A Roadmap for Developing and Deploying Building Information Modeling (BIM) for the Masonry Industry

Prepared for:

The National Building Information Modeling for Masonry Initiative

Sponsors:

International Masonry Institute (IMI), International Union of Bricklayers and Allied Craftworkers (IUBAC), National Concrete Masonry Association (NCMA), Mason Contractors Association of America (MCAA), The Masonry Society (TMS), and Western States Clay Products Association (WSCPA)

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1. INTRODUCTION

This document presents a roadmap for building information modeling (BIM) for the masonry industry. The roadmap results from an intensive nine-month effort by leading associations within the masonry industry and including the input of stakeholders: material suppliers, architects, engineers, and contractors. The Digital Building Laboratory (DBL) at the Georgia Institute of Technology prepared the roadmap. The Building Information Modeling for Masonry Initiative has adopted the following mission statement:

> *To unify the masonry industry and all supporting industries through the development and implementation of BIM for masonry software to facilitate smoother workflows and collaboration across all disciplines from owner, architect, engineer, manufacturer, mason, contractor, construction manager, and maintenance professionals.*

This initial effort was funded by the International Union of Bricklayers and Allied Craftworkers (IUBAC), the Mason Contractors Association of America (MCAA), the International Masonry Institute (IMI), the National Concrete Masonry Association (NCMA), the Western States Clay Products Association (WSCPA) and The Masonry Society (TMS).

Phase I of the national masonry initiative is led by an Executive Committee whose members are listed alphabetically by the sponsoring organizations:

- International Masonry Institute – David Sovinski
- International Union of Bricklayers and Allied Craftworkers – James Boland
- Mason Contractors Association of America – Jeff Buczkiewicz, Ed Davenport, Greig Carnevale
- National Concrete Masonry Association – Tyler Witthuhn
- The Masonry Society – Darrell McMillian, Daniel Zechmeister
- Western States Clay Products Association – Jeff Elder
- Art Theusch (ex officio), Collaborative Consulting Group, serves as an advisor to the Executive Committee
- David Biggs (ex officio), Biggs Consulting Engineering, serves as the masonry industry coordinator

Another 15 masonry groups were affiliated members and provided technical assistance to this Phase I project:

- Portland Cement Association - Jamie Farny
- Brick Industry Association - Brian Trimble
- Cast Stone Institute - Jan Boyer
- Marble Institute of America
- Masonry Institute of St. Louis - Darrell McMillian
- Masonry Institute of Michigan - Dan Zechmeister
- Tile Contractors Association of America
- Cold Spring Granite
- Interstate Brick - Jeff Elder
- Masonry Institute of America - John Chrysler
- Northwest Concrete Masonry Association
- Indiana Limestone Institute - Todd Schnatzmeyer

- Masonry Association of Florida - Pat McLaughlin
- Concrete Masonry Association of California and Nevada - Kurt Siggard
- North Carolina Mason contractors Association-Lynn Nash

In the context of this report, the roadmap represents a series of phased projects that the masonry industry must undertake in order to prepare the technical foundation (software) for masonry BIM (BIM-M) and to prepare the industry to implement masonry BIM (education). Some of these projects represent stand-alone encapsulated works that can be completed by the primary or sub-contractor to the BIM-M initiative. Others will require significant input from the masonry industry, and imply the need for a working group drawn from the masonry industry, with financial support from the industry to supervise and support the activity.

It is important to remember that the term BIM represents both an object a "building information model" and a process "building information modeling". Therefore the roadmap describes activities that focus on "objects" and "processes". The "object" activities will develop technical details and specifications describing how masonry will be represented in CAD and BIM computer software – and how this information will be preserved and transferred as building projects go from the planning to design to construction phases. The "process" activities will investigate how stakeholders in the masonry industry currently handle information regarding masonry and will describe new BIM-enabled workflows in the design and construction phases of a project.

This document is organized as follows. First, a timeline representing our vision for the development and implementation of masonry BIM is presented. This timeline provides an overall view of the BIM-M initiative in three phases. Second, specific projects that are part of the timeline are presented. Each project is presented with some detail. The projects that fall earlier in the timeline are described with greater detail, as it is likely that downstream projects will be adapted based on outcomes of the earlier projects.

Because this initiative results from significant engagement with and input from the masonry industry, Appendix 1 documents the workgroup process and provides a vision for masonry BIM from the five stakeholder viewpoints: material supply, architecture, structural engineering, general contractor/construction manager, and mason contractor. To aid those who are not familiar with the technical terms used in this document, a short glossary of BIM- and CAD-related terms are provided in Appendix 2. A short white paper on the development of BIM and making the case for the initiative's goals for BIM for masonry is included as Appendix 3. This paper will be presented at the 2013 Canadian Masonry Symposium and is included per the copyright policies associated with that conference. And finally, because this document represents the final report from the Phase I study completed by the Georgia Tech DBL, Appendix 4 contains the results of the surveys completed by the five working groups. For readers wishing to better understand the impact of BIM on the overall AEC Industry, review of a recent report on BIM by McGraw Hill is recommended.[1]

[1] Jones, S. A. and H. M. Bernstein (2012). The Business Value of BIM in North America. Smart Market Report, McGraw Hill Construction:
http://images.autodesk.com/adsk/files/mhc_business_value_of_bim_in_north_america_2007-2012_smr.pdf

This document does not address the cost of implementing the roadmap. The Executive Committee will be identifying financial and technical resources for Phase II during the upcoming planning period.

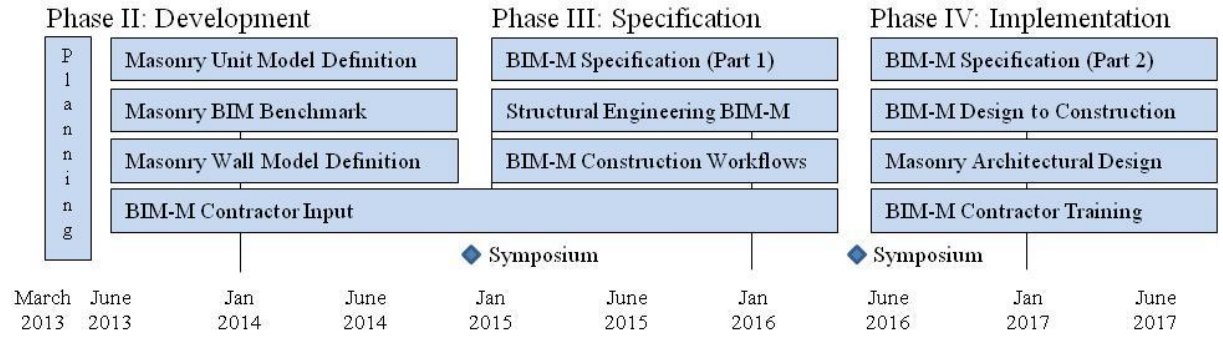
2. PHASES AND TIMELINE

The roadmap proposes three phases of work on masonry BIM, with the three phases described as: Development, Specification, and Implementation. Time is allotted at the end of each phase for the industry to assess the impact of the prior phase's projects, to refocus where necessary, and to plan for the next phase. It is envisioned at a symposium of project leaders and stakeholders will be held December 2014 and in May 2016.

In Phase II of the initiative, the foundation for a software specification will be established through four projects, which supports the primary goal of documenting the background knowledge.

The specification itself will be developed starting in Phase III, along with additional projects that focus on the integration of structural engineering into masonry BIM and on continuing the development of masonry BIM in the construction phase.

In Phase IV of the initiative, BIM for masonry will become a reality and four projects will focus on implementation of BIM-M from the earliest stages of architectural design to the details of masonry BIM in the construction phase. Phase IV will also focus on contractor training. The software specification will be continuously revised in conjunction with our commercial software partners, leading to the further development and implementation of masonry BIM.



The proposed timeline begins in March 2013 at the start of Phase II of the project and runs until the end of 2017, and, including the Phase I roadmap, represents roughly five years of activity by the masonry industry. This proposed timeline will surely raise the question: *"Can't we do this faster?"* It is important to recognize that the structural steel and precast concrete industries have been embarked on BIM development initiatives for the last 15 years, and that their efforts are still underway. BIM for structural steel and precast concrete exist and are comprehensively used in the structural steel industry and gaining traction in the precast concrete industry. Nevertheless, improvements to BIM in these industries are ongoing, to increase the functionality of BIM and to increase the market penetration of BIM in these industries. We perceive a similar path for BIM-M, that is, the initial implementations in commercial software will take place starting in late 2015, with increasing adoption and implementation ongoing from that time. We do not control

the schedules of software companies and thus the times they require for BIM-M implementation may vary significantly.

The software industry is already aware of our efforts towards masonry BIM. Software developers from Autodesk and Tradesmen attended the Masonry BIM Workgroup meetings at Georgia Tech in September 2012. Additional discussions with Bentley, Vectorworks, and SmartBIM have taken place since then and the progress towards the goals of the project are presented at the Digital Building Laboratory symposium, attended by industry leaders, in May of every year at Georgia Tech. It is anticipated that some of the ideas generated by the project will be adopted by the BIM software suppliers even absent the submission of a formal BIM-M software specification, and that the formal submission of the specification in 2015 during Phase III will lead to further implementation of masonry BIM. The Phase II masonry BIM benchmark project will formalize the relationship between the BIM-M initiative and the major software suppliers.

It is not clear at this point whether the software suppliers will implement masonry BIM at no cost to the masonry industry, or whether the software companies will ask that the masonry industry partially fund the implementation of masonry BIM. In the precast concrete industry, one company (Tekla Structures) was paid to implement BIM for precast concrete, but another (StructureWorks) used the precast concrete specification to implement BIM at no cost to the industry. In the structural steel industry, the companies that provide BIM software collaborate with the structural steel industry, but do not receive direct funding from the industry. We anticipate a hybrid outcome, where much of BIM-M is implemented gradually by the software industry at no direct cost to the masonry industry, but that certain masonry-specific functionality (for example, wall scheduling, bracing analysis, structural analysis of walls) may require seed funding from the industry.

3. PROJECTS AND TASKS

The proposed roadmap has been broken into four phases (I through IV) and 11 projects. The development of this roadmap represents Phase I. The phases and projects are described below in the order in which they should be undertaken. Planning for Phase II (Development) will begin on March 1, 2013, and the anticipated start of the Phase II projects is June 1, 2013. The projects in Phases III (Specification) and IV (Implementation) are described in somewhat less detail, as we expect that these projects will be revised to reflect the findings of the projects in Phase II.

Now that Phase I is complete, the subsequent phases and projects are as follows:

Phase	**Project**
Phase II – Development	1. Masonry Unit Model Definition 2. BIM-M Benchmark 3. Masonry Wall Model Definition 4. BIM-M Contractor Input
Phase III – Specification	5. BIM-M Software Specification (Part 1) 6. Structural Engineering and BIM-M 7. BIM-M Construction Workflows
Phase IV – Implementation	8. BIM-M Software Specification (Part 2) 9. BIM-M: Design Phase to Construction Phase 10. BIM-M Contractor Training 11. Early-Stage Masonry Architectural Design

Responsibility for leading and completing the projects has not been assigned at this time, as this is the role of the BIM-M Executive Committee. The assignments for the Phase II projects will take place during the planning process beginning in March 2013. The roadmap proposes three strategies for identifying leadership and staffing for the projects. First, for projects that are at the core of the masonry BIM software and which will lead to the development of the BIM-M specification, it is likely that the Georgia Tech DBL will lead and staff the projects. Second, for projects that involve significant industry input along with coordination with the software efforts, it is envisioned that requests for proposal (RFPs) will be issued by the initiative with the assistance of the DBL. These projects may be completed by educational institutions, by the staff of industry trade associations, etc. Finally, for projects that focus on mason contractors, the leveraging of existing contractor associations and committees, with supplemental staffing funded by the initiative, is envisioned. Significant expertise was identified at the first stakeholders meeting in Atlanta in September 2012 and it may be that project leadership is drawn from these stakeholders.

THE PROJECTS SPECIFIC TO PHASE II INCLUDE:

1. Masonry Unit Model Definition – Phase II

In this first project, the BIM-M contractor will work with a workgroup of masonry suppliers to develop requirements for digital representation of masonry units. The goal here is to develop a data structure to capture all of the geometric, aesthetic, and non-geometric data needed to select, specify and purchase masonry units. This database foundation can act as a downstream basis for digital product catalogs, web-based product selection applications, masonry e-commerce, cost-estimating and the BIM applications to be developed later in the masonry project. The masonry unit model definition can be compared to the database of structural steel shapes, created by the American Institute of Steel Construction (AISC) that forms the data foundation for structural steel modeling and fabrication software.

Project Tasks

1. Survey masonry unit suppliers to determine all of the information that should be included in the model definition.
2. Review and critique existing internal data structures used by masonry manufacturers.
3. Host face-to-face working group meeting for stakeholder input.
4. Develop interface requirements for the input of new and custom masonry types.
5. Prototype initial data structure.
6. Provide a first generation of this data structure with selected masonry units instantiated in the database.
7. Deliver data structure to stakeholders for their input of masonry units.
8. Demonstrate input of masonry unit into CAD software from the database.
9. Revise data structure based on stakeholder feedback.
10. Publish specification for data structure.

Participants

The project will be led by Georgia Tech or an outside contractor and staffed for 18 months. We request participation by BIA, NCMA and WSCPA, and request workgroup membership from the cut stone and cast stone industries as well. The effort will need to be coordinated with the

Construction Specifications Institute (CSI) for compatibility with CSI OmniClass and IFCs and IFDs and ASTM Uniformat II (standard database formats developed for use in BIM, quantity take offs, and cost estimating).

2. BIM-M Benchmark – Phase II

In this project, a typical masonry building of moderate complexity will be selected for submission to leading BIM software vendors in the United States. Plans, details, wall sections and photographs will be provided so that the software vendors have complete information about the building. The vendors will be asked to create detailed BIM models of this building, with as much masonry detail as possible – describing which aspects of masonry are well-represented and which aspects of masonry are poorly represented. The vendors will be asked to assess their own models in terms of completeness. The project team will develop a detailed hierarchy of masonry wall information that will be used for an independent assessment of the models. The project leadership will take advantage of the opportunity to engage the software providers about their thoughts on masonry BIM, and on details that they would like to see in the masonry BIM specification. The project team will provide a critique of the models, and a state of the art on masonry BIM as a result of this project. The following vendors[2] will be solicited for their input.

1. Autodesk Revit
2. Bentley BIM
3. DataCad
4. Digital Project
5. Nemetschek Vectorworks
6. Telka Structures

Project Tasks

1. Share BIM-M roadmap with BIM software vendors and solicit their feedback. Identify contacts and collaborators within each software company.
2. In conjunction with masonry industry partners, identify masonry unit types and wall assemblies that represent the majority of masonry construction in North America. Use the survey methodology first deployed in the Phase I research.
3. Pick a widely used masonry system from Step 1 and identify an existing building that uses this system. Gather plans, details, and wall sections. Photo-document the building.
4. Prepare detailed hierarchy of masonry objects: units, bonding patterns, grout, reinforcement, accessories, and details.
5. Develop a full 3-D parametric model of the building as a virtual mock-up. This is different from a BIM model as the each item in the parametric model must be "hand built" and is not an inherently masonry object.
6. Prepare a "building representation" challenge for BIM software vendors: the masonry building from Step 2 will be provided and software vendors will be asked to prepare design and/or and construction BIM models using their current software. The task requires thoughtful definition. A project too complex will get few software takers, as the work involved is too great. A model that is too simple will not demonstrate the capabilities and limits of the current systems.

[2] Other software vendors may be identified. This should be considered a preliminary list and is not exclusive nor is meant to exclude other interested parties.

7. Software providers prepare BIM models.
8. BIM models will be assessed for completeness, information validity, query-ability (for takeoffs, cost estimating, and interference checking) and well as interoperability with structural analysis and structural design. Vendors will be asked to identify areas where they feel their masonry BIM model is "complete" and areas where masonry is not sufficiently represented.
9. Translate BIM models to IFC and assess the completeness of the translation.
10. Identify "best in class" IFC model and provide this model to Tradesman Software and/or other software vendors for cost estimating purposes.

Participants

The project will be led by Georgia Tech and staffed for 18 months by DBL graduate students who are trained in BIM software. The masonry industry will be asked to provide assistance in identifying the building to be used for the BIM model. It is anticipated that each of the software suppliers will complete the BIM model (preferred) or we may also sub-contract with outside consultants to complete the BIM models.

3. Masonry Wall Model Definition – Phase II

This project is at the core of masonry BIM. Because masonry BIM is a computational model of masonry construction, and masonry walls are the fundamental assembly in masonry construction, it is critical that the data representation of the masonry wall support all of the functionality that is envisioned for BIM-M. Currently, it is simply not computationally practical for BIM software to track individual masonry units in an entire building. Therefore the masonry BIM data structure must include the definition of wall types, and must provide the means to map these wall types onto regular and irregular regions on wall surfaces.

This project will develop requirements for the digital representation of masonry walls in BIM systems. This will lead to the development of masonry families, through which a set of masonry units (extracted from the data structure defined in the masonry unit project) are arrayed according to established rules to take a generic wall in BIM and represent it as a fully-described masonry wall. It is anticipated that these walls will be represented in different levels of detail depending on the needs of the BIM user. For example, in early stages of design and on large-scale buildings, walls will be represented as regions without populated masonry units (wireframe mode). As more detail is required, these regions will be populated as masonry units represented as 2-D polygons, and finally as full 3-D photorealistic rending with masonry units modeled as solids. In addition, the wall definition must include the propagation of masonry units in various bonding pattern with modular coordination of masonry veneer and backup systems.

Project Tasks

1. Define high-level classes that must be required to be defined in masonry BIM: veneers, bonding patterns, masonry backup systems, openings, pilaster, etc. and methods for generating objects based on these classes.[3] Adapt to and coordinate with the masonry hierarchy established in the BIM for masonry benchmark project.

[3] Some of the descriptions in this project are based on the definitions used in object-oriented programming, and the terms "class" and "object" have specific meanings in this context.

2. Formalize the concept of a masonry family, which is a complete set of objects needed to define the veneer masonry and its backup system within a given bounded region in the BIM system.
3. Identify rules that define the relationships between objects. These will be the parametric rules that control bonding patterns and the relationship between veneer and backup bonding. These rules will determine how bonding patterns react to the placement of door and window openings, to the placement of floors and roof systems, and how the bonding systems will react to the region boundaries in which a given masonry family is mapped.
4. Define strategies for regions to adapt to modularity of the masonry systems embedded in them.
5. Define a set of views of the masonry system, from lightweight views that should be computationally tolerable to detailed view suitable for photorealistic rending and virtual construction.
6. Develop an interface that allows for the importing of masonry units (from the masonry unit project) into a wall definition.
7. Develop interface requirements for the input of wall types (denoted a "wall definition module") to be implemented in BIM.
8. Work with software vendors to prototype/validate initial data structure for masonry wall definitions.
9. Publish a draft specification for wall data model.

Participants
The project will be led by Georgia Tech and staffed for 18 months by a DBL graduate student and a post-doctoral assistant.

4. BIM-M Contractor Input – Phases II and III

The initial stakeholders meeting at Georgia Tech identified a number of areas where mason contractors and masons will benefit from BIM-M (see discussion on workgroup activities, in Appendices 1 and 4). In this project, we propose that mason contractors explore in greater detail the potential benefits of BIM, begin to document their current work processes and their use of software in current practice. We suggest that the leadership and staff of this project will meet with contractors within their existing associations (MCAA, IMI, TMS) and at their existing national meetings to gain a greater sample of industry needs and to continue to gather feedback on the potential for BIM implementation by the mason contractor. Input from general contractors will be solicited as well, to identify areas where general contractors desire interaction with masonry construction in their BIM models – for example, in coordination of masonry with mechanical and other building systems (clash detection). There are perceptions that the mason contractors are the "least digital" of the stakeholders in the masonry industry, and the BIM-M initiative needs to better understand the needs of mason contractors in this second phase of the process. This project will lead to the development of BIM implementation and training strategies for mason contractors, and the development of training materials for their use.

Project Tasks
1. Revise and re-submit survey to wider range of mason contractors and associated stakeholder groups (masons, masonry suppliers).
2. Identify best practices of BIM use in other non-masonry subcontractor areas.

3. Solicit input from general contractors and construction managers to their views on BIM-enabled masonry construction.
4. Meet with mason contractors at previously-established venues (MCAA, IMI, TMS meetings and others).
5. Prepared detailed "scenarios of use" in the areas of safety, planning, material procurement, quantity take off, cost estimating, wall bracing, etc. that can be used to gage the potential for BIM implementation in these areas.
6. Present these "scenarios of use" to mason contractors and validate/revise.
7. Prepare detailed report for use by the initiative and by mason contractors. Make recommendations for subsequent project on Masonry Construction Workflows.
8. Develop an educational program of courses, seminars, and webinars to introduce the BIM concept to masons and contractors. Before there is BIM-M software for masons, the masonry industry must prepare and be technologically trained to use digital tools.

Project Participants
The majority of this project will be led by the masonry industry through the working groups with interaction by DBL or another BIM-M lead contractor. The education aspect of the project will be developed through an invited RFP process with individuals and educational institutions. The major masonry organizations will implement training developed as part of this project.

THE PROJECTS SPECIFIC TO PHASE III INCLUDE:

5. BIM-M Software Specification (Part 1) – Phase III
This project will kick-off Phase III of the BIM-M initiative. In this project, the Georgia Tech DBL will synthesize the results of the Phase II project and will create a written software specification for masonry BIM. The software specification will be shared with key software vendors and stakeholders in the AEC industry for their review and comment. The specification will detail masonry wall functionality within BIM from the architectural, structural, energy and contractor viewpoints and will illustrate the data structures necessary to represent masonry construction with the detail required to support the proposed BIM-M functionality.

The specification will show how BIM for masonry will import and use digital masonry units defined in Phase II, and will build on and formalize the masonry wall definitions also established in Phase II. BIM software vendors will be asked to identify areas where they will, at no cost to the industry, adapt their software to meet the requirements of BIM-M and to identify areas where the masonry industry will need to collaborate and fund masonry-specific extensions to BIM software.

6. Structural Engineering and BIM-M – Phase III
In a conventional design workflow, structural engineers take building data in the form of plans and elevations from the architect, and assess the initial architectural design ideas for gravity and lateral loads. The engineer uses manual or computational analysis to design the walls, and returns information to the architect on the extent of walls (for in-plane and out-of-plane loads), reinforcing requirements, control joint locations, etc. In a BIM-enabled masonry workflow, structural engineers will receive a BIM model from the architects with potential wall locations identified. Structural engineers will be able to select walls that are to be load bearing (for gravity loads), resistant for lateral loads (shear walls) and non load-bearing walls.

This project will establish the workflow for BIM integration between architects and structural engineers. The information exchanges needed to transfer wall information from the architect to the structural engineer and from structural engineering BIM directly to structural analysis will be established. This project will build on the previous Masonry Wall Model Definition project. It is anticipated that the BIM-M Executive Committee and the DBL will develop an RFP for this project, and that the project will be bid to interested parties in the educational and software development community. The project will build on prior work sponsored by the IMI and NCMA to implement masonry wall structural analysis software in Bentley RAM. The project will also survey existing stand-alone masonry wall software to assess its potential interactivity with BIM-M.

7. BIM-M Construction Workflows – Phase III

This Phase III project will follow from the Mason Contractor Input from Phase II. In this project, formal construction workflows for the use of BIM-M will be formulated and shared with the mason contractors. In this context, a workflow is a flowchart that documents the structure, format, and flow of information from the moment it arrives to the mason contractor (from the general contractor or construction manager) all the way through the masonry construction process. The workflows will detail how the BIM-M software will be implemented with mason contractors, and how BIM authoring platforms will be queried for use with other software systems that utilize BIM data (clash detection, project planning, cost estimation, and wall bracing, as examples). The workflows will act as a formal mediator between the mason contractor and the software vendors, that is, mason contractors will agree that their practices are properly depicted in the workflows and that they consume and produce information in the manner described in these workflows, and the software vendors will agree to structure and process the BIM information in the manner depicted in the workflows.

The intent is to ensure that mason contractors are comfortable with the information flows that are to be implemented in BIM-M and to ensure software vendors that mason contractors are aware of the ways that the BIM-M software will produce and use masonry-specific data. The Executive Committee and the DBL will establish an RFP for this project, with the workflows to be delivered in a detailed format for use by the software vendors as they implement masonry BIM for mason contractors.

THE PROJECTS SPECIFIC TO PHASE IV INCLUDE:

8. BIM-M Software Specification (Part 2) – Phase IV

This project will kick-off Phase IV of the masonry BIM initiative – and will continue to manage the relationship between the BIM-M initiative and software vendors. At this point, it is included as an umbrella project for the continued participation in the BIM-M project by the Georgia Tech Digital Building Laboratory. The project will assess areas where BIM-M is meeting the goals set forth in the software specification and focus resources in underdeveloped areas. It will also document BIM-M and see to its implementation as part of the National BIM Standard. It will develop an industry structure for ongoing maintenance of BIM-M in the out years, at the end of Phase IV. This project will reflect back on the entire BIM-M roadmap, identifying areas where the goals of the initiative have been met, and areas for future development.

9. BIM-M: Design Phase to Construction Phase – Phase IV

This project will document and formalize the transition of a BIM model from a masonry "design" BIM model, used primarily by architects and engineers during the contract document phases of a project, to a "construction" model that is used by general and mason contractors, and construction managers during the construction phase. This project is expected to benefit from an industry-wide effort to establish multiple levels of BIM information that become more and more detailed as a given project progresses. These levels of BIM specificity are outlined in the current American Institute of Architects (AIA) E202-2008, BIM Protocol – but as yet do not contain references to the details of masonry construction. The project will focus on specific needs for masonry BIM that such as automated production of shop drawings, production of fabrication drawings for cut and cast stone, etc.

10. BIM-M Contractor Training – Phase IV

This project will follow from the BIM-M Contractor Input project in Phases II and III of the initiative. At this point in time, we anticipate that the BIM-M software will be becoming commercially available and that mason contractors are on the way towards integrating BIM software tools into their construction practices as a standard operating procedure. This project will develop training courses and webinars to assist contractors in deploying BIM-M. The training courses will demonstrate how BIM interacts with specialized software used by mason contractors and how it is used in typical mason contractor tasks such as quantity take-off, cost estimating, procurement, and project scheduling. The training will have a specific components for office staff (estimators, detailers), for field superintendents, for project managers, and for masons.

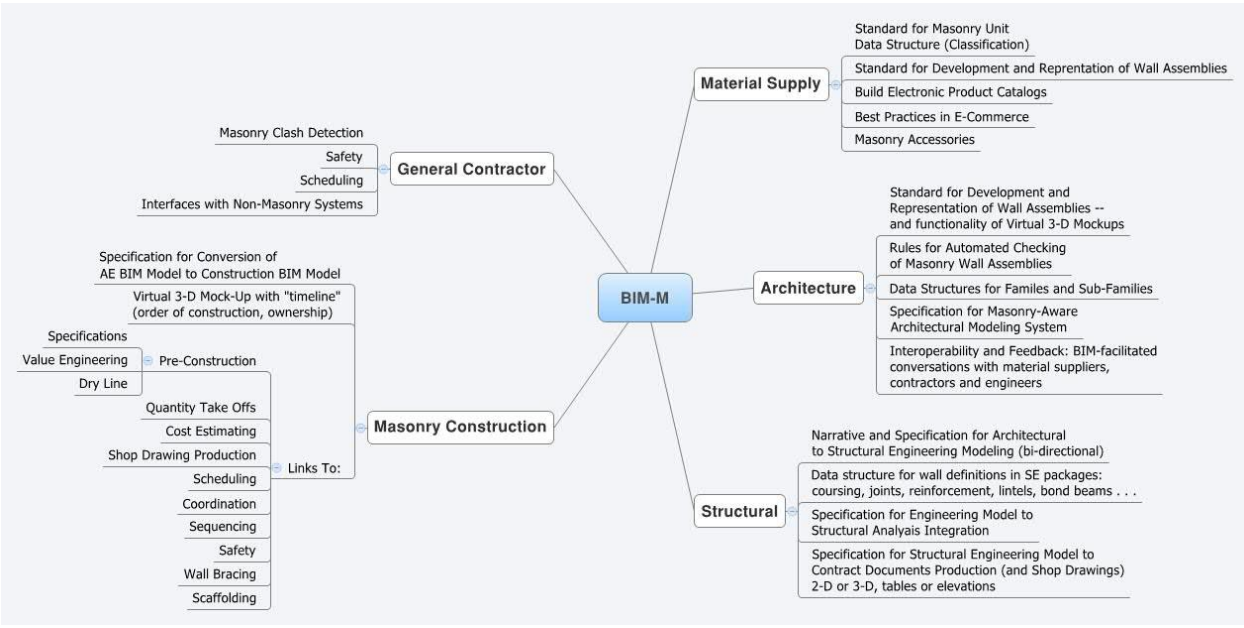
11. Early-Stage Masonry Architectural Design – Phase IV

The early development of BIM for masonry in Phases II and III of the initiative will focus on the modeling and representation of the most widely used masonry units and systems. This makes the most sense as it will dictate that the earliest releases of BIM-M will have the greatest impact on the industry. One important goal of the initiative is to serve innovation in design in masonry, and BIM tools that support design innovation need to be developed. This proposed final project in the BIM-M initiative will close the loop, circling back to the needs of architects as they propose creative use of masonry, including the use of custom masonry units, non-planar walls, new types of load-bearing masonry, prefabricated masonry systems, etc. This project will develop strategies for parametric modeling of masonry in complex building forms, and will develop rules for integrated rules for the transition of complex form-making models, used by architects in the early stages of design, into BIM-M models. The project will also extend BIM-M wall rules, developed in Project 3 (Phase II) to work with novel ideas for masonry construction. The project will advance the ties between BIM-M and existing detail libraries provided by masonry industry associations, and will describe the functionality of tools for preliminary analysis of masonry for energy use, quantity take-offs, clash-detection, cost, etc.

Appendix 1:
Workgroup Process

In Phase I, the initiative formed 5 working groups to consider the five distinct stakeholder perspectives in the design and construction process: architecture, structural engineering, general contracting, masonry contracting, and material supply. An initial survey of workgroup members, tailored to their stakeholder viewpoints, was distributed in June 2012 (results attached in Appendix 2). The workgroups met in Atlanta in early September 2012 to identify challenges in masonry design and construction and to develop a vision for and specific steps towards the development of masonry BIM. The challenge of and work products from each of the workgroups to date is described below. At this point, it is not clear that the workgroups will be charged with formal tasks in the work to come. Nevertheless, workgroup members will certainly be asked to continue as consultants so the BIM-M project – as described in the project proposals, presented earlier in this document.

In the figure below, the aspects of BIM expressed by workgroup members are captured and discussed further in the text below. In some instances the aspect expresses a desire that a given stakeholder group perceives as a benefit from a BIM-enabled masonry industry. In other instances, the aspect represents a contribution that the given stakeholder group must make in order to enable masonry BIM for the industry. The viewpoints are described as a broad narrative at this point, but as they are refined they will speak directly to the model view definitions (MVDs), BIM workflows, and data requirements for each masonry BIM viewpoint.



Key Aspects of Masonry BIM Identified by Workgroups

1. Architectural Modeling Workgroup – Maria Viteri, IMI, Lead

Tristan Al-Haddad, GT School of Architecture
Steve Georgalis, 5G Studio Collaborative
Bill Davis, THW Design
Todd Zima, Studio Gang Architects
Chad Stacy, Perkins and Will Architects
Karen Gravel, LAS Architects
Scott Conwell, International Masonry Institute
Shannon Perry, Interstate Brick

The Architectural Modeling workgroup focused on the early stages of design, and considered how masonry systems are represented in parametric modeling, CAD, and BIM applications. The AMWG will explored current digital tools work with masonry in all its forms and how current and future tools assist with typical masonry design issues: backup systems, bonding patterns, coursing, openings, corners, lintels etc. The AMWG provided best-practice examples of modeling in new "flagship" buildings as well as for buildings designed as part of everyday practice. The AMWG discussed how building product models, electronic details, and masonry libraries might be integrated into BIM-M. The workgroup also touched on the need to develop masonry BIM for existing and historic buildings, and for maintenance and retrofit and preservation projects.

The architect desires tools to quickly map masonry units and systems onto building forms, and to be able to manipulate these forms without having to re-generate the masonry. Architects want BIM systems to recognize the module on which a given masonry system acts and to guide in the dimensioning of walls and the placement of openings to conform to the masonry system. They want access to preliminary takeoffs and cost-estimates (initial and life cycle) to understand the practical implications of their design decisions. Architects are concerned with building enclosure and envelope; including the sealing for air, temperature, water and vapor; and desire that details regarding masonry reinforcing, support, ties, and sealing are included in the BIM families published by the masonry industry for their materials and systems. For novel and complex buildings, architects wants a BIM system that supports flexible parametric modeling that allow for representing novel forms of masonry.

2. Structural Modeling Workgroup – Tomas Amor, Target Corporation, Lead

Ross Shepherd, Ryan-Biggs Associates
David Biggs, Biggs Consulting Engineers
Amy Sellers, PES Structural Engineers
Brian Johnson, Autodesk
Chad Boyea, PES Structural Engineers
Craig McKee, Huckabee and Associates
Jeff Elder, Interstate Brick
John Hochwalt, KPFF Structural Engineers
Jason Jones, PES Structural Engineers
Todd Dailey, Dailey Engineering
Jamie Davis, Ryan Biggs Associates

The Structural Modeling workgroup focused on the interoperability between architectural CAD models, structural CAD models, and structural analysis – and the needs for advanced computational tools to support structural masonry analysis and design. The SMWG considered the functionality and interoperability of current structural tools for masonry, and provided a roadmap for improved software capabilities. The workgroup considered the integration of standard details and prescriptive design rules and recommendations from TMS, NCMA, WSCPA, and BIA technical notes, along with the provisions of the TMS 402 into BIM-M. The SMWG considered the representational requirements for lintels, anchors and ties, reinforcing and other aspects of structural masonry.

The structural engineer desires to closer integration with the digital tools that architects use, including the ability to share digital information bi-directionally with architects using BIM tools. The structural engineer needs to identify walls that are load-bearing and non load-bearing, and to further identify walls that are acting as part of the lateral load resisting system. The structural engineer desires to have these wall identification steps operate within BIM, to preserve the dialog with the architect during early stage structural design. In addition, masonry BIM should be linked with structural analysis software, to provide feedback on the efficacy of structural configurations. Finally, as designs mature, the structural engineer needs to have BIM-enabled tools for generating reinforcing plans and details (including movement joints) for reinforced masonry walls, as well as coordinating masonry details to the structural BIM model.

3. Construction Management Workgroup – Art Theusch, Collaborative Construction Group. Lead

Michael Hasamoh, Holder Construction	Ron Bennett, E&S Masonry
Ed Davenport, Davenport Masonry	John Haymaker, GT School of Construction
Chuck Eastman, GT School of Architecture	Austin Norberg, Seedorff Masonry
Keith Sommer, Pyramid Masonry	Dan Zechmeister, Masonry Institute of Michigan
Dave Sovinski, International Masonry Institute	Michael DeLange, George W. Auch Company

The Construction Management workgroup focused on issues of importance to general contractors and construction managers and their relationship to and coordination with mason contractors, the owner, and the design team. These issues include procurement, project scheduling, clash detection, coordination of waterproofing, safety, etc. The CMWG focused on the transition of BIM-design models to fully-authored BIM-construction models and on the integration of masonry information into these models.

Sophisticated general contractors (GCs) are pushing their subcontractors to embrace BIM technology. In many cases, general contractors are creating complex 3-D models of masonry buildings, in the absence of mason contractors' ability to do so. Contractors desire to have masonry construction fully embedded in BIM, so that BIM tools for interference checking, 4-D simulation and project scheduling can interact with masonry in a reliable manner.

4. Construction Activities Workgroup – Darrell McMillian, TMS, MISL, Lead

Jeff Buczkiewicz, MCAA	Daniel Castro, GT School of Construction
John Chrysler, Masonry Institute of America	Matthew Jollay, Jollay Masonry
Mark Goldberg, Tradesmen's Software	Greig Carnevale, Davenport Masonry
Heath Holdaway, IMS Masonry	Bill Pacetti, Jr., Tradesmen's Software
Eric Winters, SmartBIM	Laura Florez, GT School of Construction
Francisco Valdes, GT School of Architecture	Kelly Shrum, John J. Smith Masonry Company
Jerry Painter, Painter Masonry	Buddie Barnes, Dee Brown Inc.

The Construction Activities workgroup focused on BIM applications that aid specific tasks associated with mason contractors, craftworkers and their processes: cost estimating, detailing, shop drawing production, scaffolding staging and erection, material procurement and placement, geometric placement of masonry units, etc. The CAWG discussed future needs for jobsite automation and material handling that will be driven by BIM models. The CAWG explored BIM-enabled methods of coordinating between mason contractors and material suppliers.

Of all of the stakeholder groups, only the mason contractor (and the staff and masons he employs) are dependent on masonry as their livelihood. And so from this point of view, the mason contractor stands to gain the most from masonry BIM. The processes involved in planning, procuring, scheduling and executing masonry construction will all benefit from working from a rich (masonry aware) and common (available to all applications) knowledge repository. In the surveys completed as part of this research, both general and mason contractors identified project scheduling and clash detection as two of the highest priorities for masonry BIM. In addition to these two activities, mason contractors identified quantity take-off, cost estimating, scaffolding design, and wall bracing design as high priorities for masonry BIM. Mason contractors will have to support the BIM development by providing access to their internal processes and ways of doing business. When masonry BIM becomes a reality, contractors will have to commit to educating their staffs and implementing BIM workflows.

5. Material Suppliers Workgroup – Tyler Witthuhn, NCMA, Lead

Russell Gentry, GT School of Architecture
Kevin Torok, Oldcastle Masonry
Don Strange, Interstate Brick
Brian Trimble, Brick Industry Association
Andres Cavieres, GT School of Architecture
Chad Pyles, Block USA
Kurt Siggard, Concrete Masonry Association of California and Nevada

The Materials Suppliers workgroup focused on the masonry materials supply chain and on the ways that BIM might streamline the purchasing, handling, and shipping of masonry materials. The MSWG will identify means for classifying masonry units, and will identify attributes of masonry units and accessories that should be represented in a BIM-aware classification system. The MSWG identified goals for representing their products in electronic technical notes that can be directly loaded into BIM systems as units and as complete wall systems. The MSWG is coordinating with the Construction Activities workgroup to explore ways of using building information in masonry materials procurement and just-in-time delivery.

The masonry material supplier desires a closer connection to the clients that specify (architects and engineers) and purchase (building owners) their products. In order to achieve masonry BIM, the suppliers will be required to collaborate in and contribute to the development of a common electronic data structure for masonry units. They will need to support the development of electronic versions of the technical notes and industry-standard details that are currently in widespread use by masonry designers. The material suppliers stand to benefit from tighter integration of BIM and the masonry supply chain. This may allow for better prediction of masonry unit consumption, and the integration of e-commerce concepts through which mason contractors can automate the ordering and delivery of masonry units and accessories.

APPENDIX 2:
BIM GLOSSARY

AEC: Architecture/Engineering/Construction.

Building Information Modeling: The process of creating 3-D models linked to extensive information about the materials and components being used.

Building Information Model (or often just Building Model): A model (or often many models) that describe the geometry and other data regarding a building. Some BIM models are schematic, for planning purposes, and others are highly detailed (for construction purposes).

Workflow: A flowchart and narrative that describes how actors in an AEC process work, the digital tools they use, the information that they require to complete tasks, and the information they produce for downstream users. A standardized workflow can be described by a process model, and documented in BPMN.

Schema/Data Structures: The underlying computer database representation of building objects (geometry and other properties) and the relationships between these objects.

Interoperability: The ability of multiple software platforms to trade information back and forth, preserving the validity of the data.

Industry Foundation Classes (IFCs): An open, non-proprietary data model used to represent building objects. Used to transfer BIM objects between software platforms.

Parametric Modeling: Using rules to define the geometry of and relationships between building objects, so that multiple objects can be generated from a parent object, or so that models can adjust/react automatically to changes in geometry.

Scripting: Defining rules and macros/scripts/code to propagate and permute objects within a CAD system or to automate some task in a computational environment.

3-D Modeling: The representation of objects with full geometric description, instead of the traditional plan/section/elevation of paper drawings and 2-D CAD. These traditional drawings can be generated as "views" of the 3-D model.

Software Specification: Flowcharts, narratives and diagrams that describe how a piece of software is intended to function, what its inputs and outputs will be, a description of the user interface and of the data structure used by the software.

Families: Groups of pre-defined building objects arranged according to given construction practices, which can be applied to 3-D models as part of the design process. A masonry wall family might contain concrete block with brick veneer, the proper ties for the cavity wall, and the

lintels used to carry the brick and block across door and window openings. When this family is applied to a given surface in a BIM authoring tool, the proper masonry units, coursing, and details are established in the BIM model.

Virtual Mock-Up: A very highly detailed 3-D model. These models are detailed that they can be used for photorealistic renderings, construction simulation, analysis of tolerances, advanced thermal and moisture finite element analysis, etc. In general, the density of the information in the virtual mock-up is so high, that it is not possible to represent an entire building with this level of detail.

Virtual Design and Construction: The use of BIM and related technologies to inject a 4th dimension (time) and often a 5th dimension (cost) into complex building models.

Digital Product Model: A model of a product or system that includes both geometric information (a 3-D model) as well as non-geometric data such as specifications, material properties, chain of custody, environmental product declarations, etc.

BPMN: Building Process Modeling Notation. A formal and structured approach to constructing and documenting workflows.

Solid Models: CAD models that represent objects as Boolean solids: a collection of geometric features that is added and removed to create the final part. With solid models it is possible to assign material properties and to the solids and then create queries to determine weight, quantities, etc.

Wireframe: 3-D geometry that is represented in a computationally lightweight manner, with only the outer boundaries and major interior features (for example, door and window openings) shown.

Model View Definition: a subset of the BIM model as represented in IFCs, generated with a specific application in mind, for example: cost estimating or building thermal analysis.

APPENDIX 3:

WHITE PAPER ON DEVELOPMENT OF BIM AND THE BIM FOR MASONRY INITIATIVE

This paper has submitted as a draft for presentation at the 2013 Canadian Masonry Symposium and is included per the copyright policies associated with that conference. It is provided as a background on the development of BIM and the BIM for masonry initiative.

DEVELOPING A ROADMAP FOR BIM IN MASONRY: A NATIONAL INITIATIVE IN THE UNITED STATES

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ABSTRACT
Building Information Modeling (BIM) provides a unifying framework for building design, analysis, and construction. The BIM model provides a digital representation of the building, so that the modeling and analysis tools used by architects, engineers, constructors, managers and owners can read from and write to the same information source. Over the last 20 years, the development of material-specific BIM tools has been led by the structural steel and precast-concrete industries, and recent efforts are advancing the state of the art in cast-in-place concrete. This paper reports on a national initiative in the United States to develop BIM requirements for masonry. The National Building Information Modeling for Masonry Initiative (BIM-M) is developing a roadmap for BIM development in five key areas: architectural parametric modeling, structural modeling and analysis, masonry construction activities, construction management, and masonry materials provision. The paper will introduce the overall initiative, present the roadmap for BIM for masonry, and will highlight key advancements in each of the five areas.

KEYWORDS: building information modeling BIM

INTRODUCTION
BIM is an acronym that stands for an object, a "building information model" and also a process for creating and using that object "building information modeling". According to the National Institute for Building Sciences, a building information model "*is a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward.*"[1, 2] In this context, the proposed parallel definition for masonry BIM is *a digital representation of the physical and functional characteristics of masonry materials and systems*.

This paper introduces an initiative by the North American masonry industry to bring masonry materials and systems into BIM. Through a process of precedent research, stakeholder input, building case studies and software evaluation, the effort is defining the requirements for masonry BIM. The initiative is sponsored by the International Union of Bricklayers and Allied

Craftworkers (IUBAC), the Mason Contractors Association of America (MCAA), the International Masonry Institute (IMI), the National Concrete Masonry Association (NCMA), the Western States Clay Products Association (WSCPA) and The Masonry Society (TMS) and is being overseen by the Digital Building Laboratory at the Georgia Institute of Technology. The initiative is focusing on both aspects of BIM, the development of the digital representation of masonry units, products and buildings; and on the development of the business processes and workflows that will implement masonry BIM.

DEVELOPMENT OF BIM

The term BIM arose in or around the year 2000, but the fundamental work supporting the development of building product models and the use of information technology in the AEC industry has been ongoing since the mid 1980's [3]. It is beyond the scope of this work to track the historical development of BIM, but a number of important efforts that will impact the development of masonry BIM are described here. The International Alliance for Interoperability (IAI) formed in 1994 to bring information technology to the construction industry. The IAI promulgated open standards for building data models, and introduced a data standard known as Industry Foundation Classes (or IFCs) in 1996 and 1997 [4, 5]. The IAI is now known as buildingSMART and is represented in the United States by the buildingSMARTalliance (under the auspices of the National Institute of Building Sciences) and in Canada as buildingSMARTCanada (under the auspices of the Institute for BIM in Canada or IBC).

In the commercial software world, the transition from the creation of 2-D "flat" CAD drawings to the creation of full 3-D computer models took place first in the mechanical engineering, automotive, and aerospace industries with the development of parametric modeling software such as Pro/E (Parametric Technology Corporation) and CATIA (Daussault Systems). In parametric modeling systems, both the geometry of the objects, and the relationships of the objects to one another are captured. In parametric CAD systems, the concept of pre-defined, permutable parametric objects (i.e., classes, families) allow for the rapid creation of design geometry. These objects are linked to data that describe non-geometric aspects of the objects, for example material properties, supplier information, and specifications. The linking of geometric- and non-geometric data allows the parametric modeling software to integrate with engineering and manufacturing analysis applications such as quantity estimating and finite element analysis.

The Architecture, Engineering, and Construction (AEC) industry followed these precedents with the inclusion of 3-D aspects in CAD programs such as AutoCad (AutoDesk) and Microstation (Bentley), but these platforms did not support the data structures necessary for BIM. Current BIM software such as Revit (AutoDesk), BentleyBIM (Bentley), Digital Project (Gehry Technologies), and Tekla Structures (Tekla) support to varying degrees the parametric geometry and meta-data requirements necessary to create and share BIM models. All of these softwares have internal, proprietary data structures, and thus the sharing of information between BIM platforms and specialized software used in engineering analysis and construction management is limited. The OpenBIM concept being promoted by buildingSMART is pushing the industry to a more widespread use of IFCs, in support of better interoperability between BIM applications [6].

In addition to BIM software, much work has gone into understanding BIM processes, that is, the means through which the BIM software and data models will be used in practice by a wide range of stakeholders in the AEC industry. When a given building project is under design, a design-

phase or BIM authoring tool is of primary interest, and the focus is on design activities by the architect and engineering consultants: structural, mechanical, electrical etc. The American Institute of Architects (AIA) has developed a guide for implementing BIM in the design phase, and determining the level of detail to be included in the final BIM deliverable [7]. In the construction phase, a more detailed BIM model may be generated to take the place of traditional shop drawings or to drive fabrication processes. In addition, this construction-phase BIM model can be used by the general and sub-contractors for cost estimating, project scheduling, clash detection, etc. The BIM Project Execution Guide describes procedures for implementing BIM during the construction phase of a project [8]. A comprehensive report by McGraw Hill captured the value of BIM to stakeholders throughout the process, from design through construction, and provided a business case for BIM implementation in the AEC industry [9].

RELATED EFFORTS IN NON-MASONRY CONSTRUCTION SYSTEMS

One of the first efforts to develop digital data for a construction material system took place in the structural steel industry, beginning in the early 1990's. The CIS (CIMSteel Integration Standard) project from the Steel Construction Institute of the United Kingdom formed the basis for the American Institute of Steel Construction (AISC) computer database of structural steel shapes that is in use today [10]. Eastman and colleagues showed how the use of the structural steel data model could be integrated into BIM platforms and processes [11]. The efforts in bringing structural steel into BIM have been highly successful and the steel detailing software used for shop drawing production in the steel industry today rely on the construction of full 3-D parametric BIM models of structural steel in buildings. Work on the automation of design and detailing processes in structural steel is ongoing, with a focus on the transition of computer representations of steel elements and connections into IFCs [12].

Another important example for masonry BIM is the 10-year effort sponsored by the Precast Concrete Consortium / Precast/Prestressed Concrete Institute (PCI) and the Charles Pankow Foundation, to develop BIM requirements for load-bearing precast concrete buildings and for precast concrete cladding on non-precast buildings. These efforts were led by Chuck Eastman at Georgia Tech. The precast concrete BIM effort included an initial planning effort and roadmap, first published in 2003 [13]. As the work progressed, the research team led an industry-wide effort to develop parametric models for precast concrete elements [14], and to implement these elements in commercial BIM software (Tekla Structures and StructureWorks). More recent work is developing requirements for exchanges between design-level BIM authoring software, structural analysis, and construction and fabrication modeling software [15]. Real-time exchanges of BIM information among various software platforms were recently demonstrated at the US national PCI Convention in October 2012.

TECHNICAL CHALLENGES OF MASONRY BIM

The structural steel and precast concrete examples provide powerful guidance for the process that should be followed in the development of masonry BIM. The technical challenges to developing masonry BIM will however be different than those faced by the steel and precast industries. Because BIM is a digital representation of design and construction, and because masonry is a significantly different construction system relative to structural steel and precast concrete, it follows that many of the data requirements for masonry BIM will be unique. In the section below, specific challenges to the underlying information technology for masonry BIM

are highlighted. These are examples only will be greatly expanded upon and will form the basis for the masonry BIM specification, to be developed in the next phase of this research.

Multitude and complexity of masonry types: Both concrete and clay masonry units are available in a wide range of sizes, many with complex geometry. Though there are common sizes and configurations of clay and concrete masonry units available [16, 17], there is also an extended range of masonry units that are frequently used that have not been standardized [18]. And, in many instances, such as in the cut and cast stone industries, the masonry units may be made custom for the specific job. The use of custom units occurs often in brick masonry. As an example, in Frank Lloyd Wright's Johnson Wax Building, over 200 curved brick types were used [19]. In a more recent example by architects Mack Scogin and Merrill Elam, a family of custom bricks was developed for the new Yale Health Services Building [20].

Lack of a digital standard for representation of masonry units: The wide range of standard units must be instantiated in a computer data structure that is standardized across the masonry industry. This data structure must be capable of representing geometric attributes of the masonry, as well as meta-data regarding the strength and other non-geometric attributes. To facilitate photorealistic rendering of masonry construction using these units, the data structure should also include bitmaps that can be applied to the surface during rendering. An interface to this data structure, which will allow for the creation of custom units, must also be developed.

Requirements for modulation and aggregation of individual units into assemblies: Currently, it is simply not computationally practical (or even possible) for masonry BIM software to track individual masonry units in an entire building. Therefore the masonry BIM data structure must include the definition of wall types, and means to map these wall types onto regular and irregular regions on wall surfaces. The walls must be represented in at least three different modes: regions without populated masonry units (wireframe), regions with masonry units as 2-D polygons, and full 3-D photorealistic rending with masonry units modeled as solids. In addition, the wall definition must include the propagation of masonry units in various bonding pattern with modular coordination of masonry veneer and backup systems. The current version of Revit (AutoDesk) provides some aspects of this envisioned functionality.

Structural and construction definitions or viewpoints of masonry walls: Current BIM authoring tools do not differentiate between load-bearing and non loading-bearing masonry walls, and thus the transfer of architectural wall definitions to the structural engineer, and the subsequent analyses of these walls for gravity and lateral forces is not facilitated as it should be in a BIM-driven process. This functionality does exist in other material systems. In addition, the BIM data structures do not support walls being subdivided into meaningful production increments (such as the work of one masonry crew on a wall for a day or a week) so it is difficult to use the construction BIM model as a planning resource for masonry. To support alternative views of a given object, by extracting that information necessary from the given user's viewpoint, is known as a Model View Definition or MVD. As part of the masonry BIM initiative, these MVDs will be developed, along the lines of those developed for the precast concrete industry [21].

EARLY DEVELOPMENT EFFORTS IN MASONRY BIM

Though there has been no previous coordinated industry-wide effort to bring masonry into BIM, there are a number of research and software implementation efforts that are related to and

support the new industry-wide masonry BIM effort. These efforts can be categorized into one of the following areas:

1. Efforts to embed masonry objects in current BIM platforms.
2. Integration of masonry into BIM-related AEC software.
3. Parametric modeling of masonry systems and buildings
4. Data structures for representing masonry in BIM platforms.

Most of the major suppliers of brick in the United States have developed masonry families[1] for their brick, which can be imported into the Revit BIM application. This allows for Revit to display the proper brick coursing and to roughly estimate the number of bricks that are contained within a given rectangular region containing this brick. At this time however, the brick families do not contain any detailing information, no coursework coordination between brick and backup systems, etc.

In the structural domain, the masonry industry in North America supported an effort to integrate structural masonry materials into structural analysis software (Bentley Ram) [22] supporting earlier work by Biggs on hybrid steel/masonry structures [23]. Whiting et al. have developed structural modeling techniques for complex masonry structures, and briefly describe the representational requirements to transfer architectural information for complex load bearing structures into structural analysis programs [24]. Gentry et al. have also described a process by which structural analysis can be tied to architectural parametric modeling [25].

Recent work by Cavieres et al. have introduced the potential for embedding masonry as fully parametric objects in a BIM system [26]. An experimental prototype of this software was developed using Generative Components and Microstation (Bentley). The software was demonstrated at the NCMA Annual meeting in 2010, and a group of apprentice masons constructed a wall with information extracted from the BIM model [27]. Along similar lines, Monteiro et al. discuss data structures for representation of masonry patterns within BIM systems [28]. The authors discuss rules for horizontal and vertical propagation of masonry, and the relationship between the propagated wall masonry elements and other building elements such as floor plates and pilasters. The modularity of masonry is discussed, along the lines of the now withdrawn ASTM standard on block/brick masonry modularity [29]. Nawari proposed an initial view of the way that masonry walls might be represented in IFCs [30].

MASONRY BIM FROM THE STAKEHOLDERS VIEWPOINT

The national initiative began with an initial survey and follow-on symposium at Georgia Tech, held in September 2012, to gather input from stakeholder groups. Around 50 stakeholders from the AEC industry and from the masonry industry sponsors met for two days in general sessions and separately in five workgroups to provide input to the project team. These stakeholder workgroups were focused on the specific viewpoints of material suppliers, architects, structural engineers, general contractors, and masonry contractors. Key aspects of masonry BIM as voiced by each workgroup are shown in Figure 1 and discussed in brief in the text below. In some instances the aspect expresses a desire that a given stakeholder group perceives as a benefit from

[1] A family is a pre-defined arrangement of elements in a parametric model. The family includes rules that allow the family to adapt to specific dimensional requirements when it is applied to a given building. In the context of Revit and masonry, it includes masonry units represented as surface of rectangles in a given bonding pattern.

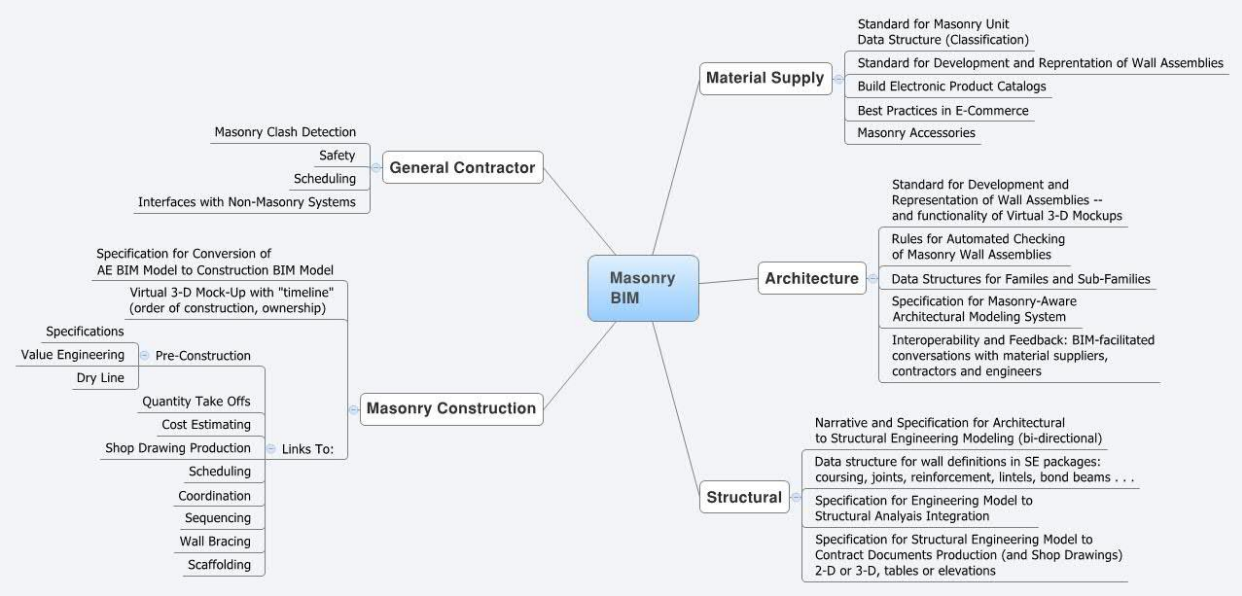

Figure 1: Key Aspects of Masonry BIM by Stakeholder Group

a BIM-enabled masonry industry. In other instances, the aspect represents a contribution that the given stakeholder group must make in order to enable masonry BIM. The viewpoints are described as a broad narrative at this point, but as they are refined they will speak directly to the model view definitions (MVDs), BIM workflows, and data requirements for each masonry BIM viewpoint.

MATERIAL SUPPLIER VIEWPOINT

The masonry material supplier desires a closer connection to the clients that specify (architects and engineers) and purchase (building owners) their products. In order to achieve masonry BIM, the suppliers will be required to collaborate in and contribute to the development of a common electronic data structure for masonry units. They will need to support the development of electronic versions of the technical notes and industry-standard details that are currently in widespread use by masonry designers. The material suppliers stand to benefit from tighter integration of BIM and the masonry supply chain. This may allow for better prediction of masonry unit consumption, and the integration of e-commerce concepts through which masonry contractors can automate the ordering and delivery of masonry units and accessories.

ARCHITECTURE VIEWPOINT

The architect desires tools to quickly map masonry units and systems onto building forms, and to be able to manipulate these forms without having to re-generate the masonry. Architects want BIM systems to recognize the module on which a given masonry system acts and to guide in the dimensioning of walls and the placement of openings to conform to the masonry system. They want access to preliminary takeoffs and cost-estimates to understand the practical implications of their design decisions. Architects are concerned with building enclosure and waterproofing, and desire that details regarding masonry reinforcing, support, ties, and sealing are included in the BIM families published by the masonry industry for their materials and systems. For novel and

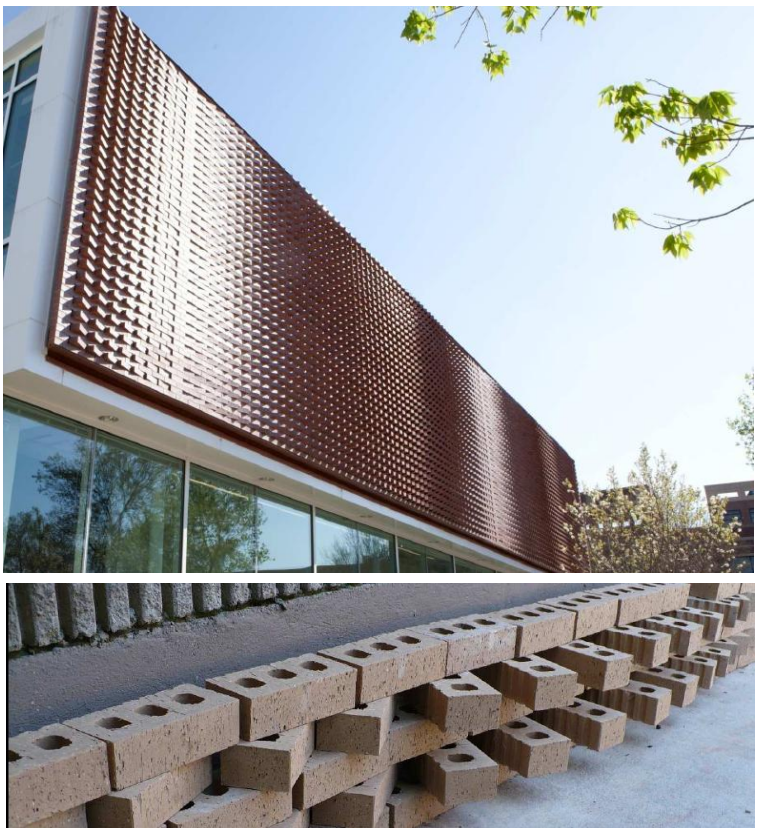

Figure 2: Parametric modeling requirements for complex masonry walls: Southern Polytechnic State University, Design Studio II, Marietta, Georgia by Cooper Carry Architects.

complex buildings, architects wants a BIM system that supports flexible parametric modeling that allow for representing novel forms of masonry (Figure 2).

STRUCTURAL ENGINEER VIEWPOINT

The structural engineer desires to closer integration with the digital tools that architects use, including the ability to share digital information bi-directionally with architects using BIM tools.[2] The structural engineer needs to identify walls that are load-bearing and non load-bearing, and to further identify walls that are acting as part of the lateral load resisting system. The structural engineer desires to have these wall identification steps operate within BIM, to preserve the dialog with the architect during early stage structural design. In addition, structural BIM should be linked with structural analysis software, to provide feedback on the efficacy of structural configurations [31]. Finally, as designs mature, the structural engineer needs to have BIM-enabled tools for generating reinforcing plans for reinforced masonry walls, as well as coordinating masonry details in the structural BIM model.

[2] A uni-directional information flow in BIM indicates that the downstream user can convert and use information provided by the upstream user, but is not able to return updated information to the originator within the BIM process. Bi-directional information flows imply that the two users can collaborate within the BIM process. In masonry, collaboration between the architect and engineer is of critical importance, due to the nature of load-bearing masonry.

GENERAL CONTRACTOR VIEWPOINT

Sophisticated general contractors (GCs) are pushing their subcontractors to embrace BIM technology. In many cases, general contractors are creating complex models 3-D models of masonry buildings, in the absence of masonry contractors' ability to do so (see example from Mortenson Construction, Figure 3). Contractors desire to have masonry construction fully embedded in BIM, so that BIM tools for interference checking, 4-D simulation, and project scheduling can interact with masonry in a reliable manner.

MASONRY CONTRACTOR VIEWPOINT

Of all of the stakeholder groups, only the mason contractor (and the staff and masons he employs) are dependent on masonry as their livelihood. And so from this point of view, the mason contractor stands to gain the most from masonry BIM. The processes involved in planning, procuring, scheduling and executing masonry construction will all benefit from working from a rich (masonry aware) and common (available to all applications) knowledge repository. In the surveys completed as part of this research, both general and masonry contractors identified project scheduling and clash detection as two of the highest priorities for masonry BIM. In addition to these two activities, mason contractors identified quantity take-off, cost estimating, scaffolding design, and wall bracing design as high priorities for masonry BIM. Masonry contractors will have to support the BIM development by providing access to their internal processes and ways of doing business. When masonry BIM becomes a reality, contractors will have to commit to educating their staffs and implementing BIM workflows.

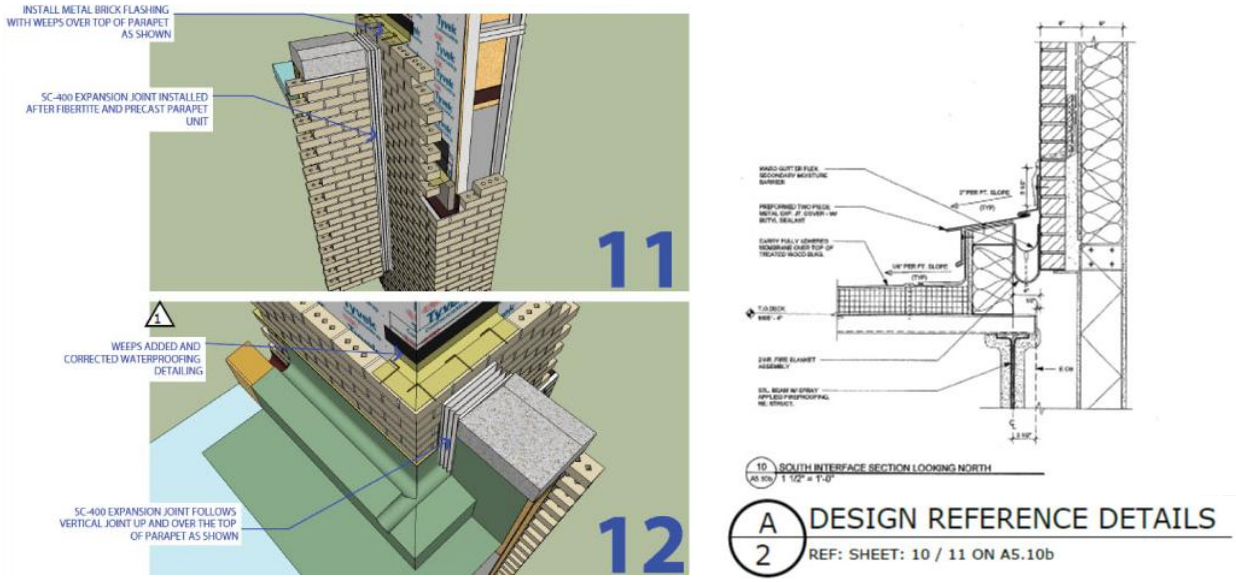

Figure 3: 3-D Virtual Mockups of Masonry Construction (courtesy Mortenson Contruction)

INSTITUTIONAL CHALLENGES TO MASONRY BIM

In addition to the technical challenges enumerated previously, the BIM-M initiative faces a number of institutional challenges beyond those faced by the precast concrete and structural steel industries. First, the stakeholders in the masonry industry are represented by a diverse set of institutions representing various and, in some matters, divergent interests. As a material system, masonry is a much more diverse and ubiquitous material as compared to steel and precast. Masonry encompasses many precursor material types (clay, concrete, natural stone, cast stone) and is widely used in both residential and commercial construction. Fortunately, the masonry industry recognizes that a commitment to BIM is important for all facets of the industry, and the initiative has garnered wide support from industry partners.

SUMMARY

BIM is an object, a building information model, as well as a process for creating and deploying that model. The National Building Information Modeling for Masonry Initiative (BIM-M) is developing a roadmap for BIM development in five key areas: architectural parametric modeling, structural modeling and analysis, masonry construction activities, construction management, and masonry materials. The project is following the examples set by the structural steel and precast-concrete industries. The major challenges to masonry BIM revolve around the complex and diverse nature of masonry, and the need to represent masonry construction in BIM systems in both compact (for computational efficiency) and highly detailed (to support virtual construction) manner to fulfill various stakeholder requirements. The masonry industry is clearly more diverse and diffuse than the precast concrete and structural steel industries, with a wider range of stakeholder groups. Success for the initiative will depend to a great degree on the willingness of the stakeholders to seek and support a common vision for masonry BIM.

ACKNOWLEDGEMENTS

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APPENDIX 4:

BIM-M STAKEHOLDERS SURVEY REPORTS

BIM-M: Architectural Modeling WorkGroup

SurveyMonkey

Though you may answer the survey anonymously, we prefer that you provide your name and email address:

		Response Percent	Response Count
Name		100.0%	7
Email		100.0%	7
	answered question		7
	skipped question		3

Page 1, Q1. Though you may answer the survey anonymously, we prefer that you provide your name and email address:

	Name	
1	Scott Conwell	Aug 20, 2012 2:50 PM
2	Shannon Perry	Aug 13, 2012 10:06 AM
3	Bill Davis	Aug 8, 2012 2:19 PM
4	Todd Zima	Aug 7, 2012 8:09 AM
5	tristan al-haddad	Aug 6, 2012 3:40 PM
6	Chad Stacy	Aug 6, 2012 1:24 PM
7	Russell Gentry	Jul 30, 2012 6:22 AM
	Email	
1	sconwell@imiweb.org	Aug 20, 2012 2:50 PM
2	shannon.perry@paccoast.com	Aug 13, 2012 10:06 AM
3	wmccdavis@gmail.com	Aug 8, 2012 2:19 PM
4	tzima@studiogang.net	Aug 7, 2012 8:09 AM
5	tristan.al-haddad@coa.gatech.edu	Aug 6, 2012 3:40 PM
6	chad.stacy@perkinswill.com	Aug 6, 2012 1:24 PM
7	russell.gentry@coa.gatech.edu	Jul 30, 2012 6:22 AM

BIM-M: Architectural Modeling WorkGroup

SurveyMonkey

Please tell us a little about yourself and your business. Which best describes your line of work:

		Response Percent	Response Count
Architect or designer		**66.7%**	**6**
Engineer		11.1%	1
Masonry Contractor		0.0%	0
General Contractor		0.0%	0
CAD/BIM draftsman		0.0%	0
CAD/BIM manager		0.0%	0
Material Supplier		11.1%	1
Masonry Industry Representative		11.1%	1
Software Provider or Programmer		0.0%	0
		Other (please specify)	2
		answered question	**9**
		skipped question	**1**

Page 1, Q2. Please tell us a little about yourself and your business. Which best describes your line of work:

1	non-practicing licensed architect	Aug 20, 2012 2:50 PM
2	Architect, LEED AP	Aug 13, 2012 10:06 AM

BIM-M: Architectural Modeling WorkGroup

SurveyMonkey

What is your role in the BIM-Masonry project? (select all that apply)

		Response Percent	Response Count
Workgroup member		**85.7%**	**6**
Executive board member		14.3%	1
AEC industry stakeholder		14.3%	1
	answered question		**7**
	skipped question		**3**

BIM-M: Architectural Modeling WorkGroup

SurveyMonkey

Do you personally use CAD or BIM tools?

		Response Percent	Response Count
Yes		**88.9%**	**8**
No		11.1%	1
		answered question	**9**
		skipped question	**1**

BIM-M: Architectural Modeling WorkGroup

SurveyMonkey

Do you manage users of CAD or BIM tools?

		Response Percent	Response Count
Yes		**66.7%**	**6**
No		33.3%	3
		answered question	**9**
		skipped question	**1**

BIM-M: Architectural Modeling WorkGroup

SurveyMonkey

What CAD software do you use in the architectural design of masonry buildings?

	Conceptual Design phase	Preliminary Design Phase	Design Development Phase	Detail Design Phase	Material Selection Phase	Final Design Phase	Load Bearing Buildings	Non-load Bearing Buildings	Response Count
SketchUp (Google)	**100.0% (2)**	**100.0% (2)**	50.0% (1)	50.0% (1)	**100.0% (2)**	50.0% (1)	50.0% (1)	50.0% (1)	2
AutoCAD (Autodesk)	**100.0% (2)**	**100.0% (2)**	**100.0% (2)**	**100.0% (2)**	**100.0% (2)**	**100.0% (2)**	0.0% (0)	50.0% (1)	2
Rhino (McNeel)	**100.0% (2)**	**100.0% (2)**	**100.0% (2)**	**100.0% (2)**	**100.0% (2)**	50.0% (1)	0.0% (0)	50.0% (1)	2
MicroStation (Bentley)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0
								Other (please specify)	2
								answered question	**4**
								skipped question	**6**

Page 2, Q1. What CAD software do you use in the architectural design of masonry buildings?

1	Autodesk Revit for DD thru CD, and CA.	Aug 8, 2012 2:32 PM
2	Revit	Aug 6, 2012 2:00 PM

BIM-M: Architectural Modeling WorkGroup

SurveyMonkey

What are the available BIM software that you use or could be used in the architectural design of masonry buildings?

	Conceptual Design phase	Preliminary Design Phase	Design Development Phase	Detail Design Phase	Material Selection Phase	Final Design Phase	Load Bearing Buildings	Non-load Bearing Buildings	Response Count
Revit architecture (Autodesk)	50.0% (2)	75.0% (3)	**100.0% (4)**	75.0% (3)	75.0% (3)	75.0% (3)	50.0% (2)	50.0% (2)	4
Bentley Architecture	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	1
Generative Components (Bentley)	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	1
ArchiCAD (Graphisoft)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0
Digital Project (Gehry Technologies)	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	1
Vectorworks	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0
								Other (please specify)	0
								answered question	**4**
								skipped question	**6**

BIM-M: Architectural Modeling WorkGroup

SurveyMonkey

What are design tasks within a masonry project that you find difficult to achieve with the current software? (general design tasks such as 1- selection, 2- generation / composition, 3- evaluation and 4-modification / exploration of alternatives)

	Response Percent	Response Count
Masonry Unit Selection	50.0%	2
Masonry Coursing and Dimensioning	25.0%	1
Modular Coordination	75.0%	3
Decorative Patterning such as Quoins, Ledges, Headers, Corbels, Projections, Recesses, Water Tables, Arches	75.0%	3
Openings (Door and Window)	0.0%	0
Masonry Backup Systems and Associated Details	**100.0%**	**4**
Construction details	75.0%	3
Structural analysis and design	0.0%	0
Energy analysis and design	25.0%	1
Restoration	25.0%	1
Other (please specify)		1
answered question		**4**
skipped question		**6**

Page 2, Q3. What are design tasks within a masonry project that you find difficult to achieve with the current software? (general design tasks such as 1- selection, 2- generation / composition, 3- evaluation and 4- modification / exploration of alternatives)

1	We have not performed extensive design of unit masonry, but have used Revit to design and detail irregular masonry units (think stone). Conceptually, we would want to be able to control all of the above factors in a unit masonry building, with restoration and structural analysis being the least important.	Aug 7, 2012 8:34 AM

BIM-M: Architectural Modeling WorkGroup

SurveyMonkey

What should the masonry industry be doing to better promote the use of its products to architects?

	Response Percent	Response Count
Better information on material, unit size, and color of different masonry types	40.0%	2
Better details regarding connectors, ties, anchoring and reinforcement types	80.0%	4
Improved Information regarding mortar types and colors	40.0%	2
Improved information on grout, including self-consolidating grout	20.0%	1
Information on water-proofing and drainage planes in masonry systems	80.0%	4
Better information on the four wall control layers: moisture, air, thermal and vapor	**100.0%**	**5**
Other (please specify)		1
answered question		**5**
skipped question		**5**

Page 2, Q4. What should the masonry industry be doing to better promote the use of its products to architects?

1	There is already good information out there on the items I checked, but "better" is always better...	Aug 7, 2012 8:34 AM

BIM-M: Architectural Modeling WorkGroup

SurveyMonkey

What information would architects like to have in digital/electronic format?

		Response Percent	Response Count
Information on material, unit size, and color of different masonry types		**100.0%**	**5**
Information regarding code requirements for connectors, ties, anchoring and reinforcement types		80.0%	4
Information on quantity take offs and cost-estimates		**100.0%**	**5**
Information on mortar types and colors		60.0%	3
Structural, seismic, fire codes		80.0%	4
Assembly / construction issues and processes		**100.0%**	**5**
Energy and sustainability related information		**100.0%**	**5**
		Other (please specify)	0
		answered question	**5**
		skipped question	**5**

BIM-M: Architectural Modeling WorkGroup

SurveyMonkey

In developing a building project with significant inclusion of masonry, what kinds of technical advice is needed to facilitate the project? How could this advice and interaction be embedded or facilitated by your CAD/BIM tools?

	Response Count
	3
answered question	3
skipped question	7

Page 2, Q6. In developing a building project with significant inclusion of masonry, what kinds of technical advice is needed to facilitate the project? How could this advice and interaction be embedded or facilitated by your CAD/BIM tools?

1	how does loadbearing masonry affect the schedule? how does it affect the cost? could there be a tool that compares cost of masonry vs. competing systems? could there be a tool that analyzes schedule of masonry vs. competing systems (note lead time for materials as well as construction time)	Aug 20, 2012 3:02 PM
2	From a design perspective, masonry manufacturers should be distributing wall family types (at least for masonry veneers) similar to the BIM catalogs of lighting and window/door manufacturers. Information on unit sizes/shapes and recommended coursing would be useful to bring into a BIM project.	Aug 8, 2012 2:32 PM
3	Advice on comparative systems is probably the key in early phases, i.e. metrics to determine whether to use masonry vs. another system, which type of masonry system, etc. This would be best aided by the ability to model comparative systems quickly, create cost analysis based on the models, and (easily) use embedded material information in the model to compare the design options. In later stages, the ability to customize exterior wall construction in the model for accurate and simplified documentation without bogging down CPUs is key.	Aug 7, 2012 8:34 AM

BIM-M: Architectural Modeling WorkGroup

SurveyMonkey

What kinds of interfaces should BIM software for masonry provide?

	Response Percent	Response Count
Energy analysis	**80.0%**	**4**
Dewpoint analysis	**80.0%**	**4**
Automatic generation of details	60.0%	3
Automatic generation of specifications	40.0%	2
Drainage plane / weather barrier analysis	**80.0%**	**4**
Cost estimation (initial construction cost and life cycle costs)	60.0%	3
Other (please specify)		3
answered question		**5**
skipped question		**5**

Page 2, Q7. What kinds of interfaces should BIM software for masonry provide?

1	automatic generation of details may not be feasible. BIM is more for systems. Construction details, particularly integration details, must be thought out and designed on an individual basis. This is not the scope of BIM.	Aug 20, 2012 3:02 PM
2	Automatic generation of details is dangerous... I'd rather see a context-based system to call-up details from a list of possible options.	Aug 8, 2012 2:32 PM
3	Drainage plane and weather barrier analysis would be fantastic.	Aug 7, 2012 8:34 AM

BIM-M: Architectural Modeling WorkGroup

SurveyMonkey

Some people involved in architectural masonry work, like others in the construction industry, are not comfortable with information technology tools. Is this an important problem the industry should address? Please tell us of the reasons for your answer and how we might improve the education of industry professionals.

		Response Percent	Response Count
Yes		**80.0%**	**4**
No		20.0%	1
		Why?	4
		answered question	**5**
		skipped question	**5**

Page 2, Q8. Some people involved in architectural masonry work, like others in the construction industry, are not comfortable with information technology tools. Is this an important problem the industry should address? Please tell us of the reasons for your answer and how we might improve the education of in...

1	Respectfully recognizing that masonry is still laid by hand by individual craftworkers, the masonry industry must move ahead with developing BIM tools and other technologies that improve efficiency whether or not they have full acceptance within our own industry. BIM is mainstream among the design industry and has been for some time.	Aug 20, 2012 3:02 PM
2	Taking information that is close to 'ingrained' or common sense from a long-time mason's point of view, and making it more complex by applying computational rules/analysis to it is working backwards. The key to successfully integrating masonry tool-sets into BIM software will be to make it as simple as possible. The user should feel like they have their own 'mason in the box'	Aug 8, 2012 2:32 PM
3	I believe it is only a problem when the sharing of information models or digital files in general between industry professionals and designers would be beneficial to all parties. This could include passing a model to an industry technical expert for analysis, or providing BIM to a mason as a guide for a complex system or detail. It seems as though this will become more useful in the future, as more effort is made to create robust models, and less time is available for traditional 2D paper detailing.	Aug 7, 2012 8:34 AM
4	It is important to educate users to the different phases of a project and how different tools can be used effectively during each phase while maintaining interoperability across phases and software platforms.	Aug 6, 2012 3:45 PM

BIM-M: Architectural Modeling WorkGroup

SurveyMonkey

Do you communicate with other design and construction professionals through BIM models? If so, is this method of communication a project or contractual requirement? How can these communications be improved? Are there specific aspects of these improvements that apply to masonry design and construction?

	Response Count
	4
answered question	4
skipped question	6

Page 2, Q9. Do you communicate with other design and construction professionals through BIM models? If so, is this method of communication a project or contractual requirement? How can these communications be improved? Are there specific aspects of these improvements that apply to masonry design and construc...

1	Yes (SketchUp models). No. We can develop more useful smart models that give designers R values/energy information, cost, fire resistance ratings, load capacities, acoustic information, and other important design information that is useful on the front end of design.	Aug 20, 2012 3:02 PM
2	Yes, I do. It is a project necessity (not contractual)... Although I would like to get to the point that IDE and my consultants use BIM...but not there yet as an industry. Aspects of this communication that need to be improved are not necessarily specific to the masonry industry.	Aug 8, 2012 2:32 PM
3	Yes, we typically link BIM between disciplines to facilitate coordination. It has not to date been a contractual requirement, but we anticipate that it is likely to become one. This communication will improve through continued experience, but of course an especially user-friendly command or setup in BIM would make this easier.	Aug 7, 2012 8:34 AM
4	Problem is that many consultants do not use Revit and translation of documents is required.... which requires additional time on our part.	Aug 6, 2012 2:00 PM

BIM-M: Structural Modeling WorkGroup

SurveyMonkey

Though you may answer the survey anonymously, we prefer that you provide your name and email address:

		Response Percent	Response Count
Name		100.0%	12
Email		100.0%	12
	answered question		12
	skipped question		0

Page 1, Q1. Though you may answer the survey anonymously, we prefer that you provide your name and email address:

	Name	
1	Amanda Sellers	Aug 20, 2012 5:49 PM
2	jamie davis	Aug 15, 2012 9:57 AM
3	John Hochwalt	Aug 13, 2012 7:51 AM
4	David Biggs	Aug 7, 2012 9:18 AM
5	Chad Boyea	Aug 7, 2012 6:09 AM
6	Todd Dailey	Aug 6, 2012 8:25 AM
7	Ross Shepherd	Aug 6, 2012 4:59 AM
8	Tomas Amor	Aug 3, 2012 10:33 AM
9	Jason Jones	Aug 2, 2012 10:59 AM
10	Jeff Elder	Aug 2, 2012 6:30 AM
11	Craig McKee	Aug 2, 2012 6:02 AM
12	Brian Johnson	Aug 1, 2012 7:21 PM
	Email	
1	asellers@pesengineers.com	Aug 20, 2012 5:49 PM
2	jdavis@ryanbiggs.com	Aug 15, 2012 9:57 AM
3	johnh@kpff.com	Aug 13, 2012 7:51 AM
4	biggsconsulting@att.net	Aug 7, 2012 9:18 AM
5	cboyea@pesengineers.com	Aug 7, 2012 6:09 AM
6	todddailey@me.com	Aug 6, 2012 8:25 AM
7	rshepherd@ryanbiggs.com	Aug 6, 2012 4:59 AM
8	tomas.amor@target.com	Aug 3, 2012 10:33 AM
9	jjones@pesengineers.com	Aug 2, 2012 10:59 AM
10	jeff.elder@paccoast.com	Aug 2, 2012 6:30 AM
11	cmckee@huckabee-inc.com	Aug 2, 2012 6:02 AM
12	brian.johnson@autodesk.com	Aug 1, 2012 7:21 PM

BIM-M: Structural Modeling WorkGroup

SurveyMonkey

Please tell us a little about yourself and your business. Which best describes your line of work:

		Response Percent	Response Count
Architect or designer		0.0%	0
Engineer		**75.0%**	**9**
Masonry Contractor		0.0%	0
General Contractor		0.0%	0
CAD/BIM draftsman		8.3%	1
CAD/BIM manager		0.0%	0
Material Supplier		8.3%	1
Masonry Industry Representative		0.0%	0
Software Provider or Programmer		8.3%	1
		Other (please specify)	1
		answered question	**12**
		skipped question	**0**

Page 1, Q2. Please tell us a little about yourself and your business. Which best describes your line of work:

1	My current role is BIM Program Manager	Aug 2, 2012 10:59 AM

BIM-M: Structural Modeling WorkGroup

SurveyMonkey

What is your role in the BIM-Masonry project? (select all that apply)

		Response Percent	Response Count
Workgroup member		**90.9%**	**10**
Executive board member		18.2%	2
AEC industry stakeholder		0.0%	0
	answered question		**11**
	skipped question		**1**

BIM-M: Structural Modeling WorkGroup

SurveyMonkey

Do you personally use CAD or BIM tools?

		Response Percent	Response Count
Yes		**75.0%**	**9**
No		25.0%	3
		answered question	**12**
		skipped question	**0**

BIM-M: Structural Modeling WorkGroup

SurveyMonkey

Do you manage users of CAD or BIM tools?

		Response Percent	Response Count
Yes		**75.0%**	**9**
No		25.0%	3
		answered question	**12**
		skipped question	**0**

BIM-M: Structural Modeling WorkGroup

SurveyMonkey

Do you create structural models with one piece of software and use a different analysis package, or do you use an integrated modeling and analysis package?

	Response Count
	10
answered question	**10**
skipped question	**2**

Page 2, Q1. Do you create structural models with one piece of software and use a different analysis package, or do you use an integrated modeling and analysis package?

1	I am assuming that in this case, "models" is referring to BIM models. In that case, we our BIM software is used independently of our analytical software.	Aug 20, 2012 8:14 AM
2	Revit for modelling. RISA or RAM for analysis	Aug 15, 2012 10:51 AM
3	different software	Aug 7, 2012 9:31 AM
4	I create structural models in Revit. Ram structural system, Ram Elements, and Etabs are the primary analysis softwares I use.	Aug 7, 2012 6:28 AM
5	Integrated modeling and analysis	Aug 6, 2012 8:35 AM
6	We use diffent pieces of software to create models.	Aug 6, 2012 5:08 AM
7	I use an integrated modeling and analysis package. I am a true believer that one model should suffice for documentation and analysis/design.	Aug 3, 2012 11:08 AM
8	In regards to masonry our current workflow is to utilize seperate sotware for modeling and analysis.	Aug 2, 2012 12:58 PM
9	RISA software for modeling and NCMA Structural Masonry Design System software plus internally created software to design masonry beams, columns, piers and walls.	Aug 2, 2012 6:56 AM
10	I have done both. However, I prefer to model and analyze in separate packages at the moment.	Aug 1, 2012 7:48 PM

BIM-M: Structural Modeling WorkGroup

What are the "structural modeling" software packages now being used for masonry design – that is, packages that you use to create structural models for subsequent analysis? For each package that you have experience with, please summarize its strengths and weaknesses. Generate a wish list for Software companies to act on.

	Response Percent	Response Count
Revit (Autodesk)	**77.8%**	**7**
Tekla Structures (Tekla)	11.1%	1
Solidworks (Dassault Systemes)	11.1%	1
Digital Project (Gehry Technologies)	0.0%	0
Autodesk Robot	22.2%	2
ETABS (CSI)	22.2%	2
Other	33.3%	3
	answered question	**9**
	skipped question	**3**

Page 2, Q2. What are the "structural modeling" software packages now being used for masonry design – that is, packages that you use to create structural models for subsequent analysis? For each package that you have experience with, please summarize its strengths and weaknesses. Generate a wish lis...

	Revit (Autodesk)	
1	Use, but not for analytical purposes.	Aug 20, 2012 8:14 AM
2	many issues when you bring the model in for clash detection. We need to be able to distinguish between 'critical' masonry elements, like bond beams and shear walls, and 'non-critical' masonry elements to avoid getting a clash at every location where a pipe penetrates a wall, etc etc	Aug 15, 2012 10:51 AM
4	Used to model masonry, but not used for analysis or design.	Aug 7, 2012 6:28 AM
5	We use Revit, subsequent analysis is done in Enercalc, RISA3D, and RAM Structural software.	Aug 6, 2012 5:08 AM
6	Only does CMU wall analysis, not design. Does not reflect masonry design requirements (bond beams, grouted vs. hollow cores, etc). Limited interoperability with analysis software. Loads/load combinations are hard to transfer without duplication of work. Limited tools for wall design (openings, analytical reinforcement, zones) Links very well with Revit.	Aug 3, 2012 11:08 AM
7	In order to see the mortar joints in a live section you have to edit the assembly and manually "split region" vertically. I would like to have this as a visibilty option rather than having to use a repeating detail component. We can easily add a parameter to denote mortar type but it would be nice to have out of the box. Again we can create this easily enough but it would also be beneficial from a quantity standpoint to have a built in parameter that auto calculates number of units based on the volume.	Aug 2, 2012 12:58 PM
9	Model any material. Limited functionality specific to masonry. Need tools for modeling headers, bond beams, rebar for masonry.	Aug 1, 2012 7:48 PM
	Tekla Structures (Tekla)	
6	Does not reflect masonry design requirements (bond beams, grouted vs. hollow cores, etc). Interoperability limited to IFC format, which doesn't retain all information in models. Provides very detailed information about connections.	Aug 3, 2012 11:08 AM
	Solidworks (Dassault Systemes)	
8	x	Aug 2, 2012 6:56 AM
	Digital Project (Gehry Technologies)	
	Autodesk Robot	
6	Does not reflect masonry design requirements (bond beams, grouted vs. hollow cores, etc). Only does analysis, not design.	Aug 3, 2012 11:08 AM
9	Model and analyze most any structure / material / section. Needs masonry material properties database & design codes.	Aug 1, 2012 7:48 PM
	ETABS (CSI)	

Page 2, Q2. What are the "structural modeling" software packages now being used for masonry design – that is, packages that you use to create structural models for subsequent analysis? For each package that you have experience with, please summarize its strengths and weaknesses. Generate a wish lis...

1	Use, well suited for building structures. Does not handle partially grouted walls easily.	Aug 20, 2012 8:14 AM
6	Does not reflect masonry design requirements (bond beams, grouted vs. hollow cores, etc). Only does analysis, not design.	Aug 3, 2012 11:08 AM
	Other	
1	SAP. Same analytical engine as ETABS, but more flexible (but more effort to model simple buildings).	Aug 20, 2012 8:14 AM
3	RAM Bentley Strctural Systems and Elements. Useful but awkward in having to work with 2 programs.	Aug 7, 2012 9:31 AM
7	In-house spreadsheet	Aug 2, 2012 12:58 PM

BIM-M: Structural Modeling WorkGroup

What are the "structural design" software packages now being used for masonry design? For each package, please summarize its strengths and weaknesses. Generate a wish list for Software companies to act on.

		Response Percent	Response Count
Structural Masonry Design System software (Masonry 5.0) (NCMA)		**71.4%**	**5**
Masonry Analysis Structural Systems (MASS™)		0.0%	0
QuickMasonry (IES)		14.3%	1
Enercalc		57.1%	4
TEDDS (CSC)		14.3%	1
Other		42.9%	3
		answered question	**7**
		skipped question	**5**

Page 2, Q3. What are the "structural design" software packages now being used for masonry design? For each package, please summarize its strengths and weaknesses. Generate a wish list for Software companies to act on.

	Structural Masonry Design System software (Masonry 5.0) (NCMA)	
2	go for elements but does not address openings in walls. Need to factor loads to approximate opening edge loads.	Aug 7, 2012 9:31 AM
3	I have used this software and found it to be user friendly and accurate.	Aug 7, 2012 6:28 AM
4	Easy to use, fast. Some limitations on modeling.	Aug 6, 2012 8:35 AM
5	Great standalone tool. Does not link with BIM software.	Aug 3, 2012 11:08 AM
7	All data must be transferred from model to software program. Slow for iterative processes	Aug 2, 2012 6:56 AM
	Masonry Analysis Structural Systems (MASS™)	
	QuickMasonry (IES)	
5	Great standalone tool. Does not link with BIM software.	Aug 3, 2012 11:08 AM
	Enercalc	
1	Limited use	Aug 20, 2012 8:14 AM
3	We have this software, but I have not used it for masonry design.	Aug 7, 2012 6:28 AM
5	Great standalone tool. Does not link with BIM software.	Aug 3, 2012 11:08 AM
6	Only use for footing design and not for wall desgin typically	Aug 2, 2012 12:58 PM
	TEDDS (CSC)	
5	Great standalone tool. Does not link with BIM software.	Aug 3, 2012 11:08 AM
	Other	
1	In-house spreadhseets, due to specialty masonry design like structural brick veneers.	Aug 20, 2012 8:14 AM
2	RAM Elements. Handles openings but still works like a black box. See STRUCTURE article where hand calcs , NCMA Software and RAM Elements were compare.	Aug 7, 2012 9:31 AM
3	Ram Elements.	Aug 7, 2012 6:28 AM

BIM-M: Structural Modeling WorkGroup

SurveyMonkey

What are the "structural modeling and design" software packages now being used for masonry design? For each package, please summarize its strengths and weaknesses. Generate a wish list for Software companies to act on.

		Response Percent	Response Count
RAM Elements Masonry Wall (Bentley)		**83.3%**	**5**
RISA 3D (RISA Technologies)		33.3%	2
Other		16.7%	1
		answered question	**6**
		skipped question	**6**

Page 2, Q4. What are the "structural modeling and design" software packages now being used for masonry design? For each package, please summarize its strengths and weaknesses. Generate a wish list for Software companies to act on.

	RAM Elements Masonry Wall (Bentley)	
2	help menus need work, i find the output difficult to decipher, and depending on the input for 'design criterion' I can get #4@16 or #11@24 for the exact same wall. Something is amiss.	Aug 15, 2012 10:51 AM
3	Strength: handles most designs; weakness: relies on finite elements and appears as black box.	Aug 7, 2012 9:31 AM
4	We have this software, but I have not used it for masonry design recently.	Aug 7, 2012 6:28 AM
5	Great tool that links to RAM Structural Systems. Not all design information is transferred from RAM into documentation model (Revit).	Aug 3, 2012 11:08 AM
6	Can't design the footing, only allows for uniform reinforcing. Would like to be able to place bar groups at wall ends for shear walls etc.	Aug 2, 2012 12:58 PM
	RISA 3D (RISA Technologies)	
3	last time I tried the software was not code compliant but developer did not care to hear that.	Aug 7, 2012 9:31 AM
5	Great tool that links to RISA Floor. Not all design information is transferred from RISA into documentation model (Revit).	Aug 3, 2012 11:08 AM
	Other	
1	We do not use modeling and design software for masonry design.	Aug 20, 2012 8:14 AM

BIM-M: Structural Modeling WorkGroup

SurveyMonkey

How would you like the structural analysis software to interact with other software?

	Response Count
	8
answered question	8
skipped question	4

Page 2, Q5. How would you like the structural analysis software to interact with other software?

1	See item 6 below. Ideallay it would be interoperable with both the BIM model and the design software.	Aug 20, 2012 8:14 AM
2	we need a program that will take the revit model wall layout and generate the analysis model. The revit model will provide all of the data for masonry walls....size,length, height, openings etc.....if this data could easily dump into an analysis program it would be extremely useful.....and coming full circle if the analysis program could create wall elevations showing the reinforcing layout and bar schedules that would be extremely helpful downstream for contractors	Aug 15, 2012 10:51 AM
3	Prefer one piece for modeling and design. RAM Elements would be more useful if it could generate loads.	Aug 7, 2012 9:31 AM
4	Ideally, masonry could be modeled in Revit and then exported directly to the analysis/design software. Once the masonry is designed, the designs could be exported back into Revit.	Aug 7, 2012 6:28 AM
5	I would like to not lose any information when the documentation software (like Revit) and the analysis software interact. Seems like each developer creates a unique link specific to their software. Exchange files such as IFC or EXC don't retain the information needed on both software.	Aug 3, 2012 11:08 AM
6	We primarily use Revit for modeling and contract documents. We would like to see an add in link to a software package that can handle multiple wall scenarios, multiple loading scenarios, handle footing desgin and roudtrip back to Revit.	Aug 2, 2012 12:58 PM
7	I would like to see a software package with the ability to take BIM models enter into Revit, create building structure in 3D, transfer structural model, enter loading data, analyse the building for loads, identify incompatibilies with material sections, design building. Once designed the building would integrate back to architectural set which would then be sent to installer who could perform building cost analysis, material takeoffs and facilitate bidding and create shop drawings.This data would then be used to track installation performance via handheld devices on the job back to base tracking progam to create as-built drawings. At a future date the as-built drawing could be used for building maintenance tracking.	Aug 2, 2012 6:56 AM
8	My preference would be for structural analysis software to act as a background service to a modeling front-end like Revit. i.e. The analysis software has virtually no GUI. That being said, I think there is value in separation for certain workflows and phases of a project.	Aug 1, 2012 7:48 PM

BIM-M: Structural Modeling WorkGroup

SurveyMonkey

How important is interoperability between design and modeling software?

	Response Count
	9
answered question	9
skipped question	3

Page 2, Q6. How important is interoperability between design and modeling software?

1	This is the "Holy Grail." Having software that could seamlessly support a BIM Model, an analytical model, and design would allow for greater efficiency in design and fewer errors. At the moment it seems like the BIM technology is evolving so rapidly, that attempt at interoperability tend to be unreliable and create concerns about increasing errors rather than reducing them.	Aug 20, 2012 8:14 AM
2	critical	Aug 15, 2012 10:51 AM
3	Very much. Eliminates transfer errors and and rduces time to design.	Aug 7, 2012 9:31 AM
4	It is very important for efficiency.	Aug 7, 2012 6:28 AM
5	Since we don't currently use this feature, at this time its not important. However if I was ever to make the switch, the interoperability would have to be accurate and easy to use; otherwise I would not make the change.	Aug 6, 2012 8:35 AM
6	Very important. Generating input only once in one's software of choice and being able to transfer the information seamlessly among the different software avoids duplication of information (elements are modeled only once), creates efficiencies (less time spent transferring information manually), and enhances design quality (minimizing chances for human error).	Aug 3, 2012 11:08 AM
7	Interoperability is key because in todays age of flattening or even decreasing project fees we have to rely on increased efficiencies.	Aug 2, 2012 12:58 PM
8	As noted above, architectural set needs to be able to transfer to other disciplines...SE, CE, ME and then back again. Once the building is designed the data and models needs to be able to be pushed back or forward to the next phase or discipline.	Aug 2, 2012 6:56 AM
9	Managing change effectively will make us more productive and help to reduce risk. I think interoperability is critical for reducing the amount of time it takes to make a design change.	Aug 1, 2012 7:48 PM

BIM-M: Structural Modeling WorkGroup

SurveyMonkey

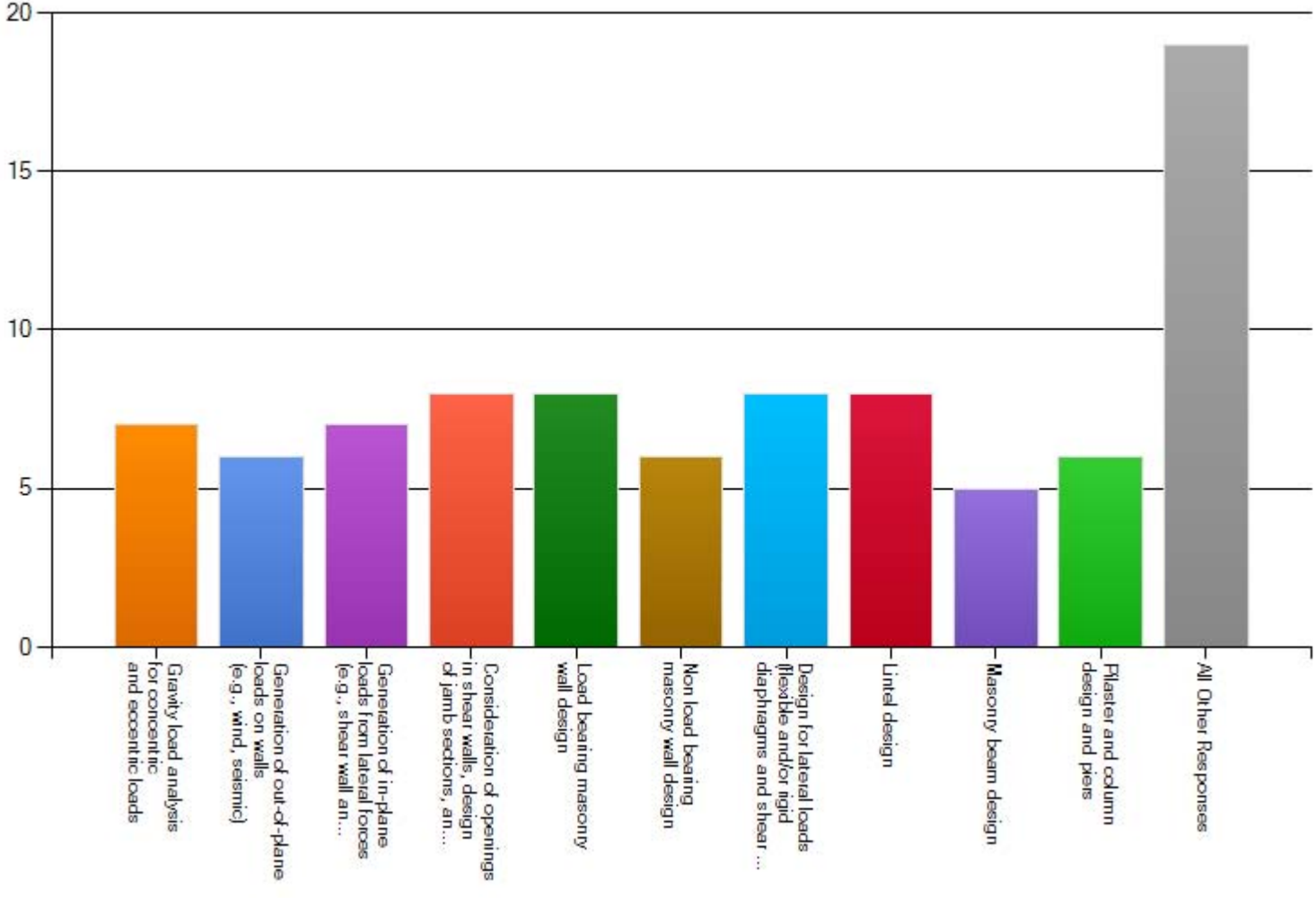
Do you typically perform planar and space frame structural analysis that includes walls? How do you create the structural modes for these walls? Do you use these models for both gravity and lateral loads?

	Response Count
	9
answered question	9
skipped question	3

Page 2, Q7. Do you typically perform planar and space frame structural analysis that includes walls? How do you create the structural modes for these walls? Do you use these models for both gravity and lateral loads?

1	Yes. Using ETABS or SAP. We tend to mostly use the models for lateral loads, and determine gravity loads manually.	Aug 20, 2012 8:14 AM
2	currently we model for gravity and lateral for steel frame buildings, but for masonry much of the analysis is still done by hand or loads are generated and individual wall designs are done in RAM	Aug 15, 2012 10:51 AM
3	Yes...Use RAM Structural system to develop model and generate loads. Masonry is input as an "other material"; material properties are not specific to masonry. Then, transfer to RAM Elements are rerun the analysis as masonry. These develop both gravity and in-plane laods.	Aug 7, 2012 9:31 AM
4	Yes. The walls are modeled in the analysis/design software. I use the analysis software to generate the loads and perform the analysis. Then I design the walls using NCMA Tek or by hand.	Aug 7, 2012 6:28 AM
5	No	Aug 6, 2012 8:35 AM
6	Yes, I have analyzed models that include walls and use analysis software for gravity and lateral load distribution. I often finalize my design in a structural dsign standalone software and transfer the design into the model by hand.	Aug 3, 2012 11:08 AM
7	No	Aug 2, 2012 12:58 PM
8	Currently determine loads and forces by planar analysis.	Aug 2, 2012 6:56 AM
9	Yes. I've created the walls in Revit and directly in analysis/design software. These analyses typically include both gravity and lateral loads based on the size and type of projects we designed.	Aug 1, 2012 7:48 PM

In designing and analyzing masonry structural systems in your practice, what aspects are important to you?



BIM-M: Structural Modeling WorkGroup

SurveyMonkey

In designing and analyzing masonry structural systems in your practice, what aspects are important to you?

	Response Percent	Response Count
Gravity load analysis for concentric and eccentric loads	77.8%	7
Generation of out-of-plane loads on walls (e.g., wind, seismic)	66.7%	6
Generation of in-plane loads from lateral forces (e.g., shear wall analysis and design)	77.8%	7
Consideration of openings in shear walls, design of jamb sections, and the placement of the movement joints	**88.9%**	**8**
Load bearing masonry wall design	**88.9%**	**8**
Non load bearing masonry wall design	66.7%	6
Design for lateral loads (flexible and/or rigid diaphragms and shear walls)	**88.9%**	**8**
Lintel design	**88.9%**	**8**
Masonry beam design	55.6%	5
Pilaster and column design and piers	66.7%	6
Interaction of frame and masonry elements (hybrid systems)	66.7%	6
Rebar Layout (spacing, laps, etc)	77.8%	7
Material take-offs, such as grouting volume, etc	66.7%	6

Page 2, Q8. In designing and analyzing masonry structural systems in your practice, what aspects are important to you?

1	Preferably ability to transfer info to drawings.	Aug 7, 2012 9:31 AM

BIM-M: Structural Modeling WorkGroup

SurveyMonkey

What information would your architectural clients like to have submitted in electronic format?

	Response Percent	Response Count
Material and size	80.0%	8
Reinforcement	60.0%	6
Quantity take-offs and cost estimates	50.0%	5
Mortar types	40.0%	4
Electronic submittals	**90.0%**	**9**
Other (please specify)		1
answered question		**10**
skipped question		**2**

Page 2, Q9. What information would your architectural clients like to have submitted in electronic format?

1	It appears to me that the next step up in information for the BIM model will be linking the BIM model to the specifications. We are getting some inquiries about providing that service.	Aug 20, 2012 8:14 AM

BIM-M: Structural Modeling WorkGroup

SurveyMonkey

Some people involved in structural masonry work, like others in the construction industry, are not comfortable with information technology tools. Is this an important problem the industry should address? Please tell us of the reasons for your answer and how we might improve the education of industry professionals.

	Response Count
	8
answered question	8
skipped question	4

Page 2, Q10. Some people involved in structural masonry work, like others in the construction industry, are not comfortable with information technology tools. Is this an important problem the industry should address? Please tell us of the reasons for your answer and how we might improve the education of indus...

1	Coming from a large firm, I do not see this as an important issue. I imagine that keeping up with the various tools that are available may be more of a challenge for sole proprietorships and small firms, but I do not see that as something that the masonry industry should focus on addressing.	Aug 20, 2012 8:14 AM
2	the engineering profession cannot afford to be stagnant. Between the increased code requirements (wind calcs used to take 30 seconds to produce!), and the decreased fee structures, engineers have to rely on more productive and streamline ways of producing designs.	Aug 15, 2012 10:51 AM
3	With few exceptions, masons appear to be slow to accept technology changes. Information technology is no different. Other industries seem to embrace advances that help them.	Aug 7, 2012 9:31 AM
4	Yes, there is a steep learning curve with the new technology, but in the end, it makes the process more efficient.	Aug 7, 2012 6:28 AM
5	Before I respond, I need to know if the benefits of a BIM model are worth the trouble of creating it.	Aug 6, 2012 8:35 AM
6	Yes, this is an important problem in our industry. We have to motivate professionals to utilize the tools available by educating them and clearly presenting the benefits of doing so to all stakeholders, from the engineer to the contractor, to the supplier, to the client.	Aug 3, 2012 11:08 AM
7	The cost to train and educate the design community and construction industry on the various tools and to keep them up to date is high with payback often never realized. Codes change as quickly. It is impossible to stay current with all of the codes and technology changes.	Aug 2, 2012 6:56 AM
8	I think if you can show how these tools can benefit them, they will listen and adopt. Nonetheless, even with good educational efforts, there will still be laggards.	Aug 1, 2012 7:48 PM

BIM-M: Structural Modeling WorkGroup

SurveyMonkey

Do you communicate with other design and construction professionals through BIM models? If so, is this method of communication a project or contractual requirement? How can these communications be improved? Are there specific aspects of these improvements that apply to masonry design and construction?

	Response Count
	10
answered question	10
skipped question	2

Page 2, Q11. Do you communicate with other design and construction professionals through BIM models? If so, is this method of communication a project or contractual requirement? How can these communications be improved? Are there specific aspects of these improvements that apply to masonry design and construc...

1	Yes. Yes. First, by having all members of the project fully capable of using the BIM software. Second, by reducing overlap between structural and architectural models. For example, the architect often wants to show masonry in their model as it is part of the wall assembly. As structural engineer, we want to show the masonry in our model as it is a structural element. It would be very helpful if the software could facillitate the sharing of elements like masonry.	Aug 20, 2012 8:14 AM
2	the communication is through model sharing. Masonry is a grey area since the architect is usually modelling these walls since they need to be reflected in their drawings. If you could have a command in Revit structure to copy all masonry walls out of an architectural file that would eliminate the double modelling that occurs and would greatly help in coordinating wall locations and openings since this data would 'regenerate' every time you brought in the current architectural model.	Aug 15, 2012 10:51 AM
3	Not personally. Sometimes a contractual requirement from architect. Some mason contractors won't or can't invest in technology.	Aug 7, 2012 9:31 AM
4	Yes. It is mostly a project requirement. The contractual deliverable is still paper documents. The communication can be improved by improving interoperability between different software venders.	Aug 7, 2012 6:28 AM
5	Not yet.	Aug 6, 2012 8:35 AM
6	Yes we do and in some instances are required by contract.	Aug 6, 2012 5:08 AM
7	I currently communicate with genereal contractors (sharing Navisworks files), steel fabricators (with IFC exports from my Revit models), and the owner (with Revit model). It is a contractual requirement with the GC and owner, and project requirement with steel fabricators. Communications can be improved by getting them started as soon as possible, establishing expectations early, and explaining benefits to each party. Having a universal file format that retains information is critical. This applies to masonry design.	Aug 3, 2012 11:08 AM
8	Yes, primarily a project requirement but we have a number of government projects where it is a contractual requirement. I believe communication can be improved and has been effective on our projects when the GC and trades are brought on board during the desgin phase. Specific to masonry I think having sequencing input from the GC during design is key espcially on multi-system projects.	Aug 2, 2012 12:58 PM
9	We are a manufacturer of brick and have all of our products modeled in BIM. Models include technical data, material properties and design helps	Aug 2, 2012 6:56 AM
10	I did while I was in practice. At the time, exchanging BIM models was entirely by choice. The main improvement for communication for me would include more streamlined model sharing and revision control services. This would need to happen throughout design, construction, and now even into operations.	Aug 1, 2012 7:48 PM

BIM-M: Structural Modeling WorkGroup

SurveyMonkey

What CAD software do you use in the architectural design of masonry buildings?

	Conceptual Design phase	Preliminary Design Phase	Design Development Phase	Detail Design Phase	Material Selection Phase	Final Design Phase	Loa Beari Buildi
SketchUp (Google)	**100.0% (2)**	**100.0% (2)**	50.0% (1)	50.0% (1)	50.0% (1)	0.0% (0)	0.0%
AutoCAD (Autodesk)	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	0.0% (0)	0.0% (0)	**100.0%**
Rhino (McNeel)	**100.0% (1)**	**100.0% (1)**	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0%
MicroStation (Bentley)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0%
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BIM-M: Structural Modeling WorkGroup

SurveyMonkey

What are the available BIM software that you use or could be used in the architectural design

	Conceptual Design phase	Preliminary Design Phase	Design Development Phase	Detail Design Phase	Material Selection Phase	Final Design Phase	Loa Beari Buildi
Revit architecture (Autodesk)	**100.0% (2)**	**100.0% (2)**	**100.0% (2)**	**100.0% (2)**	50.0% (1)	50.0% (1)	**100.0%**
Bentley Architecture	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0%**
Generative Components (Bentley)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0%
ArchiCAD (Graphisoft)	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	**100.0% (1)**	0.0% (0)	0.0% (0)	0.0%
Digital Project (Gehry Technologies)	**100.0% (1)**	**100.0% (1)**	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0%
Vectorworks	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0%

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BIM-M: Structural Modeling WorkGroup

SurveyMonkey

What are design tasks within a masonry project that you find difficult to achieve with the current software? (general design tasks such as 1- selection, 2- generation / composition, 3- evaluation and 4-modification / exploration of alternatives)

	Response Percent	Response Count
Masonry Unit Selection	**100.0%**	**3**
Masonry Coursing and Dimensioning	66.7%	2
Modular Coordination	66.7%	2
Decorative Patterning such as Quoins, Ledges, Headers, Corbels, Projections, Recesses, Water Tables, Arches	33.3%	1
Openings (Door and Window)	33.3%	1
Masonry Backup Systems and Associated Details	66.7%	2
Construction details	66.7%	2
Structural analysis and design	**100.0%**	**3**
Energy analysis and design	66.7%	2
Restoration	33.3%	1
Other (please specify)		0
answered question		**3**
skipped question		**9**

BIM-M: Structural Modeling WorkGroup

SurveyMonkey

What should the masonry industry be doing to better promote the use of its products to architects?

	Response Percent	Response Count
Better information on material, unit size, and color of different masonry types	75.0%	3
Better details regarding connectors, ties, anchoring and reinforcement types	**100.0%**	**4**
Improved Information regarding mortar types and colors	50.0%	2
Improved information on grout, including self-consolidating grout	75.0%	3
Information on water-proofing and drainage planes in masonry systems	50.0%	2
Better information on the four wall control layers: moisture, air, thermal and vapor	75.0%	3
Other (please specify)		0
answered question		**4**
skipped question		**8**

BIM-M: Structural Modeling WorkGroup

SurveyMonkey

What information would architects like to have in digital/electronic format?

		Response Percent	Response Count
Information on material, unit size, and color of different masonry types		100.0%	2
Information regarding code requirements for connectors, ties, anchoring and reinforcement types		100.0%	2
Information on quantity take offs and cost-estimates		100.0%	2
Information on mortar types and colors		100.0%	2
Structural, seismic, fire codes		100.0%	2
Assembly / construction issues and processes		100.0%	2
Energy and sustainability related information		100.0%	2
		Other (please specify)	0
		answered question	2
		skipped question	10

BIM-M: Structural Modeling WorkGroup

SurveyMonkey

In developing a building project with significant inclusion of masonry, what kinds of technical advice is needed to facilitate the project? How could this advice and interaction be embedded or facilitated by your CAD/BIM tools?

	Response Count
	2
answered question	2
skipped question	10

Page 3, Q6. In developing a building project with significant inclusion of masonry, what kinds of technical advice is needed to facilitate the project? How could this advice and interaction be embedded or facilitated by your CAD/BIM tools?

1	Practical schematic design options would be useful. Too often the selection of project is based upon preference of CM and justified by their perceived cost. BIM could remove the subjectivity of the CM with realistic data at the schematic phase.	Aug 7, 2012 9:34 AM
2	Software should understand the wall type system and its limitations.	Aug 3, 2012 11:13 AM

BIM-M: Construction Management Workgroup

SurveyMonkey

Though you may answer the survey anonymously, we prefer that you provide your name and email address:

		Response Percent	Response Count
Name		100.0%	5
Email		100.0%	5
	answered question		5
	skipped question		0

Page 1, Q1. Though you may answer the survey anonymously, we prefer that you provide your name and email address:

	Name	
1	Keith R. Sommer	Aug 19, 2012 5:58 PM
2	Mitchel DeLange	Aug 16, 2012 12:41 PM
3	Ron Bennett	Aug 15, 2012 1:27 PM
4	Dave Sovinski	Aug 15, 2012 1:09 PM
5	Austin Norberg	Aug 6, 2012 10:37 AM
	Email	
1	krsommer@mail.com	Aug 19, 2012 5:58 PM
2	mdelange@auchconstruction.com	Aug 16, 2012 12:41 PM
3	ronb@e-smasonry.com	Aug 15, 2012 1:27 PM
4	dsovinski@imiweb.org	Aug 15, 2012 1:09 PM
5	norberg.austin@seedorff.com	Aug 6, 2012 10:37 AM

BIM-M: Construction Management Workgroup

SurveyMonkey

Though you may answer the survey anonymously, we prefer that you provide your name and email address:

		Response Percent	Response Count
Architect or designer		0.0%	0
Engineer		0.0%	0
Masonry Contractor		**40.0%**	**2**
General Contractor		20.0%	1
CAD/BIM draftsman		0.0%	0
CAD/BIM manager		0.0%	0
Material Supplier		0.0%	0
Masonry Industry Representative		**40.0%**	**2**
Software Provider or Programmer		0.0%	0
		Other (please specify)	0
		answered question	**5**
		skipped question	**0**

BIM-M: Construction Management Workgroup

SurveyMonkey

What is your role in the BIM-Masonry project? (select all that apply)

	Response Percent	Response Count
Workgroup member	**100.0%**	**5**
Executive board member	20.0%	1
AEC industry stakeholder	0.0%	0
answered question		**5**
skipped question		**0**

BIM-M: Construction Management Workgroup

SurveyMonkey

Do you personally use CAD or BIM tools?

		Response Percent	Response Count
Yes		40.0%	2
No		**60.0%**	**3**
		answered question	**5**
		skipped question	**0**

BIM-M: Construction Management Workgroup

SurveyMonkey

Do you manage users of CAD or BIM tools?

		Response Percent	Response Count
Yes		40.0%	2
No		**60.0%**	**3**
		answered question	**5**
		skipped question	**0**

Page 2, Q1. What are the hardest aspects of masonry systems to coordinate and manage?

1	Coordination between Architects, Engeneers, GC and the other trades.	Aug 19, 2012 6:24 PM
2	Lintels, reinforcement (solid grouted), coordinating all penetrations (amount, size and location), expansion and control joints, coordinating pre-fabrication systems (attaching clips to steel through sheathing).	Aug 17, 2012 5:06 AM
3	Details, details, details. A large portion of time (labor cost) are associated attempting to gather the necessary information for integration of other structural or architectual compomnents related to their attachment and location.	Aug 15, 2012 1:41 PM
4	Integrating various wall and floor system components. Scheduling masonry work with other trades.	Aug 15, 2012 1:12 PM
5	Structural elements such as rebar and masonry piers that cannot be interrupted.	Aug 6, 2012 11:06 AM

Page 2, Q2. To better facilitate high quality project coordination, what information should masonry contractors be providing to the construction manager?

1	All trades need to coordinate access to all work and location of every penitration in the walls and dead space for Mech, Elect. Plumbing, and any other material that needs to penitrate walls or block access to build the walls.	Aug 19, 2012 6:24 PM
2	Wind bracing (external or internal), staging material/site management	Aug 17, 2012 5:06 AM
3	Schedule, flow or intended direction of work i.e. starting work on East wall working clockwise around structure, and integration and coordination of other trade's work necessary to complete the masonry.	Aug 15, 2012 1:41 PM
4	Accurate schedule needs. List of prerequisites prior to masonry starting.	Aug 15, 2012 1:12 PM
5	The information that I have been providing is wall heights, bond beam and masonry pier locations, rebar, and openings that require additional reinforcement for lintels.	Aug 6, 2012 11:06 AM

Page 2, Q3. Are most masonry contractors currently able to provide the information required for project management? Is the information needed provided in a format that is compatible with BIM?

1	Some times but in most cases everyone is out to get his work done, it's not always coordintated and as I've said before access is often blocked or penitrations or missed. Usually even if the information is given no one seems to pay it much attendion.	Aug 19, 2012 6:24 PM
2	No. Most masonry contractors have been using some form of modeling, but not BIM (not collaborative).	Aug 17, 2012 5:06 AM
3	Yes, most info can be provided now. I don't know if it is compatible with BIM.	Aug 15, 2012 1:41 PM
4	Possibly not the most contractors - but... the larger contractors who do the vast majority of the work are capable.	Aug 15, 2012 1:12 PM
5	I am about to complete the first project for our company and now have the tools to supply most anything that is required.	Aug 6, 2012 11:06 AM

Page 2, Q4. What are the most important issues that masonry contractors should address to become leading partners in construction projects?

1	Not just masonry contractors but all trades need to have a stronge GC coordinating the team that understands every trade's needs and the details of the structure. Then if there are design questions get the answers from the design team in a reasonable time frame.	Aug 19, 2012 6:24 PM
2	How to streamline the process and make it faster and economical to use masonry rather than steel.	Aug 17, 2012 5:06 AM
3	Above all "COST" as well as knowledge of design restrictions or ehancements and schedules.	Aug 15, 2012 1:41 PM
4	Becoming the structural system. Becoming the envelope / enclosure contractor. Otherwise you are simply another sub - not a bad thing, just a statement.	Aug 15, 2012 1:12 PM
5	Have an accurate up to date model, be able to help with clash detection, and use the software for scheduling purposes.	Aug 6, 2012 11:06 AM

Page 2, Q5. What software packages are used by CMs for management and coordination?

1	In my experence very little was used.	Aug 19, 2012 6:24 PM
2	Autodesk Navisworks (coordination, scheduling, clash detection), Autodesk Revit, VICO (estimating), MC2 (estimating), and Primavera (scheduling)	Aug 17, 2012 5:06 AM
3	Not sure.	Aug 15, 2012 1:41 PM
4	I am part of a project using Navisworks for coordination between all of the trades.	Aug 6, 2012 11:06 AM

Page 2, Q6. What information should masonry contractors provide in digital form to facilitate the CM's job?

1	That is one of the reasons I have agreed to set in on this program. To learn more of what is out there and bring it back to Floridia Contractors and the Masonry Association of Fl., talk about it and bring their thoughts back to the BIMM Team.	Aug 19, 2012 6:24 PM
2	Wind bracing, layouts, control joints, etc.	Aug 17, 2012 5:06 AM
3	Submittals, shop drawings, RFI responses and change order request.	Aug 15, 2012 1:41 PM
4	Shop drawings for anchor systems, rebar, scaffold and bracing. Anything that helps with trade coordination.	Aug 15, 2012 1:12 PM
5	We were required to locate bond beams and masonry piers for clash detection.	Aug 6, 2012 11:06 AM

Page 2, Q7. Do you communicate with other design and construction professionals through BIM models? If so, is this method of communication a project or contractual requirement? How can these communications be improved? Are there specific aspects of these improvements that apply to masonry design and construc...

1	No I have little experience with BIM.	Aug 19, 2012 6:24 PM
2	Some projects we have started to engage in BIM delivery; however, BIM has been very limited. We are using it mainly for overhead coordination for now. Mechanical and sheet metal contractors have been leading our industry for the time being. This is mostly a project requirement for now.	Aug 17, 2012 5:06 AM
3	Not a this juncture.	Aug 15, 2012 1:41 PM
4	N/A	Aug 6, 2012 11:06 AM

BIM-M: Construction Management Workgroup

SurveyMonkey

What are design tasks within a masonry project that you find difficult to achieve with the current software? (general design tasks such as 1- selection, 2- generation / composition, 3- evaluation and 4-modification / exploration of alternatives)

	Response Percent	Response Count
Masonry Unit Selection	0.0%	0
Masonry Coursing and Dimensioning	0.0%	0
Modular Coordination	0.0%	0
Decorative Patterning such as Quoins, Ledges, Headers, Corbels, Projections, Recesses, Water Tables, Arches	0.0%	0
Openings (Door and Window)	0.0%	0
Masonry Backup Systems and Associated Details	0.0%	0
Construction details	**100.0%**	**1**
Structural analysis and design	0.0%	0
Energy analysis and design	0.0%	0
Restoration	**100.0%**	**1**
Other (please specify)		2
answered question		**1**
skipped question		**4**

Page 3, Q3. What are design tasks within a masonry project that you find difficult to achieve with the current software? (general design tasks such as 1- selection, 2- generation / composition, 3- evaluation and 4- modification / exploration of alternatives)

1	Most designers still use preloaded 2D details that they have had for years. They add no additional information to the model.	Aug 17, 2012 5:16 AM
2	Unfamiliar with this type of software.	Aug 15, 2012 2:04 PM

BIM-M: Construction Management Workgroup

SurveyMonkey

What information would architects like to have in digital/electronic format?

		Response Percent	Response Count
Information on material, unit size, and color of different masonry types		50.0%	1
Information regarding code requirements for connectors, ties, anchoring and reinforcement types		**100.0%**	**2**
Information on quantity take offs and cost-estimates		50.0%	1
Information on mortar types and colors		0.0%	0
Structural, seismic, fire codes		50.0%	1
Assembly / construction issues and processes		50.0%	1
Energy and sustainability related information		50.0%	1
		Other (please specify)	0
		answered question	**2**
		skipped question	**3**

BIM-M: Construction Management Workgroup

SurveyMonkey

What information would architects like to have in digital/electronic format?

		Response Percent	Response Count
Information on material, unit size, and color of different masonry types		50.0%	1
Information regarding code requirements for connectors, ties, anchoring and reinforcement types		**100.0%**	**2**
Information on quantity take offs and cost-estimates		50.0%	1
Information on mortar types and colors		0.0%	0
Structural, seismic, fire codes		50.0%	1
Assembly / construction issues and processes		50.0%	1
Energy and sustainability related information		50.0%	1
		Other (please specify)	0
		answered question	**2**
		skipped question	**3**

Page 3, Q6. In developing a building project with significant inclusion of masonry, what kinds of technical advice is needed to facilitate the project? How could this advice and interaction be embedded or facilitated by your CAD/BIM tools?

1	Reinforcing steel layout, simplifying embedded connections, and use of std masonry units and colors in lieu of special order materials. Unfaliliar with CAD/BIM software to comment.	Aug 15, 2012 2:04 PM

BIM-M: Construction Management Workgroup

SurveyMonkey

What kinds of interfaces should BIM software for masonry provide?

	Response Percent	Response Count
Energy analysis	**100.0%**	**2**
Dewpoint analysis	50.0%	1
Automatic generation of details	**100.0%**	**2**
Automatic generation of specifications	**100.0%**	**2**
Drainage plane / weather barrier analysis	**100.0%**	**2**
Cost estimation (initial construction cost and life cycle costs)	50.0%	1
Other (please specify)		0
answered question		**2**
skipped question		**3**

Page 3, Q8. Some people involved in architectural masonry work, like others in the construction industry, are not comfortable with information technology tools. Is this an important problem the industry should address? Please tell us of the reasons for your answer and how we might improve the education of in...

1	If you do not have the necessary knowledge or skills required to utilize info technology tools, then they are wasted. Training, education and continuing education are necessary to bring the industry up to date with competing alternative materials. To improve education of the industry professional in the near term could be done through required continuing educations credits, trade conventions, local colleges, etc. Long term, it must be incorporated into related curiculums.	Aug 15, 2012 2:04 PM

BIM-M: Construction Activities WorkGroup

SurveyMonkey

1. Though you may answer the survey anonymously, we prefer that you provide your name and email address:

		Response Percent	Response Count
Name		100.0%	15
Email		100.0%	15
	answered question		15
	skipped question		2

2. Please tell us a little about yourself and your business. Which best describes your line of work:

	Response Percent	Response Count
Architect or designer	12.5%	2
Engineer	0.0%	0
Masonry Contractor	**43.8%**	**7**
General Contractor	0.0%	0
CAD/BIM draftsman	0.0%	0
CAD/BIM manager	0.0%	0
Material Supplier	0.0%	0
Masonry Industry Representative	25.0%	4
Software Provider or Programmer	18.8%	3
Other (please specify)		0
answered question		**16**
skipped question		**1**

3. What is your role in the BIM-Masonry project? (select all that apply)

	Response Percent	Response Count
Workgroup member	**92.3%**	**12**
Executive board member	23.1%	3
AEC industry stakeholder	0.0%	0
answered question		**13**
skipped question		**4**

4. Do you personally use CAD or BIM tools?

		Response Percent	Response Count
Yes		31.3%	5
No		**68.8%**	**11**
		answered question	**16**
		skipped question	**1**

5. Do you manage users of CAD or BIM tools?

		Response Percent	Response Count
Yes		18.8%	3
No		**81.3%**	**13**
		answered question	**16**
		skipped question	**1**

6. Masonry construction at the unit placement level, involves many interrelated tasks. Please check all the tasks below where construction information technology could improve mason contractor effectiveness and comment on how that might change current contractor operations.

	Response Percent	Response Count
Preliminary or alternate estimates to assist designers with material selection decisions	90.0%	9
Detailed Material take-offs and cost-estimating	**100.0%**	**10**
Shop drawing production	90.0%	9
Production planning, including crew sequencing and scheduling	**100.0%**	**10**
Interference Checking	70.0%	7
Scaffolding planning, design, and erection	70.0%	7
Shoring	50.0%	5
Material delivery	70.0%	7
Complex detailing at masonry interfaces	**100.0%**	**10**
Dimensional locating of masonry walls and units	70.0%	7
Layout of foundation dowels for masonry walls	60.0%	6
Coordination with MEP	90.0%	9
OTJ training of masons and allied craftworkers	50.0%	5
Construction safety	60.0%	6
Site management of material and equipment	60.0%	6

Masonry cleaning	40.0%	4
Masonry inspections and testing	50.0%	5
Wall bracing	50.0%	5
Product/System warranties and other building commissioning items	60.0%	6
	answered question	**10**
	skipped question	**7**

7. Are there other masonry construction tasks where BIM may play a role in addition to the list above?

	Response Percent	Response Count
1	**100.0%**	**4**
2	25.0%	1
3	25.0%	1
	answered question	**4**
	skipped question	**13**

Page 1, Q1. Though you may answer the survey anonymously, we prefer that you provide your name and email address:

	Name	
1	Kelly Shrum	Aug 27, 2012 5:21 AM
2	Jeff Buczkiewicz	Aug 20, 2012 9:48 AM
3	Jerry Painter	Aug 19, 2012 4:44 PM
4	Darrell McMillian	Aug 19, 2012 4:51 AM
5	francisco valdes	Aug 18, 2012 3:48 PM
6	Buddie Barnes	Aug 16, 2012 11:42 AM
7	Greig Carnevale	Aug 9, 2012 8:24 AM
8	John Chrysler	Aug 7, 2012 8:51 AM
9	Mark Goldberg & Bill Pacetti Jr.	Aug 7, 2012 7:21 AM
10	Bill Pacetti	Aug 7, 2012 6:28 AM
11	Heath Holdaway	Aug 6, 2012 9:08 AM
12	Eric Winter	Aug 6, 2012 6:36 AM
13	Matthew B. Jollay	Aug 1, 2012 8:10 AM
14	John Chrysler	Jul 31, 2012 2:03 PM
15	Heath Holdaway	Jul 31, 2012 12:07 PM
	Email	
1	kelly@smithmasonry.com	Aug 27, 2012 5:21 AM
2	jeffb@masoncontractors.org	Aug 20, 2012 9:48 AM
3	jerry@paintermasonry.com	Aug 19, 2012 4:44 PM
4	misldarrell@masonrystl.org	Aug 19, 2012 4:51 AM
5	fvaldes6@gatech.edu	Aug 18, 2012 3:48 PM
6	buddiebarnes@deebrown.com	Aug 16, 2012 11:42 AM
7	gcarnevale@davenportmasonry.com	Aug 9, 2012 8:24 AM
8	jc@masonryinstitute.org	Aug 7, 2012 8:51 AM
9	Support@Tradesmens.com	Aug 7, 2012 7:21 AM
10	billjr@tradesmens.com	Aug 7, 2012 6:28 AM

Page 1, Q1. Though you may answer the survey anonymously, we prefer that you provide your name and email address:

11	heath@imsmasonry.com	Aug 6, 2012 9:08 AM
12	eric.winter@smartbim.com	Aug 6, 2012 6:36 AM
13	matt@jollaymasonry.com	Aug 1, 2012 8:10 AM
14	jc@masonryinstitute.org	Jul 31, 2012 2:03 PM
15	heath@imsmasonry.com	Jul 31, 2012 12:07 PM

Page 2, Q2. Are there other masonry construction tasks where BIM may play a role in addition to the list above?

	1	
1	Coordination with steel fabricators for embed items masons need to install for the steel supplier	Aug 27, 2012 5:24 AM
2	Installation related sustainability and lean construction project criteria.	Aug 19, 2012 5:46 AM
3	aplicability of standards and tolerancing	Aug 18, 2012 3:53 PM
4	Keeping gneric project specifications up-to-date and applicable for products on project	Aug 7, 2012 9:12 AM
	2	
2	3D creation and viewing of masonry related details for sharing with designers and craftworkers.	Aug 19, 2012 5:46 AM
	3	
2	Real-time weather data for coordinating and implementing hot/cold weather and wall bracing provisions.	Aug 19, 2012 5:46 AM

Page 2, Q3. Please identify the top three tasks from question 1. above where BIM-M resources should be focused.

	1	
1	Detailed Material take-offs and cost-estimating	Aug 27, 2012 5:24 AM
2	Detailed Material take-offs and cost-estimating	Aug 20, 2012 9:53 AM
3	Detailing at complex interfaces of masonry or other material.	Aug 19, 2012 5:07 PM
4	Detailed material take-offs and cost-estimating (with final versus bid-time constuction cost tracking).	Aug 19, 2012 5:46 AM
5	Masonry construction at the unit placement level, involves many interrelated tasks. Please check all the tasks below where construction information technology could improve mason contractor effectiveness and comment on how that might change current contractor operations. Preliminary or alternate estimates to assist designers with material selection decisions	Aug 18, 2012 3:53 PM
6	Shop drawing production	Aug 9, 2012 8:41 AM
7	Interference Checking	Aug 7, 2012 9:12 AM
8	Detailed Material take-offs and cost-estimating	Aug 6, 2012 9:23 AM
9	Material takeoff	Aug 6, 2012 6:44 AM
10	Complex detailing at masonry interfaces	Aug 1, 2012 11:33 AM
	2	
1	Production planning, including crew sequencing and scheduling	Aug 27, 2012 5:24 AM
2	Production planning, including crew sequencing and scheduling	Aug 20, 2012 9:53 AM
3	Preliminary and alternate estimates	Aug 19, 2012 5:07 PM
4	Production planning, including crew sequencing and scheduling (with scheduling including material, labor and equipment).	Aug 19, 2012 5:46 AM
5	Complex detailing at masonry interfaces	Aug 18, 2012 3:53 PM
6	Scaffolding planning, design, and erection	Aug 9, 2012 8:41 AM
7	Coordinataion with MEP	Aug 7, 2012 9:12 AM
8	Production planning, including crew sequencing and scheduling	Aug 6, 2012 9:23 AM
9	Shop drawings	Aug 6, 2012 6:44 AM
10	Material take off and cost estimating	Aug 1, 2012 11:33 AM
	3	
1	Coordination with MEP	Aug 27, 2012 5:24 AM

Page 2, Q3. Please identify the top three tasks from question 1. above where BIM-M resources should be focused.		
2	Complex detailing at masonry interfaces	Aug 20, 2012 9:53 AM
3	Interference checking	Aug 19, 2012 5:07 PM
4	Shop drawing production (and other project submittals also; shop drawings should be vetted through BIM for interference checking).	Aug 19, 2012 5:46 AM
5	Shop drawing production	Aug 18, 2012 3:53 PM
6	Site management of material and equipment	Aug 9, 2012 8:41 AM
7	Complex Design with Masonry Interfaces	Aug 7, 2012 9:12 AM
8	Shop drawing production	Aug 6, 2012 9:23 AM
9	Interference detection	Aug 6, 2012 6:44 AM
10	masonry layout	Aug 1, 2012 11:33 AM

Page 2, Q4. Are there potential improvements to masonry products that would increase mason productivity and effectiveness?		
1	Any material improvements that would let the mason contractor work cleaner, faster (not harder) and with less waste of time and materials would greatly increase overall productivity and effectiveness.	Aug 19, 2012 5:46 AM
2	Continue to develop lighter masonry products to make it easier for men to lift and install. Continue to develop mortar with more consistand color and board life.	Aug 6, 2012 9:23 AM
3	Ensuring that materials are accurately produced for the job and procured in a timely manner for the project are important, but proper preparation onsite (Layout, stocking, scaffolding, lift plan) before the masons get to an area to work are what benefits production the most. Whether or not pre-assembled or unitized systems within masonry would benefit or not is still up in the air. One of the main benefits of masonry is the flexibility to work around out of tolerance conditions onsite and to fill in areas that were poorly addressed during design. Like most things, putting the proper planning before hand allows you to perform better, and that is the same whether you have a unitized type product or you lay units one by one.	Aug 1, 2012 11:33 AM

Page 2, Q5. How could improved masonry products be integrated with construction information technology and BIM?

1	Make it easier for product selection based on compatiblity, function and sizing among other things	Aug 19, 2012 5:07 PM
2	A. Materials that have basic module data includied in BIM which could then be used by the designer to better locate door and window openings, etc., and reduce the need of field cutting masonry units. B. Standard masonry BIM details that have been vetted through the industry for installation efficiency. C. Masonry shop drawing capability in BIM (including interference checking). D. BIM tool(s) for designing and approving masonry sample panels and mock-ups.	Aug 19, 2012 5:46 AM
3	Don't know.	Aug 6, 2012 9:23 AM
4	If you had the ability to prefabricate some aspects of masonry, it seems as though BIM would have to be integrated to ensure proper integration into a model and search for potential clash conflicts. Flexibility would have to be built into the systems as well to ensure for tolerances and variations that occur onsite. Similar to the glass curtainwall industry.	Aug 1, 2012 11:33 AM

Page 2, Q6. In case of a mason contractor installing masonry veneers:

	Where could information technology help?	
1	More and better detailing	Aug 19, 2012 5:07 PM
2	Anything that would increase the flow of information regarding material supply and job-site stocking, labor assignment, project schedule milestones, project construction requirements, etc.	Aug 19, 2012 5:46 AM
3	Location and sizes of misc. support steel, site management and equipment, scaffolding planning, design, and erection	Aug 9, 2012 8:41 AM
4	Consistancy with code and generally accepted industry practice	Aug 7, 2012 9:12 AM
5	Detailed Material take-offs and cost-estimating / Complex detailing at masonry interfaces	Aug 6, 2012 9:23 AM
6	If the money was able to support the service, we could have a better handle throughout all processes.	Aug 1, 2012 11:33 AM
	Which issues are the most important, from a mason contractor business and profit standpoint?	
1	Dimensions, layout and coordination with MEP	Aug 19, 2012 5:07 PM
2	Increased production rates, reduced material and equipment waste, accurate cost tracking.	Aug 19, 2012 5:46 AM
3	Production, safety	Aug 9, 2012 8:41 AM
4	Project coordination and smooth flow of work	Aug 7, 2012 9:12 AM
5	Coordination and sequencing of other trades.	Aug 6, 2012 9:23 AM
6	Ensuring that the investment allows for a pay off. This can happen in multiple ways, but it needs to occur.	Aug 1, 2012 11:33 AM
	In the placement of masonry products, what could improve installer productivity and effectiveness?	
1	Both of the above	Aug 19, 2012 5:07 PM
2	Daily and weekly list(s) of project material and labor needs (including project schedule milestones) and BIM generated veneer elevations and details for installation.	Aug 19, 2012 5:46 AM
3	Having a crystal clear plan on what work is to be done and how to do it, Coordination with other trades (access to work, scaffolding, flashings, opening details, etc.)	Aug 9, 2012 8:41 AM
4	Having the preceding work (substrate and support) completed and ancilary products present and layed out	Aug 7, 2012 9:12 AM
5	Coordination and sequencing of other trades.	Aug 6, 2012 9:23 AM
6	Layout takes up a good bit of time, also ensuring that other aspects are in place correctly for our system occupies are time significantly before we start laying	Aug 1, 2012 11:33 AM

Page 2, Q6. In case of a mason contractor installing masonry veneers:

units in the wall. If there are marked materials that coordinate to exact placement points, such as on a large scale stone job, this can also decrease productivity while they wait for a piece to be located.

Page 2, Q7. In case of a mason contractor installing structural (load-bearing) masonry:

	Where could information technology help?	
1	Same as above	Aug 19, 2012 5:07 PM
2	Anything that would increase the flow of information regarding material supply and job-site stocking, labor assignment, project schedule milestones, project construction requirements, etc.	Aug 19, 2012 5:46 AM
3	Locations of steel embeds, reinforcing requirements, scaffolding planning, design, and erection, schedule, Site management of material and equipment	Aug 9, 2012 8:41 AM
4	Consistancy with code and generally accepted industry practice	Aug 7, 2012 9:12 AM
5	Detailed Material take-offs and cost-estimating / Shop drawing production / Wall bracing	Aug 6, 2012 9:23 AM
6	Some benefits could be made in reinforcement placement, CJ placement, etc, but all these are minimal in my opinion.	Aug 1, 2012 11:33 AM
	Which issues are the most important, from a mason contractor business and profit standpoint?	
1	Ditto	Aug 19, 2012 5:07 PM
2	Increased production rates, reduced material and equipment waste, accurate cost tracking.	Aug 19, 2012 5:46 AM
3	Production, safety	Aug 9, 2012 8:41 AM
4	Project coordination and smooth flow of work	Aug 7, 2012 9:12 AM
5	Coordination and sequencing of other trades.	Aug 6, 2012 9:23 AM
6	Again, having the time to allocate to the productive installation of masonry is what counts the most. Many times, a OPS does not allow for proper allocation of crew size and production to achieve a cost effective installation. This causes you to bounce around a job, further lowering productivity and increasing overhead cost per unit as well.	Aug 1, 2012 11:33 AM
	In the placement of masonry products, what could improve installer productivity and effectiveness?	
1	Ditto	Aug 19, 2012 5:07 PM
2	Daily and weekly list(s) of project material and labor needs (including project schedule milestones and special inspection schedules); BIM generated shop drawings (A/E approved; including wall elevations and details) for installation.	Aug 19, 2012 5:46 AM
3	Having a crystal clear plan on what work is to be done and how to do it. Coordination with other trades (access to work, scaffolding, flashings, opening details, etc.)	Aug 9, 2012 8:41 AM
4	Access to work area and acilary products present and layed out	Aug 7, 2012 9:12 AM
5	Lighter units.	Aug 6, 2012 9:23 AM

Page 2, Q8. From a mason contractor standpoint, what are the biggest issues regarding material supply and delivery?

	Issue 1	
1	Availability	Aug 19, 2012 5:07 PM
2	Having designers and owners make material choices as early as possible in the design process.	Aug 19, 2012 5:46 AM
3	Schedule	Aug 9, 2012 8:41 AM
4	Clear specification of material requirements (e.g. not specifying CMU as f'm = 2,500psi)	Aug 7, 2012 9:12 AM
5	Lead times of material.	Aug 6, 2012 9:23 AM
6	Ensuring product meets owner/architect/contractor expectations	Aug 1, 2012 11:33 AM
	Issue 2	
1	On time delivery	Aug 19, 2012 5:07 PM
2	Balancing "just in time" delivery and available job-site storage space.	Aug 19, 2012 5:46 AM
3	Shop drawings	Aug 9, 2012 8:41 AM
4	Time to acquire materials (e.g. contract issued one day and starting project next day)	Aug 7, 2012 9:12 AM
5	Inconsistant colors in the material.	Aug 6, 2012 9:23 AM
6	Educating the owner/architect/contractor on product/installation tolerances and how processes have to occur to complete effectively.	Aug 1, 2012 11:33 AM
	Issue 3	
1	MSDS and LEEDs paperwork	Aug 19, 2012 5:07 PM
2	Identification and tracking of special units for availability and lead-time for delivery.	Aug 19, 2012 5:46 AM
3	Site logistics	Aug 9, 2012 8:41 AM
4	Understanding implications of mortar (proportion v. property requirements)	Aug 7, 2012 9:12 AM
5	Trucking costs for heavy material.	Aug 6, 2012 9:23 AM
6	Product handling and transfer- ensuring no damage	Aug 1, 2012 11:33 AM
	Issue 4	
1	Price/economy	Aug 19, 2012 5:07 PM
2	Collecting and following product warranty information related to manufacturer and A/E acceptance and contractor installation.	Aug 19, 2012 5:46 AM

Page 2, Q8. From a mason contractor standpoint, what are the biggest issues regarding material supply and delivery?

6	Product marking and tracking. If you have a large scale stone job (thin or standard veneer) its alot like putting together a puzzle, therefore lay down and tracking becomes increasingly important onsite to ensure a productive operation is accomplished.	Aug 1, 2012 11:33 AM
	Other	
2	Facilitating and tracking of all project material submittals and substitutions.	Aug 19, 2012 5:46 AM

Page 2, Q9. From a mason contractor standpoint how could material supply be improved? Will construction information technology and BIM play a role? If yes, explain how?

1	Tracking use (installation count), inventory control and delivery scheduling	Aug 19, 2012 5:07 PM
2	Any and all of the items listed in No. 8. Yes, I believe CIT/BIM should play a role, especially by facilitating the flow of project information to and from the mason contractor.	Aug 19, 2012 5:46 AM
3	Speeding up the shop drawing process, getting answers back on questions quickier, especially involving other trades.	Aug 9, 2012 8:41 AM
4	Lead times might be quicker if we can have detailed material take-offs quicker.	Aug 6, 2012 9:23 AM
5	Yes, most notably in the dimensional stone veneer segment and integrating that through from the supplier to the subcontractor to the architect.	Aug 1, 2012 11:33 AM

Page 2, Q10. Do you communicate with other design and construction professionals through BIM models? If so, is this method of communication a project or contractual requirement? How can these communications be improved? Are there specific aspects of these improvements that apply to masonry design and construc...

1	No	Aug 19, 2012 5:07 PM
2	No, not yet.	Aug 19, 2012 5:46 AM
3	So far have not worked in a BIM model, most of the projects we work on have a BIM model and other trades are required to work in, but Masonry typically is not required to take part.	Aug 9, 2012 8:41 AM
4	No	Aug 7, 2012 9:12 AM
5	By establishing clear standards for the internal model design from a mason's point of view. At some level less is more, a limited model that we can rely upon being be fully imported is more useful than an open ended model that might contain anything.	Aug 7, 2012 7:22 AM
6	No I don't.	Aug 6, 2012 9:23 AM
7	Currently we do not. I think it is coming soon though. Our trade or scope does not have this requirement as many times the subcontractors utilized do not have this level of sophistication.	Aug 1, 2012 11:33 AM

Page 3, Q1. What CAD software do you use in the architectural design of masonry buildings?

1	none	Aug 7, 2012 6:27 AM

Page 3, Q2. What are the available BIM software that you use or could be used in the architectural design of masonry structure?

1	n/a	Aug 7, 2012 6:27 AM

Page 3, Q3. What are design tasks within a masonry project that you find difficult to achieve with the current software? (general design tasks such as 1- selection, 2- generation / composition, 3- evaluation and 4- modification / exploration of alternatives)

1	Tradesmen's 3D Master Estimator supports most of these already.	Aug 7, 2012 6:27 AM

Page 3, Q4. What should the masonry industry be doing to better promote the use of its products to architects?		
1	On-going cross checking of the design process with applicable codes and standards.	Aug 19, 2012 5:53 AM
2	n/a	Aug 7, 2012 6:27 AM
3	BIM add ons for masonry coursing and takeoffs	Aug 6, 2012 6:47 AM

Page 3, Q5. What information would architects like to have in digital/electronic format?		
1	n/a	Aug 7, 2012 6:27 AM

Page 3, Q6. In developing a building project with significant inclusion of masonry, what kinds of technical advice is needed to facilitate the project? How could this advice and interaction be embedded or facilitated by your CAD/BIM tools?		
1	Have a fully detailed model, including banding, special pieces, recessing, projecting etc. for each spot in the entire project.	Aug 7, 2012 7:24 AM
2	full masonry detailed model for each area of a project.	Aug 7, 2012 6:27 AM

Page 3, Q7. What kinds of interfaces should BIM software for masonry provide?		
1	Dimensional guidance for laying out walls and openings based on standard masonry material module sizes.	Aug 19, 2012 5:53 AM

Page 3, Q8. Some people involved in architectural masonry work, like others in the construction industry, are not comfortable with information technology tools. Is this an important problem the industry should address? Please tell us of the reasons for your answer and how we might improve the education of in...		
1	refer to Mark Goldberg response.	Aug 7, 2012 6:27 AM

Page 4, Q5. How would you like the structural analysis software to interact with other software?		
1	On-going cross checking of the structural design with masonry codes and	Aug 19, 2012 5:55 AM

Page 4, Q5. How would you like the structural analysis software to interact with other software?

	standards.	

Page 4, Q6. How important is interoperability between design and modeling software?

1	Unless I'm misunderstanding your terms, Design software should be modelling software. So there is no interoperability issue at all.	Aug 7, 2012 7:25 AM
2	Very important.	Aug 6, 2012 6:48 AM

Page 4, Q8. In designing and analyzing masonry structural systems in your practice, what aspects are important to you?

1	Masonry shop drawing production and review.	Aug 19, 2012 5:55 AM

Page 4, Q10. Some people involved in structural masonry work, like others in the construction industry, are not comfortable with information technology tools. Is this an important problem the industry should address? Please tell us of the reasons for your answer and how we might improve the education of indus...

1	Software usability and user knowledge are inherent problems in information technology. It is incumbent upon the software designers to create as intuitive and power product as possible. At the same time, the user has some responsibility to understand common user interfaces.	Aug 7, 2012 7:25 AM

Page 5, Q1. What are the hardest aspects of masonry systems to coordinate and manage?

1	Coursing	Aug 6, 2012 6:49 AM

Page 6, Q6. One of the potential issues in the masonry supply chain is the specification and classification of masonry units. What steps should be taken to improve the specification and classification of units? How can specifications and classifications of masonry units be embedded in BIM?

1	Among other things, Material classications should be associated with a dimensionality (each, lineal, area, volume).	Aug 7, 2012 7:26 AM

BIM-M: Materials Supplier WorkGroup

SurveyMonkey

Though you may answer the survey anonymously, we prefer that you provide your name and email address:

		Response Percent	Response Count
Name		100.0%	5
Email		100.0%	5
	answered question		5
	skipped question		1

Page 1, Q1. Though you may answer the survey anonymously, we prefer that you provide your name and email address:

	Name	
1	Chad Pyles	Aug 27, 2012 7:26 PM
2	Kurt Siggard	Aug 27, 2012 10:22 AM
3	Brian Trimble	Aug 17, 2012 7:58 AM
4	Don Strange	Aug 12, 2012 11:06 AM
5	Chad Pyles	Aug 8, 2012 2:39 PM
	Email	
1	chadp@specblockusa.com	Aug 27, 2012 7:26 PM
2	kurt@cmacn.org	Aug 27, 2012 10:22 AM
3	btrimble@bia.org	Aug 17, 2012 7:58 AM
4	don.strange@paccoast.com	Aug 12, 2012 11:06 AM
5	chadp@specblockusa.com	Aug 8, 2012 2:39 PM

BIM-M: Materials Supplier WorkGroup

SurveyMonkey

Please tell us a little about yourself and your business. Which best describes your line of work:

		Response Percent	Response Count
Architect or designer		0.0%	0
Engineer		0.0%	0
Masonry Contractor		0.0%	0
General Contractor		0.0%	0
CAD/BIM draftsman		0.0%	0
CAD/BIM manager		0.0%	0
Material Supplier		**60.0%**	**3**
Masonry Industry Representative		40.0%	2
Software Provide or Programmer		0.0%	0
		Other (please specify)	1
		answered question	**5**
		skipped question	**1**

Page 1, Q2. Please tell us a little about yourself and your business. Which best describes your line of work:

1	trade association, so like material supplier	Aug 20, 2012 1:28 PM

BIM-M: Materials Supplier WorkGroup

SurveyMonkey

What is your role in the BIM-Masonry project? (select all that apply)

		Response Percent	Response Count
Workgroup member		**100.0%**	**6**
Executive board member		0.0%	0
AEC industry stakeholder		0.0%	0
	answered question		**6**
	skipped question		**0**

BIM-M: Materials Supplier WorkGroup

Do you personally use CAD or BIM tools?

		Response Percent	Response Count
Yes		16.7%	1
No		**83.3%**	**5**
		answered question	**6**
		skipped question	**0**

BIM-M: Materials Supplier WorkGroup

SurveyMonkey

Do you manage users of CAD or BIM tools?

		Response Percent	Response Count
Yes		16.7%	1
No		**83.3%**	**5**
		answered question	**6**
		skipped question	**0**

BIM-M: Materials Supplier WorkGroup

SurveyMonkey

Masonry material supply involves multiple steps. How can each of these steps be improved, using computers and information technology?

	Response Percent	Response Count
Raw material handling	75.0%	3
Masonry unit production	75.0%	3
Finishing	75.0%	3
Packaging	75.0%	3
Warehousing or batching	75.0%	3
Shipping and site placement logistics	**100.0%**	**4**
Others	50.0%	2
	answered question	**4**
	skipped question	**2**

Page 2, Q1. Masonry material supply involves multiple steps. How can each of these steps be improved, using computers and information technology?

	Raw material handling	
1	Better efficiency and inventory control less waste	Aug 27, 2012 7:45 PM
2	the cement industry is already highly automated and computerized for the manufacture or cement	Aug 24, 2012 12:25 PM
3	implementing correct accounting for the types and amounts of raw materials	Aug 17, 2012 8:14 AM
	Masonry unit production	
1	Fewer culls, increased standardization	Aug 27, 2012 7:45 PM
2	not applicable for cement	Aug 24, 2012 12:25 PM
3	ability to control various aspects of manufacturing along with quality control	Aug 17, 2012 8:14 AM
	Finishing	
1	Consistency	Aug 27, 2012 7:45 PM
2	not applicable for cement	Aug 24, 2012 12:25 PM
3	N/A	Aug 17, 2012 8:14 AM
	Packaging	
1	Increase output	Aug 27, 2012 7:45 PM
2	see shipping and site placement	Aug 24, 2012 12:25 PM
3	allow various packaging to be used depending on the customer's needs not what the packaging equipment can handle	Aug 17, 2012 8:14 AM
	Warehousing or batching	
1	Inventory control and efficiency	Aug 27, 2012 7:45 PM
2	already optimized for cement	Aug 24, 2012 12:25 PM
3	accurate inventory control using UPC/RFID or other identification	Aug 17, 2012 8:14 AM
	Shipping and site placement logistics	
1	Efficiency	Aug 27, 2012 7:45 PM
2	differences exist for delivery methods: bagged (palletized) vs. bulk (silo). bags require site storage, disposal, pallets shold be recycled. silos require electricity and water hook-ups, refilling dry mortar or cement mixture. this plays into what kind of support or services are offered from supplier and how best to accommodate the needs of the project	Aug 24, 2012 12:25 PM
3	accurate shipping information that could possibly track mileage for LEED	Aug 17, 2012 8:14 AM

Page 2, Q1. Masonry material supply involves multiple steps. How can each of these steps be improved, using computers and information technology?

	reporting	
4	Accurate quantity surveys	Aug 12, 2012 11:13 AM
	Others	
1	Accurate reporting	Aug 27, 2012 7:45 PM
2	none	Aug 24, 2012 12:25 PM

BIM-M: Materials Supplier WorkGroup

SurveyMonkey

Are there specific “long lead time” materials in the masonry industry that often cause delays in masonry construction? Please list them. Do you envision a way for Construction IT to help address these delays? How?

	Response Count
	4
answered question	4
skipped question	2

Page 2, Q2. Are there specific “long lead time” materials in the masonry industry that often cause delays in masonry construction? Please list them. Do you envision a way for Construction IT to help address these delays? How?

1	Architectural units - increase efficiency and consistency	Aug 27, 2012 7:45 PM
2	not so for cement (mortar, grout)	Aug 24, 2012 12:25 PM
3	Special shapes. IT systems could formulate a plan to get the materials made in an appropriate time frame so that they are delivered with the regular units. This may include new ways of forming and firing materials in a quicker time frame while still maintaining quality and durability.	Aug 17, 2012 8:14 AM
4	Shaper caps, blades, forming equipment	Aug 12, 2012 11:13 AM

Page 2, Q3. Are there specific problems in the clay, concrete, cut stone or cast stone industries that should be addressed by this effort? If so, please list them.

1	color consistency in colored concrete units	Aug 27, 2012 7:45 PM
2	not applicable for cement	Aug 24, 2012 12:25 PM
3	Making it easy for a designer to use masonry with the computer programs they are used to working with.	Aug 17, 2012 8:14 AM
4	The brick industry works more towards the back end of projects, preferring to show up on bid or after reather than earlier in the design phases.	Aug 12, 2012 11:13 AM

Page 2, Q4. What are the issues that could be improved in dealing with the procurement and delivery of masonry accessories, such as ties, anchors, reinforcing, etc? Can you imagine how construction information technology and BIM might play a role in these issues?

1	Having a true and accurate take off of these materials going into the project	Aug 27, 2012 7:45 PM
2	not applicable for cement	Aug 24, 2012 12:25 PM
3	BIM models could accurately detemine quantities, deliver them to the jobsite on a just in time method and onto the proper scaffold so handling is kept to a minimum along with potential damage to the product.	Aug 17, 2012 8:14 AM

Page 2, Q5. How can masonry material tracking and delivery be improved?

1	Having a true list of material needed for each section on the project	Aug 27, 2012 7:45 PM
2	cement industry already does this well	Aug 24, 2012 12:25 PM
3	Make it less susceptible to problems that are occuring at the jobsite - delays in bringing in a crane, clearing blockage due to other delivery vehicles, mason not being onsite to accept delivery, etc.	Aug 17, 2012 8:14 AM
4	Orders could be better checked vs. foremans daily production reports.	Aug 12, 2012 11:13 AM

Page 2, Q6. One of the potential issues in the masonry supply chain is the specification and classification of masonry units. What steps should be taken to improve the specification and classification of units? How can specifications and classifications of masonry units be embedded in BIM?

1	A system that can choose the proper specification and classification needed per the design, but does not over engineer	Aug 27, 2012 7:45 PM
2	not applicable for cement	Aug 24, 2012 12:25 PM
3	I don't really see this as being a problem. the only issue may be the proper delivery of the correct hollow or solid unit, having the right compressive strength, fire resistance rating, etc. As long as those units don't get mixed up, it will keep the mason from thinking so hard if he/she is using the correct unit in the correct application or location. Is there a way to attach RFID tags into/onto units that the production, classificiation moves with the material throughout the construction process - and maybe beyond into the use phase. An owner can verify the materials used even after 50 years since the information is embedded in the wall.	Aug 17, 2012 8:14 AM
4	Interstate Brick does so currently	Aug 12, 2012 11:13 AM

Page 2, Q7. Do you communicate with other design and construction professionals through BIM models? If so, is this method of communication a project or contractual requirement? How can these communications be improved? Are there specific aspects of these improvements that apply to masonry design and construc...

1	Not at this time	Aug 27, 2012 7:45 PM
2	do not currently communicate with others through BIM, but appreciate being included in the process to make sure that all cementitious materials and mortar or grout formulations are properly included	Aug 24, 2012 12:25 PM
3	Not yet.	Aug 17, 2012 8:14 AM
4	More a communication method at this time.	Aug 12, 2012 11:13 AM

Page 3, Q4. What should the masonry industry be doing to better promote the use of its products to architects?

1	masonry industry already does a lot of training for architects and this needs to continue	Aug 24, 2012 12:32 PM

Page 3, Q6. In developing a building project with significant inclusion of masonry, what kinds of technical advice is needed to facilitate the project? How could this advice and interaction be embedded or facilitated by your CAD/BIM tools?

1	current project specifications are a must. many architects don't have time to know much about cement, mortar, or grout, so having popups or dropdowns embedded into BIM tools could save them a lot of time	Aug 24, 2012 12:32 PM

BIM-M: Materials Supplier WorkGroup

SurveyMonkey

What kinds of interfaces should BIM software for masonry provide?

	Response Percent	Response Count
Energy analysis	50.0%	1
Dewpoint analysis	0.0%	0
Automatic generation of details	**100.0%**	**2**
Automatic generation of specifications	**100.0%**	**2**
Drainage plane / weather barrier analysis	0.0%	0
Cost estimation (initial construction cost and life cycle costs)	**100.0%**	**2**
Other (please specify)		1
answered question		**2**
skipped question		**4**

Page 3, Q7. What kinds of interfaces should BIM software for masonry provide?

1	in my opinion, dewpoint and drainage plane are important and related issues, but not perhaps as necessary for structural modeling.	Aug 24, 2012 12:32 PM

BIM-M: Materials Supplier WorkGroup

SurveyMonkey

Some people involved in architectural masonry work, like others in the construction industry, are not comfortable with information technology tools. Is this an important problem the industry should address? Please tell us of the reasons for your answer and how we might improve the education of industry professionals.

		Response Percent	Response Count
Yes		100.0%	2
No		0.0%	0
		Why?	2
		answered question	2
		skipped question	4

Page 3, Q8. Some people involved in architectural masonry work, like others in the construction industry, are not comfortable with information technology tools. Is this an important problem the industry should address? Please tell us of the reasons for your answer and how we might improve the education of in...

1	it will be critical to expose architects to these tools so that they are well understood and properly used. hands-on learning should be helpful along with webinars to introduce the material	Aug 24, 2012 12:32 PM
2	Because most salesmen who interact with design professionals only know color and price, and sell that way. Few know how to design or build.	Aug 12, 2012 11:18 AM

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SurveyMonkey

Do you create structural models with one piece of software and use a different analysis package, or do you use an integrated modeling and analysis package?

	Response Count
	2
answered question	2
skipped question	4

Page 4, Q1. Do you create structural models with one piece of software and use a different analysis package, or do you use an integrated modeling and analysis package?

1	not applicable to cement industry	Aug 24, 2012 12:33 PM
2	Different	Aug 12, 2012 11:20 AM

BIM-M: Materials Supplier WorkGroup

SurveyMonkey

What are the hardest aspects of masonry systems to coordinate and manage?

	Response Count
	2
answered question	2
skipped question	4

Page 5, Q1. What are the hardest aspects of masonry systems to coordinate and manage?

1	in my opinion, construction details and spacing of accessory elements	Aug 24, 2012 12:35 PM
2	Material lifts	Aug 12, 2012 11:22 AM

BIM-M: Materials Supplier WorkGroup

Masonry construction at the unit placement level, involves many interrelated tasks. Please check all the tasks below where construction information technology could improve mason contractor effectiveness and comment on how that might change current contractor operations.

	Response Percent	Response Count
Preliminary or alternate estimates to assist designers with material selection decisions	**100.0%**	**2**
Detailed Material take-offs and cost-estimating	**100.0%**	**2**
Shop drawing production	**100.0%**	**2**
Production planning, including crew sequencing and scheduling	**100.0%**	**2**
Interference Checking	50.0%	1
Scaffolding planning, design, and erection	50.0%	1
Shoring	50.0%	1
Material delivery	**100.0%**	**2**
Complex detailing at masonry interfaces	**100.0%**	**2**
Dimensional locating of masonry walls and units	50.0%	1

Layout of foundation dowels for masonry walls	50.0%	1
Coordination with MEP	50.0%	1
OTJ training of masons and allied craftworkers	**100.0%**	**2**
Construction safety	50.0%	1
Site management of material and equipment	50.0%	1
Masonry cleaning	**100.0%**	**2**
Masonry inspections and testing	**100.0%**	**2**
Wall bracing	50.0%	1
Product/System warranties and other building commissioning items	**100.0%**	**2**
Other 1	0.0%	0
Other 2	0.0%	0
	answered question	**2**
	skipped question	**4**

Page 6, Q1. Masonry construction at the unit placement level, involves many interrelated tasks. Please check all the tasks below where construction information technology could improve mason contractor effectiveness and comment on how that might change current contractor operations.

Preliminary or alternate estimates to assist designers with material selection decisions		
1	yes	Aug 24, 2012 12:56 PM
2	We do this	Aug 12, 2012 11:29 AM
Detailed Material take-offs and cost-estimating		
1	yes, fewer missed items and more accurate accounting	Aug 24, 2012 12:56 PM
2	We help facilitate	Aug 12, 2012 11:29 AM
Shop drawing production		
1	probably	Aug 24, 2012 12:56 PM
2	We do this	Aug 12, 2012 11:29 AM
Production planning, including crew sequencing and scheduling		
1	maybe, though this would seem to be a more complex issue	Aug 24, 2012 12:56 PM
2	We occasionally help facilitate	Aug 12, 2012 11:29 AM
Interference Checking		
1	definitely, though this would seem to be a more complex issue	Aug 24, 2012 12:56 PM
Scaffolding planning, design, and erection		
1	possibly	Aug 24, 2012 12:56 PM
Shoring		
1	yes	Aug 24, 2012 12:56 PM
Material delivery		
1	probably	Aug 24, 2012 12:56 PM
2	We do this	Aug 12, 2012 11:29 AM
Complex detailing at masonry interfaces		
1	definitely	Aug 24, 2012 12:56 PM
2	We do this	Aug 12, 2012 11:29 AM
Dimensional locating of masonry walls and units		
1	probably	Aug 24, 2012 12:56 PM
Layout of foundation dowels for masonry walls		

Page 6, Q1. Masonry construction at the unit placement level, involves many interrelated tasks. Please check all the tasks below where construction information technology could improve mason contractor effectiveness and comment on how that might change current contractor operations.

1	yes	Aug 24, 2012 12:56 PM
	Coordination with MEP	
1	definitely	Aug 24, 2012 12:56 PM
	OTJ training of masons and allied craftworkers	
1	probably, if used correctly. allows them to see small details through the big picture	Aug 24, 2012 12:56 PM
2	We occasionally do this	Aug 12, 2012 11:29 AM
	Construction safety	
1	probably helpful	Aug 24, 2012 12:56 PM
	Site management of material and equipment	
1	like delivery, probably helpful	Aug 24, 2012 12:56 PM
	Masonry cleaning	
1	less important in my view	Aug 24, 2012 12:56 PM
2	We help facilitate	Aug 12, 2012 11:29 AM
	Masonry inspections and testing	
1	probably very helpful, but this would seem to be a more complex issue. my guess is that the schedule will be constantly updated, so timing of these types of activities will continually be changing	Aug 24, 2012 12:56 PM
2	We do this	Aug 12, 2012 11:29 AM
	Wall bracing	
1	yes	Aug 24, 2012 12:56 PM
	Product/System warranties and other building commissioning items	
1	not sure	Aug 24, 2012 12:56 PM
2	We do this	Aug 12, 2012 11:29 AM
	Other 1	
	Other 2	

BIM-M: Materials Supplier WorkGroup

SurveyMonkey

Please identify the top three tasks from the list above where BIM-M resources should be focused.

		Response Percent	Response Count
1		100.0%	2
2		100.0%	2
3		50.0%	1
	answered question		2
	skipped question		4

Page 6, Q2. Please identify the top three tasks from the list above where BIM-M resources should be focused.

	1	
1	in my view, detailing	Aug 24, 2012 12:56 PM
2	Cost & Quantity surveys	Aug 12, 2012 11:29 AM
	2	
1	I could see grouping interference checking along with MEP	Aug 24, 2012 12:56 PM
2	Material order scheduling	Aug 12, 2012 11:29 AM
	3	
1	if structural safety is top priority, then bracing and shoring. if material management is more important, then estimates (including costs) and take-offs	Aug 24, 2012 12:56 PM

Page 6, Q3. Are there potential improvements to masonry products that would increase mason productivity and effectiveness?

1	lighter units, easier handling, simplified insulation strategies	Aug 24, 2012 12:56 PM

Page 6, Q4. How could improved masonry products be integrated with construction information technology and BIM?

1	allow for choices and have the product specs be pulled along for the design	Aug 24, 2012 12:56 PM

BIM-M: Materials Supplier WorkGroup

SurveyMonkey

In case of a mason contractor installing masonry veneers:

		Response Percent	Response Count
Where could information technology help?		100.0%	1
Which issues are the most important, from a mason contractor business and profit standpoint?		100.0%	1
In the placement of masonry products, what could improve installer productivity and effectiveness?		100.0%	1
	answered question		1
	skipped question		5

Page 6, Q5. In case of a mason contractor installing masonry veneers:

	Where could information technology help?	
1	material id and ordering	Aug 24, 2012 12:56 PM
	Which issues are the most important, from a mason contractor business and profit standpoint?	
1	details, cost estimating, planning/sequencing/scheduling	Aug 24, 2012 12:56 PM
	In the placement of masonry products, what could improve installer productivity and effectiveness?	
1	see question #3 above	Aug 24, 2012 12:56 PM

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In case of a mason contractor installing structural (load-bearing) masonry:

		Response Percent	Response Count
Where could information technology help?		100.0%	1
Which issues are the most important, from a mason contractor business and profit standpoint?		100.0%	1
In the placement of masonry products, what could improve installer productivity and effectiveness?		100.0%	1
	answered question		1
	skipped question		5

Page 6, Q6. In case of a mason contractor installing structural (load-bearing) masonry:

	Where could information technology help?	
1	inspections, shoring, bracing	Aug 24, 2012 12:56 PM
	Which issues are the most important, from a mason contractor business and profit standpoint?	
1	production, shoring/bracing, location of dowels	Aug 24, 2012 12:56 PM
	In the placement of masonry products, what could improve installer productivity and effectiveness?	
1	preliminary estimates, shop drawings, scaffolding design, detailing	Aug 24, 2012 12:56 PM

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SurveyMonkey

From a mason contractor standpoint, what are the biggest issues regarding material supply and delivery?

		Response Percent	Response Count
Issue 1		**100.0%**	**1**
Issue 2		**100.0%**	**1**
Issue 3		**100.0%**	**1**
Issue 4		0.0%	0
Other		0.0%	0
		answered question	**1**
		skipped question	**5**

Page 6, Q7. From a mason contractor standpoint, what are the biggest issues regarding material supply and delivery?

	Issue 1	
1	just-in-time delivery, not too much excess	Aug 24, 2012 12:56 PM
	Issue 2	
1	site storage space	Aug 24, 2012 12:56 PM
	Issue 3	
1	classifying similar materials for easy location (fewer mix-ups)	Aug 24, 2012 12:56 PM
	Issue 4	
	Other	

Page 6, Q8. From a mason contractor standpoint how could material supply be improved? Will construction information technology and BIM play a role? If yes, explain how?

1	BIM would seem to be able to help reduce lost time, better manage material delivery and storage, give avery accurate accounting of quantities, help track damaged materials (minimize losses)	Aug 24, 2012 12:56 PM