = building information modeling

BPMN = business process modeling notation

CV = coordination view

GTDS = general testing and documentation server

IDM = information delivery model

IFC = industry foundation classes

MVD = model view definition

NBIMS = national BIM standard

About the authors

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Abstract

The precast concrete National BIM Standard (NBIMS) initiative is an industrywide effort encompassing the major building model exchanges dealing with precast concrete and addressing a range of contracting and procurement methods. The standard was developed according to the guidelines described within the NBIMS for facilitating information exchanges and improving interoperability. The precast concrete NBIMS effort is the first of its kind to deal with a large set of exchanges. The tradeoffs and advantages of this large-scale approach are reviewed as well as areas that require additional attention. Two demonstrations were conducted to showcase the functionality that the software companies are developing in support of the standard and to provide an example of the potential of open BIM. They also revealed the importance of full validation testing and certification.

Keywords

BIM, building information modeling, interoperability.

Review policy

This paper was reviewed in accordance with the Precast/Prestressed Concrete Institute's peer-review process.

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