Strategic Plan to Develop BIM Interoperability in Structural Concrete

White Paper by the ATC-81 Project Management Committee[1]

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Today, there are challenges with software interoperability between disparate modeling platforms, as most anyone who works in concrete has likely experienced. The term 'interoperability' is used to describe the capability of different programs to exchange data in a reliable manner. The duplication of modeling efforts between design models, analytical models, construction/scheduling models, estimating/quantity survey models, rebar or formwork detailing models is extensive – millions of dollars are spent making models each year that should be compatible. Efficient, robust interoperability is the answer. Making software platforms "talk to" each other intelligently will save the industry not only time and money in creating models, but more significantly time and money in construction and fabrication as well. It will allow design and build teams to work together from project inception through completion, updating in real time and aiding each other to make the best decisions in the larger scope of the project.

The Applied Technology Council (ATC) is directing this effort, under a grant from The Charles Pankow Foundation and the Ready-Mixed Concrete Research and Education Foundation. ATC is working with the ACI Foundation of the American Concrete Institute and the Strategic Development Council (SDC), ACI's technology forum, to develop a strategic plan for BIM[2] in structural concrete design and construction. ATC is building on the proven project model developed under the ATC-75[3] project, which sought to refine IFCs[4] for structural engineering and brought together a similar project team. By bringing design, construction, fabrication and software professionals together, ATC fosters a collaborative, consensus-based project

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[2] Building Information Modeling is the process of generating and managing building data during its life cycle. Typically it uses three-dimensional, real-time, dynamic building modeling software to increase productivity in building design and construction. The process produces the Building Information Model (also abbreviated BIM), which encompasses building geometry, spatial relationships, geographic information, and quantities and properties of building components.

[3] ATC-75 Development of Industry Foundation Classes (IFCs) for Structural Components (http://www.atcouncil.org).

[4] Industry Foundation Classes - The IFC data model is a neutral and open specification that is not controlled by a single vendor or group of vendors (open architecture). It is an object oriented file format with a data model developed by buildingSMART (International Alliance for Interoperability, IAI) to facilitate interoperability in the building industry, and is a commonly used format for Building Information Modeling (BIM). The IFC model specification is open and available.

approach. The decisions made are considered from all angles, and the software providers have been eager to invest in such well-rounded, collaboratively developed industry recommendations.

Much work has been done in this arena to date. The comprehensive Domain Survey[5] sponsored by Tekla and conducted by the Reinforced Concrete BIM Consortium details an enormous breadth of data types that stakeholders would wish to carry between virtual models, and how the data should be handled. It is a clear foundation for future work; what remains is to parse it into priorities that can be implemented on a meaningful timeline. The SDC provided a survey of its members that asked questions about how respondents use BIM and what keeps them from fully embracing it, to ascertain current industry practices and attitudes. Additionally, participants in this project have been interviewed in a longer format to gather their experience with BIM and thoughts on future progress. (These documents have been summarized and summaries are posted on the ATC -81 project website.)

The end goal of SDC is to foster robust interoperability for reinforced concrete construction projects throughout the design/build/facilities management lifecycle, for all stakeholders. In this project, we seek to develop a strategic plan that will synthesize the state of the art of current IFC interoperability and prioritize the attribute exchanges that would most benefit the industry.

BIM Implementation

Before interoperability can be realized, the project participants must be operating and engaged in BIM platforms. There continues to be tremendous growth across the industry in the utilization of BIM technology. It is clear, however, that the enhancement of interoperability will add significant leverage to the value of this technology and permit broader industry participation. Interoperability creates the possibility for a far more efficient, and thereby cost-effective, business model that permits the reliable exchange or sharing of data among project participants.

From the research conducted, it is apparent that issues like cost and time involved in training staff, the difficult task of choosing what platforms to invest in, investment in computing power that can manipulate models at a useful speed and recreating company standard details are initially the most pressing for new users. These initial factors then give way to more technical concerns, such as unwieldy file size, loss of data richness (schedule or cost tags, quantity types and native parts for example) and lack of standards for describing concrete shapes and rebar,

[5] *User and Functional Requirements for 3D Parametric Modeling of Cast-in-place Reinforced Concrete Structures, A Draft Specification*, by R. Sacks, C. M. Eastman, R. Barak and Y.S. Jeong on behalf of the members of the Reinforced Concrete BIM Consortium, DRAFT November 19, 2007.

which greatly reduce the values that could be gained by sharing models for construction and fabrication.

There is also a "culture of why" to overcome, as one interview participant phrased it. Resistance to change is always a factor when an endeavor has been performed seemingly adequately in the past through comfortable, known means. These human factors will need to be addressed as part of the development of the strategic plan.

The implementation of BIM across the traditional industry participants creates the opportunity for mutual benefit in the electronic interchange of data, provided that there is also a sharing of risk and an ability to rely on both the validity of the data and the appropriate application of it in the context for which it was intended. The economic benefits of this scenario are derived from the efficient use of labor to develop the data, but more significantly from the time or schedule and overall cost (labor, material, equipment, financing and project carry costs) savings that can be realized. There are also improvements to data quality and electronic coordination, cost estimating and construction scheduling. Interoperability is the key to unlocking the broad industry gains that lie ahead.

BIM Interoperability Goals in Concrete Construction

The goal is to reach a place where all stakeholders can use any model data in the software that works best for their needs. Interoperability will mean that data input by one user is not lost to other users, upstream or downstream. To achieve this goal, our project team will examine the IFC data fields defined by the Domain Report and determine what the priority of implementation should be, so that software developers have manageable, meaningful scope to work with. IFC is the most universal and open platform for data exchange, and will be the tool of communication and transfer for the industry. As an international collaborative project, IFC broaches all barriers between software and purposes, and its development establishes data formats and protocols for application of that data that will bring all users together in common understanding of overall business practices that each actor in the project delivery process plays a crucial role in and can gain benefits from.

Identifying industry initiatives that will facilitate the process, such as establishment of standards for describing concrete shapes and rebar (suggested by multiple interviewees), will be a large part of the effort. Establishing collaboration between professionals involved in every stage of reinforced concrete projects gives us a unique opportunity to truly find the best path forward.

Interoperability Goals. Planning to build interoperability begins with developing the goals that will allow interoperability to be achieved. These goals are organized by their priority, weighted by the importance and viability. These goals will change over time as they are achieved and new priorities are assigned. Some example goals are:

Design/Detailing

- Concrete Material Properties[6]
- Geometry[7]
- Analysis
- Element Design
- Coordination / Clash Detection
- Reinforcement[8] Database, Size and Arrangement
- Composite Members[9]
- Formwork[10] Database
- Code checking

Manufacturing/Fabricating

- Bill of Material / Procurement
- Concrete Mix Design
- Rebar Fabrication, Size and Configuration (Bend Diagram)
- Embed Fabrication
- Composite Member Fabrication
- Formwork Fabrication

Construction

- Geometry
- Sequence Scheduling
- Design Completeness Checking
- Constructability Checking
- Formwork Installation
- Formwork Stripping and Shoring
- Rebar Installation, Reference Mark and Arrangement
- Composite Member Installation
- Accessory Installation
- Safety

[6] Compressive strength, durability, etc.
[7] Element size and location, includes edges, pour joints, etc.
[8] Deformed steel bar reinforcement, pre/post tension tendons and rail reinforcement, etc.
[9] Form deck, encased structural steel shapes and concrete filled sections, etc.
[10] Steel, wood, standard, adjustable, custom, finishes, etc.

Strategies to Achieve Goals. Strategies represent a plan for achieving a goal. For each goal to succeed key strategies/elements must be identified:

1. Champion. Industry leader to advocate for the goal and to bring necessary participation from other industry leaders.
2. Definition. A clear definition of the objectives of the goal.
3. Time Frame. Develop a prospective time frame to develop and implement the goal.
4. Financial Constraints. Develop an estimate of the prospective costs to implement the goal.

With these key elements defined each goal can be prioritized. It may be that goals will need to be divided into smaller objectives in order to effectively define strategies that can be achieved under time and financial constraints.

STRATEGIC PLANNING SESSION

This paper was written to provide background to the development of BIM interoperability in structural concrete. The Strategic Planning Session scheduled for May 5th and 6th in conjunction with the SDC Meeting in Kansas City, Missouri, will be the forum for discussion and deliberation on the development of the BIM interoperability strategic plan. In this forum we can examine the goals presented here and revise and expand them as necessary to include others that the group sees as important. The group can then begin to identify strategies to achieve goals and prioritize them for industry to undertake.