# BIM and fire protection engineering

By including all life safety systems in the BIM rendering, engineers improve the building's model as a whole.

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## Learning objectives

- Know how BIM can help integrate all fire and life safety systems in a building's model, not just suppression, detection, and alarm.
- Learn how BIM technology can change how buildings operate throughout their lifecycles if it is used to its full potential.
- Understand that effectiveness of BIM is limited only by the amount of information available in the model.

Building information modeling (BIM) has been used in various forms throughout the fire protection industry. However, most of the BIM work has been focused on stand-alone models that have historically been proprietary to the contractors that developed them. Specifically, fire sprinkler and fire alarm contractors have been using 2-D and 3-D models of their respective systems, but that has historically been the limit. As BIM technology improves and moves outward from structural and architectural models, the fire protection industry as a whole reaps the benefits because fire protection engineering encompasses not just active and passive suppression systems, but the overall life safety of buildings and the occupants. If the model is being constructed for all systems, life safety integration can be better applied throughout.

Fire sprinkler contractors have been using specialized and somewhat limited forms of BIM for many years. Customized programs allow sprinkler designers to develop systems in 3-D models and automatically prepare hydraulic calculations, print lists of system components, and even put hangers and bracing on drawings based upon pipe sizes and dimensions. All of these tools are extremely useful for the designer but did not really go beyond the designer, except on paper. They also have been limited to the specific system application rather than shared with the building model.

Similarly, fire alarm drafting programs have been developed that allow designers to build systems that automatically assign network addresses to devices, calculate voltage drops, perform battery calculations, and prepare riser diagrams. These tools can significantly improve designers' efficiency by automatically performing tasks that would otherwise take hours, days, or weeks to complete. Once again, however, the program technology historically has not gone beyond the designers' offices.

With the trending developments of 3-D modeling in architectural and engineering design over the past several years, industry is abuzz about what the future holds. Imagine if the technology that has been limited to the designer can now be extended to the sprinkler fitter or fire alarm technician in the field. Moreover, imagine the power of the models in the field or in the hands of the end users where others can use the information the designer input to troubleshoot or manage the systems better.

BIM allows designers to create intelligent environments that enable all users of the model to have instant access to all of the information available in the model. Therefore, the ultimate limitation of BIM is the amount of information available in the model and input by the designer. If a user selects a specific component of the system, the model can provide make,

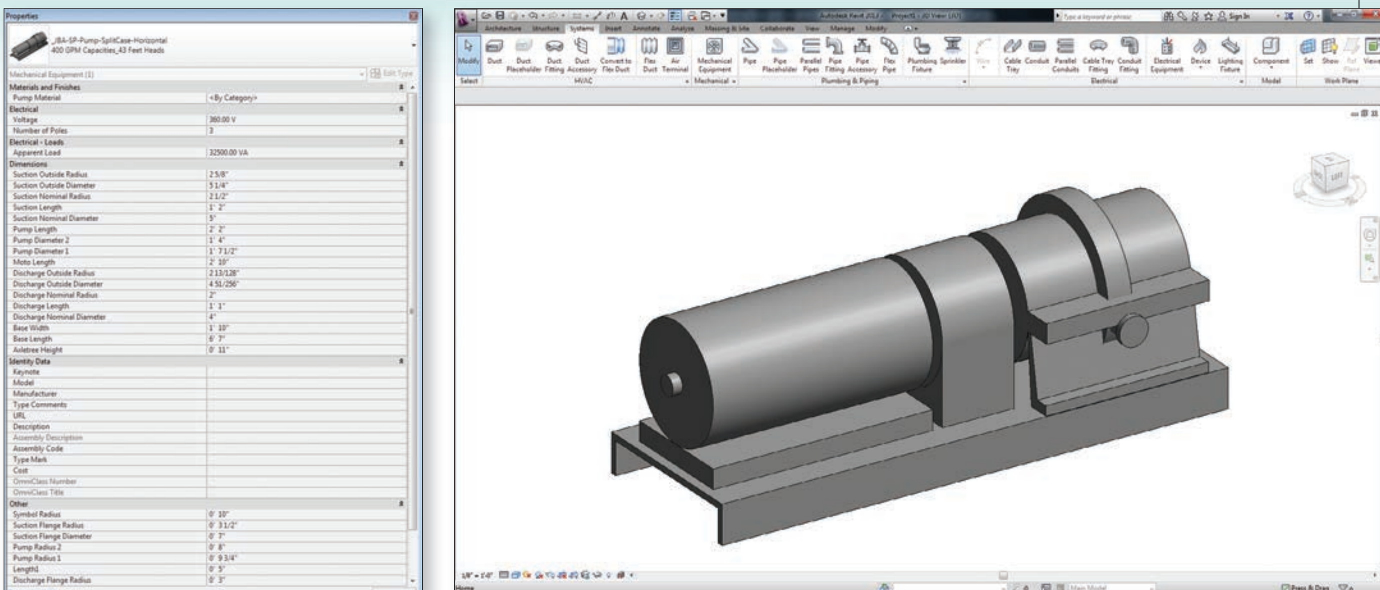

**Figure 1: Without specific information from manufacturers, designers can create and input the specific information about system components into the model. Courtesy: JBA Consulting Engineers**

model, serial number, cost, and all relevant specifications of the system component. It can even include operation and maintenance information relative to the system component.

Consider fire suppression systems as an example. If a user selects a fire pump or pressure maintenance pump in the system, a powerful, well-established BIM file can provide the user with all of the relevant information. If input correctly, the model can identify the make, model, flow, and pressure of the pump as well as the pump performance curve. If the pump motor is selected, the information may include make, model, voltage, amperage, horsepower, service factor, or any host of pertinent information that the designer specifies. It could also include preventive maintenance information as well as replacement part information.

By allowing access to the model throughout the design and construction process, installers can modify information as they install it. Field technicians or commissioning agents can take photographs of motor and pump nameplates as soon as they are installed or commissioned and associate the nameplate photograph with the specific pump or motor. This information can be accessed by building engineers and maintenance staff without having to travel to the room where the equipment is located.

This information could be especially useful for large buildings or campus environments. As an example, consider a fire alarm company that has a maintenance contract with a facility that reports a problem with its system that has been provided with a model. Any 24-hour technician can access the model to see what type of equipment the system has without going to the field to investigate first. The technician can select the panels to view what type of boards might be installed in specific fire alarm panels or transponders and get potential replacements before he leaves his shop. In this example, the responding technician does not need to have intimate familiarity with the system beforehand because he can access the model to understand what components are installed and how. The technician also save time by taking potential replacement parts on his first trip to the site instead of making multiple trips to the site and back.

On large and/or fully integrated buildings, building engineers often review events on the building management system (BMS) for mechanical, electrical, and plumbing issues as a first order troubleshooting measure. Smaller buildings and buildings without integrated systems do not afford building engineers this luxury. When it comes to fire protection systems, the BMS may not integrate with fire protection systems. However, a well-coordinated BIM can be the single source for building engineers to troubleshoot and evaluate all systems within their buildings.

The efficiency is not limited to service and maintenance contracts because maintenance personnel often have to respond to common issues. If a campus engineer receives a complaint of a faulty smoke alarm in a dormitory room, he or she can review the BIM and take an appropriate replacement before trekking across campus.

### Clash detection and commissioning

For large buildings that have tenant improvements, a BIM could be an ideal tool. Casinos in Las Vegas are continually modifying and improving their environments to stay on top of trends, attract new customers, and maintain loyal customers. Each improvement requires documentation with the local authorities having jurisdiction (AHJ); however, without an overall plan identifying each of the

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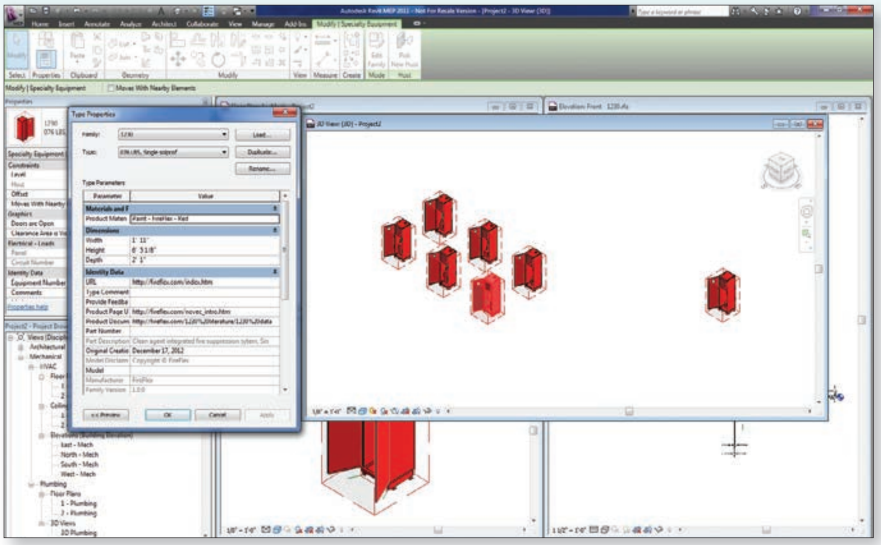

Figure 2: Manufacturers can provide information about each piece of equipment, including where to find more information. This screenshot of a packaged special suppression system allows users to select the cabinet and its properties and identifies the information available as well as where to find more. Courtesy: INVIEW Labs

small changes, a building could completely reinvent itself such that compliance becomes questionable.

Having a model established for a property allows the owners and designers to understand the impacts to the overall property when even small changes are made. Changing a retail store to a restaurant may not seem like a significant revision. However, if the occupant loads increase beyond available capacity or the kitchen floor drains penetrate an exit passageway below, there may be more costly impacts to the overall building that a model could mitigate. Modeling might be able to identify conflicts or issues with certain design elements early in the design or planning stage.

The ease of accessing a model rather than drawings applies to many disciplines. Smoke management systems are often designed, tested, and/or commissioned by fire protection engineering specialists. They often involve multiple systems such as sprinkler waterflow switches, smoke detectors, dampers, and fans. Having a well-established and maintained BIM model allows each trade to identify not only its equipment but also the equipment it interacts with.

During commissioning of the smoke management system, it is often difficult to carry around the sprinkler, fire alarm, mechanical, and architectural drawings that show all of the related components. Having a tablet that connects to a cloud model would greatly improve efficiency. As the commissioning commences, portions of the system are marked with the appropriate information about commissioning that takes place directly in the model. Pressure tests and inspection of ducts, fan start-up, and measurements are all directly recorded in the model and associated with the respective equipment. If specific components fail, they can be red-flagged for follow-up. Integration with the model would allow for all the detailed commissioning information to carry on through the life of a building.

When testing and inspections are complete, the model serves as a database to generate reports of tests conducted and inspections observed. During final testing and commissioning, if portions of a system fail to operate properly, information on specific equipment tests can be viewed directly from the model. After handover, reports of failures from testing and commissioning can be reviewed so that if recurrent problems exist, the system(s) can be modified to correct them. The model can also serve as a database for how the system performed at start-up so future revisions can be evaluated.

### BIM and passive protection

BIM technology is most often associated with active fire protection and life safety systems like fire alarm, fire suppression, and smoke control, as mentioned above. However, BIM technology is gaining increasing ground in passive fire protection features like doors, walls, dampers, and penetration sealants.

Fire-resistance rated walls are a common issue throughout a building's lifetime. If the type of fire-resistance rated walls is not identified properly on drawings, there is often confusion about ratings for doors, penetrations, and other opening protective. The International Building Code (IBC) has begun to require that these walls be marked in the field to address this issue. The IBC also has different classifications for fire-resistance rated walls depending on the level of protection. For example, a 1-hour exit passageway requires a 60-minute door, whereas a 1-hour corridor wall requires a 20-minute door. The exit passageway strictly limits penetrations by ducts or pipes, but the corridor walls have fewer restrictions. On drawings and 2-D plans, these 1-hour walls are often indistinguishable, except to trained professionals. An exit passageway on a 2-D drawing is often confused for a corridor, having significant impacts in the field.

BIM models allow these walls to be differentiated within the model and can be set up to limit and/or restrict penetrations and openings. Each wall can be defined by the appropriate fire-resistance rating and also establish what types of doors, opening protection, and penetration firestop systems are permitted. Using software routines similar to clash detection software, designers can establish if piping or ductwork has penetrated a wall, such as an exit enclosure, that would be

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prohibited by the IBC. Alternatively, if penetrations by duct or pipe are permitted, the wall definitions establish what type of damper (fire, smoke, or combination fire/smoke damper) and what the F- and T-ratings for the piping penetrations require, if any. In the larger scheme, it could even reference listed opening protection for the given penetration.

Again, during commissioning of the building, designers or commissioning agents can use tablets or hand-held devices that access the cloud-based model as they walk the building. If there are questions concerning penetrations observed on-site, the user can select the specific wall and determine what type of wall it is, what the fire-resistance rating is, and how to properly protect penetrations and openings.

As the building ages, engineers and maintenance personnel can continually monitor passive fire protection elements to confirm that openings and penetrations of walls, floors, and ceilings are compliant with the original design. If modifications or improvements are made to the building, future designers and engineers understand how the wall was classified and why it was protected, and can then identify how to design future elements.

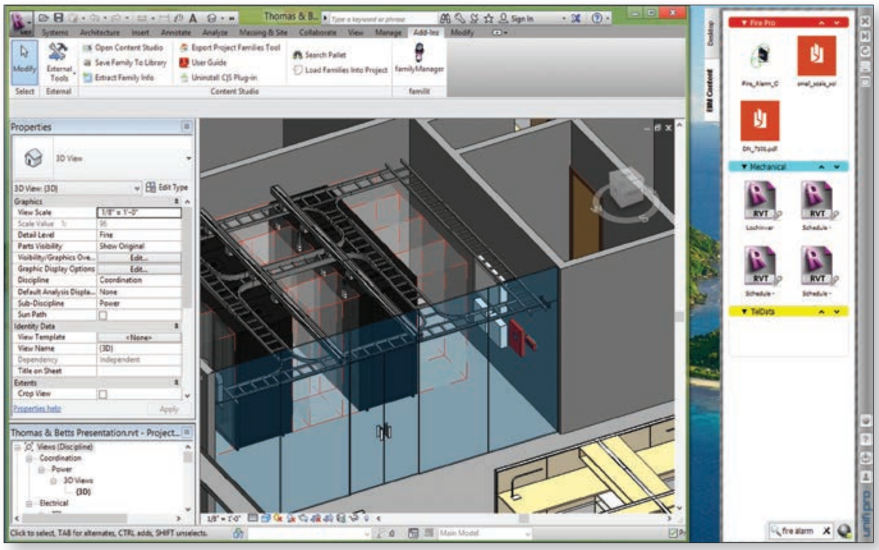

**Figure 3: Companies like INVIEW Labs are further developing programs to manage and organize BIM models. This screenshot of "Unifi" assists users in managing BIM information into a customizable desktop environment. Courtesy: INVIEW Labs**

### Industry acceptance

The BIM technology discussed thus far is available; however, as with any new technology deployed, it is not error-free and at its full potential. The primary limitation for BIM technology today is the amount of content available from manufacturers and in a coordinated standard. Every project that uses BIM technology can be set up slightly differently, such that training is required for each model and the content from manufacturers, if available, may not integrate seamlessly. The amount of information in the model also varies depending upon why BIM was used.

While there are leaders and innovators in BIM technology, there is no well-established protocol that allows everyone to take advantage of the powerful tools that can be developed. In this digital age, where design and construction teams are spread throughout the globe on one project, it is challenging to find agreement on a common standard. Multiple nationalities may be working on a project in the Middle East, and each has its own belief on how the standard should be implemented. Without proper content development and standardization, BIM could develop into a poorly functioning or dysfunctional model. Sometimes too much information does not make the model efficient, whereas too little does not make efficient use of the model.

A BIM model that is set up well and monitored continually will have coordinated, integrated, and searchable databases of information. A BIM model becomes not just a 3-D model of the building to search for fire protection equipment or features. It becomes a database of information that can be used to identify trends, estimate repair costs, or monitor functionality. It can also help with integrating the life safety systems across multiple trades.

Industry must embrace the technology by having all manufacturers create common standards for BIM tools. Many fire protection companies have developed BIM content but may limit availability to users or specifiers. Because there are always costs associated with developing content, there may be hesitation based on the return on investment for developing content when manufacturers have a large library of products. Alternatively, if designers have access to a manufacturer's complete product line while designing in a model, they may prefer that product line to another that does not have sufficient information for their building.

The content currently available from most manufacturers is also generally limited to product specifications as noted above. A pump may have its performance data. A sprinkler may include its appropriate listings and approvals as well as coverage data. A speaker/strobe may indicate the sound pressure level and light intensity of the appliance.

However, as manufacturers take initiative to really develop the content as it relates to their products, BIM becomes an even more powerful design tool. Because clash detection has been established in models to avoid conflicts

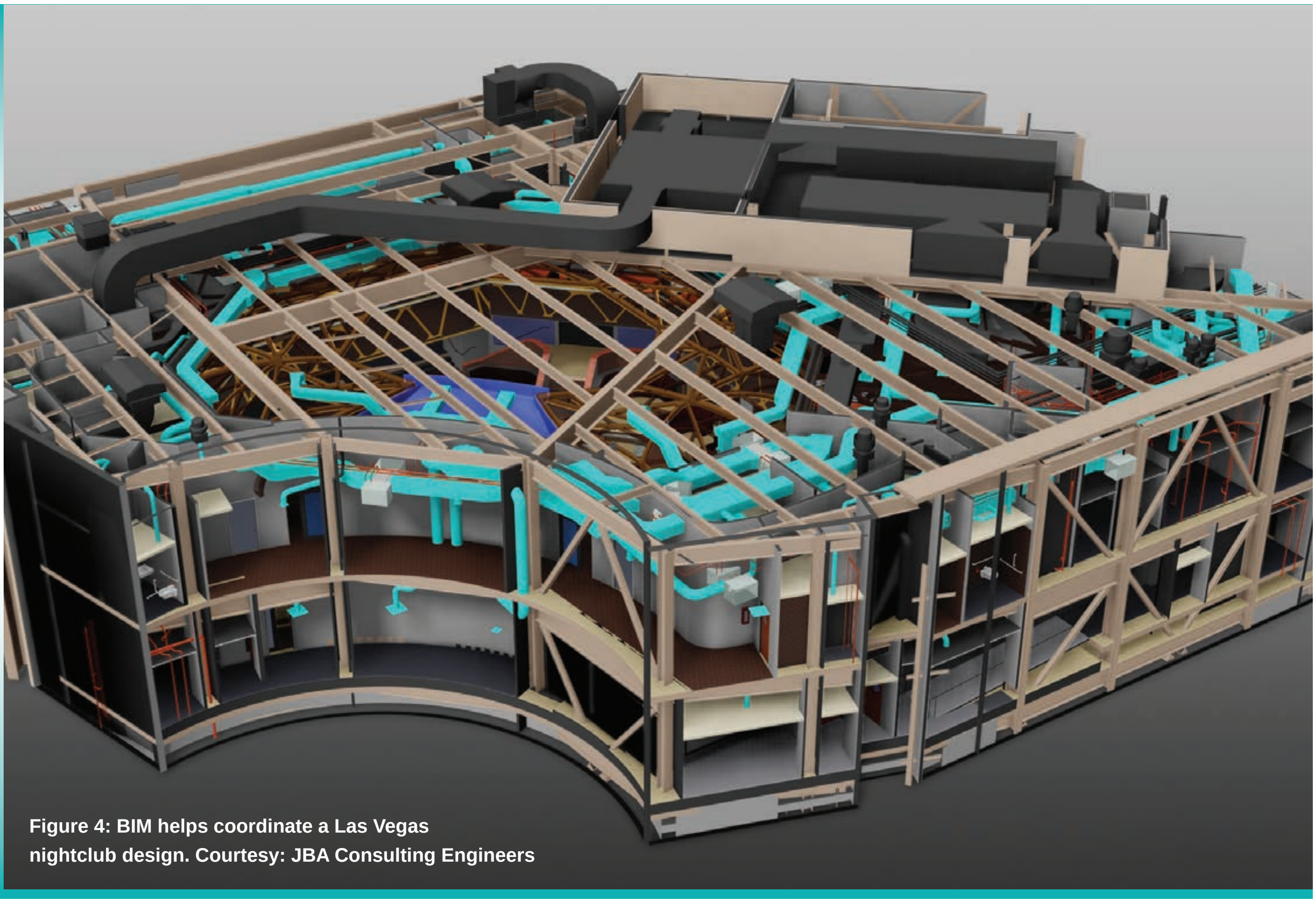

Figure 4: BIM helps coordinate a Las Vegas nightclub design. Courtesy: JBA Consulting Engineers

between mechanical, electrical, and plumbing equipment as well as for wall construction, manufacturers can develop content specific to the listings of the products.

For designers, engineers, and AHJ, BIM will be invaluable as manufacturers include all listings and restrictions for their specific fire protection products. When a designer puts a sprinkler in a model that is too close to a ceiling, beam, or other obstruction, a notification could be established in the model identifying that there is a conflict with the sprinkler and another object. Fire alarm speaker BIM content could be developed that establishes when minimum sound pressure levels are not achieved as a result of distance to other speakers or obstructions from walls and doors.

If the proper models and design content are developed in unison, the ability to design could become significantly more efficient. Sprinklers can be located based upon spray pattern development and viewed in the model. For aircraft hangars or other places where water monitors are used, spray patterns based upon flow and pressure data can be integrated into the design to optimize layouts in conjunction with anticipated obstructions. Fire alarm appliances could be distributed based upon acoustical properties of walls, floors, ceilings, and finishes.

Even passive fire protection elements, such as wall construction or through-penetration firestop systems, could use content development. Often, designers use the same assembly for penetrations because they are familiar with it and believe it complies with the assembly and the listing. If through-penetration firestop companies provide a content library for their products based upon wall types and listings/approvals, confusion regarding compliance could be mitigated. The wall and penetration are selected and the content library automatically selects the most appropriate penetration fire-stop system.

While some manufacturers may be lacking in content development, they are not alone in having work to do. Designers have to coordinate with model developers. Fire protection engineering is not limited to active and passive fire protection systems; designers could work with developers to improve BIM. Specifically, the means of egress of a building and features associated with it are equally, if not more, important. Model building codes often prescribe minimum lighting levels, travel distances to exits, and distances for exit signs. BIM can allow designers to fully coordinate and automate egress as models change.

Models could be developed to assign each space with an area and use such that spaces can be "populated" according prescribed densities of people. A theater with 1,000 fixed seats and a 1,500-sq -ft stage may have 1,100 people assigned to the space. The space requires a minimum of four exits, and the main exit must accommodate at least one-half of the total occupant load. The model could be set up to assign people to egress through specific doors and paths. If the occupant load increases during the design of the building, notifications can be set up to warn designers that occupant loads exceed available egress widths.

### Challenges and issues

While content development for models could improve, BIM is not without other issues. As many organizations that have worked on BIM projects have discovered, it requires a significant shift from traditional architectural and engineering workflow. Since the model is constantly developing, 2-D drawings to drafters may not be the most effective routine. Engineers and designers need to get directly into the model and input information as the model develops. It is not just showing information in space, but providing specifications of equipment as the model is developed. The designer is actually inserting the component into the model, similar to how the installer inserts the component in the building.

Since BIM models are not just 3-D representations of a building but an information database correlated to that model, the file sizes get very large. As noted previously, cloud server models may be an ideal solution for certain applications, but some owners and developers may want to limit access to the organizations that can make changes. In such situations, the model may be updated routinely for other organizations to download and work from, which can be challenging when dealing with large file transfers.

Another recognized obstacle is the contractual and legal issues concerning intellectual property rights and how BIM models are accessed or made available. Standard design contracts often establish who owns the rights to the intellectual property, which can be contentious during and after negotiations. Multiple parties are providing input into a model that the owner may ultimately be paying for. While, under such conditions, the project owner(s) may feel entitled to unrestricted use and access, the designers may want limitations on who can access the model and how access is controlled. Since the designers, engineers, and architects may not input proprietary equipment into the model, procedures and terms for how contractors and installers input information into the model without significantly changing the system parameters must be established. In other words, a clear method for handing over from design to construction and from construction to operations must be established to protect all parties and their respective intellectual property.

As with most design disciplines, BIM and fire protection engineering will continue to develop into a more powerful tool that allows designers, owners, and building personnel to effectively use models and BIM databases to manage buildings from cradle to grave. All active and passive fire protection systems, from suppression, alarm, and detection to fire-resistance rated walls, floors, and ceilings can be managed and maintained by all parties associated with buildings. The current and future status of BIM technology related to fire protection engineering is exciting for everyone in the building and construction industry.

Imagine the time when you can design a building using actual assemblies and components, check for conflicts prior to reaching the field, and then install and maintain those components through an efficient and functional BIM model. That time is now. What the future holds is how far we can capitalize on the benefits of integrating the BIM model. |cse|

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