ATC-81

Development Of IFCs
For Structural Concrete
Strategic Planning Session Report

July 20, 2010
INITIAL RELEASE

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ATC-81

DEVELOPMENT OF IFCs FOR STRUCTURAL CONCRETE STRATEGIC PLANNING SESSION REPORT

July 20, 2010

INITIAL RELEASE

PREPARED FOR SDC BY

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ATC

SDC
The Concrete Industry's Strategic Development Council

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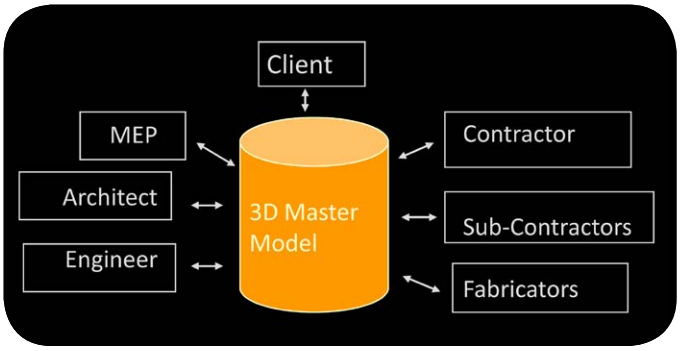


INTRODUCTION

The ATC-81 Project Management Committee (PMC) held the Strategic Planning Session on May 5 and 6, 2010 in Kansas City, in conjunction with the ACI Foundation's Strategic Development Council's Session #27. The primary objectives of this session were to identify priorities in the exchange of design and construction data for reinforced concrete, to identify goals toward reaching those priorities, and to develop strategies for each goal.

This session report summarizes the issues discussed and broad conclusions and directions reached by the PMC and project participants in those discussions.

PROJECT STRUCTURE

The Strategic Planning Session is characterized as Task 2 of the project, with Task 1 being the ground work performed in gathering state-of-the-industry background information. The data gathered in Task 1 is comprised of a survey performed by the ACI Foundation's Strategic Development Council (SDC), a Domain Report compiled by the Reinforced Concrete Building Information Modeling (BIM) Consortium (2007) and interviews conducted for this project with professionals in various fields dealing with reinforced concrete construction. Those three sources were used to create a White Paper summarizing the state of the industry and putting forth a "straw man" set of priorities to seed discussion at the Planning Session.

Task 3 will be the development of a Strategic Plan, a living document that will set forth the goals and strategies developed and track their evolution.

TASK 1 - PROJECT RESEARCH

Two documents were made available detailing some of the industry's research on the attitudes and needs of practitioners in the field of concrete construction. The first was the survey that SDC conducted in the spring of 2009, which captured the current usage and attitudes toward BIM technology among respondents. The other was the detailed Domain Report developed by the Reinforced Concrete BIM Consortium, a group composed of research, engineering, industry and software provider participants. Building upon that information, a series of interviews were conducted with professionals from contracting, engineering, fabrication and detailing, software and academic/research organizations. These data were the basis for the White Paper, which set the stage for the Strategic Planning Session.

SDC SURVEY (2009)

The SDC survey was primarily a survey of current practice and opinion. The most pervasive implication of the SDC survey was that respondents believed that the use of BIM is driven by the architecture and engineering fields, and is mainly used for visualization, clash detection, constructability modeling and document production.

Sixty-seven percent of the respondents were engineers doing primarily design work. Respondents mainly saw some limited demand for BIM technology in their business and anticipated demand rising from the owner-end. They believed that BIM is used more for structural steel and cast-in-place concrete than for most other applications.

Revit Structures and AutoCad 3D were by far the most utilized software tools for cast-in-place concrete in this group. They were being used to interface with architects and engineers, and to a limited extent, contractors; very little BIM interface with suppliers or owners was reported.

The final pages of the survey relay all respondents' answers to the question "what is the biggest obstacle to using BIM-related software for cast-in-place concrete design and construction?" The major theme seemed to be the time and cost involved in purchasing software and training personnel. More telling, however, were answers such as these: lack of standards; lack of demand; lack of consistency of data relevance among stakeholders; lack of trust in the software's accuracy. Unmanageable file size is also cited. Additionally, there appear to be perceived obstacles to using BIM in restoration/retrofit vs. new construction and a perception that BIM is only relevant for very large projects.

USER AND FUNCTIONAL REQUIREMENTS FOR 3D PARAMETRIC MODELING OF CAST-IN-PLACE REINFORCED CONCRETE STRUCTURES

(Reinforced Concrete BIM Consortium, 2007)

This document contains a very detailed step-by-step model of the business practices required in the design, engineering, detailing, construction and recordkeeping of concrete construction. Building on these models, the report describes the attributes, associated behaviors and meta-data that software needs to support in order to utilize BIM at all stages of the design/construction process.

The model assumes a full and robust implementation of BIM; that is, initial data input would conform to requirements for downstream users and all users in a model would have the same understanding of how the data will be used. It is important, therefore, that the picture of industry needs and desires be accurate.

The business process models in section 2 of the report detail the conceptual workflow among stakeholders and the data exchange points in a project of this type. The workflow and data exchanges are based on actual project life, and would apply with or without software support. It includes exchange and collaboration from concept to construction, encompassing design, engineering, formwork, quantity take-off, code checking, etc.

The user requirements (section 3) and functional specifications (section 4) make up the bulk of the document. These are instructions to the software providers detailing what data needs to be handled and how it should be handled, including meta-data and data with multiple uses.

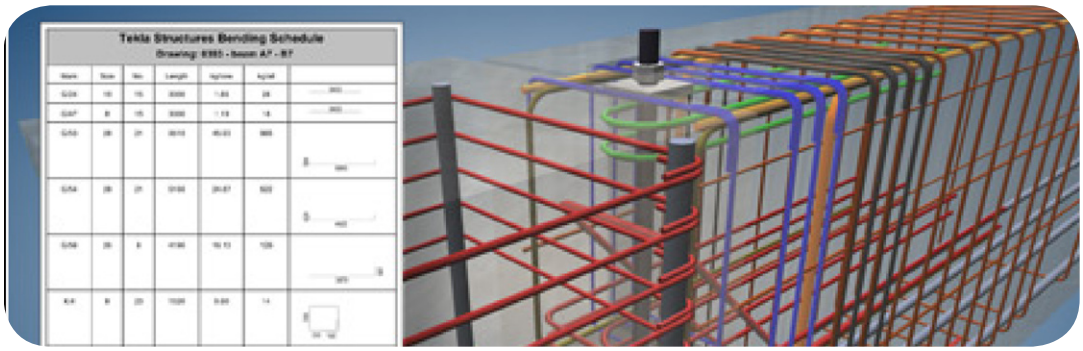
INTERVIEWS

Interviews were conducted in groups of up to five participants, with one to three moderators. The participants were drawn from lists provided by the American Concrete Institute (ACI), including members of the ACI 131 Committee. A general contact was made through the ACI web-mail server, and the first round of interviews consisted of respondents to this general email solicitation. The first round of interviews was conducted in January 2010, and the second round was conducted in April 2010.

An agenda was distributed prior to the interviews, asking participants to consider their thoughts on and experience with BIM in a guided discussion organized by:

- Experience with BIM and interoperability
- Current use of BIM
  - software used
  - method of implementation
  - obstacles faces
  - benefits experienced
- Interoperability
  - with whom data is currently exchanged
  - how data is currently exchanged
  - what exchanges the user would consider suitable for BIM technology (and not)
  - interviewees' idea of the greatest obstacle to use of BIM in the full project life
- Future of BIM
  - estimate of how long it takes to recoup the investment in BIM
  - interviewees' idea of where BIM is going
  - estimation of the greatest benefits to BIM
  - idea of who benefits most

Within each interview, there was a wide variety of experience with BIM. While there were those who use BIM to its fullest capability in their practices, there were many who had not yet "taken the plunge". The most experienced practitioners were enthusiastic about BIM's capabilities. They reported not only saving time and money on a per-job basis, but also developing new relationships and revenue streams from their use of BIM. Some use BIM across the board on all projects, and some assess on a project-by-project basis which would be appropriate for BIM. The two users who stood out as having very mature and profitable BIM implementations were both large General Contractors. Engineers were well versed in modeling and several were making strides to incorporate BIM, although they reported difficulty in taking advantage of their efforts in analytical modeling for any other purpose. Many Fabricators and Detailers felt that they were without options for interoperable software and a few did not feel they would benefit from BIM, although they would be forced to implement its use to meet client demands. The rebar software representatives felt that there is no software that both meets the



needs of detailers and is interoperable; that no wider platform adequately handles the data necessary.

Methods of implementation and training were discussed, and those lessons learned are valuable insights into the "human factors" of implementing change of a paradigm-shifting magnitude. One very useful tactic seemed to be using BIM software for documentary purposes only, at first, allowing users to become familiar with the tool without the pressure of active service. The added benefit of this approach was to load the software with real-world historical data relevant to a particular firm's business practices, making it more accurate in predicting future schedules, quantities, costs, etc.

Concerns, or obstacles, were primarily divided into three categories: financial, technical and those "human factors", which included both the expected resistance to change and also the inter-disciplinary issue of trust between professions. Most interviewees expressed some concern about the lack of legal guidelines and precedents at this early stage of use. Financial concerns were predictable – the cost of purchasing software and the investment in training, primarily. Technical concerns were predominantly related to choosing a software package and understanding data flow between professions.

Benefits were discussed; most felt the greatest reward in the use of BIM is increased collaboration, and through that collaboration, the ability to detect problems before they become field problems. Other benefits identified include early cost estimating, especially in the design phase, automated construction document production, schedule and materials management, ability to create a log of historical data for future use and value as a marketing tool. Two new lines of business were specifically identified by participants. One firm reported hiring out their BIM group as expert resources for other firms; another reported offering more detailed as-built models for facilities managers as a value-added service.

All agreed that BIM, implemented perfectly across the board, would begin a new era of building. When asked who would benefit the most from BIM, the answers were well distributed, from owners to architects to general contractors to subcontractors. All felt the cost of implementation would eventually be recouped. Many identified the greatest benefit overall to be the shift to a collaborative paradigm, where groups are connected from the beginning and share data throughout the process. In the end, it seemed to be the consensus that BIM will bring the building community together with a new level of cooperation and higher levels of performance.

WHITE PAPER

The white paper was developed as a synthesis of the research performed and used as a roadmap for the planning session. It was distributed to attendees prior to the meeting, with the hope that it would seed the strategic planning process before the session began. The paper contained some suggested lists of attributes as interoperability goals, and those attributes were meant to be merely starting points for the day's discussion.

The white paper also laid out the format of the expected outcome of the session. Goals were defined as exchange attributes in need of refinement or definition in order to further interoperability for reinforced concrete (i.e., "formwork database"). Strategies to achieve the goals were broken into four parts. The work group was tasked with identifying:

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

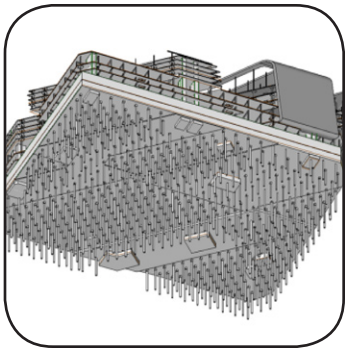
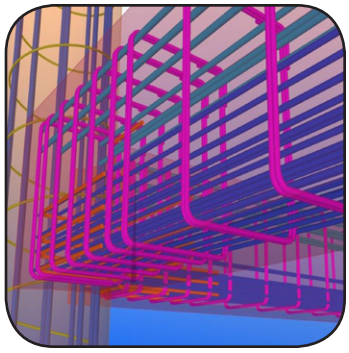
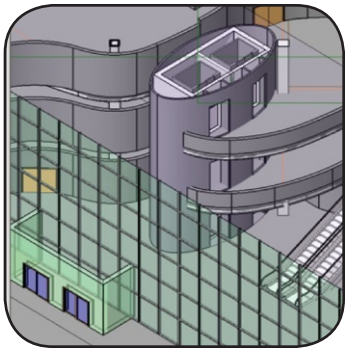
TASK 2 - STRATEGIC PLANNING SESSION

The session was held in conjunction with the SDC #27 session, in an effort to facilitate involvement from as wide a group as possible. It was structured to allow a focused working day on May 5th, and to introduce the topic and results of the break out groups to the entire SDC session audience on May 6th.

The session began with an overview of the project. Background, goals and objectives of this meeting were discussed. Presentations were given on each of the Task 1 components, as well as an overview of complementary work being done by the ACI 131 Committee. The group then held an open discussion forum, in an effort to formalize one goal and strategy. It became apparent that the first priority would be to identify the goal and the champion; further formalization would likely take place in the development of the Strategic Plan (Task 3).

The plenary sessions were divided roughly by profession or application. The three groups were design/detailing, detailing/fabrication/manufacturing and construction. They determined the interoperability priorities for their professions – the most important types of information to exchange – and then worked to identify the most appropriate champions for each of those goals.

The design/detailing group was pressed to determine, at their early stage of the building process, who would input what kind of information at what time. Such questions touch on larger issues of business processes, and while a great deal of productive discussion was held, answers were not obvious. The group chose to focus on the accurate exchange of basic geometry as the highest priority goal.

The detailing/fabrication/manufacturing group identified three major goals. They determined that geometry standardization would result in new IFC classes for "joints" and "pours", as well as new attributes to the IFC "beam" class, and that ACI would be the most appropriate champion for that endeavor. Their next priority was reinforcement fabrication, size and configuration, and they identified the Concrete Reinforcing Steel Institute (CRSI) as the champion (though they suggested the Post Tensioning Institute (PTI), the ACI 315 committee and perhaps even the American Association of State Highway and Transportation Officials (AASHTO) as additional resources). Their third priority was concrete design mix, development of exchange standards for which would result in modifications to the IFC material class. They identified the National Ready Mixed Concrete Association (NRMCA), the Portland Cement Association (PCA) and the Structural Engineering Institute (SEI) as possible champions for that effort.

The construction group developed a graphical approach to the division of construction information by responsible groups. Using a guideline roughly dividing a structure into the formwork layer, the structural elements, the non-concrete elements that penetrate various layers, the concrete itself and the placing and finishing elements, they prioritized five types of exchanges. Geometry was the first priority, to be championed by ACI. Reinforcement they determined to be the realm of CRSI. Concrete material they believed should be defined by the National Ready Mixed Concrete Association (NRMCA). Project management was broken into quantity/estimating (American Society of Professional Estimators (ASPE)/Association for the Advancement of Cost Engineering International (AACE)), schedule (American Society of Concrete Contractors (ASCC)) and curing (ACI/PCA). They believed QA/QC processes to be an important component of BIM capabilities, but were not able to identify a champion.

The groups came together to present their findings to each other at the end of the afternoon, and some common threads were identified. The results of the break out sessions and the consolidated discussion afterward were carried forward to the general SDC #27 session the following morning. In presenting these findings to the larger group, more awareness of the project was raised, and more input was available.

In the larger session, the project was introduced, background given, and the results of the work session were presented. The goals that were common to the plenary groups were presented, and a new goal was added. The group determined that formwork is vital to planning construction, in estimating, scheduling, and even dealing with sustainability issues. Scaffolding, Shoring and Formwork Institute (SSFI) and the ACI 347 Formwork for Concrete committee were suggested as possible champions for the effort to describe formwork in BIM.

The legal issues that have been a concern for most participants were touched on briefly; the concerns are much larger than concrete alone. Legal issues are beyond the scope of this project.

TASK 3 – STRATEGIC PLAN

The Strategic Plan will be developed from the work of this session, and will include more detailed development of each goal. The four aspects of each goal will be identified, as well as key contacts for seeking champions. The document will be updated periodically to reflect projects in progress and identify new goals as they may be developed. It will be a working document that functions as a guide for continuing to develop interoperability for structural concrete as each new piece is added to the puzzle.

The goals were discussed in the context of developing standards of describing and capturing information about particular areas of information in reinforced concrete construction. The areas of information prioritized were geometry, reinforcement, concrete materials, project management (the sub-categories of quantity/estimation and schedule/sequencing) and formwork. Potential champions were identified for each goal. The champion would take on the work of developing the standards for describing and working with the information that falls into the category.

GOAL	CHAMPION
Geometry	American Concrete Institute (ACI)
Reinforcement	Concrete Reinforcing Steel Institute (CRSI)
Concrete Materials	National Ready Mix Concrete Association (NRMCA)
Project Management ▶ Quantity/Estimation ▶ Schedule/Sequence	American Society of Professional Estimators (ASPE) American Society of Concrete Contractors (ASCC)
Formwork	American Concrete Institute (ACI)

The Strategic Plan will develop these goals by providing a more defined scope for each goal, as well as a rough time and cost estimate.

Some goals discussed fell to lower priorities, either because of feasibility concerns or simply because the group deemed them to be less urgent. Those included:

- Facilities Maintenance Data
- Tolerances
- Labor Requirements (resource-loaded scheduling)
- Submittals/RFIs/Product Data
- Quality Control/Testing
- Placing/Top Surface Finishes
- Composite Members
- Code Checking

As the primary goals are successfully assigned, it may become feasible to begin defining these additional areas of data as well. The Strategic Plan will be revised periodically to show progress on each goal and ongoing development of new goals. It is hoped that the momentum gained in the first-tier goals will be carried forward into these more second- and third-tier priorities, as interoperability for reinforced concrete is refined.

END OF REPORT

APPENDIX A: Work Session Participants

APPENDIX B: Work Session Meeting Notes

APPENDIX C: Work Session Materials

I. Agenda

II. Presentation(s)

III. Interview Summaries

IV. White Paper

APPENDIX A:
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APPENDIX B:
Work Session Meeting Notes

NISHKIAN DEAN
CONSULTING AND STRUCTURAL ENGINEERS SINCE 1919

Meeting Minutes

Detailed, Grouped by Each Meeting and by 'Old Business' and 'New Business'

IFCs for Structural Concrete **Project # ND1000**
Tel: Fax:

Strategic Planning Session Meeting 1

Date	Start	End	Next Meeting	Next Time	Prepared By	Company
5/5/2010	09:00 AM	05:00 PM			Michelle Kernen	Nishkian Dean

Purpose	Location	Next Location	General Notes
Strategic Planning Session	InterContinental Hotel Kansas City, MO		All times shown are CENTRAL.

Attended By

PMC - ENGINEERING/CONSTRUCTION - Aaron White
PROJECT PARTICIPANTS - Alan Sweat
PMC - SOFTWARE - Alistair Wells
PMC - SOFTWARE - Allan Bommer
PMC - ENGINEERING/CONSTRUCTION - Bill Klorman
PROJECT PARTICIPANTS - Bill Shebetka
PROJECT LEADERSHIP - Chris Darnell
PROJECT ADVISORY PANEL - Dan Frangopol
PMC - SOFTWARE - Dave Grundler, Jr
PROJECT LEADERSHIP - Douglas Sordyl
PROJECT LEADERSHIP - Ed Dean
PMC - ENGINEERING/CONSTRUCTION - Erleen Hatfield
PROJECT PARTICIPANTS - Gary Knight
PMC - INDUSTRY - John Turner
PROJECT PARTICIPANTS - Luis Perez
PROJECT LEADERSHIP - Michelle Kernen
PROJECT PARTICIPANTS - Mike Moffat
PMC - INDUSTRY - Peter Carrato
PMC - ENGINEERING/CONSTRUCTION - Phil Williams
PROJECT PARTICIPANTS - Richard Stehly
PROJECT PARTICIPANTS - Scott Carmichael
PROJECT PARTICIPANTS - Steve Jones
PROJECT LEADERSHIP - Tom McLane
PROJECT PARTICIPANTS - William Owings

Non-Attendees

Item	Meeting Item Description	Resp	Status	Due Date	Compl'd	Cls'd
New Business						
Introductions						
001-001	E. Dean (PL) led the group in introductions, and requested that each person identify their interest in BIM and their reason for attending this strategy session. Experience with BIM ranged from long time champions		Information			Yes

Item	Meeting Item Description	Resp	Status	Due Date	Compl'd	Cls'd
New Business						
	of BIM to those who have not yet used BIM but are interested in its effect on their industry. Attendees included engineers, construction managers, concrete/RMC/reinforcing suppliers, software engineers, research and academic professionals, testing providers and representatives from ATC and SDC facilitating this project. All attendees expressed a belief that BIM is changing or will change the concrete construction industry.					
Goals						
001-002	E. Dean (PL) noted that the goal for today's work is to identify what is important to exchange between programs, remembering that no single program or platform will work for all needs. E. Hatfield (PMC-ENG) added the question "when does BIM become the standard of care?" to the general discussion. W. Klorman (PMC-ENG) noted that his hope is that the industry can determine ways to effectively deal with issues that feed into legal concerns pre-emptively, instead of having standards develop from court cases and handed down by lawyers and insurance companies. He believes that if the industry polices itself, policies developed will be more manageable and less cumbersome, while equally effective.		Information			Yes
BIM Consortium Work						
001-003	P. Carrato (PMC-IND) gave an overview of the work of the BIM consortium that resulted in the "User and Functional Requirements for 3D Parametric Modeling of Cast-in-place Reinforced Concrete Structures", which was issued as a draft in 2007. The document was intended to guide software developers in producing software. He noted that there were no rebar detailers in the work group. P. Carrato (PMC-IND) noted that the group found a wide variance in business practices when they attempted to map them. A. Bommer (PMC-SW) inquired whether the process mapping is useful if so varied; P. Carrato (PMC-IND) believes that it is helpful to map one's own practices to understand better what is exchanged when and what is expected of the exchange. He gave the example of the "neat line drawing" - mapping who needs it and when can better define what it is expected to contain. He characterized the transition to BIM as a different transition than from paper to CAD, which many view it as analagous with. He likened it more to a transition from a hand saw to a laser-guided saw. The work process is affected by the change. Users need to look at what is no longer value-added - what do they not need to do anymore? A specific example is paper drawings, which he believes will eventually have no place. He characterized a drawing as a report from the model, and discussed model checking as a new step in the process. E. Hatfield (PMC-ENG) noted that the ICC Code offers online model checking/code checking. A construction model would be updated to become an as-built model, and if desired, further refined into a facilities		Information			Yes

Item	Meeting Item Description	Resp	Status	Due Date	Compl'd	Cls'd
New Business						
	management model. J. Turner (PMC-IND) noted that some states still require stamped and sealed paper drawings. A. Wells (PMC-SW) noted that the report is somewhat outdated at this point, and should be considered a starting point.					
BIM Strategy Development						
001-004	E. Hatfield (PMC-ENG) gave an overview of the ACI 131 Committee meeting in Chicago. The discussion centered around two main topics of 1) what is needed in a BIM model, and 2) who models what, and when. She has been developing a survey to gather input on these topics, and brought a draft to discuss. She believes that the answer to "who models what and when" will lead to best practice development, and ultimately will help users to develop approaches to dealing with legal concerns as well. She noted that there is some sensitivity in the realm of who introduces elements and at what point, as there may be some shift in responsibilities. If it is determined eventually that it is more effective for engineers to introduce rebar, for example, that will take scope from detailers. S. Jones (PMC-SW) noted that the shift to early teaming may address that, in that rebar detailers would likely be involved earlier in the process. P. Williams (PMC-ENG) pointed out that there is a wealth of lessons learned that can be borrowed from the mechanical engineering field. They found that engineers were giving up what they didn't want to do in the first place. He urged that this group use the experience of those who've gone ahead. M. Moffat (PARTIC) noted that the definition of roles and responsibilities will be key. D. Grundler (PMC-SW) pointed out that these concerns, while vital, are more within the purview of ACI 131 than this project, which is focused on interoperability/exchange. E. Dean (ND) agreed, characterizing this group's task as to identify useful tasks and who can perform them. E. Hatfield (PMC-ENG) will be distributing the ACI 131 survey in the near future.		Information			Yes
ATC-81 Interviews						
001-005	M. Kernen (PL) discussed the interview process for this project, in which 22 professionals were interviewed in group teleconferences. They were asked to discuss their experience with and opinions of BIM, as well as their hopes BIM and its impact on their professions. Participants included general contractors, engineers, fabricators/detailers, a rebar software provider and a research professional. All levels of experience with BIM were represented. A few large general contractors reported the most profitable use of BIM, and their implementation varied widely, from the across-the-board use on all projects to use on only selected projects meeting certain criteria. The research professional interviewed deals primarily with general contractors, and found that most were not yet fully embracing BIM, but all were researching it.		Information			Yes

Item	Meeting Item Description	Resp	Status	Due Date	Compl'd	Cls'd
New Business						
	Engineers on the whole were making the transition from modeling to BIM, and seemed fairly open to the process. Fabricators and Detailers expressed a reticence to use BIM and a feeling of being left behind in the process, as they come to the table much later in the design-build cycle. They also felt that they had no real software options for their use that were BIM compatible. P. Carrato (PMC-ENG) believes this to be a misrepresentation of fabricators and detailers across the board; he feels they are much more open to BIM than the participants in this interview process would indicate. Legal concerns were raised by the interview group, primarily 1) what data should be released, and 2) who owns the data and the liability. M. Kernen (PL) gave an overview of the implementation processes of the firms who have implemented, as well as the concerns and suggestions raised. She also discussed the benefits that users reported and the participants' visions for the future of BIM.					
White Paper						
001-006	E. Dean (PL) prepared a white paper in advance of this meeting, with the intent of using it as a starting point and straw man to spur discussion. The white paper gave some background on the project and progress to date, and laid out possible categories of interoperability to be discussed. It also framed the product that this session seeks: a strategy to achieve each goal identified, to include: 1) champion, 2) definition, 3) time frame and 4) financial constraint. The breakout groups, divided by discipline, will identify goals, and within each goal, begin to define it, decide who is the best group to tackle it, how long it will take and roughly what the cost will be in the effort.		Information			Yes
Open Discussion						
001-007	He led the group through an open discussion with the intent of developing one goal together. Some ideas for goals were listed - visualization; finishes; facilities management data; project management/scheduling; tolerances. Concrete material properties were discussed more in-depth, and would entail exchanges: ---to the engineer, compression strength, durability, aggregate, etc. ---to the supplier, exposure class or performance-based definition ---to the constructor, properties for constructability Reinforcement was discussed to even greater detail. The question of the appropriate level of definition for various users, and how reinforcement fits in with other trades was raised. The goal needs to be defined. D. Grundler (PMC-SW) encouraged thinking upstream rather than downstream, and determining what the fabricator needs to see from the design team. A. Wells (PMC-SW) confirmed there is no IFC for rebar currently, and no real definition of shapes or classes to use in creating one. No IFC exists for concrete material,		Information			Yes

Item	Meeting Item Description	Resp	Status	Due Date	Compl'd	Cls'd
New Business						
	either. J. Turner (PMC-IND) believes that shapes for rebar are so varied that they are nearly irrelevant, and perhaps rebar needs to be considered unique for each piece, which can be a real challenge for the engineer. Several suggestions on how to classify and handle rebar were noted, but each had significant drawbacks. Improving element geometry transfer is a basic goal. The champion for that effort would likely be ACI, but not the 131 committee. A. Wells (PMC-SW) considers it intrinsic to concrete, but not BIM-specific. He believes a standard for modeling should be developed.					
Breakout Session - Design/Detailing						
001-008	E. Hatfield (PMC-ENG) led this breakout group. They began with the straw man list from the white paper, and prioritized basic geometry. They put tolerance/deflection on the second tier of priorities along with tests/slumps/breaks, more complex geometry and the analysis model. They discussed reinforcement, considering it a good idea to carry the data but did not identify their choice for who and when for input. They considered ties and chairs to be part of means and methods and internal to the reinforcing contractor. They felt that the forms left in place, shoring and re-shoring were valuable to carry. They were unsure about the usefulness of carrying water stops and joints. They determined code checking to be a low priority. E. Dean (PL) noted that most of the items they identified were "push" items - things that this group would provide to others. This group did not progress to the point of identifying goals or tasks.		Information			Yes
Breakout Session - Detailing/Fabrication/Manufacturing						
001-009	A. White (PMC-ENG) led this breakout group. They worked primarily on items considered a "pull" - those things that design and detaling professionals need from others. They started with the straw man list from the white paper. Those items were ranked as follows: 1) Bill of Material/Procurement - the group determined this flows from #3 2) Concrete Mix Design - needed for fabrication 3) Reinforcement Fabrication, Size and Configuration (Bend Diagram) - PULL 4) Embed Fabrication - pull, but covered in existing IFCs 5) Composite Member Fabrication - pull, but minor 6) Formwork Fabrication - push to construction They added a new item of geometry attributes unique for fabrication and manufacturing. -construction joints/pour breaks -formwork finish -top surface finish -fiber wraps Project management was added to the list as well. The group prioritized the attributes and noted champion and outcome as follows:		Information			Yes

Item	Meeting Item Description	Resp	Status	Due Date	Compl'd	Cls'd
New Business						
	1) Geometry - new IFC classes for "joints" and "pours", and new attributes to IFC "beam"; ACI 2) Reinforcement Fabrication, Size and Configuration - (no outcome listed); CRSI, PTI, ACI 315, and possibly AASHTO 3) Project Management and Concrete Design Mix - modification to the IFC material class; RMC, Portland Cement Association, ACI 301, SEI					
Breakout Session - Construction						
001-010	P. Williams (PMC-ENG) led this breakout group. This group focused on "pull" items. They reviewed the straw man list in the white paper, and developed their own list of items they identified as push or pull data. They settled on categorizing attributes graphically, with a sketch indicating a "realm" of information that indicated the champion naturally. They determined the following priorities and champions: -Geometry; ACI -Reinforcement; CRSI -Concrete Material; NRMCCA -Project Management ---Quantity/Estimating; ASPE/ACE ---Schedule; ASCC ---Curing; ACI/PCA -QA/QC; (no champion identified)		Information			Yes
Summary of Breakout Sessions						
001-011	E. Dean (PL) noted the common themes between the groups - geometry, reinforcement, concrete material and project management. He summarized the champions identified as: -ACI for geometry -CRSI for reinforcement -NRMCA for materials, and possibly PCA -For project management, he suggested that AGC may be a starting place. P. Williams (PMC-ENG) suggested ASCC, and W. Klorman (PARTIC) added ASPE. For QA/QC, R. Stehly (PARTIC) suggested that some testing agencies may be appropriate to champion; he said that he would attempt to find the appropriate group for that task. E. Dean (PL) suggested ACI 347 for formwork. A. White (PMC-ENG) noted that formwork and how to deal with it is an important challenge. P. Carrato (PMC-IND) suggested also associating shoring and re-shoring with formwork.		Information			Yes
Wrap Up (May 6)						
001-012	E. Dean (PL) updated the working session presentation with information for the general session on May 6. He discussed the goal and methodology of the project and the previous day's efforts, and summarized the goals identified (ref item 001-011).		Information			Yes

Item	Meeting Item Description	Resp	Status	Due Date	Compl'd	Cls'd

New Business

He noted that a champion was not identified for formwork, and it was not included in the initial listing; W. Klorman (PMC-ENG) expressed his feeling that general contractors will say that formwork is crucial. He reiterated that formwork is a huge part of the timing, cost, sustainability, etc. E. Dean (PL) suggested ACI 347 as the champion, and D. Sordyl (PL) identified SSFI as the industry group for formwork. W. Shebetka (PARTIC) noted that formwork vendors are generally not using BIM, and will need to be brought on board by large customers like Baker. E. Dean (PL) added formwork to the list, with SSFI and ACI 347 as possible champions.

GOAL SUMMARY
-Geometry - ACI
-Reinforcement - CRSI
-Concrete Materials - NRMCCA/PCA
-Project Management
---Quantity/Estimation - ASPE
---Schedule/Sequence - ASCC
-Formwork - ACI

E. Dean (PL) briefly touched on the legal issues that all have expressed concern with. While they are very important and will impact all users, they are beyond the scope of this group.

Cc:	Company Name	Contact Name	Copies	Notes

These notes are intended to be an accurate reflection of the topics discussed and the conclusions reached. If there are any coments or clarifications, please direct those to the preparer for consideration.

APPENDIX C:
Work Session Materials
i. Agenda

AGENDA

ATC-81 IFCs for Concrete

Strategic Planning Session
InterContinental Kansas City at the Plaza, Kansas City, MO

May 5 and 6, 2010

May 5, 2010		
8:00 a.m. – 9:00 a.m.	**Registration/Continental Breakfast**	Pavillion Pre-Function Area
9:00 a.m. – 9:30 a.m.	**Introductions** Introductions Agenda Review *E. Dean* Strategic Work Plan *E. Dean*	Pavillion One
9:30 a.m. – 10:00 a.m.	**Review of Task 1 Findings/State of the Industry** Overview *P. Carrato, M. Kernen, E. Hatfield*	Pavillion One
10:00 a.m. – Noon	**Discussion of Objectives and Priorities** Open discussion	Pavillion One
Noon to 1:30 p.m.	**Lunch**	Pavillion Five
1:30 p.m. – 3:00 p.m.	**Strategy Development** Overview *E. Dean* Group 1 – Design/Detailing *E. Hatfield (Pavillion 6)* Group 2 – Det/Fab/Manuf *A. White (Pavillion 2)* Group 3 – Construction *P. Williams (Pavillion 7)*	
3:00 p.m. – 3:30 p.m.	**Break** *Participants should take this opportunity to switch breakout groups if desired*	
3:30 p.m. – 4:30 p.m.	**Strategy Development (cont'd)**	
4:30 p.m. – 5:00 p.m.	**Day 1 Wrap-up** Discussion *E. Dean*	Pavillion One
5:30 p.m. – 7:00 p.m.	**Welcome Reception**	Poolside

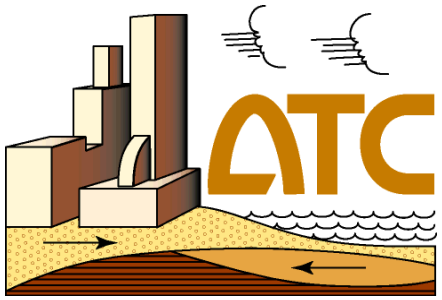
May 6, 2010

7:30 a.m. – 8:00 a.m.	**Continental Breakfast**	Salon 3
8:00 a.m. – 9:30 a.m.	**SDC Welcome / Introduction** *C. Bedard, SDC Chair* **SDC Business Update** **ACI and Critical Industry Challenges** *R. Stehly*	Salon 3
9:30 a.m. – 10:00 a.m.	**Strategy Overview** *E. Dean, E. Hatfield, A. White, P. Williams*	Salon 3
10:00 a.m. – 10:30 a.m.	**Break**	
10:30 a.m. – 12:00 p.m.	**Strategic Plan – Vision, Goals, Strategies** *E. Dean*	Salon 3
12:00 p.m.	**Lunch** For those registered for SDC session #27	

APPENDIX C:
Work Session Materials

ii. Presentations

Developing a Strategic Plan for BIM Interoperability and Structural Concrete ATC-81



SDC Session #27

May 5 & 6, 2010

The InterContinental

Kansas City, MO

Agenda

- Day 1
  - Welcome/Introductions
  - Review of Task 1 Findings / State of the Industry Report
  - Discussion of Objectives and Priorities
  - Lunch
  - Strategy Development
  - Wrap up
- Day 2
  - Welcome/Introductions
    - SDC Business Update
    - Critical Industry Challenges
  - SDC BIM Strategic Overview
  - SDC BIM Strategic Plan

Funding Organizations

The Charles Pankow Foundation

Ready Mixed Concrete Research and Education Foundation

Participants

MANAGEMENT

- Doug Sordyl, ACI Foundation
  - Program Manager
- Chris Darnell, SDC
  - Program Manager
- Thomas R. McLane, ATC
  - Project Manager
- Edwin T. Dean, Nishkian Dean
  - Principal Investigator
- Michelle Anderson, Nishkian Dean
  - Project Administrator

PROJECT ADVISORY PANEL

- Dan Frangopol, PAP Chair
- Chuck Eastman
- Dave Hutchinson
- Jim Jacobi
- Steve Jones
- Paul Mlakar
- Deke Smith

INSDUSTRY CHAMPION

- Bob Risser

PMC Participants

ENGINEERING

- Erleen Hatfield, Buro Happold
- Aaron White, Walter P. Moore and Associates, Inc.
- Phil Williams, Webcor

INDUSTRY

- Pete Carrato, ACI
  - Chair, ACI BIM Committee 131
- Mike Schneider, ASCC
  - Baker Concrete
- John Turner, CRSI
  - CRSI Regional Manager

PMC Participants

SOFTWARE

- AEC Autodesk (Revit Structure)
  - Scott Hammond
- Bentley Systems
  - Allan Bommer
  - Raul Karp
- Tekla
  - Alistair Wells
- Digital Project
  - Chi Ng
- aSa
  - Dave Grundler
- Computers and Structures, Inc.
  - Rob Tovani

IFC's for Concrete Construction

No. 6

STRATEGIC PLANNING

Strategic Planning

Mission

The results from the research effort will be to develop a comprehensive report that describes current state of the industry, attribute exchange priorities, and a strategy for implementing effective IFC exchanges.

INTEROPERABILITY

No. 9 IFC's for Concrete Construction

WORK PLAN

Strategic Planning Tasks

Task 1 – Planning Research

Task 2 – Planning Session

Task 3 – Plan Report

Strategic Planning

Task 1 Research

Assess and assemble the current state of the industry and opinion of industry participants, design professionals, suppliers and builders.

- SDC BIM Survey
- Telephone Interviews
- Domain Report

Strategic Planning

Task 2 Session

The strategic planning session will bring together professionals and industry representatives in a forum to foster discussion, solicit input and gain support for industry initiatives for concrete BIM interoperability.

- Two-day Session
- Coalesce goals and strategies

Strategic Planning

Task 3 Strategic Plan

This report will highlight the state of the industry and portray a vision, goals and strategies for increasing interoperability in reinforced concrete construction.

The Strategic Plan will be the seminal guide for future industry investment in developing concrete BIM objectives.

IFC's for Concrete Construction

No. 14

Michelle Kernen, Nishkian Dean

PLANNING RESEARCH


ATC
SDC
The Concrete Industry's
Strategic Development
Council

Interviews

Interview Method

Group interviews, with one or more moderators

Participants drawn from ACI lists

Discussion guide distributed

- -Intro/Experience
- -Current use of BIM
- -Interoperability
- -Vision of the future of BIM

Participants

9 Interviews

22 Interviewees

-7 General Contractors

-5 Engineers

-5 Detailers or Fabricators

-4 from a Provider of Rebar Detailing Software

-1 Research Professional

Experience with BIM

The most experienced reported using BIM for some time

-Save time and money

-Have developed new revenue streams from BIM

-The two respondents with the most mature and profitable BIM implementations were both General Contractors

Engineers were comfortable in 3D and most were making strides in incorporating BIM.

Experience with BIM

Fabricators and Detailers were for the most part less than enthusiastic, feeling

-That their function occurs too late in the design-build process to benefit from BIM

-That they do not have software choices that work for them and work with BIM

The provider of Rebar Detailing Software felt that the BIM software in existence cannot handle the type and volume of data required to meet rebar detailing needs.

Implementation

Training

Most firms either :

- Hire a BIM consultant to choose software and train personnel, or
- Choose a select group internally to explore software, train a core group, and use that group to train the rest of their staff

"Going Live"

Three methods discussed:

- Implementation on a pilot project
- Implementation across all new projects as of a certain date
- Implementation on a project-by-project basis, as a result of criteria evaluation

Concerns

There were four main categories of concerns:

Financial -cost of purchasing software -commitment of software purchases -training investment -long-term financial advantage -will this really be worth it?	Technical -what software is best for me? -what software will my clients want me to use? -how much can I trust the data that comes to me? -will the data I create keep its fidelity?
"Human Factors" -how do we train our people? -what if some people don't get it? -does this mean we will start getting accurate, complete data? -will our trade be given equal footing to use BIM?	Legal -what data will be released? -who owns the data? -who owns the liability?

Suggestions

Some thoughtful suggestions were raised:

-Industry report on the best software for various purposes

-Industry initiative to standardize concrete and rebar shapes and naming conventions

-Wider education about the LOD system of classification of model status and authorized uses at various stages

-Introduction of BIM software as documentation and coordination tool, before using as production tool, to slowly acclimate staff

-Development of team mentality with all players, whether the project is structured as a team or not

Rewards

Most felt the greatest reward in the use of BIM is increased collaboration, and through that collaboration, the ability to detect problems before they are field problems.

Other benefits identified included

- -early cost estimating, especially in the design phase
- -automated construction document production
- -schedule and materials management
- -ability to create a log of historical data for future use
- -value as a marketing tool

Two new lines of business were specifically identified by participants. One firm reported hiring out their BIM group as expert resources for other firms. Another reported offering more detailed as-built models for facilities managers.

Vision for the Future

Question of "who benefits most?" had many answers –

-Owners, having a working model of their facility

-General Contractors, eliminating field changes

-Subcontractors, lowering overhead by fabricating off site

All respondents felt the cost of implementation would ultimately be recouped by all parties.

The greatest benefit identified by most is the shift to a collaborative paradigm and the increased productivity that will result. In the end, it seems to be the consensus that BIM will bring the building community together in a new level of cooperation and performance

IFC's for Concrete Construction

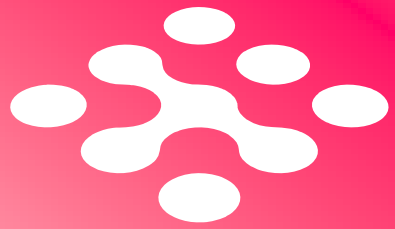
No. 25

Peter Carrato, Bechtel

CONCRETE DOMAIN PUBLICATION

The BIM Consortium

Sponsored by



TEKLA

To develop a specification of an effective and efficient parametric modeling tool for reinforced concrete design, engineering and construction …

that Tekla will then implement.

Facilitated and Guided by

Design Computing

Georgia Institute of Technology

Building Information Modeling LAB

Technion - Israel Institute of Technology

Participating Organizations

• Concrete Contractors and Construction Managers

Accu-Crete

Atomic Energy of Canada Limited

Barton Malow

Bechtel

Grand River Construction

M. A. Mortenson

• Structural Engineers

Ghafari

SOM

Thornton Tomasetti Group

Walter P. Moore

• Software Developers

Tekla Inc.

Tekes

The Specification

- 216 Pages Long
- 110 Figures
- 6 Tables
- Begun March 2006
- Published November 2007
- 4 Face to Face meetings

Main Topics

- Process Modeling
- User Requirements
- Functional Specification

User Requirements

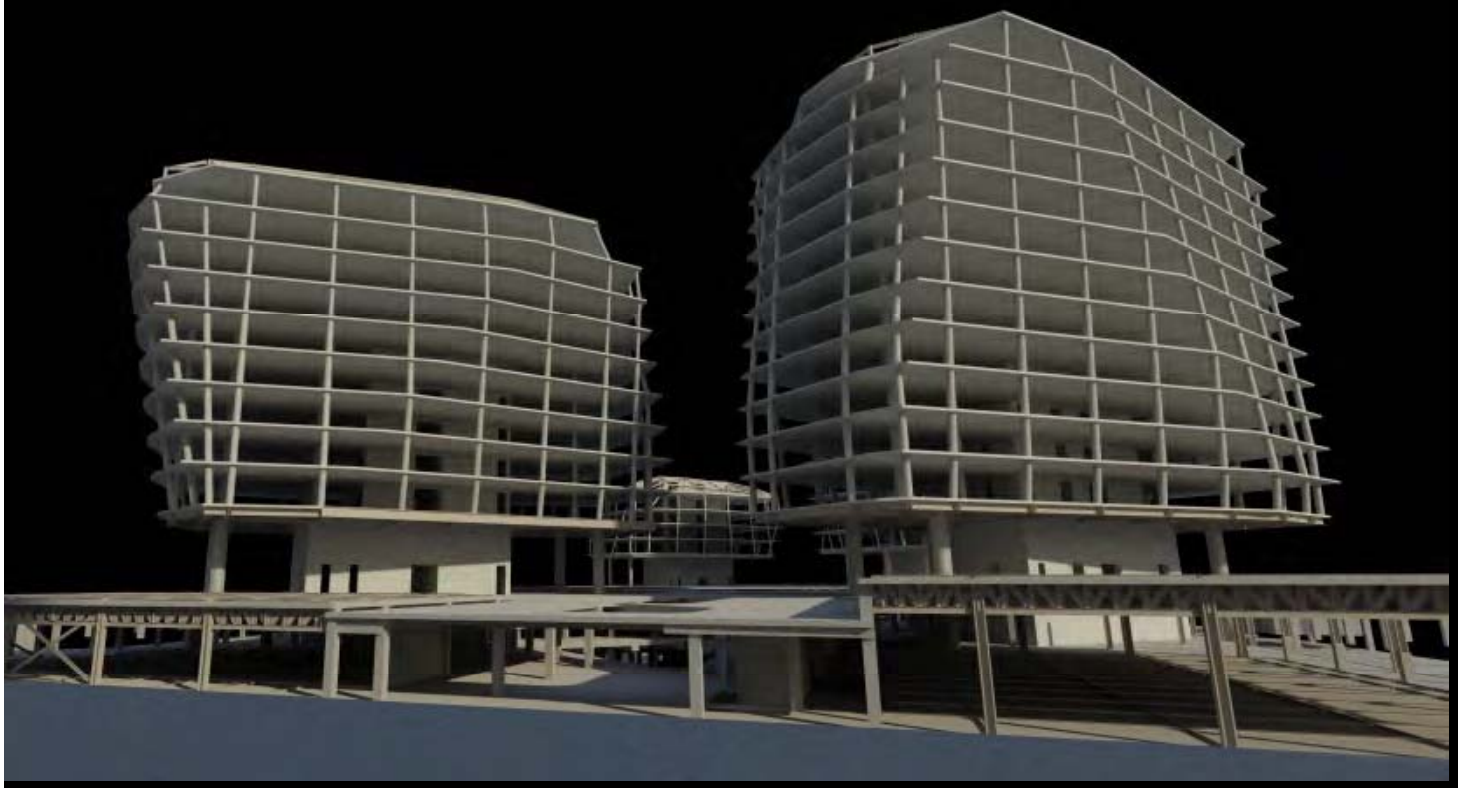
- Modeling Structures
- Analysis and Design
- Modeling Concrete Material
- Reinforcing
- Concrete Placing
- Forming and Shoring
- Project Management

IFC's for Concrete Construction

No. 27

Erleen Hatfield, Buro Happold

ACI 131 VALUE OF BIM



Buro Happold

The Concrete Benefits of BIM

Erleen Hatfield, PE LEED

Partner

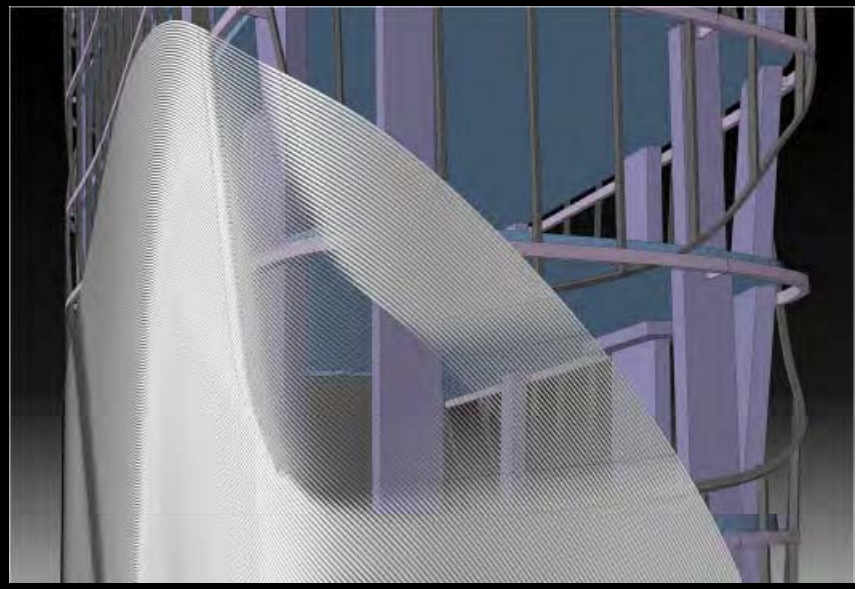
March 24, 2010

Building Information Modeling

- Why use BIM?

Many Benefits:

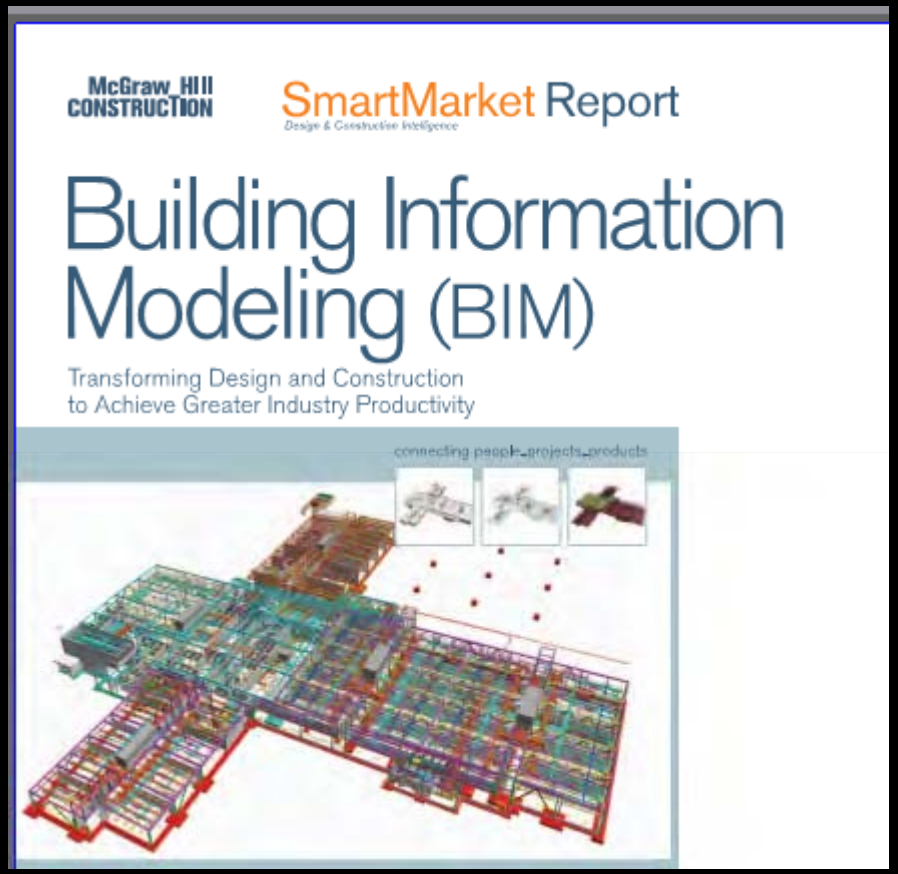
- Speed and accuracy
- Visualization/Communication
- Better Describes Complex Geometry
- Clash Detection
- Better Defines Scope and Complexity



BIM is here to stay

2009 McGraw-Hill Construction research indicates:

- Almost half (49%) of AEC industry participants (architects, engineers, contractors and owners) surveyed in North America have adopted BIM
- The majority of those companies predict that over 60% of their projects will be BIM within two years.



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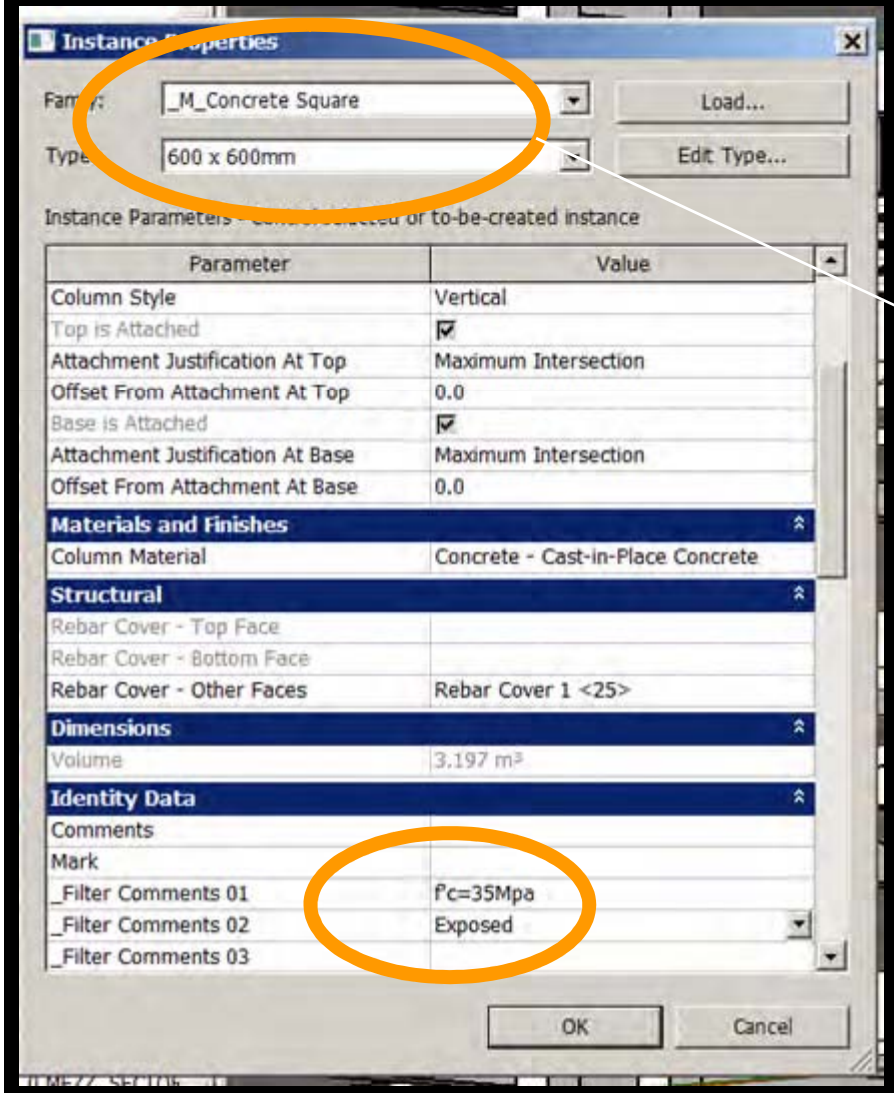
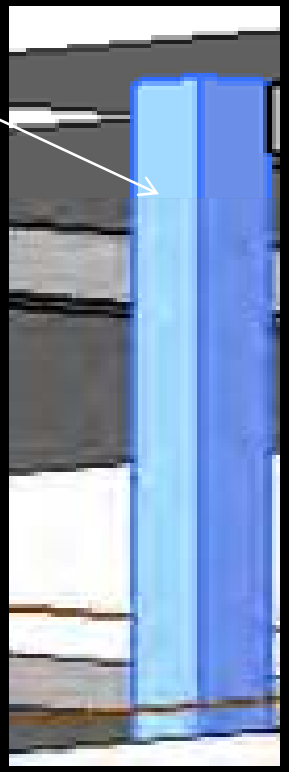
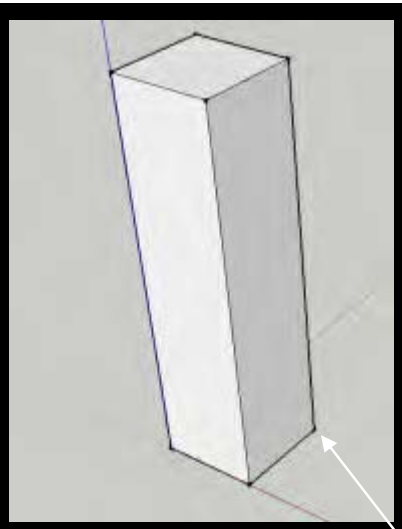
“I” = Information

- Smart Objects
  - Have Properties



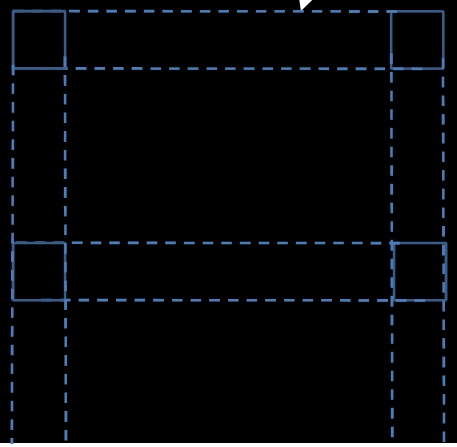




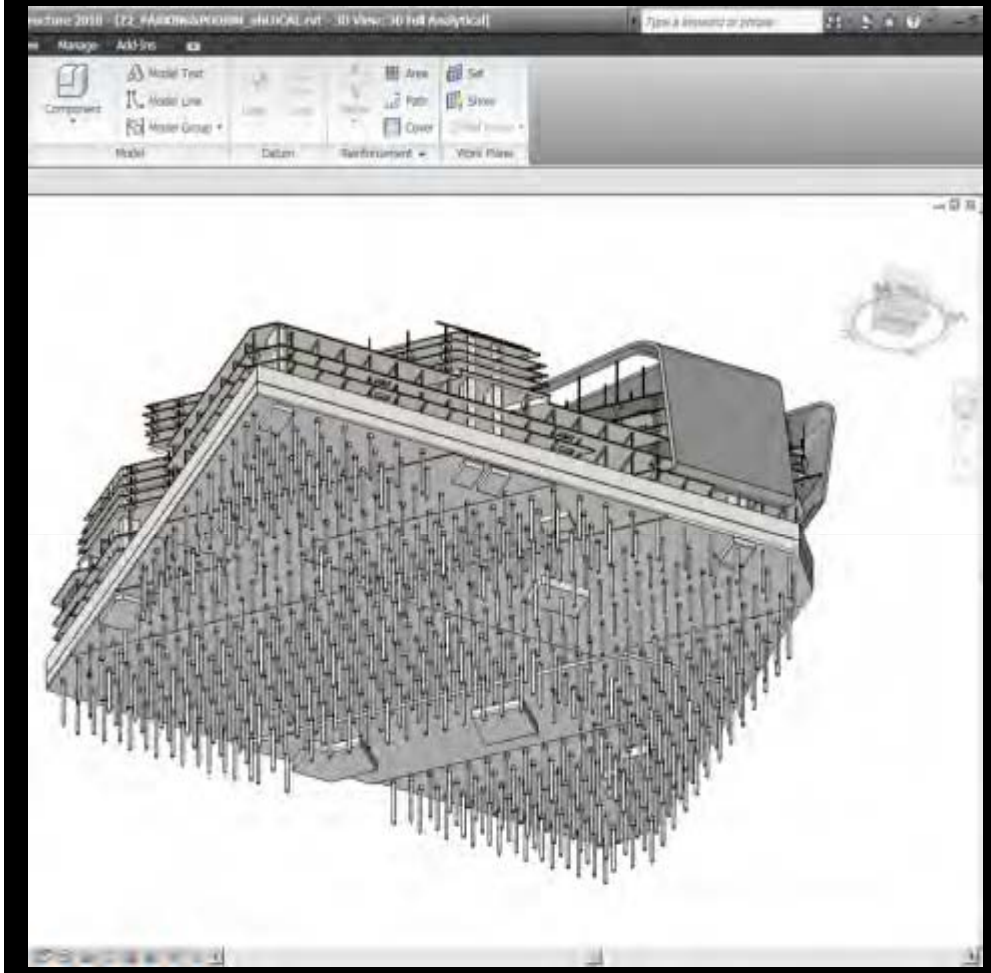
Sketch Up is not BIM

No information attached

Old way – just draw lines



Software used for BIM



REVIT: Str/MEP/Arch

Bentley Str/M/E/Arch

Digital Project / CATIA

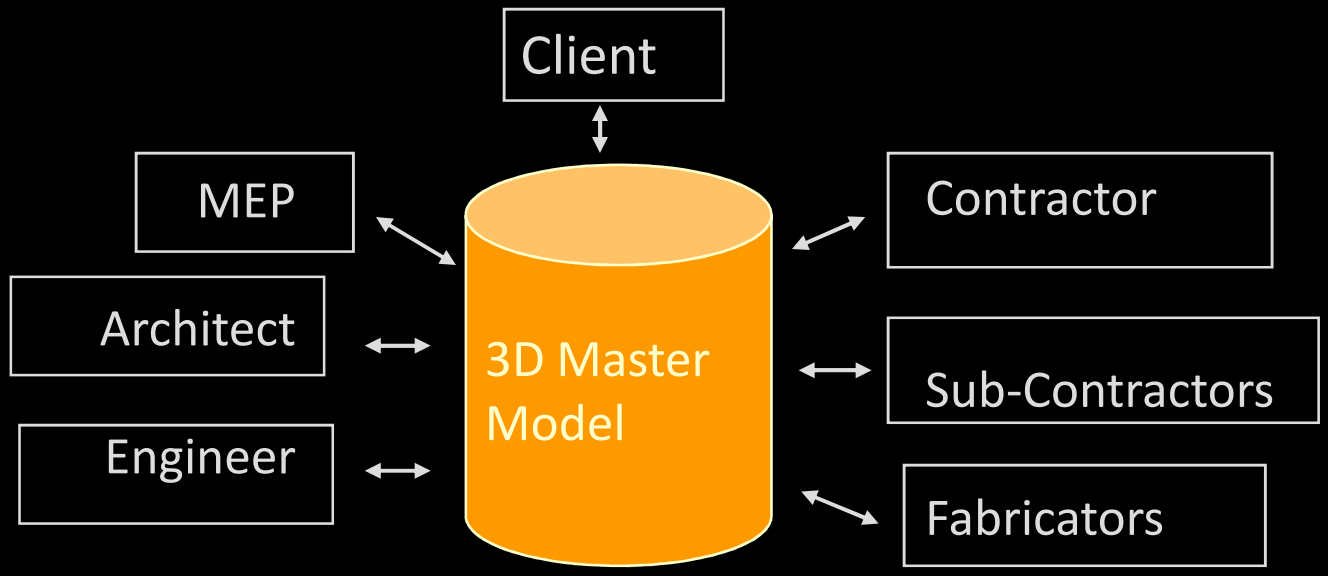
TEKLA

SketchUp and Rhino typically lack Info

Buro Happold

Master Model Concept

- Many models can be consolidated into Master Model
- Typically controlled by the Architect or Contractor
- References information from multiple sources
- Used for coordination of design and construction
- Model can be the Construction Documents



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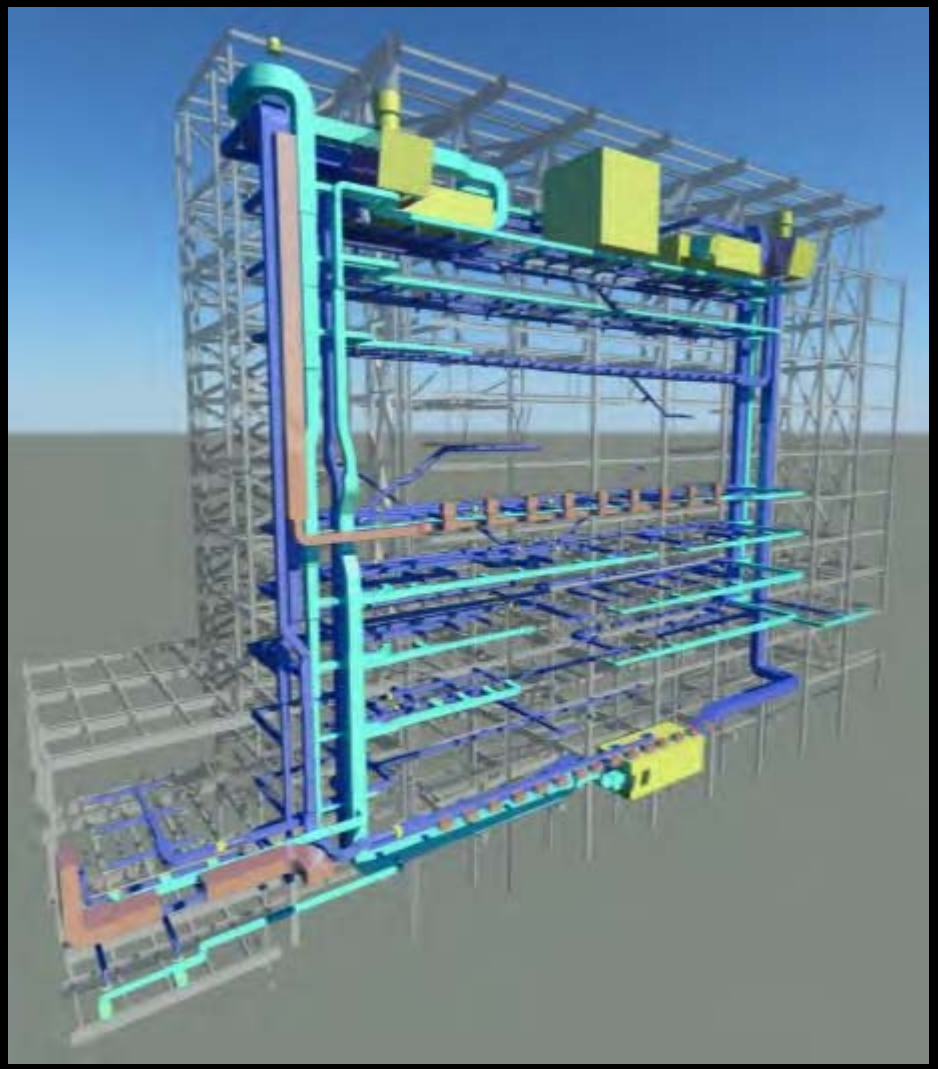
A/E/C Industry goes BIM



Currently BIMs have no rules or standards

- The degree of detail varies
- No industry standard process
- New job title: BIM manager

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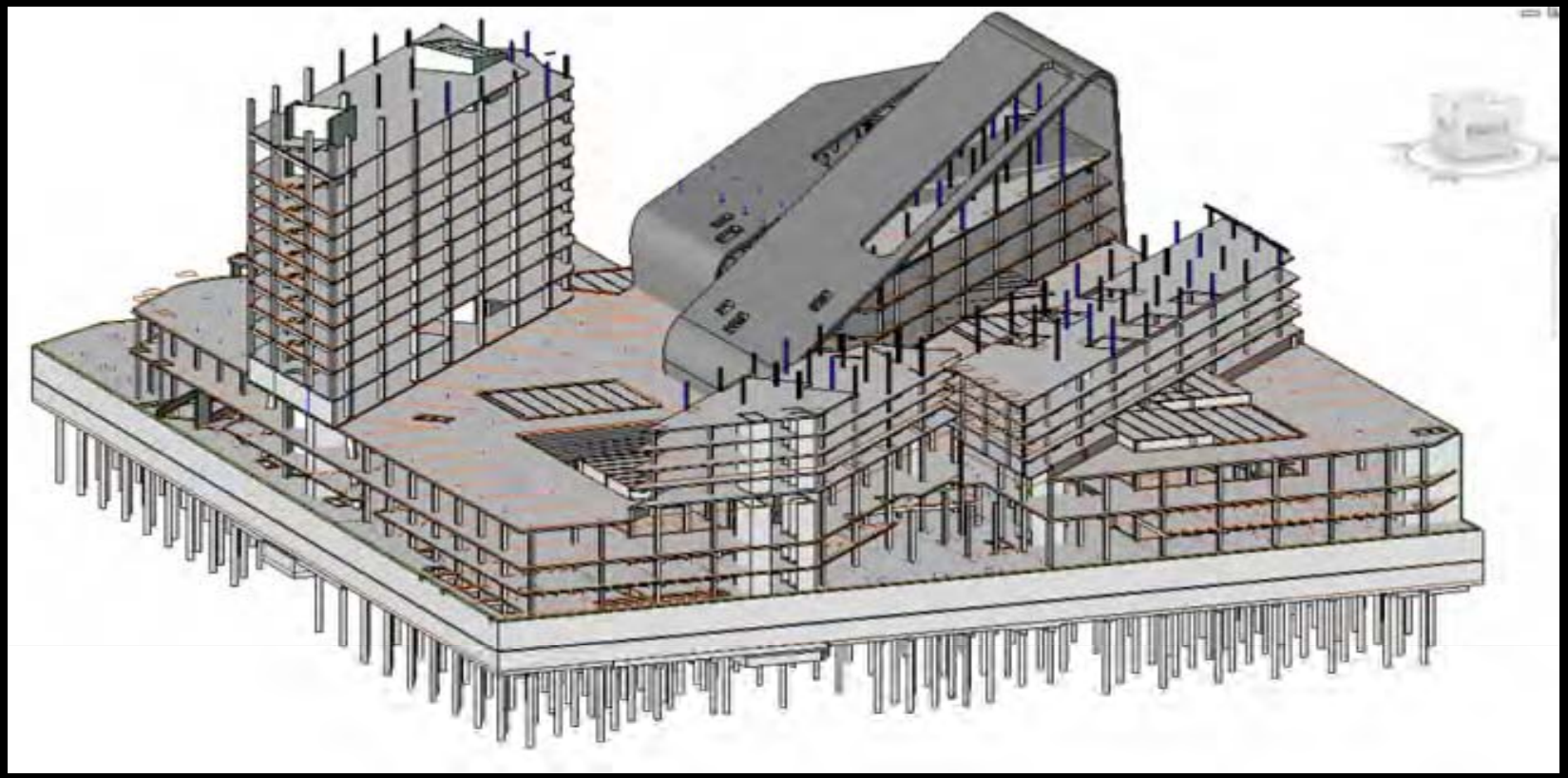


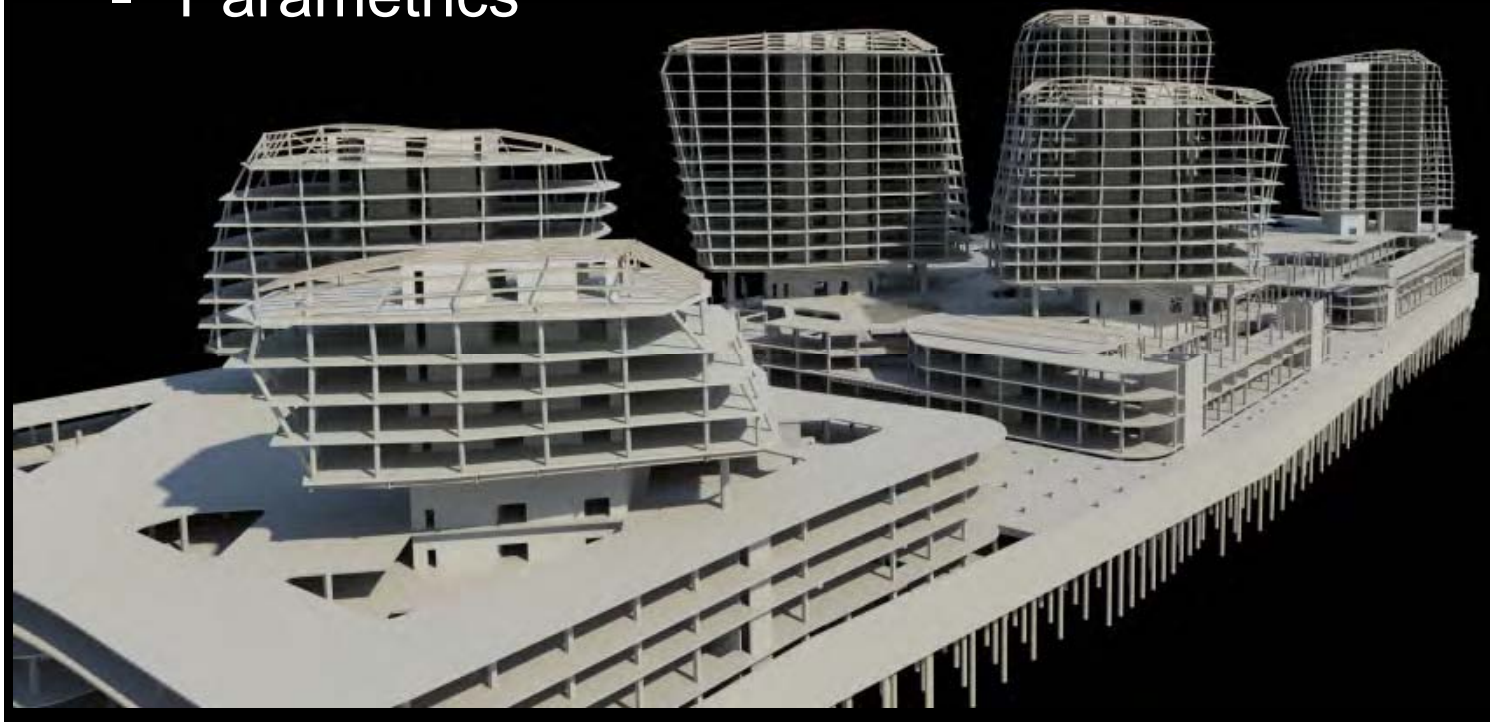
Why use BIM?

Buro Happold

Many Benefits of BIM

Improves:

- Speed and accuracy
- Visualization/Communication
- Better Describes Complex Geometry
- Clash Detection
- Better Defines Scope and Complexity
- Parametrics



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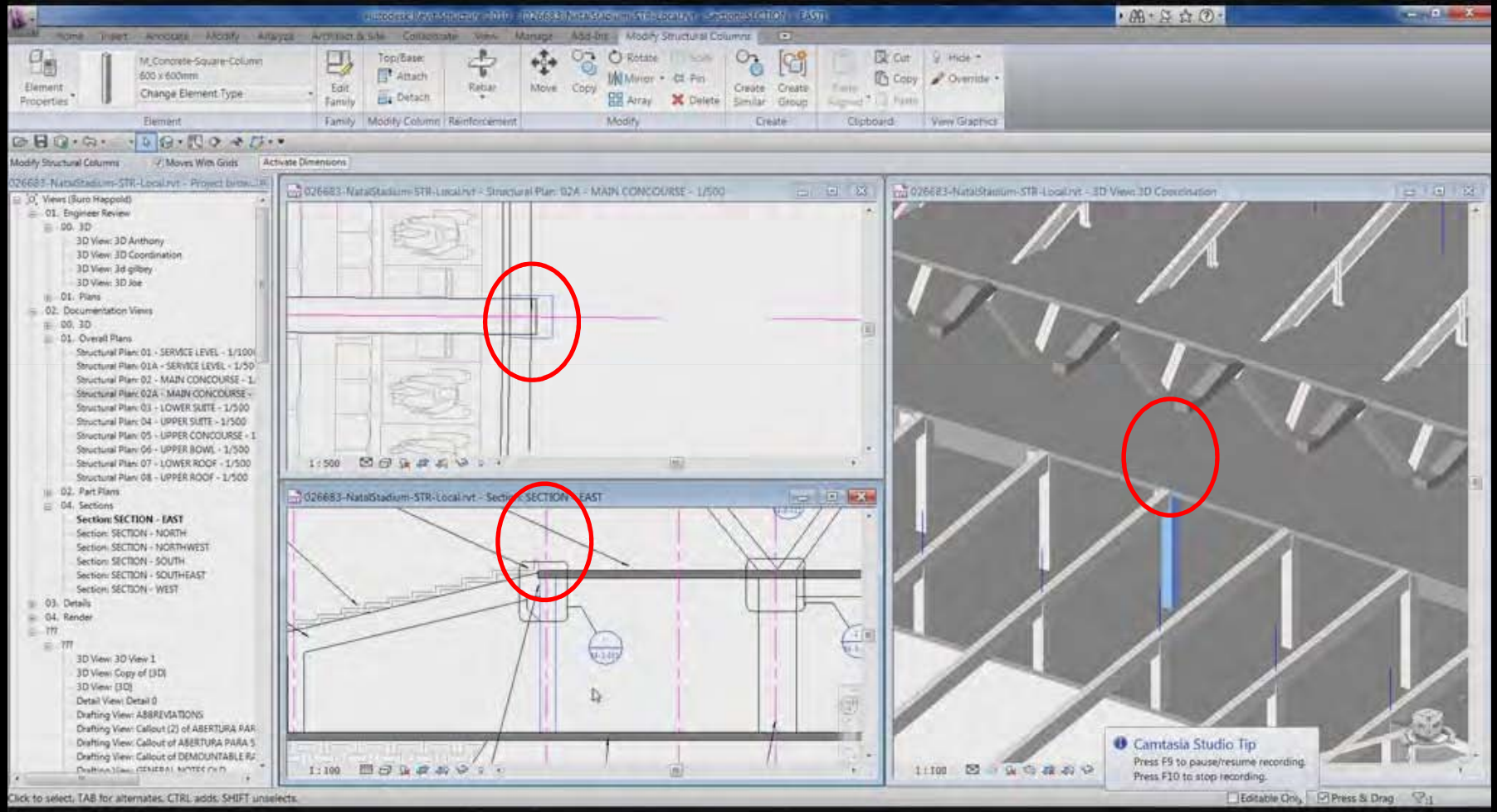
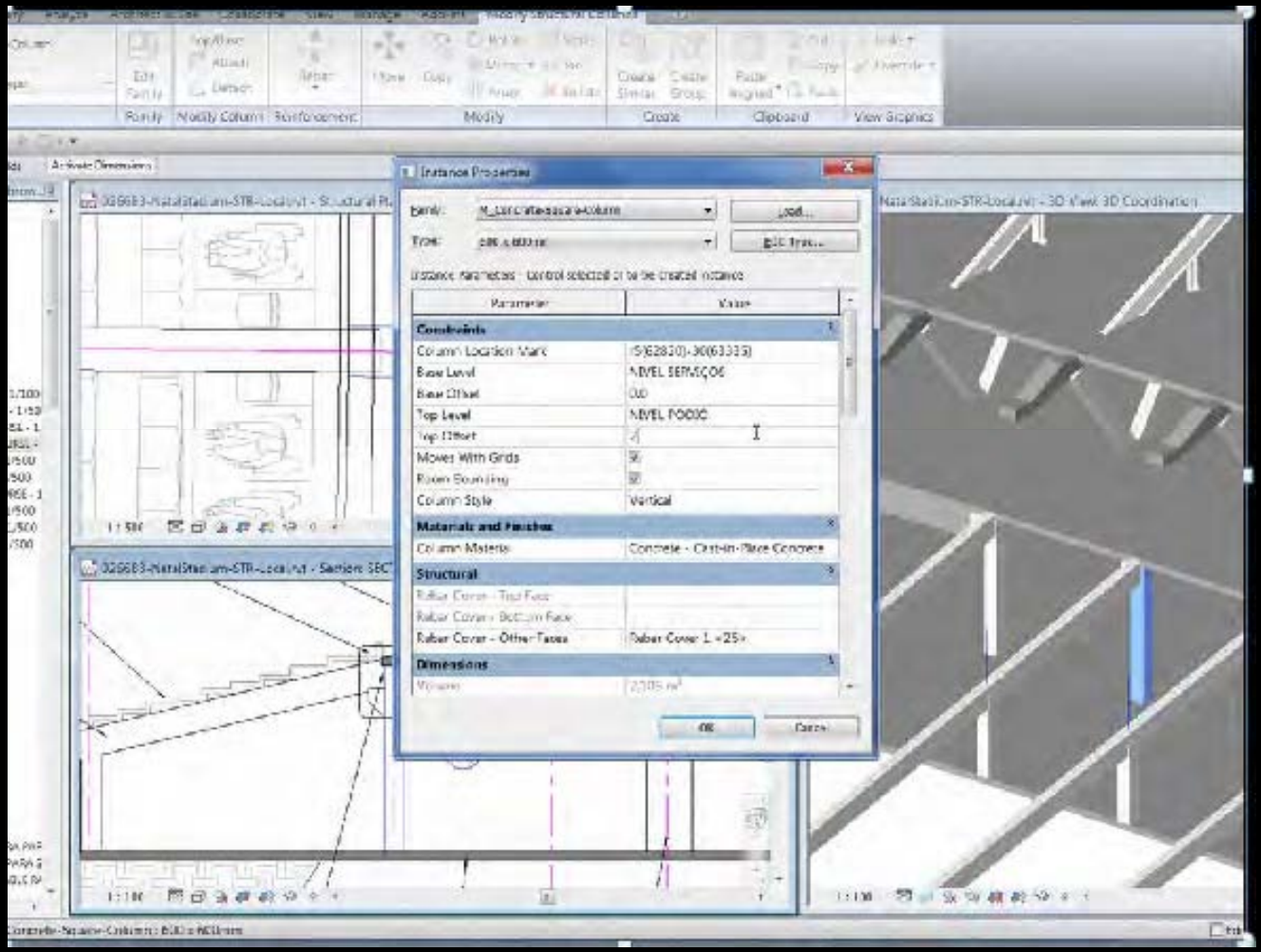
Improves Speed and Accuracy



Change anywhere in a Revit BIM and changes occur everywhere…..

Improves Speed and Accuracy



Change anywhere in a Revit BIM and changes occur everywhere…..

Buro Happold

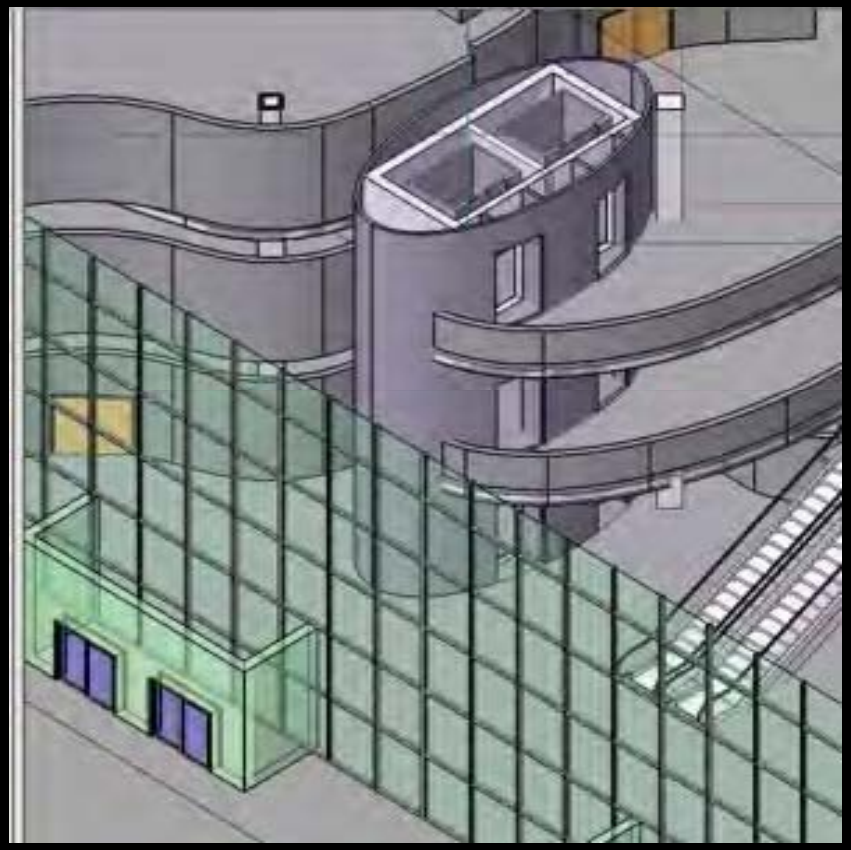
Improves Speed and Accuracy

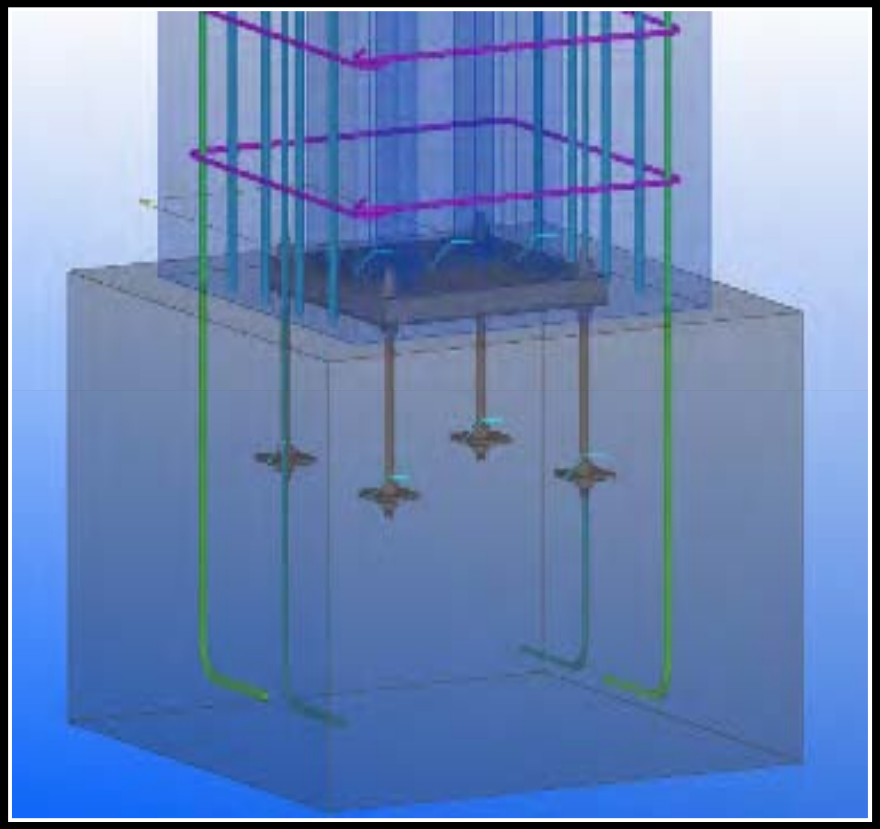
Change anywhere in a Revit BIM and changes occur everywhere…..

Buro Happold

Design Benefits - Visualization

- 3-D assists owner or architect in making decisions



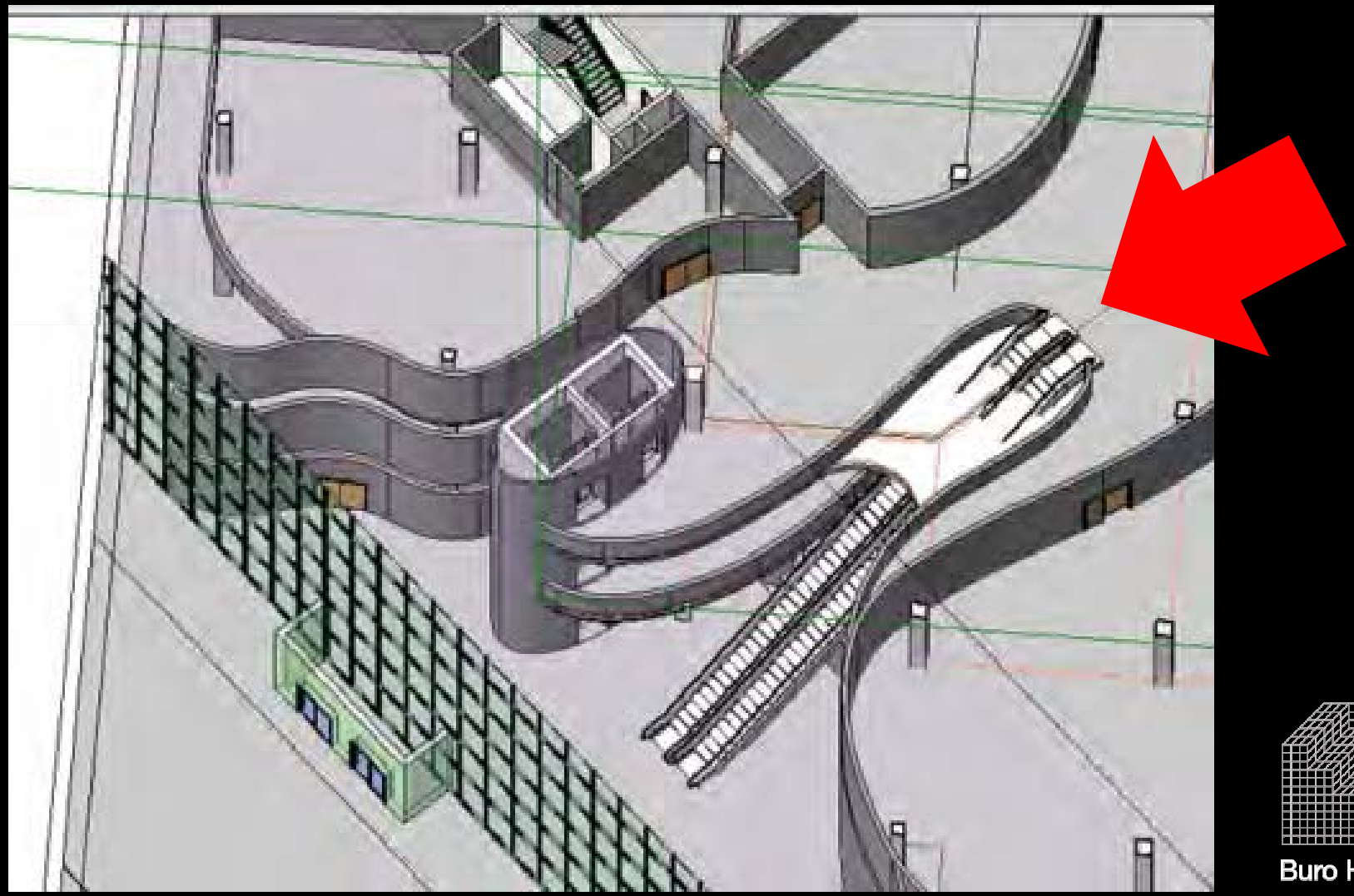


On a large scale…or small

Buro Happold

Design Benefits - Clash detection

Coordination and Clash Detection



Buro Happold

Design Benefits - Clash detection

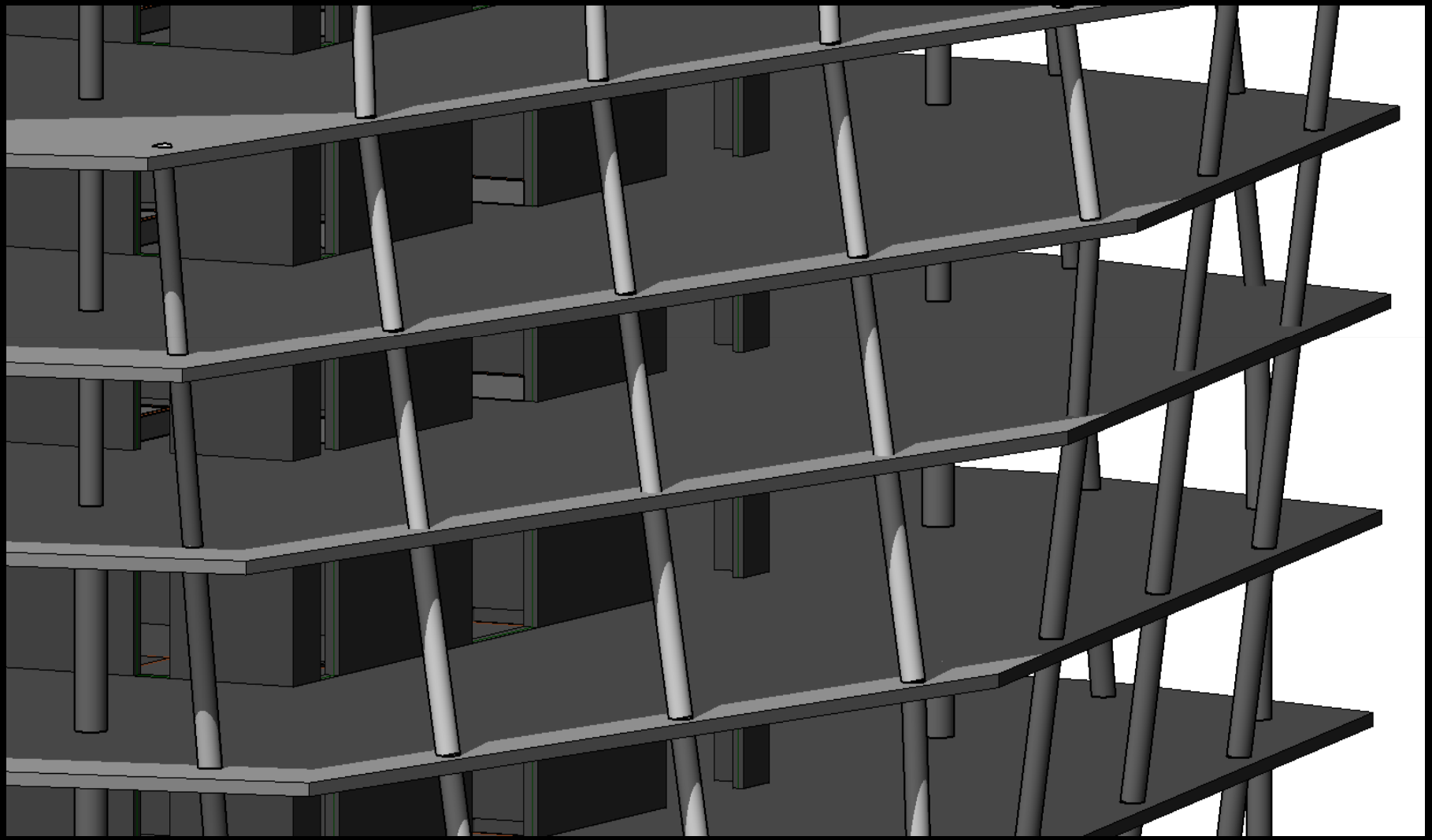
Interference Report

Interference Report Project File: L:\BH-Revit\Revit2010\Imperial Library\Structural\Framing\Steel\023231-Yale SOM-S10-NY_Local.rvt
Created: Wednesday, March 10, 2010 3:23:14 PM
Last Update:

	A	B
1	Workset1 : Floors : Floor : CTW 5 1/2" : id 358651	023231-Yale SOM-ME10-NY_Central.rvt : Mechanical : Ducts : Rectangular Duct : Mitered Elbows / Taps - Mark 4205 : id 1174012
2	Workset1 : Floors : Floor : CTW 5 1/2" : id 358651	023231-Yale SOM-ME10-NY_Central.rvt : Mechanical : Ducts : Rectangular Duct : Radius Elbows / Taps - Mark 5484 : id 1489566
3	Workset1 : Floors : Floor : CTW 5 1/2" : id 358651	023231-Yale SOM-ME10-NY_Central.rvt : Mechanical : Ducts : Rectangular Duct : Radius Elbows / Taps - Mark 5531 : id 1489810
4	Workset1 : Floors : Floor : CTW 5 1/2" : id 358651	023231-Yale SOM-ME10-NY_Central.rvt : Mechanical : Ducts : Rectangular Duct : Radius Elbows / Taps - Mark 5548 : id 1489831
5	Workset1 : Floors : Floor : CTW 5 1/2" : id 358651	023231-Yale SOM-ME10-NY_Central.rvt : Mechanical : Ducts : Rectangular Duct : Radius Elbows / Taps - Mark 5865 : id 1496401
6	Workset1 : Floors : Floor : CTW 5 1/2" : id 358651	023231-Yale SOM-ME10-NY_Central.rvt : Mechanical : Ducts : Rectangular Duct : Radius Elbows / Taps - Mark 5896 : id 1496719
7	Workset1 : Floors : Floor : CTW 5 1/2" : id 358651	023231-Yale SOM-ME10-NY_Central.rvt : Mechanical : Ducts : Rectangular Duct : Radius Elbows / Taps - Mark 6691 : id 1547909
8	Workset1 : Floors : Floor : CTW 5 1/2" : id 358651	023231-Yale SOM-ME10-NY_Central.rvt : Mechanical : Ducts : Rectangular Duct : Radius Elbows / Taps - Mark 6693 : id 1547968
9	Workset1 : Floors : Floor : CTW 5 1/2" : id 358651	023231-Yale SOM-ME10-NY_Central.rvt : Mechanical : Ducts : Rectangular Duct : Mitered Elbows / Taps - Mark 8521 : id 1790324
10	Workset1 : Floors : Floor : CTW 5 1/2" : id 358651	023231-Yale SOM-ME10-NY_Central.rvt : Mechanical : Ducts : Rectangular Duct : Mitered Elbows / Taps - Mark 8531 : id 1792171
11	Workset1 : Floors : Floor : CTW 5 1/2" : id 358651	023231-Yale SOM-ME10-NY_Central.rvt : Mechanical : Ducts : Rectangular Duct : Mitered Elbows / Taps - Mark 8547 : id 1793437
12	Workset1 : Floors : Floor : CTW 5 1/2" : id 358651	023231-Yale SOM-ME10-NY_Central.rvt : Mechanical : Ducts : Rectangular Duct : Mitered Elbows / Taps - Mark 8592 : id 1796802
13	Workset1 : Walls : Basic Wall : Exterior - 14" Concrete : id 467079	023231-Yale SOM-ME10-NY_Central.rvt : Mechanical : Ducts : Rectangular Duct : Mitered Elbows / Taps - Mark 4598 : id 1419840
14	Workset1 : Walls : Basic Wall : Exterior - 14" Concrete : id 467079	023231-Yale SOM-ME10-NY_Central.rvt : Mechanical : Ducts : Rectangular Duct : Mitered Elbows / Taps - Mark 4613 : id

Design Benefits-Complex Geometry

- Easier to create, define and describe complex geometry



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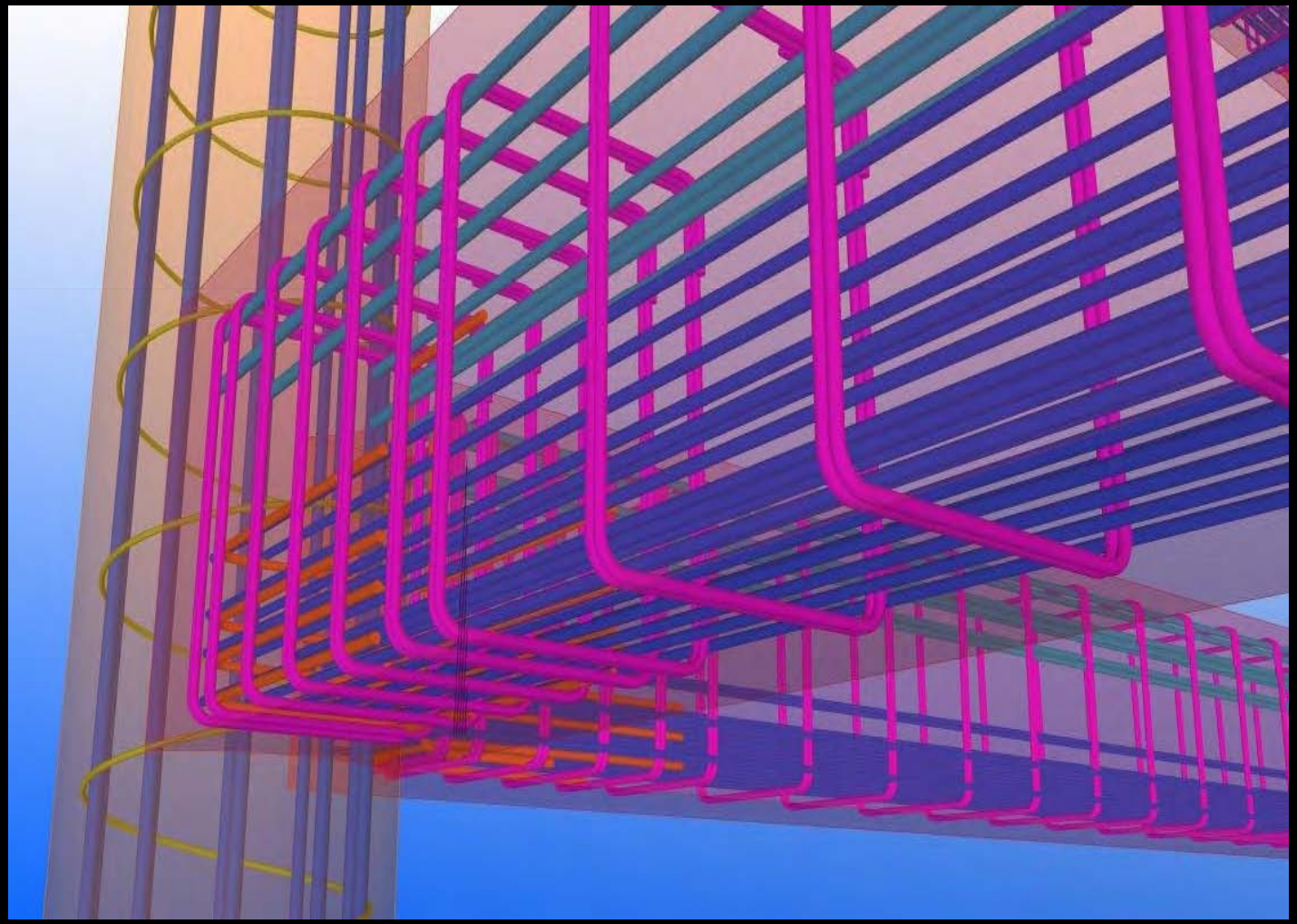
Design Benefits - Concrete Modeling

- Complex concrete beam/column intersections
- Easier to understand



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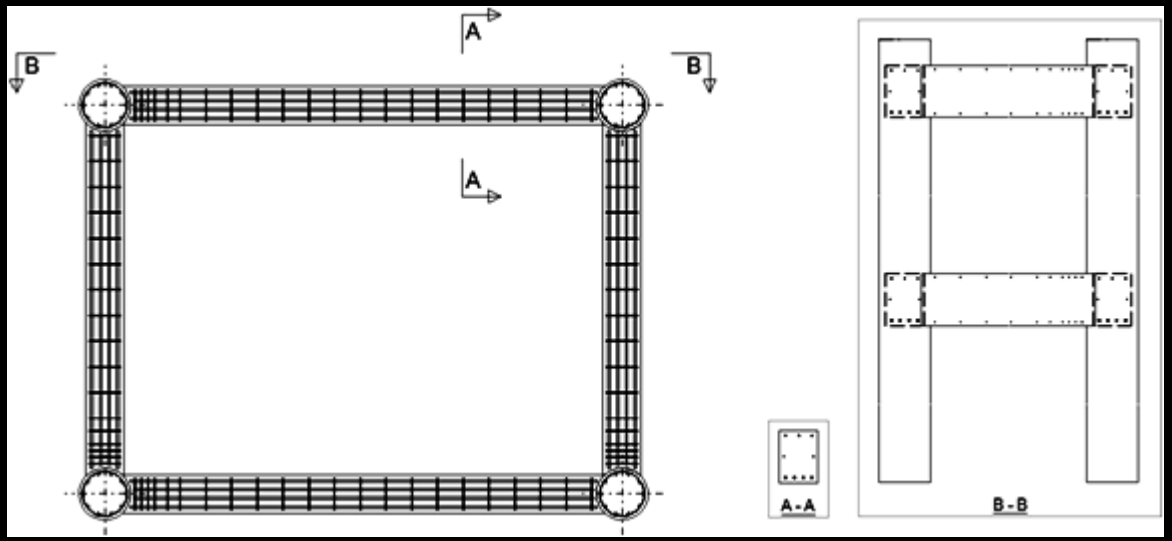
Design Benefits - Concrete Modeling

- Sections can be cut at any point
- Desired level of detail can be shown
- Blowup views show member sections and reinforcing placement
- Helpful to illustrate potential reinforcing congestion



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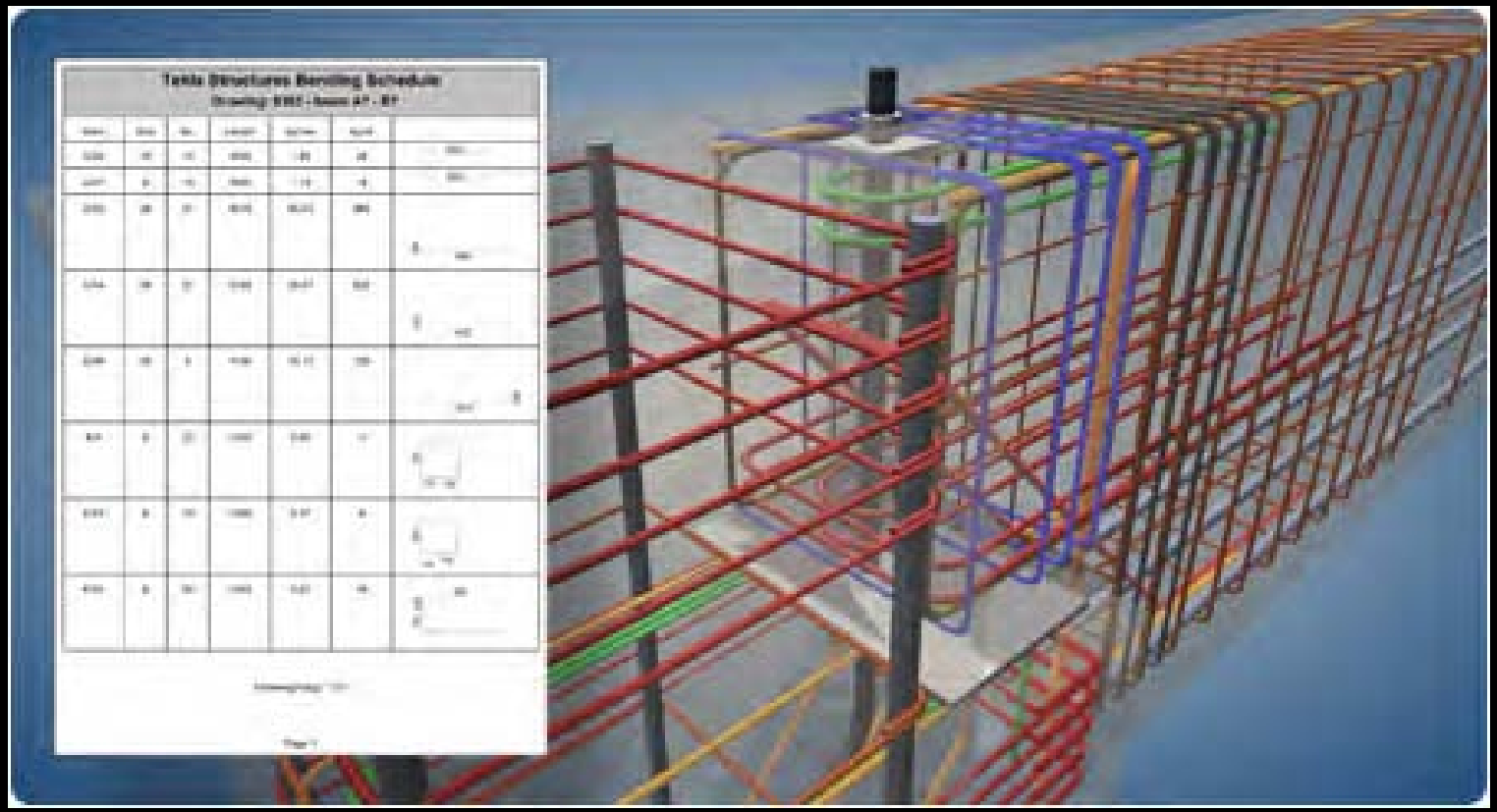
Concrete Modeling

- Models speed concrete quantity take offs
  - Concrete volumes / Surface area for formwork
  - Rebar quantities



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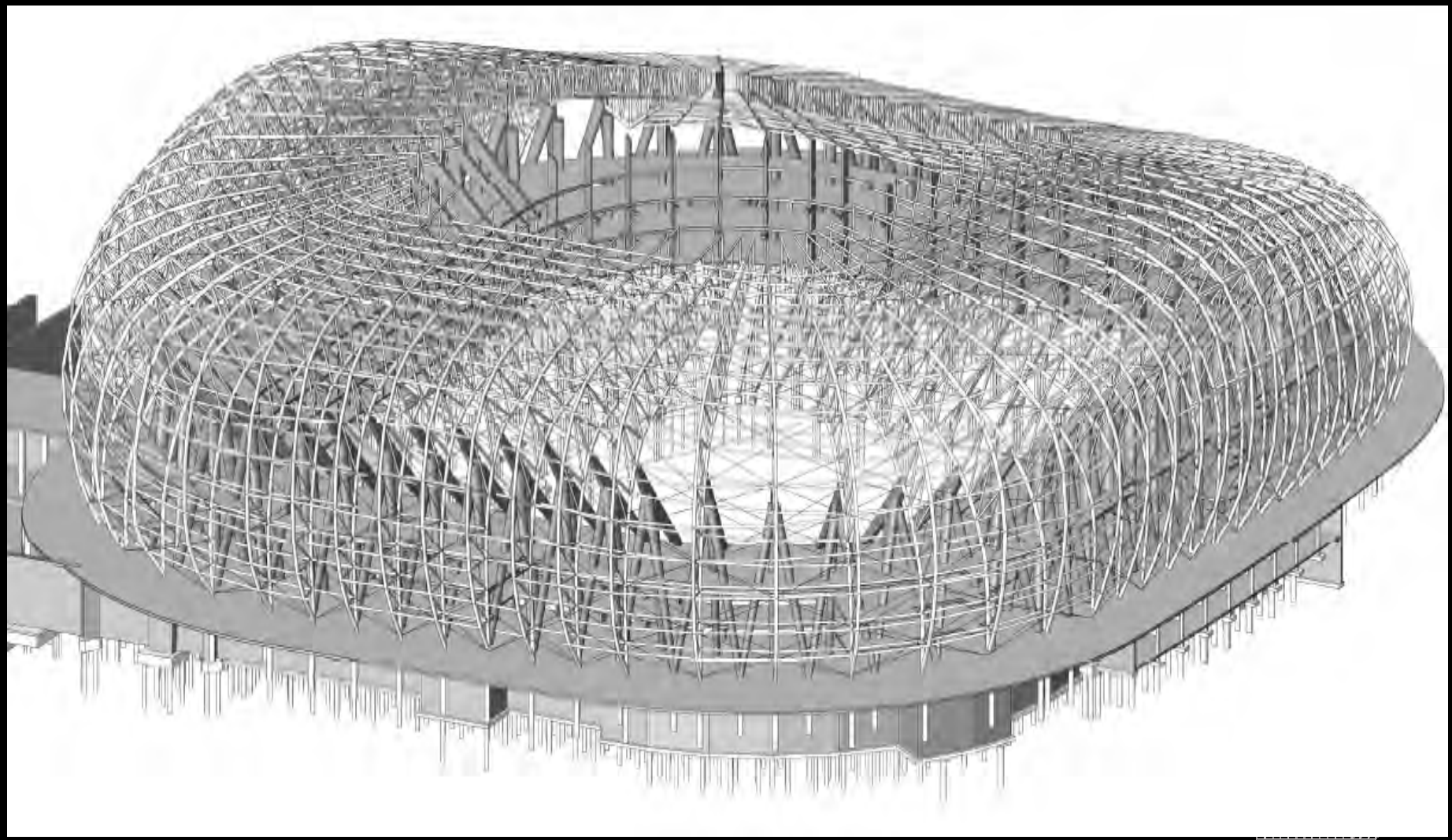
Parametrics



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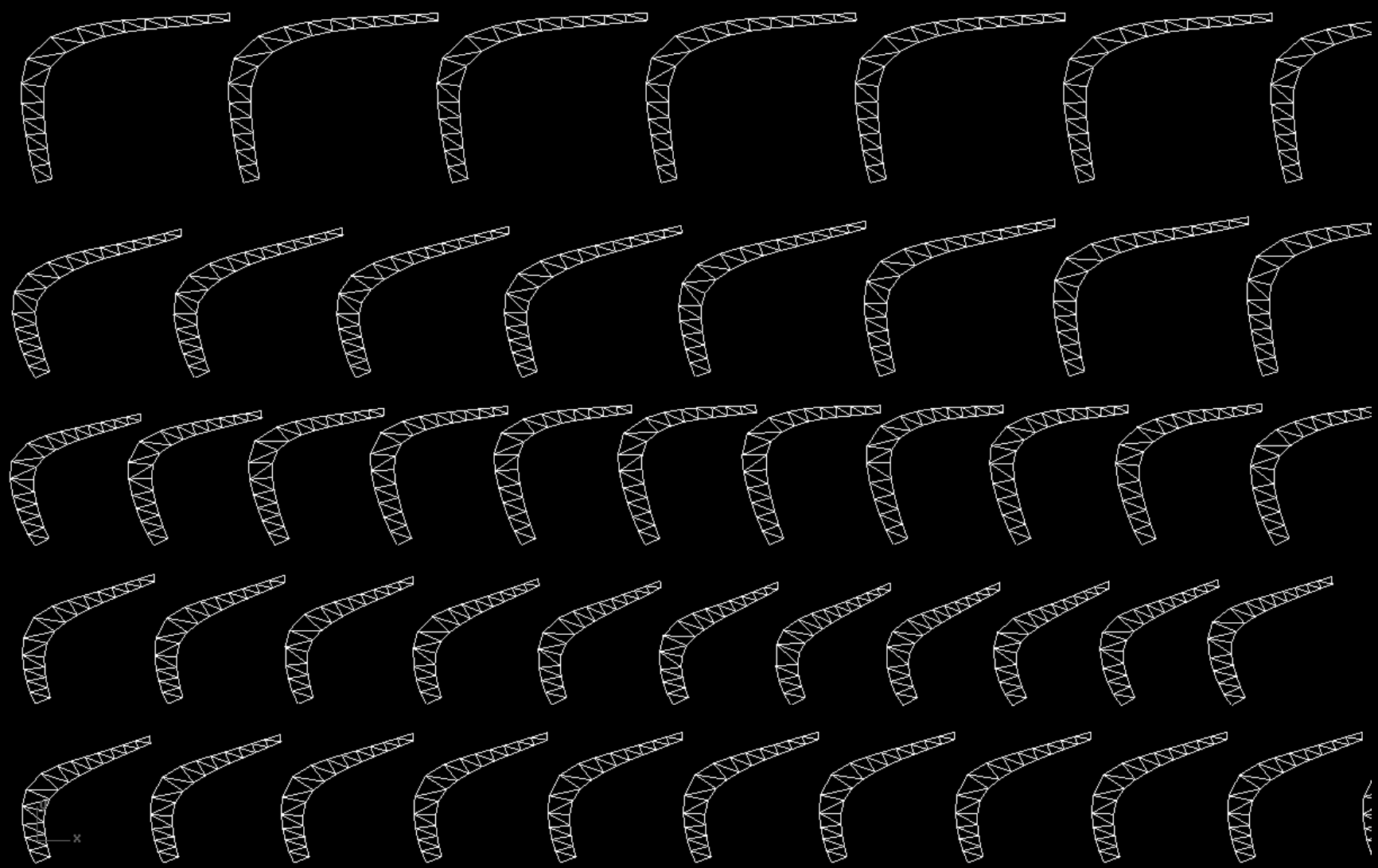
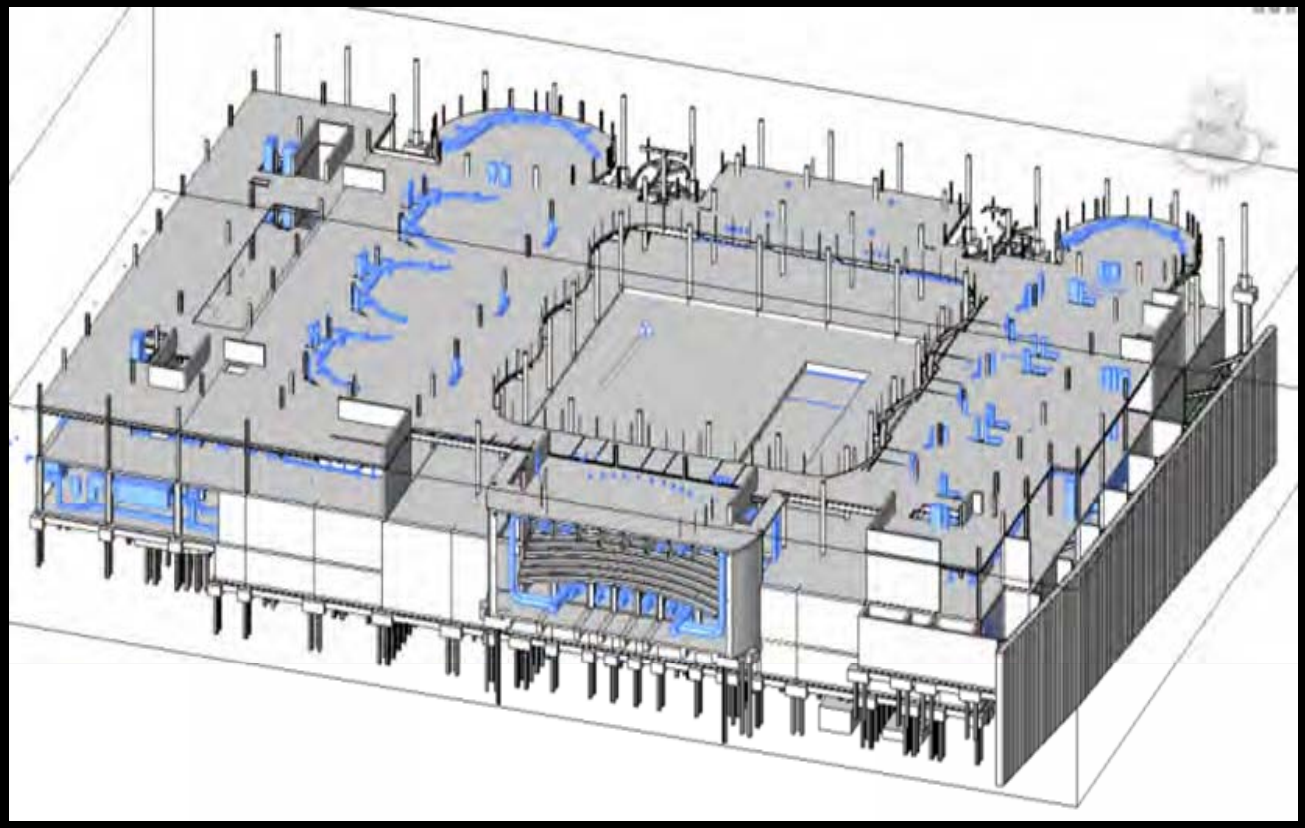
Design Benefits - Parametrics

- Powerful feature can quickly change large amounts of data





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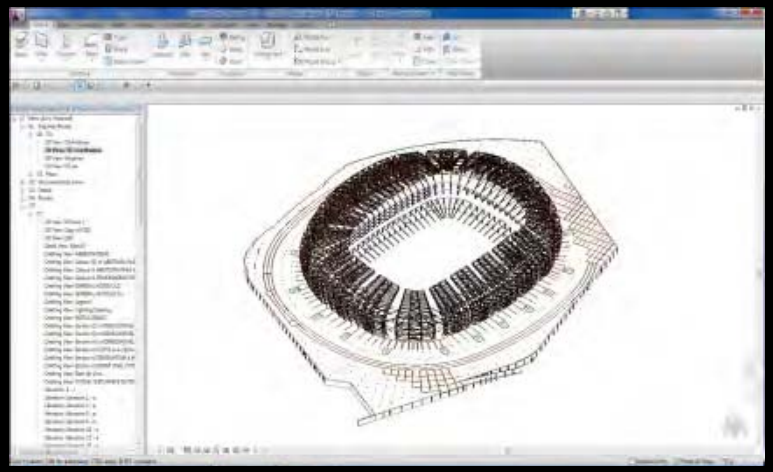
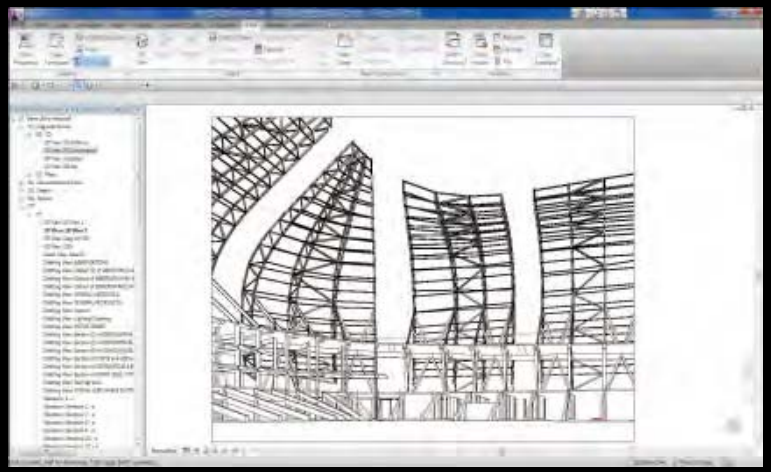
The Design Process Changes

BIM change the Process





- BIM models can be the contract deliverables
- Used by the contractor /subs
- Right to rely on the model with drawings for reference
- Currently we still need paper for typical details and specs

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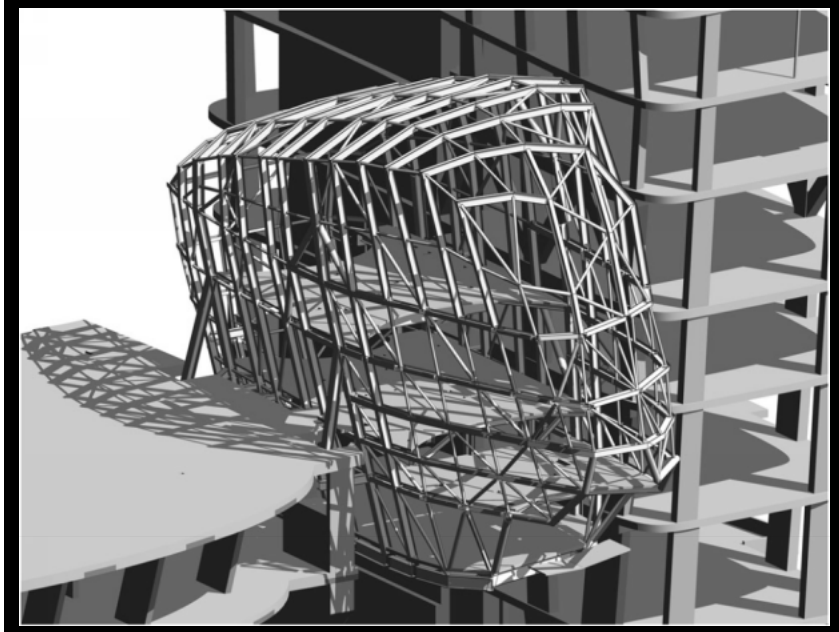
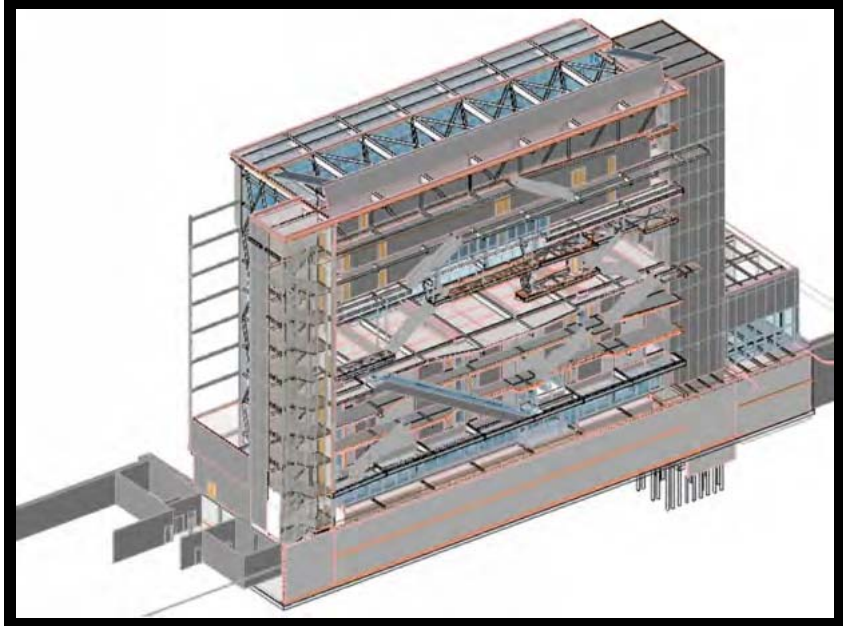
BIM changes the Process





- When will BIM become the "standard of care"
- New contracts are available to address BIM
  - AIA E202
  - Consensus Doc E301

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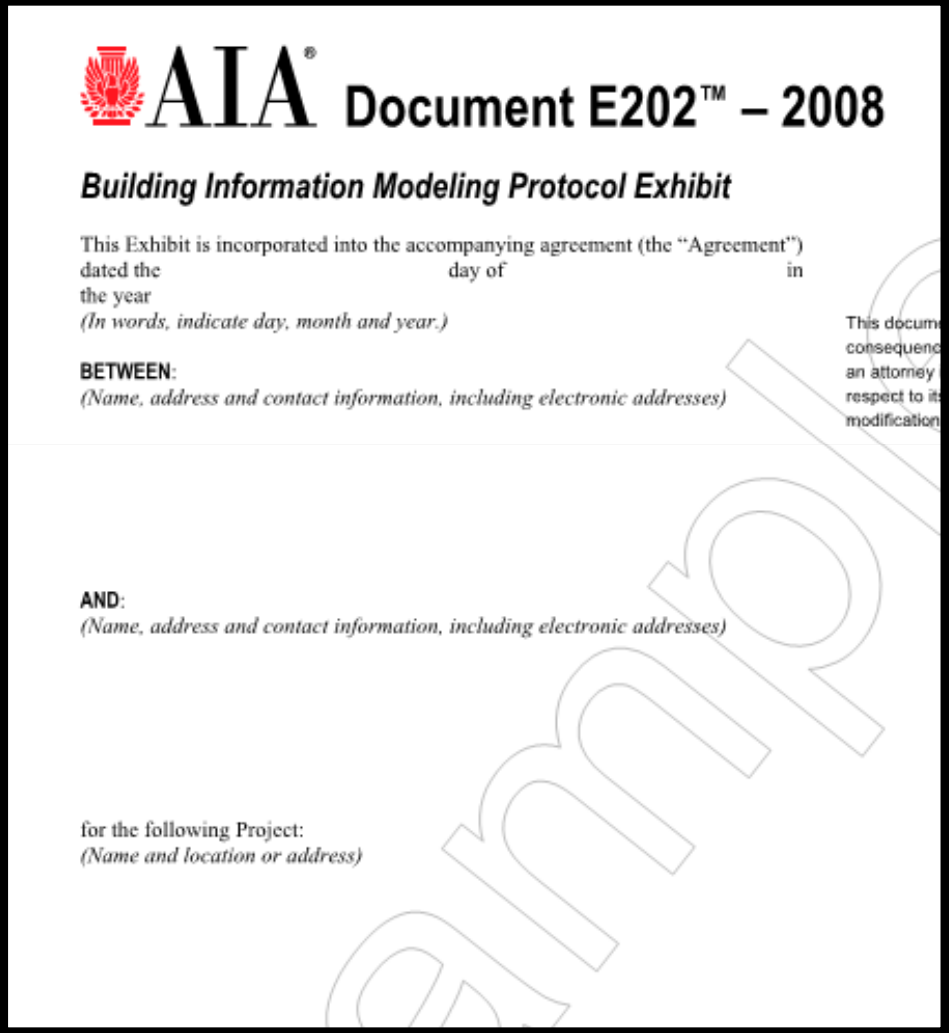
E202™–2008 Building Information Modeling Protocol Exhibit



AIA® Document E202™ – 2008

Building Information Modeling Protocol Exhibit

This Exhibit is incorporated into the accompanying agreement (the "Agreement") dated the day of in the year
(In words, indicate day, month and year.)

BETWEEN:
(Name, address and contact information, including electronic addresses)

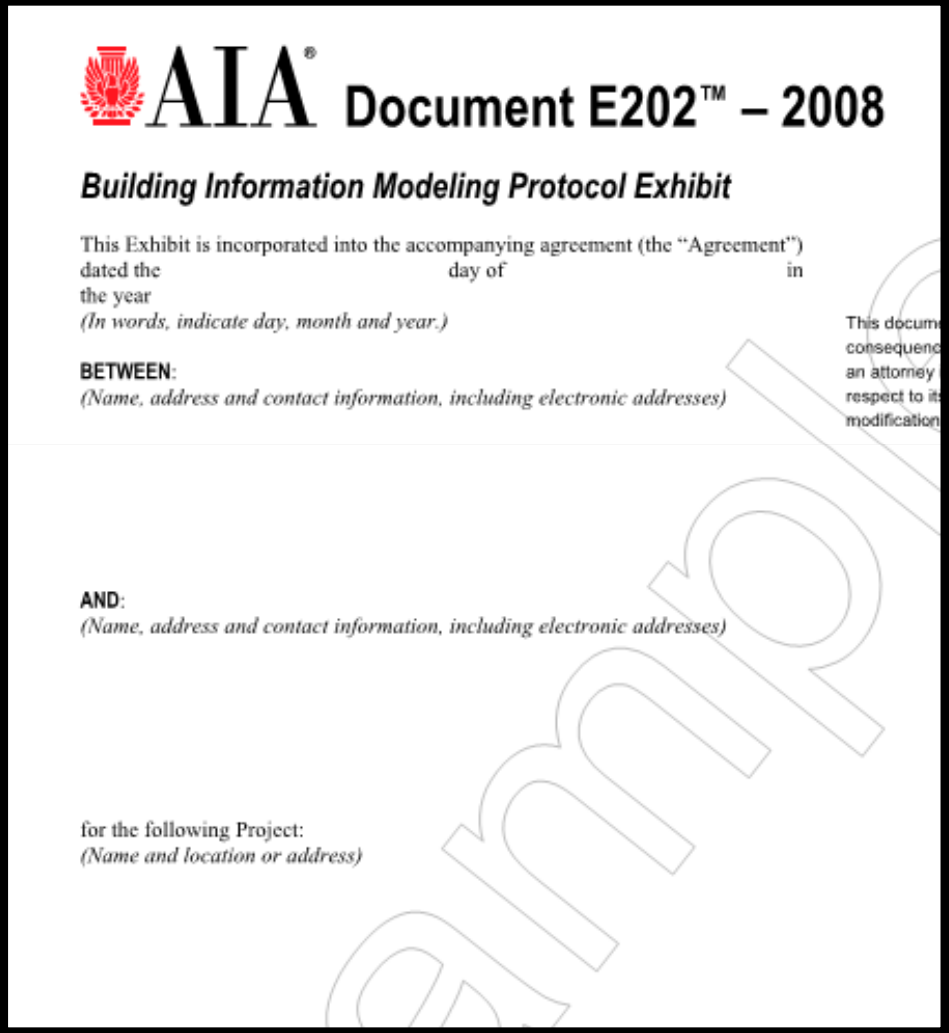
AND:
(Name, address and contact information, including electronic addresses)

for the following Project:
(Name and location or address)

- Defines the extent users may rely on model content
- Clarifies model ownership
- Establishes BIM standards and file formats
- Provides the scope of responsibility for model management from the beginning to the end of the project.

Available for free at:
http://www.aiacontractdocuments.org

E202™–2008 Building Information Modeling Protocol Exhibit



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(Name, address and contact information, including electronic addresses)

AND:
(Name, address and contact information, including electronic addresses)

for the following Project:
(Name and location or address)

- Though written primarily to support a project using Integrated Project Delivery E202 may also be used on projects delivered by more traditional methods.

Available for free at:
http://www.aiacontractdocuments.org

AIA E202 Contract

AIA Document E202™ – 2008

Building Information Modeling Protocol Exhibit

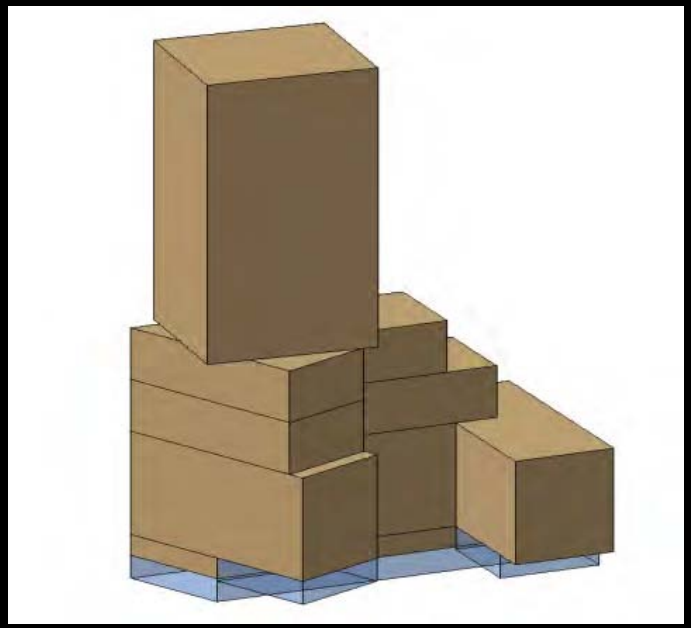
LEVEL OF DEVELOPMENT (LOD)

- LOD 100 – Equivalent to conceptual design.
  MEA is the design team
- LOD 200 – Equivalent to schematic design.
  MEA is the design team
- LOD 300 – Equivalent to contract documents.
  MEA is the design team
- LOD 400 – Model is suitable for fabrication.
  MEA is typically the fabricator or trades.
- LOD 500 – Model is an as-built.
  - MEA is typically the general contractor or architect

AIA E202 Contract - Level of Development

LEVEL OF DEVELOPMENT 100

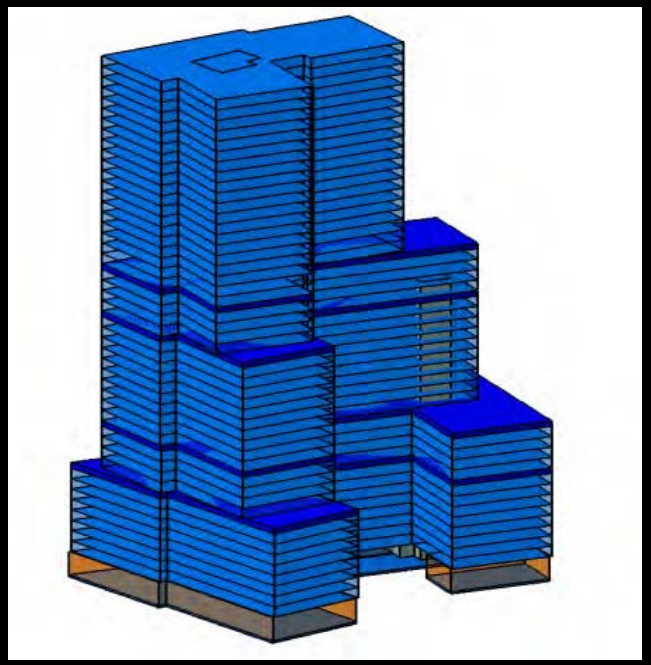
- Equivalent to conceptual design.
- Model consists of overall building massing
- Users are authorized to perform whole building types of analysis (volume, building orientation, cost per square foot, etc.)



AIA E202 Contract - Level of Development

LEVEL OF DEVELOPMENT 200

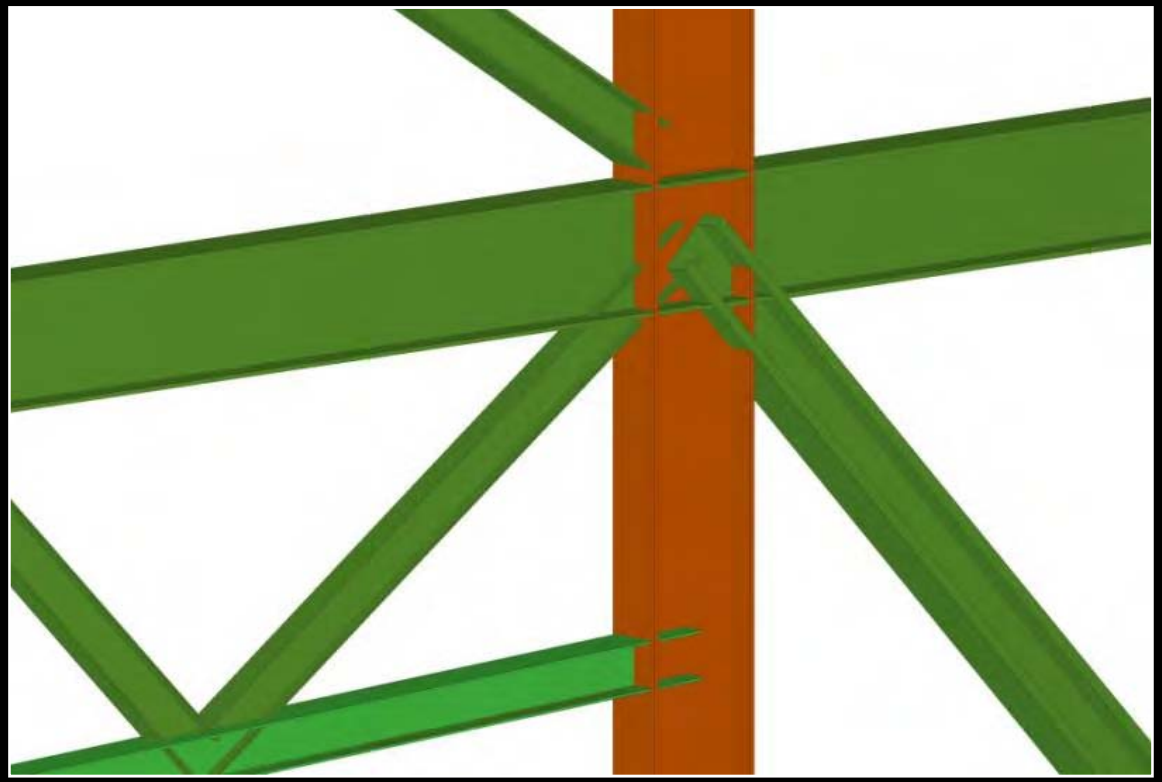
- Similar to schematic design or design development.
- Model consists of "generalized systems or assemblies with approximate quantities, size, shape, location and orientation."



AIA E202 Contract - Level of Development

LEVEL OF DEVELOPMENT 300

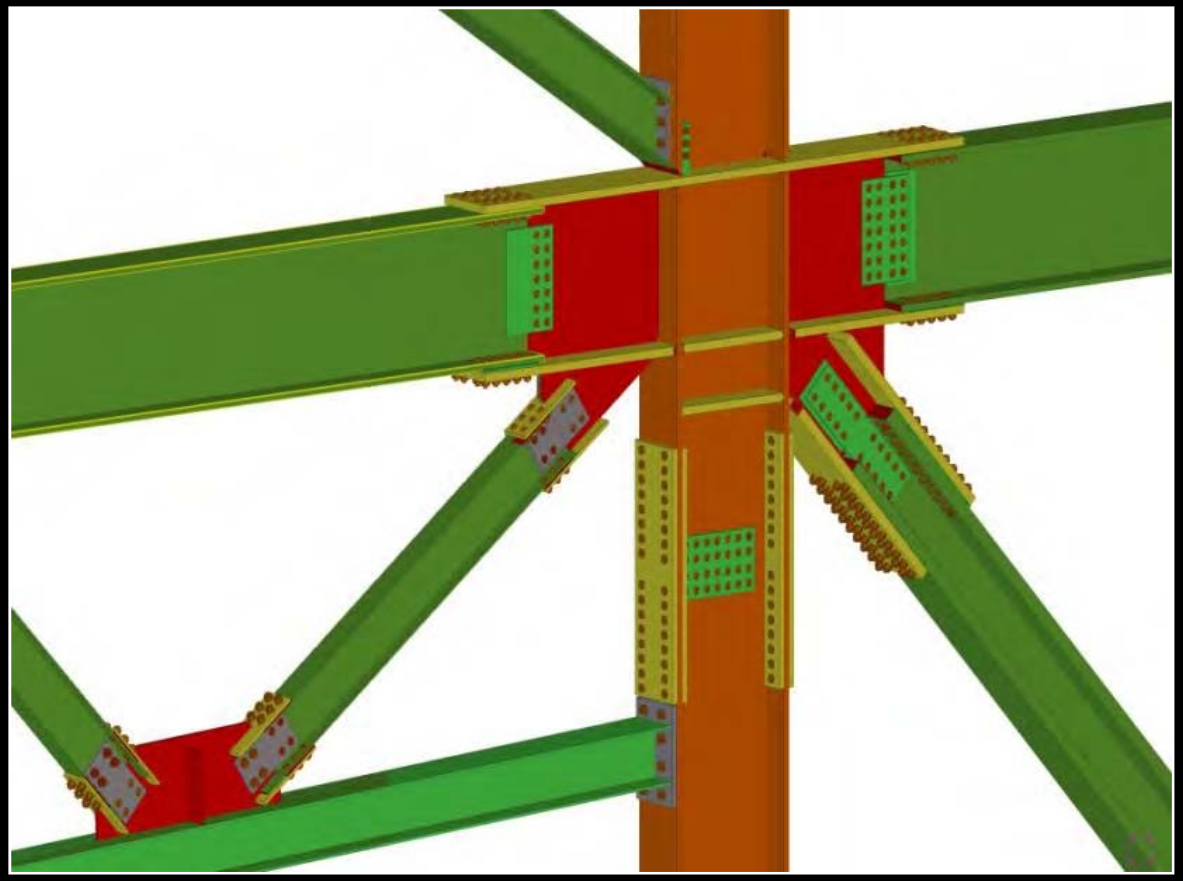
- Model elements are suitable for generation construction documents. MEA is the typically the design team.



AIA E202 Contract - Level of Development

LEVEL OF DEVELOPMENT 400

- Suitable for fabrication. The MEA is most likely to be the fabricator



AIA E202 Contract - Level of Development

LEVEL OF DEVELOPMENT 500

- As builts. The MEA is most likely the general contractor or fabricators

AIA E202 - Model Elements Chart

MODEL ELEMENTS TABLE

- Reliance on model elements

§ 4.3 Model Element Table

Identify (1) the LOD required for each Model Element at the end of each phase, and (2) the Model Element Author (MEA) responsible for developing the Model Element to the LOD identified.

Insert abbreviations for each MEA identified in the table below, such as "A – Architect," or "C – Contractor."

NOTE: LODs must be adapted for the unique characteristics of each Project.

Model Elements Utilizing CSI UniFormat™					LOD	MEA	LOD	MEA	LOD	MEA	LOD	MEA	LOD	MEA	LOD	MEA	Note Number (See 4.4)
A SUBSTRUCTURE	A10	Foundations	A1010	Standard Foundations													
			A1020	Special Foundations													
			A1030	Slab on Grade													
	A20	Basement Construction	A2010	Basement Excavation													
			A2020	Basement Walls													
B SHELL	B10	Superstructure	B1010	Floor Construction													
			B1020	Roof Construction													
	B20	Exterior Enclosure	B2010	Exterior Walls													
			B2020	Exterior Windows													
			B2030	Exterior Doors													
	B30	Roofing	B3010	Roof Coverings													
			B3020	Roof Openings													
C INTERIORS	C10	Interior Construction	C1010	Partitions													
			C1020	Interior Doors													
			C1030	Fittings													
	C20	Stairs	C2010	Stair Construction													
			C2020	Stair Finishes													

AIA E202 - Model Element Table

MODEL ELEMENTS – defined by the design team

- Example of completed LOD Table

§ 4.3 Model Element Table

Identify (1) the LOD required for each Model Element at the end of each phase, and (2) the Model Element Author (MEA) responsible for developing the Model Element to the LOD identified.

Insert abbreviations for each MEA identified in the table below, such as "A – Architect," or "C – Contractor."

NOTE: LODs must be adapted for the unique characteristics of each Project.

Model Elements Utilizing CSI UniFormat™					SCHEMATIC DESIGN		DESIGN DEVELOPMENT		50% CDs		100% CDs		STEEL SHOP DWG MODEL		AS-BUILT MODEL		Note Number (See 4.4)
					LOD	MEA	LOD	MEA	LOD	MEA	LOD	MEA	LOD	MEA	LOD	MEA	
A SUBSTRUCTURE	A10	Foundations	A1010	Standard Foundations	100	STR	200	STR	200	STR	300	STR	X	X	500	CON	
			A1020	Special Foundations													
			A1030	Slab on Grade	100	ARC	200	STR	200	STR	300	STR	X	X	500	CON	
	A20	Basement Construction	A2010	Basement Excavation	100	ARC	200	STR	200	STR	300	STR	X	X	500	CON	
			A2020	Basement Walls	100	ARC	200	STR	200	STR	300	STR	X	X	500	CON	
B SHELL	B10	Superstructure	B1010	Floor Construction	100	STR	200	STR	200	STR	300	STR	400	FAB	500	CON	
			B1020	Roof Construction	100	STR	200	STR	200	STR	300	STR	400	FAB	500	CON	

Consensus Docs – E301

CONSENSUSDOCS 301

BUILDING INFORMATION MODELING (BIM) ADDENDUM

This document was developed through a collaborative effort of entities representing a wide cross-section of the construction industry. The organizations endorsing this document believe it represents a fair and reasonable consensus among the collaborating parties of allocation of risk and responsibilities in an effort to appropriately balance the critical interests and concerns of all project participants.

These endorsing organizations recognize and understand that users of this document must review and adapt this document to meet their particular needs, the specific requirements of the project, and applicable laws. Users are encouraged to consult legal, insurance and surety advisors before modifying or completing this document. Further information on this document and the perspectives of endorsing organizations is available in the ConsensusDOCS Guidebook.

GENERAL PRINCIPLES

1.1 This Addendum does not effectuate or require a restructuring of contractual relationships or shifting of risks between or among the Project Participants other than as specifically required per the Addendum and its Attachments.

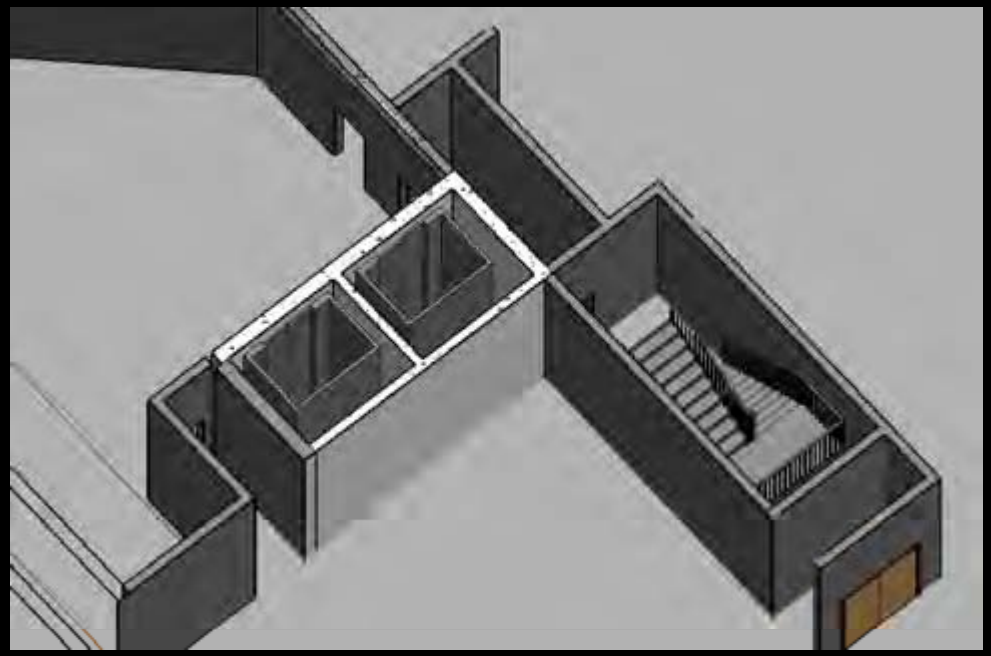
ConsensusDOCS

Consensus Docs – E301

- Created by AGC and the ConsensusDOCS™ coalition, an initiative of 21 construction and surety organizations

Consensus Docs – E301

- Released on June 30th, 2008
- Provides protective language from a contractors view point
- Initiates communication about BIM
- Aims to have all parties agree on BIM execution plan
- You can download a sample located at: http://www.consensusdocs.org/



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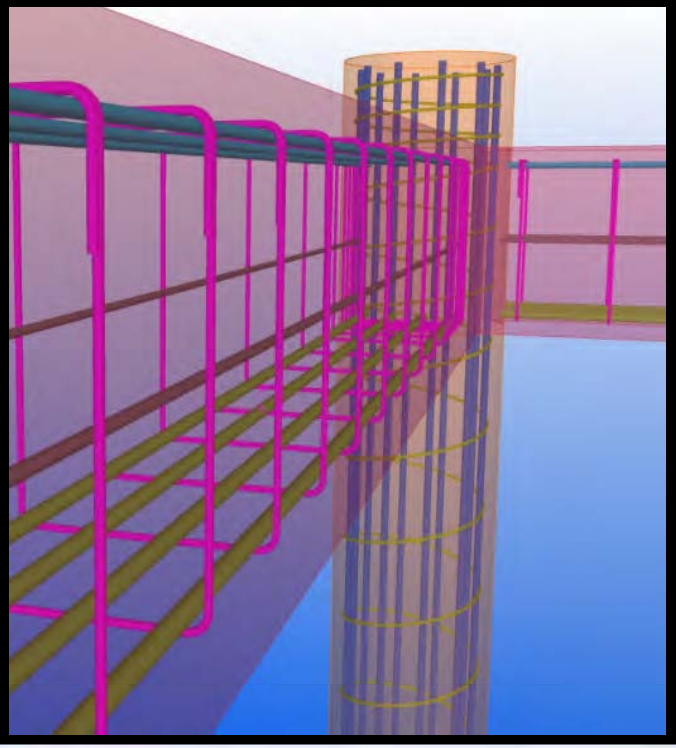
Benefits for downstream use too

Delivery Benefits

Improves Estimating

- Quantities are better defined
- Speeds up take offs quickly pull:
  - Volume
  - Rebar
  - Surface area
- Accurate quantities known at bid time



List

Report

Tekla Structures
Rebar Bending Schedule

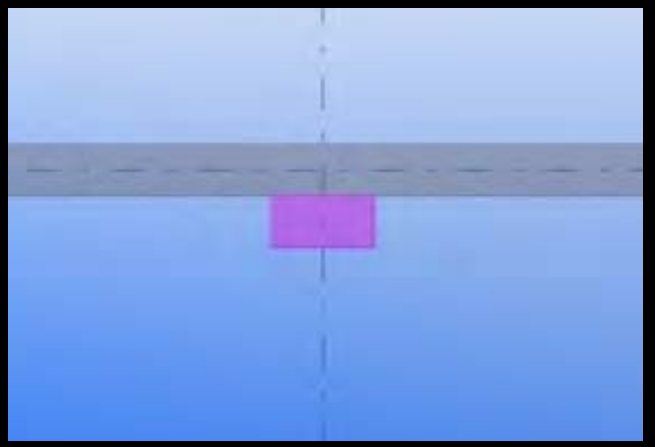
No.	Grade	Size	Length	Type	A
114	A615-60	#3	120 1/2"	T1	3 1/2"
21	A615-60	#3	114"	T2	5"
4	A615-60	#4	205"	STR	205"
3	A615-60	#5	205"	STR	205"
4	A615-60	#8	205"	STR	205"
12	A615-60	#8	359"	STR	359"

Happold

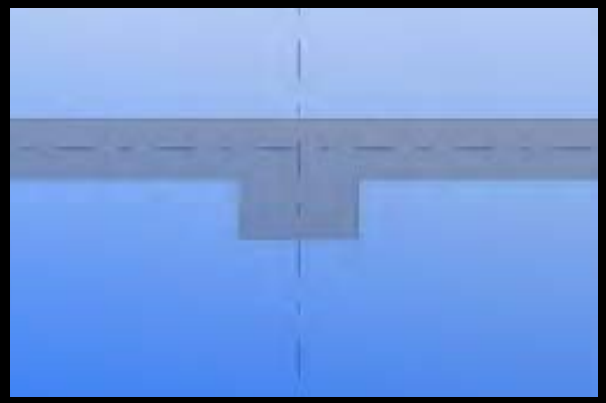
Concrete Modeling - Concerns

- Models must maintain fidelity
  - Garbage in = Garbage out

Column poking thru slab



Modeled Pilaster



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Delivery Benefits

Speed up Shop Drawings

- Instead of using 2D details – can use model
- Approval and Comments can be in the model
- Software has revision tracking and approval history

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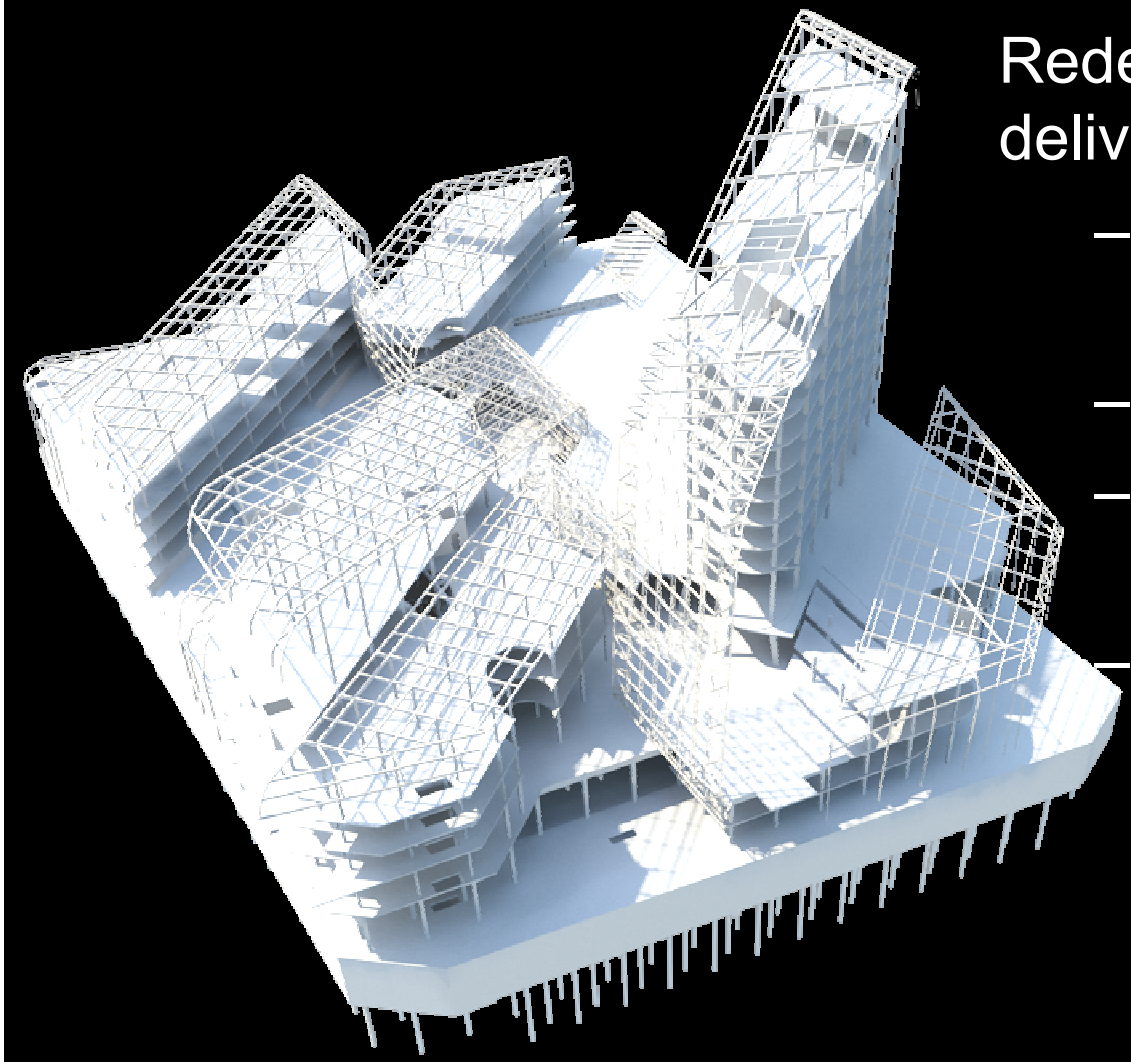
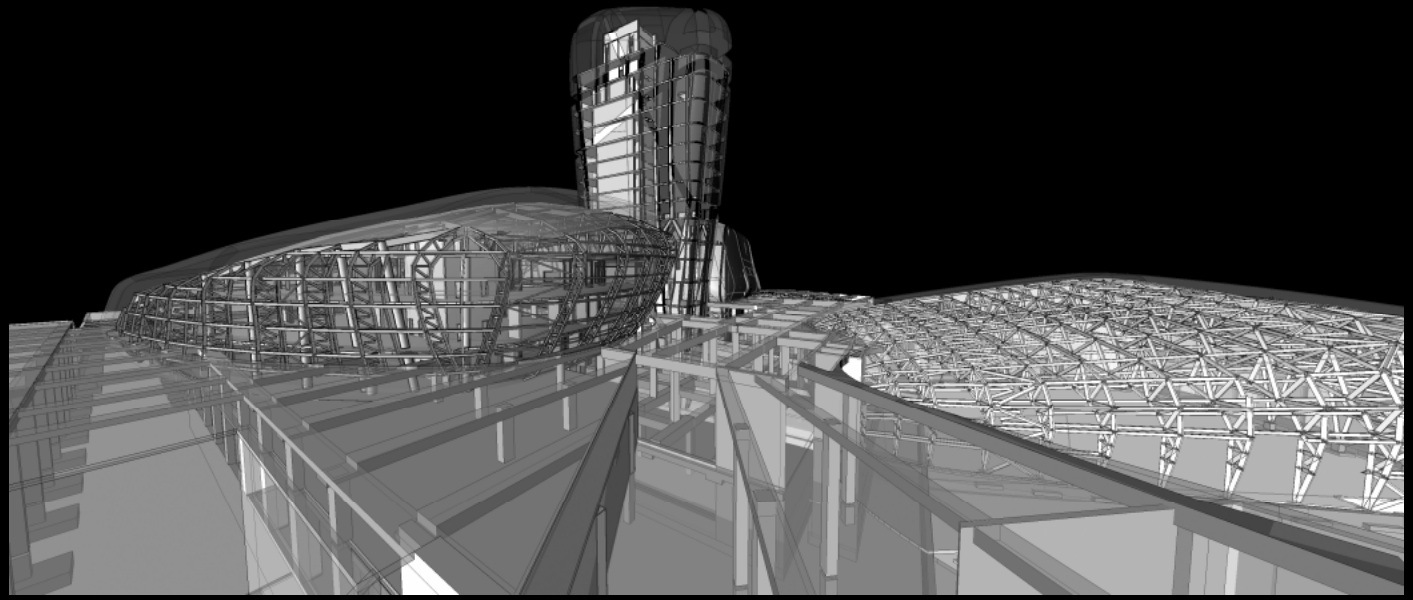
What is the future of BIM?



Redefining the structural delivery process

- Improves design team coordination
- Better defines scope
- Soon will be the “standard of care”
- Can provide benefits for all stakeholders



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Questions?

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IFC's for Concrete Construction

No. 29

Edwin T. Dean, Nishkian Dean

PMC WHITE PAPER

PMC White Paper

- Compile research on the state of the industry
- Discuss BIM Implementation
- Identify BIM Interoperability Goals
  - Design
  - Detailing/Manufacturing/Fabricating
  - Construction
- Identify Elements of Strategies

PMC White Paper

Primary purpose of the white paper was to begin the dialog for this Strategic Planning Session

IFC's for Concrete Construction

No. 32

OBJECTIVES AND PRIORITIES

IFC's for Concrete Construction

No. 33

Strategic Planning

Interoperability Goals

- Design
- Detailing / Manufacturing / Fabricating
- Construction

Design / Detailing Goals

Example Attributes

- Concrete Material Properties
- Geometry
- Analysis
- Element Design
- Coordination / Clash Detection
- Reinforcement Database, Size and Arrangement
- Composite Members
- Formwork Database

Detailing / Manufacturing / Fabricating Goals

Example Attributes

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

Construction Goals

Example Attributes

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

Strategies

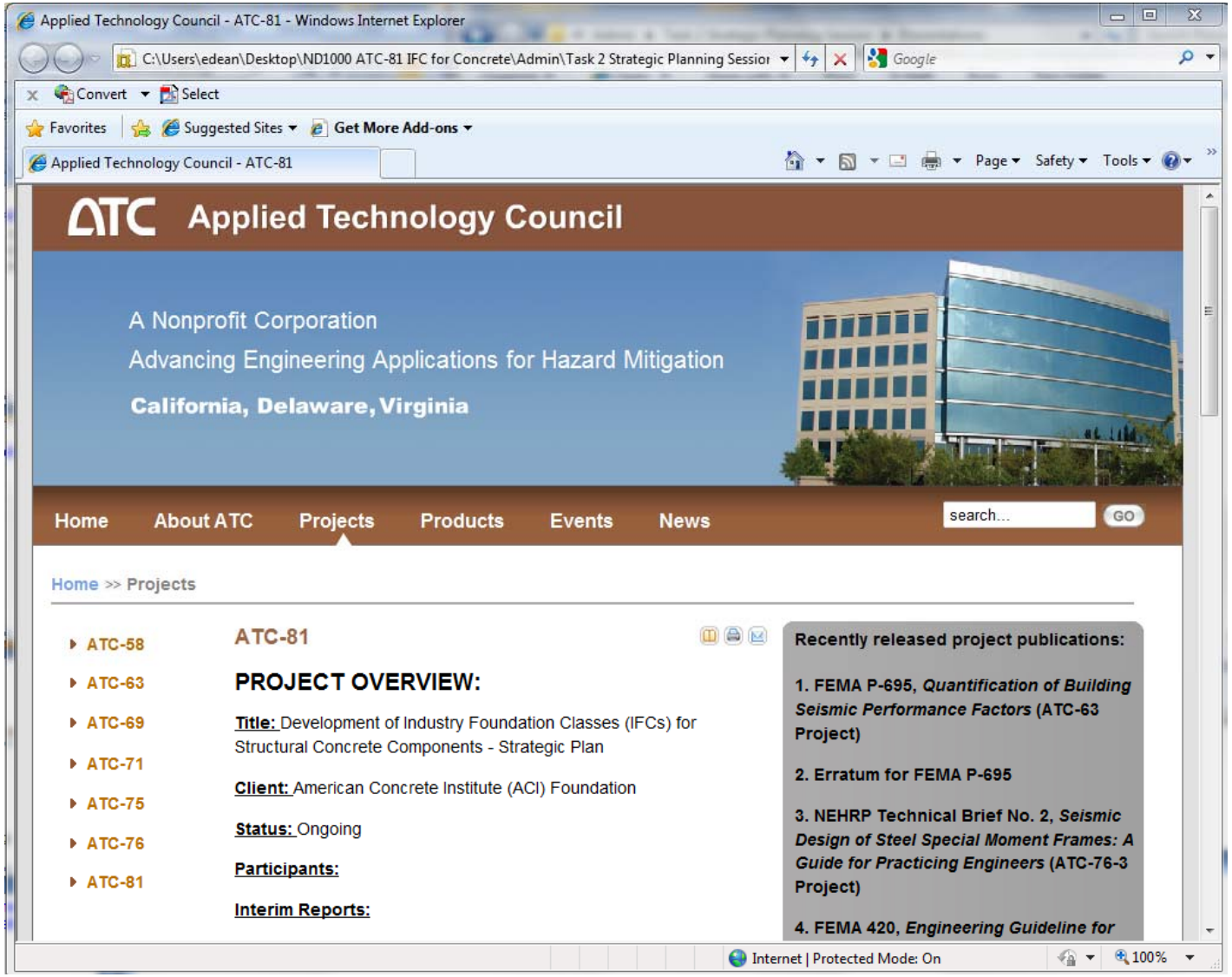
Strategies to Achieve Goals.

1. Champion
2. Definition
3. Time Frame (months/years)
4. Financial Constraints ($/$$/$$$)

Schedule (Preliminary)

- Strategic Planning Research 1/2010
- Strategic Planning Session 3/2010
- Strategic Plan Report 6/2010

Project Web Site



NISHKIAN DEAN
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ed.dean@nishkiandean.com
www.nishkian.com

www.atcouncil.org

Supplemental Information

- What is an IFC
- ATC-75 Project

WHAT IS AN IFC

IFC

- Industry Foundation Class – IFC
  - Exchange protocol;
  - Non proprietary, open architecture file format for exchanging data;
  - International NBIMS protocols maintained by buildingSMART

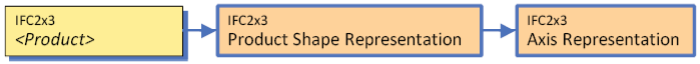
Model View Definition (MVD)

MVD - Axis

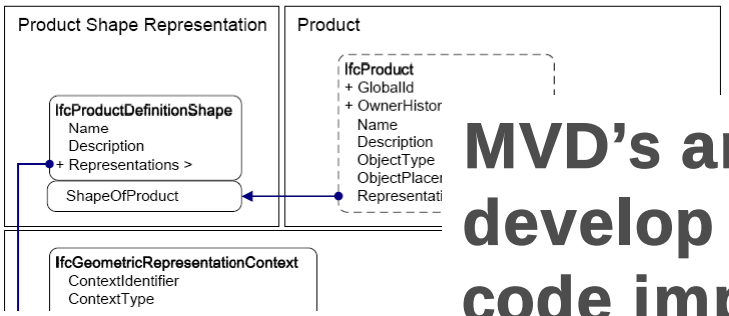
IFC Release Specific Concept Description (IFC2x3)
Axis Representation

Reference		**Version**	1.0	**Status**	Draft
Relationships					
History	5th August, 2008				
Authors	Matthias Weise (mw@aec3.de)				
Document Owner	AEC3				

Usage in view definition diagram



Instantiation diagram (example for a 2D axis)



IFC - Axis

Example (spf)

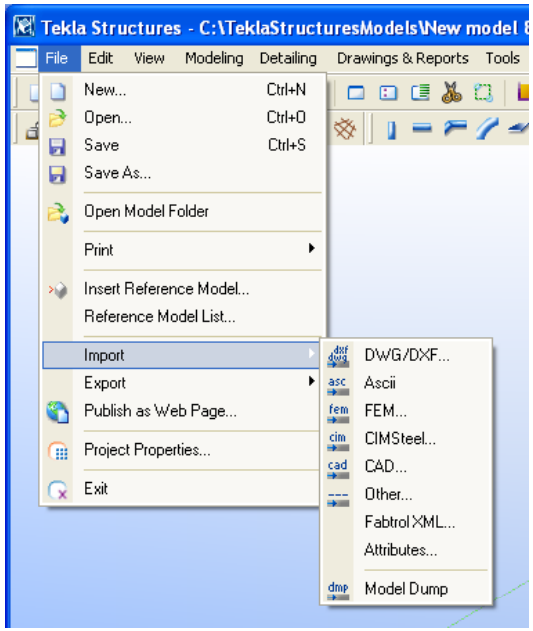
```
/***** Product ********************/
#100= IFCWALLSTANDARDCASE('3rPX_Juz59peXXY6wDJl18',#2,
      'Wand-Ext-ERDG-1',$,$,#101,#120,$);
/***** Local Placement (relative to other spatial structure elements) ************/
#101= IFCLOCALPLACEMENT(#102,#105);
#102= IFCLOCALPLACEMENT(#103,#106);
#103= IFCLOCALPLACEMENT(#104,#107);
#104= IFCLOCALPLACEMENT($,#107);
#105= IFCAXIS2PLACEMENT3D(#108,#110,#112);
#106= IFCAXIS2PLACEMENT3D(#109,#110,#111);
#107= IFCAXIS2PLACEMENT3D(#109,#110,#111);
#108= IFCCARTESIANPOINT((1.9397681,-6.0964898,0.));
#109= IFCCARTESIANPOINT((0.,0.,0.));
#110= IFCDIRECTION((0.,0.,1.));
#111= IFCDIRECTION((1.,0.,0.));
#112= IFCDIRECTION((0.,1.,0.));

/***** Product Representation ********************/
#120= IFCPRODUCTDEFINITIONSHAPE($,$,(#121,#130));
/***** Axis Representation ********************/
#121= IFCSHAPEREPRESENTATION(#125,'Axis','Curve2D',(#122));
#122= IFCPOLYLINE((#123,#124));
#123= IFCCARTESIANPOINT((0.,0.));
#124= IFCCARTESIANPOINT((10.,0.));
#125= IFCGEOMETRICREPRESENTATIONCONTEXT('Plan','Model',3,1.0000000E-5,#107,#126);
```

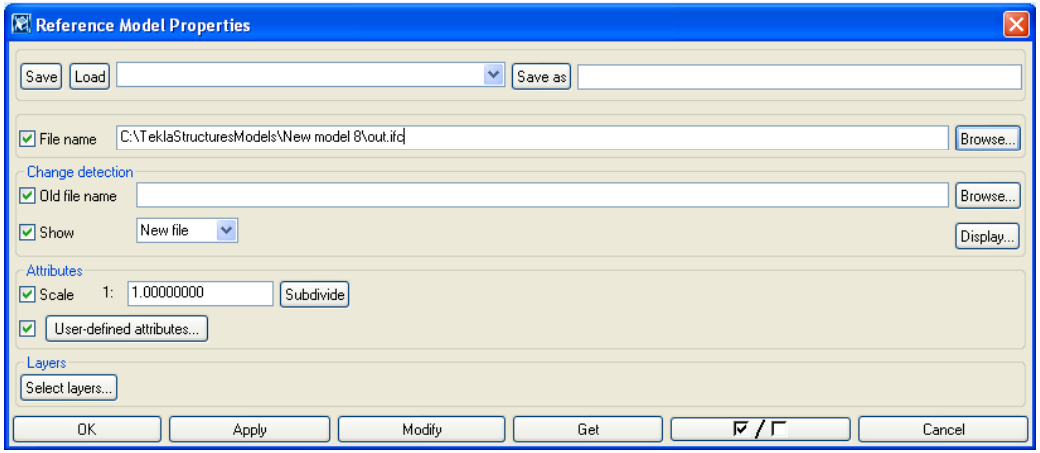
```
***************/
4,'Body','SweptSolid',(#131));
#133,#110,2.7);
EF(.AREA.,$,#134);
110,#111);
2,#143,#140));
3));
3));
);
04460E-16));
CONTEXT('Plan','Design',3,1.0000000E-5,#107,#145);
```

MVD's are used to develop the IFC code implemented by software programs

Example - TEKLA release 15

IFC Export and Imports are accessed from the pull down menu.





IFC's for Concrete Construction

No. 48

ATC-75 PROJECT

Vision

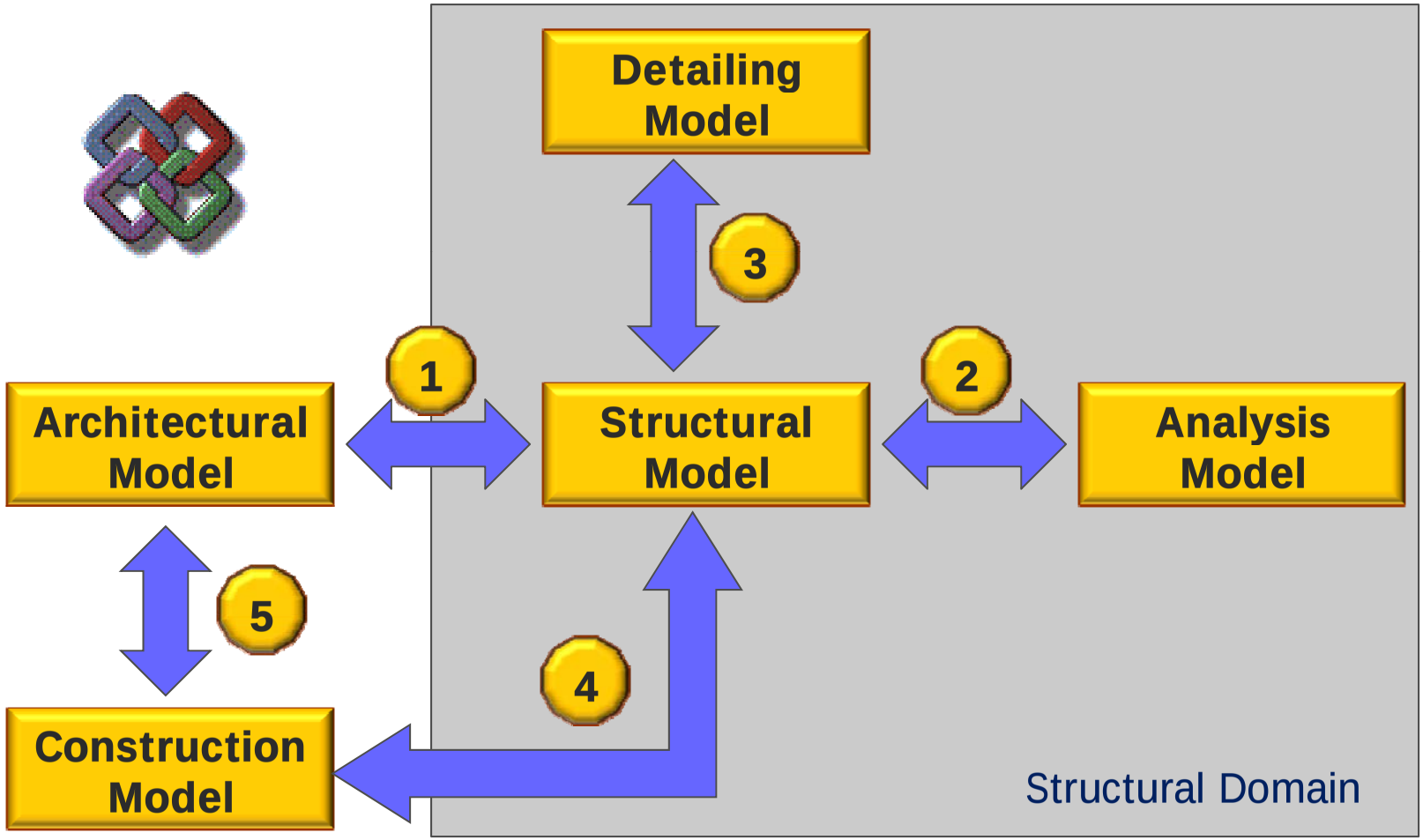
Create a robust process for seamless, efficient, reproducible exchange of accurate and reliable structural information that is widely and routinely utilized among all tools and stakeholders.

Generate it once, use it many times – interoperability.

ATC-75 Project

- Creating interoperability between BIM software platforms.
  - Identifying priority exchange attributes
  - Creating an industry definition – IDM
  - Generating software protocols – MVDs
- Increasing industry awareness
- Engaging BIM software platform support – getting onto the pull down menus

IFC Exchange Pathways



APPENDIX C:
Work Session Materials

iii. Interview Summaries

ATC 81 Development of IFCs for Concrete

Practitioners Focus Groups

Task 1, Research: Summary of Interviews

April 27, 2010 revision

The individual interviews have been summarized; this document is intended to capture the main themes that participants have discussed. Twenty two professionals were interviewed in-depth; seven were general contractors, five were engineers, five were in fabricating or detailing, one a research professional and four from a provider of rebar detailing software.

Concept and use of BIM:

The large GCs have embraced BIM, and most report quantifiable cost savings from the practice; one GC estimates 6-10% cost savings per project. They commonly use a neutral construction software as a portal to coordinate the various models. The engineers are accustomed to modeling for analysis purposes and are moving into BIM. Fabricators seem to take data "downstream", for the most part, and have very limited opportunities to utilize interoperability due to software package restrictions. On the whole, they seem to be exploring software, with the knowledge that they need to be ready to deal with BIM but a perceived lack of options for software appropriate to their use. Some have been modeling in 3D for a period, but not with the added BIM capabilities. The research professional who participated in an interview currently works to develop tools for GCs to facilitate use of BIM, and so has a hand in many proprietary and open source software packages.

Some firms reported that they currently "share and compile" rather than utilize direct transfer of models. One firm is outsourcing as model experts for other firms and has found that some would rather hire experts than invest in software and training for their own staff.

One firm discussed using BIM as part of the "Public Private Partnership" concept of project development, where a government entity contracts with a consortium of public firms to design, construct and operate a facility. In those types of projects, BIM is an invaluable tool. That participant also identified new revenue streams from offering enhanced as-built models including things like door hardware, paint color and maintenance schedules to the end user.

BIM implementation strategies:

One group reported hiring a special BIM group to implement and develop templates and standards to be adopted firm-wide. Others began by implementing BIM firm-wide with new projects as of a certain date, and are modeling all new projects in BIM. One firm implemented BIM as a communication tool in the field first, and loaded that historical data prior to implementing as a design and management tool. One firm has a BIM group that assesses projects for BIM use based on cost return or higher risk, and invests the resources on those projects only.

Some groups are finding that new employees are coming from trade school, or even high school, with modeling and/or BIM training already, sometimes replacing 2D CAD training completely. One rebar detailer discussed the difference between training a detailer to model and training a modeler to detail; their feeling was that some people will not be able to make the transition from 2D to 3D.

Observations about BIM software:

Most agreed that database-based software is better equipped to handle the large volume of data required to deal with rebar, as well as cost and schedule information. A suggestion was made that IFC be developed to a point where it could be the database that forms the foundation for new software packages, which would naturally ensure interoperability. Another suggestion was that multiple database sources be anchored to the same model, so that wildly varying types of data can be captured and transferred meaningfully.

One participant noted that the introduction of BIM has made designers follow through to a higher level of detail than they have in the past.

Another believes that the retooling of the work process that needs to take place to accommodate BIM and standardize the work flow is significant. One participant characterized it as understanding BIM as a process rather than a technology.

One participant observed that the automotive and aerospace industries can be pointed to as case studies of the concepts behind BIM being implemented and showing demonstrable return.

Obstacles and Remedies:

The lack of standards for describing shapes and rebar – even to the level that fabrication shops often have their own specific sets of shapes and descriptions, there is no standard for communicating shapes and types of concrete forms or rebar, or concrete strength, rebar density, etc. The industry organizations could develop such a standard.

Separate, competing software packages – the point was raised that mechanical software files (SolidWorks, ProE, Inventor) are generally very exchangeable, and it's in the design world that software does not communicate well. Compliance with IFC protocols would address this issue.

Unwieldy file size – many report difficulty using BIM past a certain level of detail due to the file size, especially when discussing rebar. Some offer the database-based software notion as a way around the issue; alternatively, BIM servers are coming into play in some projects.

Lack of data richness – some found that the only data that is reliable is geometry, and that transfers lose the richer information that once was attached to modeled pieces. One suggestion was wider availability of custom fields.

Difficulty staying "up to date" – one participant noted that the rebar industry often has turnaround times on the order of 1-2 days, and that keeping current is difficult with BIM.

Timing – some rebar and detailing participants felt that they are generally not engaged early enough in the process to gain any benefit from BIM. They felt that the solution would be an early teaming, where they are involved and can help with arrangement and constructability from the beginning.

Trust issues – the issue of trusting other professions to a) use the model with the same purposes in mind, b) enter accurate data in the appropriate manner and c) interpret data as intended were expressed. The remedy seems to be early adoption of a collaborative paradigm. Doubts about fidelity can be addressed through start-to-finish coordination, where many practitioners use and review the model all the time. One GC indicated that they take off a model unit 12 to 15 times before it is built, which represents continuous checking and discovery

of any errors. Additionally, the AIA's Level of Detail definitions go a long way toward defining the uses and expectations of a model at various points in the project life, which should offer all stakeholders a uniform playbook to work from.

Legal concerns – Many participants have encountered reluctance to share data from a liability and/or intellectual property rights standpoint. One participant characterized this as a fear of new technology. He believes that the legal obligation and the ownership of data is the same as always, simply represented in a new format, and feels that the issue will resolve itself. It was suggested that this area needs to be addressed industry-wide.

Cost of software and training – it is prohibitive, and one firm suggested that they are hired as expert consultants by many firms who wish to avoid the cost of software and the software selection process.

Culture of "why?" (*resistance to change)* – all participants experienced the obstacle of resistance to change, and most considered it the biggest obstacle to implementation of BIM. One firm reported that the older field superintendants and estimators were the least welcoming of BIM due to a culture of "why?" However, the firm that first loaded the tool with historical data reported that those users were the most welcoming. They had time to get familiar with it as an aid only, and were only later asked to rely on it as a primary tool. The method of implementation is crucial.

Benefits of BIM reported:

Early clash detection
Early cost estimating
Change propagation
Automated construction document production
Schedule and materials management
Availability of quality historical data for use in future project planning
Availability of a building model for owner use
Value as a marketing tool
Use as a relationship-builder with owners and facilities managers

Thoughts on Future Direction:

Owner requirements for IDM have been an issue, in that some owners proscribe the BIM software to be used. For some firms this means purchasing and learning new software or being ineligible. Real interoperability, however, would allow delivery in any package required.

The suggestion was made that the software developed in the future should be database-based, and perhaps even using IFC as the prototype database.

It was also suggested that prefabrication and offsite fabrication will dominate the drive to BIM, rather than onsite fabrication, and the place for development is with suppliers.

All agreed that the investment in BIM will ultimately be recouped, though the fabricator in the group felt his profession would be one of the last to reach that threshold. Cost savings in construction seems to be the first and most quantifiable benefit, but ultimately the owner benefits the most when higher quality projects are delivered for less cost in less time. BIM has engendered a shift to a collaborative paradigm, allowing construction information to mesh into the early stages of design and eliminating the traditional extended iteration process.

Glossary of Terms:

BIM – 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. *(definition from Wikipedia)*

IFCs – 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. 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. *(definition from Wikipedia)*

Interoperability – With respect to software, the term interoperability is used to describe the capability of different programs to exchange data via a common set of exchange formats, to read and write the same file formats, and to use the same protocols. *(definition from Wikipedia)*

IDM – Integrated Data Management is a tools approach to facilitate data management and improve performance. IDM consists of an integrated, modular environment to manage enterprise application data, and optimize data-driven applications. It manages data over its lifetime, from requirements to retirement. *(definition from Wikipedia)*

LOD (100 through 500) – Level of Development, as established by AIA. They consist of:

LOD 100 - Essentially the equivalent of conceptual design, the model would consist of overall building massing and the downstream users are authorized to perform whole building types of analysis (volume, building orientation, cost per square foot, etc.)

LOD 200 - Similar to schematic design or design development, the model would consist of "generalized systems or assemblies with approximate quantities, size, shape, location and orientation." Authorized uses would include "analysis of selected systems by application of generalized performance criteria."

LOD 300 - Model elements are suitable for the generation of traditional construction documents and shop drawings. As such, analysis and simulation is authorized for detailed elements and systems.

LOD 400 - This level of development is considered to be suitable for fabrication and assembly. The MEA (*model element author*) for this LOD is most likely to be the trade contractor or fabricator as it is usually outside the scope of the architect's or engineer's services or would constitute severe risk exposure if such parties are not adequately insured.

LOD 500 - The final level of development represents the project as it has been constructed - the as-built conditions. The model is suitable for maintenance and operations of the facility. *(definition from AIA E202)*

Interview Participants:

Martin Reifschneider, Bechtel
Dick Birley, Condor Rebar
Dave Anderson, Condor Rebar
Mahela Birley, Condor Rebar
Greg Hutchinson, Condor Rebar
Doug Sholl, HDR
Frank Haase, Webcor
Jason Lien, Encon United
John Eddy, SSOE Group
Jim Dick, Pankow Builders
Luis Perez, Pankow Builders
Bill Klorman, Klorman Construction
Dennis Hunter, Gerdau Ameristeel
Bob Edwards, Rebar Detailing & Estimating
Shokry Rashwan, National Research Council (CA)
Christopher Brown, Skimore Owings & Merrill
Robbie Hall, CMC Rebar
Peter Zdgiebloski, CMC Rebar
Mike LaNier, Berger ABAM
Daniel Berend, Facchina Construction
Jim Davy, McHugh Construction
Tom Strong, Ellis Don

Interview Moderators:

Michelle Kernen, Nishkian Dean
Aaron White, Walter P. Moore
Ed Dean, Nishkian Dean

APPENDIX C:
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iv. White Paper

Strategic Plan to Develop BIM Interoperability in Structural Concrete

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

Initial Release, April 22, 2010

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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[1] Edwin T. Dean, Principal Investigator, Michelle Kernen, Nishkian Dean; Aaron White, Walter P. Moore; Erleen Hatfield, Buro Happold; Phil Williams, Webcor; Bill Klorman, Klorman Construction; John Turner, CRSI; Mike Schneider, Baker Concrete; Peter Carrato, Bechtel; Alistar Wells, Tekla; Allan Bommer, Raoul Karp, Bentley; Chi Ng, Gehry Technologies; Dave Grundler, Jr., ASA; Rob Tovani, CSI; and Scott Hammond, Autodesk

[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.