# Coordinating fire protection designs via BIM

BIM can be a very powerful tool in the design and construction industry. It takes 2-D information far beyond just a 3-D environment. It places the tool of a database or model in the hands of fire protection engineers, giving them the benefit of what they want to achieve within the BIM model.

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**Figure 1:** Different ceiling heights and open floor plans require coordination of sprinklers and fire alarm notification appliances within the Graton Resort & Casino, Rohnert Park, Calif. This image illustrates the variations in ceiling heights along the casino floor. The Graton Resort & Casino is larger than 300,000 sq ft and contains a variety of different uses as well as a very complex ceiling configuration within the main casino. The ceiling is a series of waves that required a lot of coordination for sprinkler location and positioning with other systems and ceiling features. Exiting was complex in that the engineers needed to employ a variety of features to make exit capacity and travel distances work. Using a BIM model approach to this type of project saved time and effort while also allowing the design team to better coordinate systems within the building. All graphics courtesy: JBA Consulting Engineers, an NV5 Co.

According to the Autodesk website, building information modeling (BIM) is an intelligent 3-D model-based process that equips architecture, engineering, and construction (AEC) professionals with the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure. So what does that really mean? And how can the use of BIM benefit the design community, specifically in the fire protection industry?

The concept of BIM in the AEC industry has been around since the 1960s, but didn't evolve to its current use until the early 2000s. The design community used a 2-D platform to design buildings for many years, even after the introduction of the personal computer gave way to computerized software for architectural and engineering design. Two-dimensional platforms allowed designers to use an inventory of stored symbols and line types to improve on the hand drafting that was previously used in the industry.

Then the use of 3-D design became prevalent, giving way to what is now BIM. Three-dimensional modeling allows engineers to see what they are designing before it is built, to get a feel for the layout of the space and how the various elements fit into the design. This helps designers avoid conflicts with other disciplines or trades before the system is installed.

When BIM was introduced, it allowed a database or model to be used so that an inventory of symbols can include objects. BIM is a form of 3-D modeling, but takes it even further by introducing other dimensions, such as time (for scheduling purposes) and cost (for estimating and control). It also introduces what could be considered a database to store specific information about the objects used in design. Objects are added to the model to build the database or design. The objects store information that can be used in a wide variety of ways to enhance the database or model being used to design the building. This, in turn, enhances the design tools available to the design community.

## Learning objectives

- Describe some of the ways BIM is being used in the fire protection industry.
- Outline how BIM can be used in the future to coordinate fire protection designs.
- Learn to use 3-D models to coordination fire protection system design.

### Fire protection system design

Fire protection engineers and contractors have been using 3-D modeling

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for many years to design systems, such as automatic sprinkler, standpipe, fire pumping, and special hazard-suppression systems. The use of 3-D design applications helps with the coordination of design and installation by showing the designers how the various components of the systems will fit into the building or space. Some applications also have integrated hydraulic calculations into the program to allow for more efficiency in design.

Most of the fire protection system shop drawings being developed today use a combination of 2-D and 3-D designs. Two-dimensional floor plans are used to show piping runs and layout as well as sprinkler locations. They also are used to show sprinkler locations on reflected ceiling plans to coordinate the layout with other ceiling devices.

Three-dimensional applications are used to show riser details, floor control valve locations, fire pump rooms, and other equipment where space relationships are necessary. These are beneficial because they show how the equipment or systems fit into the spaces for which they are being designed. However, most of the applications being used to develop design and shop drawings have been 3-D applications, and are not truly BIM applications.

With BIM becoming more prevalent in the design community over the past 10 to 15 years, fire protection systems are now being designed using BIM applications. Some software programs export the information from the BIM model to 2-D for shop-drawing use. This allows for continuity in the model as the construction process begins. It also allows for continuous coordination from the design to construction phases.

The BIM model allows the design team to determine space layouts for major equipment and then the contractor to avoid field conflicts with other trades and key building elements. By adapting the design model to construction, the concept design can be enhanced to shop-drawing design while keeping the original design concepts in place.

### BIM's payback

The benefits of a BIM application design through the life of the building allows the contractors to keep an inventory of equipment within the model, so that recurring maintenance and repairs can be performed on the system while knowing what equipment is in place and without having to field-verify equipment every time. This can include major equipment, such as pumps, controllers, valves, and sprinklers. The transfer of the information in the BIM model to the end user allows the use for facilities-management purposes

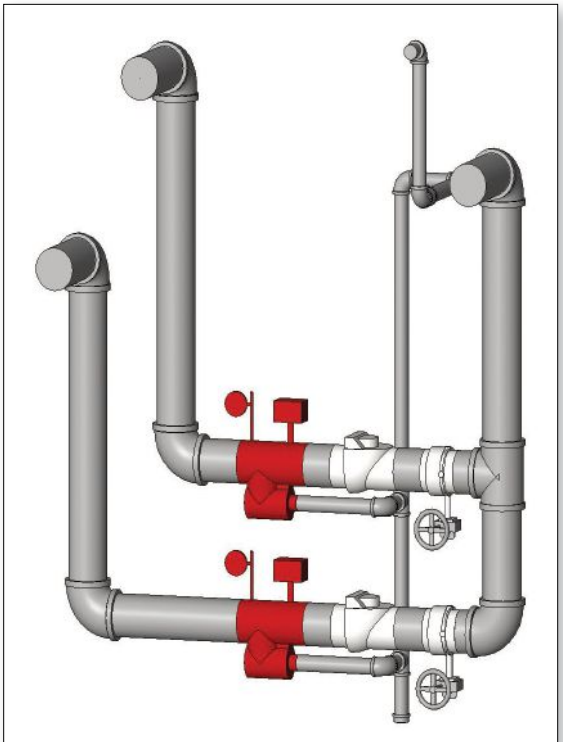

**Figure 2: This BIM model depicts a typical floor control assembly for a fire sprinkler system.**

BIM applications for fire alarm and detection systems are not as common as for suppression systems. This may be due to the smaller size of equipment as well as wiring runs being easier to coordinate in the field, whereas suppression systems have a need for coordinating larger pipe and equipment. However, BIM applications can be of benefit to the fire alarm and detection industry as a tool for inventory and cataloging of equipment. While detailed field coordination may not be as critical with the smaller equipment, the use of BIM can help with panel locations, fire command rooms, and coordinating the placement of devices on ceilings with other trades.

The traditional applications seen for fire protection BIM design are for installed systems. However, there also can be a benefit of using BIM for fire-engineering designs. Egress plans can be automated through the use of BIM. Egress plans are used to develop the exiting scheme for buildings and take into account the occupant load of rooms and the overall building while showing the egress routes to exit the building.

BIM applications can take the architectural model and import room data into the egress model. The room data can give the type or use of the room and the size of the room. Those two factors are then used to determine the calculated occupant load of the room to determine the width and quantity of exits from the room or space, and for the overall building. Using a BIM application allows engineers to calculate the occupant load based on load factors found in the building code.

Developing egress plans in a 2-D platform often requires the use of polylines to determine the required area of the space. Once that is determined, a manual calculation is performed to determine the occupant load. Changes to the plan show up when the polylines differ from the initial layout.

With BIM applications, changes to rooms and areas can be automated using the BIM model to show deviations in the areas and calculated loads. This automation can reduce the effort typically seen when using only a 2-D model or application.

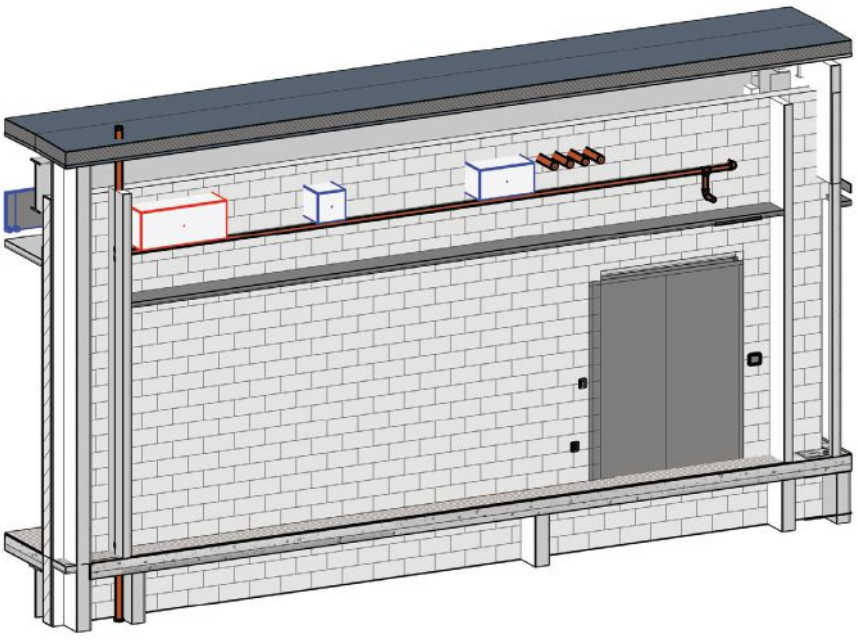

**Figure 3: A BIM model shows penetrations of a fire-resistance-rated wall that will require protection.**

Required egress capacity also can be automated using BIM applications. While doors, stairs, and other exit components still need to be placed, the BIM application can help confirm the exit capacity is sufficient to accommodate the calculated occupant load. The designer can take the occupants of the various rooms and spaces into consideration when determining the required egress routes, and the BIM application can confirm that the capacity is within the required amounts. This allows the calculation of occupant loads and confirmation of overall and individual capacity to be streamlined, saving time and effort. When developing egress plans, the most tedious task is determining the calculated occupant loads and required capacity and verifying that all building occupants are accounted for in the exiting capacity. When dealing with very large crowds, automating this portion of the process can be of great benefit.

Using the data from the model allows the fire protection designer to automate some of the exiting process. Engineers will still need to manually determine the exit flow, but the time to determine the total occupant load and the required exit capacity is reduced. It is also very useful for streamlining the changes in design that occurs during the overall design process. By using a BIM application, more time can be spent on determining the egress routes while less time overall is needed to develop the exiting scheme for the building.

### Benefits and special needs

Other examples include using BIM applications to develop a hazardous materials identification system (HMIS) or a hazardous materials management plan (HMMP). An HMIS is essentially a survey of all of the potentially hazardous materials found or used in a building. The type of material must be quantified in terms of weight or volume and then analyzed toward its classifications. Is it a physical hazard, such as combustible and flammable materials, or it is a health hazard, such as a corrosive or toxic material? How much of the material is being used or stored in a given space or process?

Once these are determined, then an inventory can be developed that shows how much and of what type each hazardous material exists. The benefit of using a BIM application is to allow the data to be stored in the model or database for future reference and for the initial survey. It can be used to allow the designer to determine whether the amount of material being used or stored in the space is within the exempt amounts allowed by code. If the material exceeds the code-exempt amounts, then additional measures need to be taken into account for the room or space to comply with code.

The inventory can then be developed in a BIM model that correlates to the location of the space within the building and shows the nature of the space for building operators and possibly responding personnel. Rather than catalog the inventory in a separate database, the BIM model or database can be used to store this information. This model can be used during the design of the building to formulate the code-required protection scheme and by the end user for building operations.

The end user also can use this to maintain the types and quantities of materials at the levels for which the building or space is designed. This becomes part of the HMMP and takes on a life through the lifecycle of the building, rather than as a separate database to be used when determining the impacts that changes to the building may have.

### Fire resistance

Another benefit for using BIM applications to coordinate fire protection designs is the ability to define wall types for opening protection requirements. In the United States, most of the jurisdictions use an edition of the International Building Code (IBC). The IBC defines various wall types and requires different levels of protection based on these wall types. It also defines fire partitions and fire barriers and has fire-resistance ratings ranging from 30 minutes to 3 hours. Fire barriers used for exiting also take on different opening protection requirements.

Opening protection for fire-resistance-rated walls, floors, and roofs range from doors and windows to ductwork and penetrations. Each opening or penetration requires a specifically listed assembly to protect the integrity of the wall or barrier. Using BIM applications, the designer can identify the specific wall or floor configuration by not only defining the fire-resistance rating, but also the specific wall or floor classification. This would allow other designers to choose the appropriate protection for the opening or penetration.

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The fire protection designer often works closely with the architect to define the wall type and then advise on the protection scheme for doors and windows. Door ratings can include fire-resistance-rated doors, smoke- and draft-control assemblies that provide fire and smoke protection, and doors that have specific requirements for the maximum transmitted-temperature rise. It can be difficult to design the correct door type if only the hourly rating of the wall is shown on the plans. Using BIM applications, designers can more readily identify the specific wall type to choose the right door application.

For example, if the wall is a 1-hour-rated corridor, a 20-minute smoke-and-draft control assembly can be chosen for the design. However, if the wall is a 1-hour fire barrier, a 45-minute fire door is required. If the wall is part of an exit enclosure, then the 2-hour wall would require a 90-minute-rated door with the T rating to meet the temperature-rise requirements.

With 2-D applications, a line type is usually used to identify the wall type, which typically only identifies the hourly rating. If a BIM application is used, the database contains not only the hourly rating, but also the specific type of wall. This level of information could avoid costly changes in the field caused by the wrong application being chosen based only on the hourly rating.

### Consider all requirements

Another benefit to using a BIM application for identifying wall types is for the protection of HVAC ductwork that penetrates fire-resistance-rated wall and floor assemblies. As with doors, there are different requirements for protecting the opening where ductwork passes through the assembly. Some penetrations require fire dampers, some require smoke dampers, some require both, and some do not require dampers at all if other measures are provided.

It will help in the coordination of the HVAC design if the specific wall types are known, so that the appropriate type of protection for the ductwork can be chosen. There are many damper variations from which to choose based on the wall type and configuration. If the designer is able to better identify the type of wall by referencing the BIM model, this would better help in the coordination of the design and also avoid costly changes arising from the wrong damper being chosen.

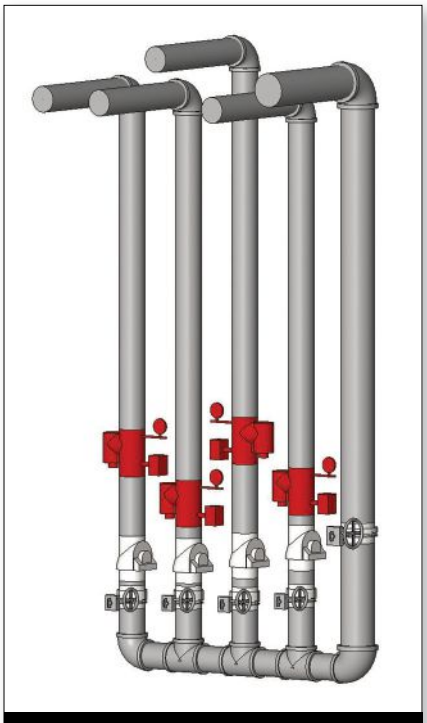

**Figure 4: A fire sprinkler riser room is shown. An isometric diagram coordinates the location of a multiple riser assemblies within the building.**

Lastly, by using BIM to identify a specific wall type, the penetrations can be identified and the appropriate through-stop penetration assembly can be chosen. Through-stop penetration assemblies are as numerous as they are specific to the type and amount of items (conduit, pipe, ductwork, etc.) penetrating the rated assembly as well as the types of assembly being penetrated. By identifying the type of assembly and knowing the types of penetrants, the designer can have more control over the types of penetration-protection schemes to use. The designer also may be able to adapt the design of the penetrations to match available through-stop penetration assemblies.

The use of BIM applications to coordinate opening protection for walls and floors has numerous possibilities. Some can be adapted today and put in use while others may need to be worked on for future applications. The true benefit of identifying wall types depends on how the different models are shared by various disciplines. Because each discipline essentially creates its own model from the architect's model, the models would have to be shared or linked to gain the maximum benefit. By doing this, the fire protection designer can identify the type of wall and then the architects, interior designers, and mechanical and electrical trades can determine the appropriate protection scheme for openings and penetrations.

The use of BIM brings new tools to the fire protection designer, as it can now provide more than a 2-D or 3-D model to the design. It allows information specific to the design into the model itself. It can be used as a database for ongoing reference for service and parts inventory as well as a database for cataloging materials within specific areas of the building.

It also can enhance the design workflow process by giving the designers the necessary information to appropriately design their systems where conflicts may occur. This is especially true where equipment and designs require penetrations of fire-resistance-rated walls. The BIM model also can help automate some of the design process, saving time and cost. The advantages to using BIM for coordinating fire protection designs is only limited by the things we have not thought of yet. csel

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