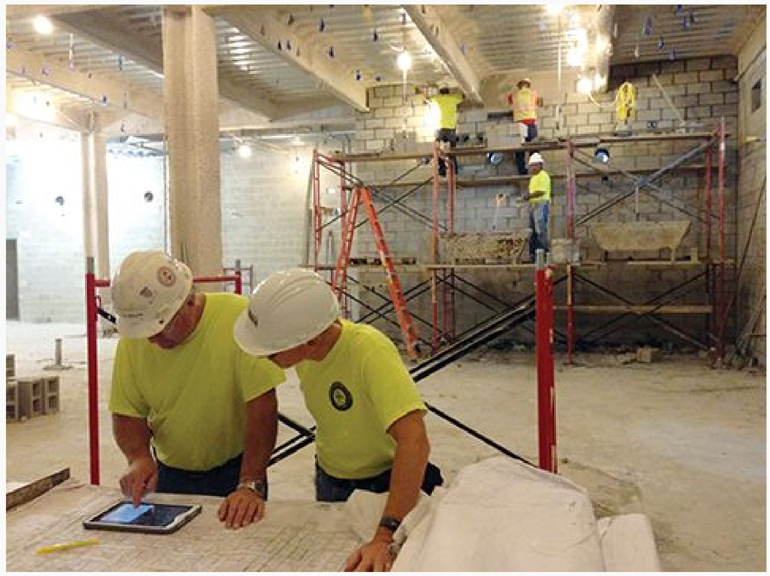
BIM for Masonry: The bricks and mortar industry enters the digital age

constructionspecifier.com/bim-for-masonry-the-bricks-and-mortar-industry-enters-the-digital-age/

By Dave Sovinski and Scott Conwell, FAIA, ALA, CSI, CDT, LEED AP



All images courtesy International Masonry Institute

Building information modeling (BIM) is changing the way construction projects are both designed and delivered, offering challenge and opportunity for stakeholders. This interoperability opens up new worlds for alternative project delivery and provides the ability to support masonry design earlier in the project than ever before.

With design-build and various types of integrated project delivery (IPD) systems entering the marketplace in greater numbers, the unit-masonry industry is already looking ahead with its BIM for Masonry (BIM-M) initiative.[1]
In 2012, a coalition of associations, companies, and individuals met at Georgia Institute of Technology to work out the initial "Roadmap for BIM-M." Professors Chuck Eastman and Russell Gentry provided support, and the group appointed David Biggs, PE, SE, as the project manager.

Primary funding for the BIM-M initiative and project leadership is from the International Union of Bricklayers and Allied Craftworkers (BAC), International Masonry Institute (IMI), Mason Contractors Association of America (MCAA), and the National Concrete Masonry Association (NCMA). Additional support comes from the Western States Clay Products Association (WSCPA), The Masonry Society (TMS), Brick Industry Association (BIA), and various regional and local groups. A partnership with the Charles Pankow Foundation supports the BIM-M efforts.

What does BIM mean for design/construction professionals?
The initiative's first project—to provide a unit masonry data base for developers of BIM software—is well underway. Brick, concrete masonry unit (CMU), and cast-stone manufacturers are sharing data on unit shapes, sizes, textures/finishes, and material properties, including weight, thermal properties, and sustainability-related data such as location of manufacture and recycled content. This way, designers can easily find the exact units for a specific project need. Data also assists with design priorities in modular construction, allowing designers to minimize masonry cuts and partial units—this keeps cost to a minimum and aesthetic to a maximum.

The wall systems project brings information to the building enclosure design. Standard (or 'base') assemblies are provided with multiple options for modification depending on individual needs. This gives design flexibility with information about:

- backup systems;

- air, vapor, and moisture control layers;
- insulation;
- flashings;
- anchors;
- ties and accessories; and
- exterior veneer.

A wall can be single-wythe masonry or a full cavity wall with options to modify system performance based on climate, energy needs, aesthetics, local practices, or design preference.

BIM-M will provide a level of development (LOD)of 350 for design, and 400 for construction purposes. (An LOD at 350 is generally enough information for construction documents, while a level of 400 gives more detail similar in scope to a shop drawing.) Figure 1 provides examples of a masonry cavity wall at various levels of detail that have been incorporated into the 2014 *LOD Specification* by the BIMForum.[2]

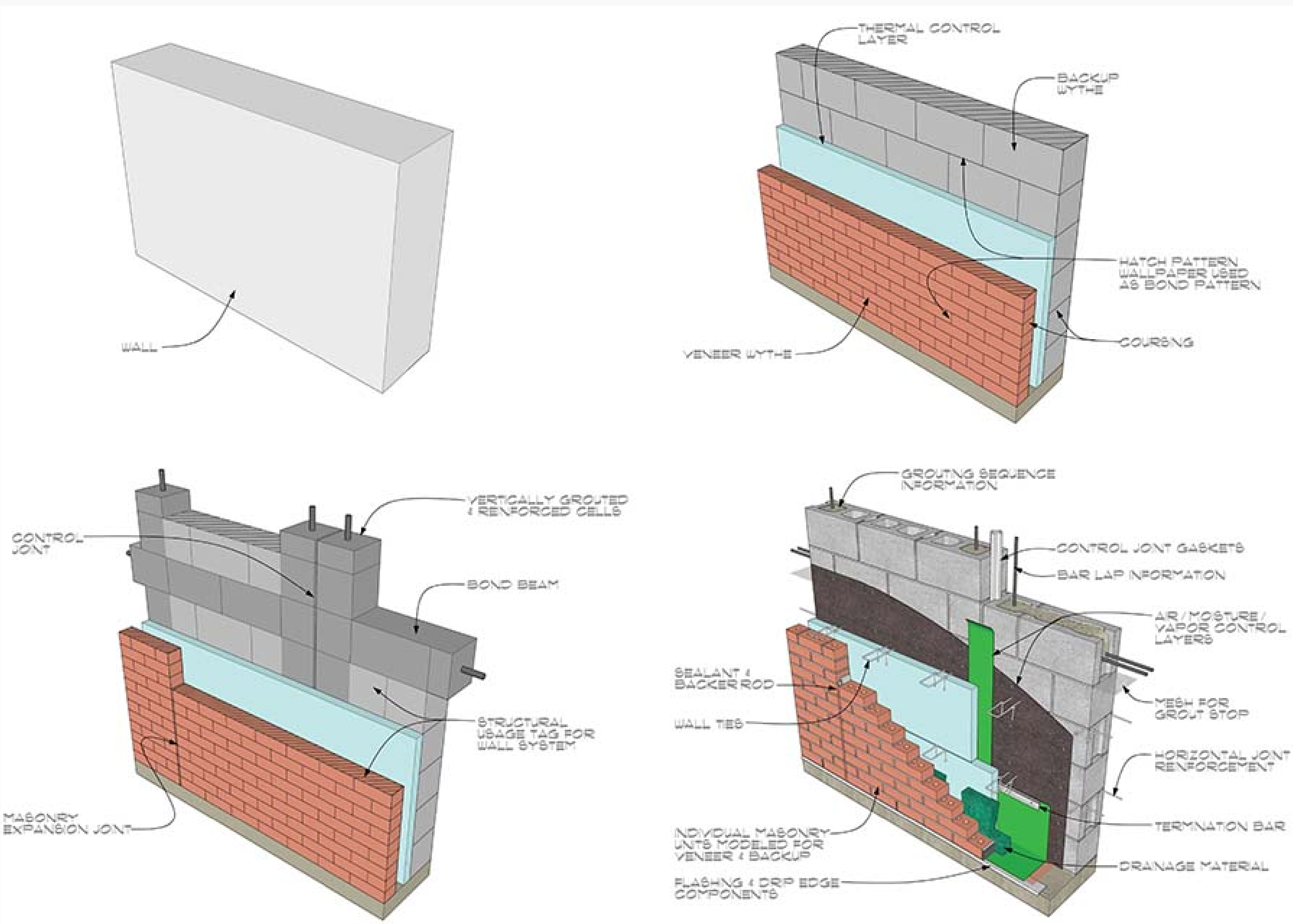


Figure 1: Masonry cavity walls, at various levels of development (LODs), have been incorporated into the 2014 LOD Specification by the BIMForum.

BIM for Masonry: The bricks and mortar industry enters the digital age

constructionspecifier.com/bim-for-masonry-the-bricks-and-mortar-industry-enters-the-digital-age/2/

The increasing sophistication of BIM models gives masonry subcontractors the opportunity to provide project information much earlier in the planning. Without BIM, a mason contractor rarely has the information needed to fit masonry tasks within the overall schedule or sequence of trades. With this limitation, a schedule is simply durations of tasks or walls based on typical crew sizes and assumptions about site access. With BIM-M, mason contractors can see how their tasks fit within the master schedule, which enables them to make more accurate predictions about task duration and labor needs.

For this project, the bricklayers worked alongside the mechanical, electrical, and plumbing (MEP) trades to install pipe sleeves through the masonry walls as they were constructed, per the BIM model.

Another contractor benefit is easier site layout and stocking plans. Instead of fighting other trades for precious space on a jobsite to store materials, the master BIM model allows a mason contractor to coordinate through better communication to avoid site conflict and moving materials multiple times. This benefit applies to scaffolding and other equipment needs. Contractors also benefit from a 3D visualization that provides a digital representation of the building, allowing for greater accuracy in planning and construction.

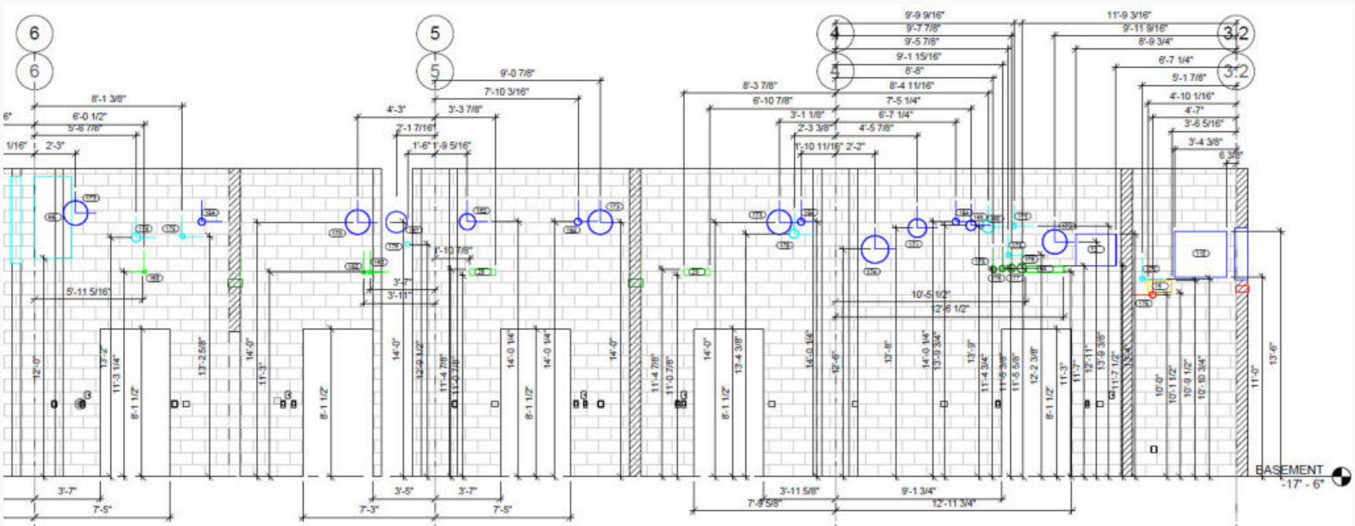
Advanced software creates quantity takeoffs, directs fabrication, and performs energy analysis. Additionally, there is the classic BIM benefit of clash detection. A case study later in this article provides an excellent example of the schedule and cost savings by trade coordination using this aspect of cooperative work.

Furthering the discussion

A key milestone for the BIM-M effort occurred in April 2015 when more than 120 architects, engineers, contractors, manufacturers, and software providers met in St. Louis, Missouri, for a symposium. An opening presentation from Will Ikerd (Ikerd Consulting) on the 2014 Level of Development Specifications from BIMForum, noting the relationship of masonry to the larger BIM picture was very informative. It showed Division 04 is well-represented through the efforts stimulated by BIM-M and the actions of the TMS BIM Committee. (In fact, masonry is represented on the cover of BIMForum's LOD document.)

The session for designers highlighted progress on the masonry unit database. Mark Unak of Codifyd (a product-content technology firm from Chicago) demonstrated a search engine for masonry products. BIM-M will be moving forward with a unified database where manufacturers can choose which products and attributes to include in the database. This greatly enhances the ability of architects and engineers to search for masonry unit options and include them in their BIM models.

The ‘designers’ session also included presentations from Mike Adams, Morgan Wiese, and Clint Bailey of Integrus Architecture (a Seattle architectural/engineering firm), and Shawn Zirbes of CAD Technology Center (one of the largest Autodesk partners in the United States). Both companies are BIM-M consultants who demonstrated tips and aids for users of Autodesk Revit to model masonry more efficiently. These will be included in the upcoming *Best Practices Guide for Modeling of Masonry in Autodesk Revit* , which includes actual models and text. (It will be available online for all to use.)



This partial elevation view of the composite model locates the MEP sleeve penetrations for the bricklayers. Each sleeve has a unique number and is color-coded per trade, as outlined in the caption to Figure 2.

The symposium’s ‘contractors’ session had several highlights. IMI’s Mark Swanson presented an overview of BIM and digital technologies expanding throughout the construction industry. Jim Schrader of Power Construction (Chicago) gave the general contractor perspective on what BIM services masonry contractors need to provide as part of the overall project—a model that can be useful with clash detection is essential. Adrian Siverson of R&D Masonry (Marysville, Washington) and Peter Sindic of Richards & Weyer Construction (Lyons, Illinois) gave two perspectives of BIM services masonry contractors are doing on projects. The mason contractors found efficiencies and economy from using some level of BIM on projects, even when they are not mandated to use it on the overall project.

Each speaker emphasized having BIM capability is a necessity, but the required degree of BIM services varies depending on the demands of each project. The key is to only do as much modeling as is useful to accomplish the project—just because one can model to great detail, does not mean it is always needed.

Attendees were also exposed to various software examples from Tradesmens Software, Autodesk Revit, Sketchup, and Cad Blox. “Mobile Apps for Construction” was the title of a presentation that will be available through BIM-M.

BIM for Masonry: The bricks and mortar industry enters the digital age

Where BIM-M goes from here

Starting with the realization BIM is not a fad, but rather a new way of both designing and delivering construction services, the masonry industry remains coordinated and firmly behind the financial support of the project. In fact, this is the largest cooperative masonry industry effort ever undertaken.

In the photo above, a bricklayer installs mechanical duct sleeves at precise locations per the BIM model, as he constructs the masonry.

There is a growing relationship with BIM Forum, integrating BIM-M with broader industry advancements, and the aforementioned *Best Practices Guide*. A roadmap posted online lists the many activities and final goals of the project, targeting December 2017 as the symbolic end of Generation 1 of the initiative.[3] These goals include:

As the concrete masonry wall was constructed, the bricklayers installed 468 sleeves for fire protection, 231 sleeves for plumbing, 343 sleeves for water, and 10 miscellaneous sleeves. There was a total of 1537 sleeves.

- masonry unit database accessible to all BIM users;
- masonry wall definitions for LOD 350 with standard details;
- software upgrades that achieve LOD 350 or greater for design;
- software that allows contractors to achieve LOD 400 or greater for construction purposes and can detect clashes with specific masonry features (*e.g.* bond beams, grouted cells, shelf angles, etc.);
- software upgrades that operate with other masonry-specific software;
- improved design tools (*e.g.* software upgrades, add-ins, plugs-ins) using Autodesk Revit that provide for modularity, early project pricing, and masonry detailing;
- improved contractor tools (*e.g.* software upgrades, apps for mobile devices, hardware-specific for field use) for contractors to improve project efficiency and utilize developing BIM tools; and
- beginning of development of new software specific to construction by third-party vendors.

Case study

A recent healthcare research lab project in Chicago illustrates how building information modeling improves masonry trade coordination and helps a project run more smoothly.[4]

The intricate construction of CMU walls laden with structural requirements and mechanical penetrations for this project was greatly aided through the use of BIM by providing the mason contractor advance input and notice of the various mechanical, electrical, and plumbing (MEP) requirements (Figure 2).

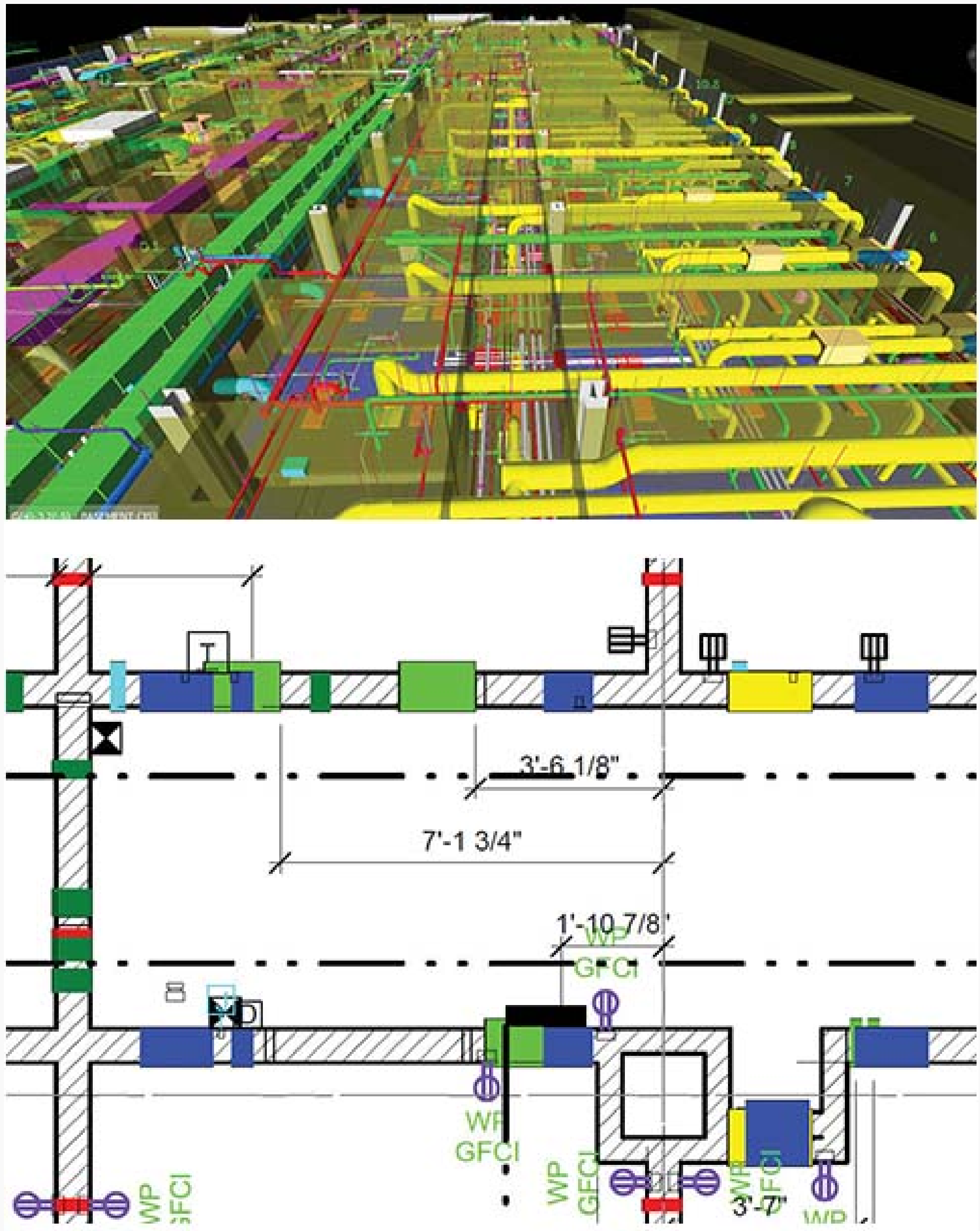


Figure 2: The coordination model in the top image shows MEP pipes and ducts passing through the masonry walls. In the lower image, a plan view of the composite model shows some of the MEP penetrations. Light green is mechanical, dark green is water, yellow is electrical, red is fire protection, blue is HVAC, and cyan is plumbing/domestic water vent.

BIM for Masonry: The bricks and mortar industry enters the digital age

constructionspecifier.com/bim-for-masonry-the-bricks-and-mortar-industry-enters-the-digital-age/4/

As a result, the masonry on this project progressed in coordination with other trades, rather than in opposition—an obvious benefit to both the contractor and craftworkers. It also provided the opportunity to showcase the benefits of designing and constructing with masonry to the owner, designer, and construction manager/general contractor.

A bricklayer (left) works in alongside a pipefitter (right) to simultaneously construct the block wall and the plumbing contained within it.

The 4180-m^2 (45,000-sf) basement of a research lab featured numerous small rooms and spaces constructed entirely of 5.3-m (17 ½-ft) high CMU partitions, corridor walls, and shaft walls—all grouted and reinforced vertically at 1220 mm (48 in.) on-center (o.c.), and with horizontal bond beams at the mid-spans and the tops of each wall. Typical of laboratories, this project required extensive and well-coordinated MEP and fire protection (MEP) systems running within and through the masonry walls, creating a challenge for all the trades involved.

To simplify construction, the entire project, including the masonry, was built using BIM. The contracting team worked with the architect to develop a 3-D computer model providing all information on the MEP elements passing through and within the masonry walls. This model was particularly useful to the mason contractor, as it consolidated information from other trades and effectively replaced seven individual sets of MEP shop drawings that would have otherwise been necessary.

The BIM model was used to generate dimensioned 2-D plans and elevations that were uploaded to a cloud storage server and accessible to the bricklayers in the field via tablet computer and/or printed drawings. These plans and elevations showed precise locations, sizes, and elevations of more than 1500 penetrations through the masonry walls. The bricklayers then placed their sleeves and box-outs as specified in the BIM model drawings.

As the concrete masonry was constructed, BAC bricklayers installed:

- 468 sleeves for HVAC;
- 69 sleeves for electrical;
- 159 sleeves for mechanical pipe;
- 257 sleeves for fire protection;
- 231 sleeves for plumbing;
- 343 sleeves for water; and

- 10 miscellaneous sleeves.

The total was 1537 sleeves in the masonry walls.

Sequencing of trades

The general contractor made the early decision to sequence the installation of the piping and ductwork within and through the masonry walls at the same time as the masonry construction. Only a few large sections of ductwork direct-mounted to the structural slab above were installed before the masonry.

The contractor rationalized the thousands of pipes and ducts at various elevations would present an unnecessary obstacle to the masons if they were installed prior to the masonry. Conversely, installing the MEP components after the masonry would require excessive cutting through CMU walls, resulting in inefficiencies. Therefore, it made sense to build the block walls with the accommodations for pipes and ducts in a single operation, with the MEP trades working side by side with the bricklayers.

The use of BIM also alerted the contracting team to the option of prefabricating plumbing and gas assemblies—this freed up valuable work space and sped up the construction schedule. The laboratory facility contained 50 lab sinks, 15 toilets, and 50 prefabricated gas assemblies with plumbing running either inside the block walls or in a chase between block walls. For the pipe trades to assemble the piping onsite, per conventional methods, demand for work space would be increased in areas that were already congested. Therefore, the plumbing and gas lines were built in the plumbing contractor's shop on racks made of steel struts and transported to the site prefabricated. Once they were in place, the bricklayers built their masonry around the plumbing and gas lines.

The BIM model made it possible to prefabricate the toilet room plumbing assemblies on steel strut racks to conserve space onsite. The plumbing racks were integrated into the block walls per the coordination model.

Weekly job meetings run by the masonry foreman were critical. The MEP trades needed to know the masons' plans four to five days in advance in order to relocate their manpower from other areas on the job, and to stage their horizontal penetration sleeves and vertical in-wall piping, making sure to have them ready for the masons at the proper time. Each day (sometimes twice daily), the mechanical and plumbing foremen checked in with the masonry foreman on specific labor and material needs.

According to Pete Sindic, project manager of Richards & Weyer Masonry, "There was a high level of cooperation and teamwork between the bricklayers and the other trades throughout the project."

Chris Coyne, superintendent with Power Construction, agreed with this assesment.

"This was one of the more intense masonry projects I've worked on with the prefab MEP units in the masonry walls coupled with all the overhead sleeves and the amount of reinforcing," he said. "It required a high degree of organization by the masonry contractor, as well as working hand-in-hand with the MEP trades in a team environment."

“Every day was a new adventure in the basement,” Coyne continued. “Now that the masonry is finished, we all get lost down there due to the amount of masonry walls and the maze-like configuration.”

BIM for Masonry: The bricks and mortar industry enters the digital age

Conclusion

The Chicago project illustrates the emerging role building information modeling is playing in the construction industry, and the vital need for masonry to be part of that process. It shows how clash detection, scheduling, and communications help save time and money while increasing efficiency—all hallmarks of the BIM-M initiative.

Upon completion of the masonry work, the MEP trades were able to easily install their pipes and ducts without cutting through the masonry due to the well-coordinated sleeve penetrations.

Generally, BIM leads to a more collaborative work environment where subcontractors have involvement at early stages, bringing specific trade and craft expertise to the design of projects. As design professionals and specifiers work in evolving project delivery methods (*e.g.* design–build) and forms of integrated project delivery, it is good to keep in mind the value of early communications and input from sub trades.

BIM-M represents the masonry industry's commitment to ensure its crafts and the materials with which its members work are central to the future of the construction industry.

David Sovinski is the International Masonry Institute's (IMI's) national director of industry development. IMI represents an alliance between the International Union of Bricklayers and Allied Craftworkers (BAC) and union masonry contractors. His experience includes masonry project manager, estimator, and architecture and technology teacher at Indiana University Purdue University Indianapolis (IUPUI). Sovinski has a degree in construction management from Purdue University. He can be contacted via e-mail at dsovinski@imiweb.org.

Scott Conwell, FAIA, ALA, CSI, CDT, LEED AP BD+C, is IMI's director of industry development and technical services. In his 20 years with the institute, he has developed masonry seminars to architects and contractors all over the United States from small in-house seminars to large industry conferences, including upcoming sessions on masonry and ceramic tile at CONSTRUCT 2015. Conwell leads IMI's team on the Masonry Detailing Series (masonrydetails.org)—an online collection of masonry details and technical information. He can be reached at sconwell@imiweb.org.