SOCIETY OF FIRE PROTECTION ENGINEERS
POSITION STATEMENT P-05-11

Building Information Modeling and Fire Protection Engineering

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1.0 Executive Summary

In this document, the Society of Fire Protection Engineers (SFPE) outlines how Building Information Modeling (BIM) technology is currently being used in the fire protection engineering profession and provides recommendations for the profession's future direction in the BIM arena.

BIM technology is a dynamic and powerful tool for use in all phases of the facilities industry whose interest and acceptance is growing worldwide. Since the use of BIM is relatively new in the field of fire protection engineering, this document attempts to define BIM, how BIM is currently being applied and the cost/benefits of BIM. This background information is essential so fire protection professionals who do not regularly use BIM can better understand the issues in BIM technology that may impact the future direction of the profession.

The last part of this document provides recommendations that SFPE will encourage on future additions to the current BIM models that will assist the fire protection community in keeping pace with the level of design and information provided by other engineering disciplines.

1.1 BIM Defined

BIM is an acronym for "Building Information Modeling". It is officially defined in the National BIM Standard (NBIMS-US™) as "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 life-cycle from inception onward." NBIMS-US is a product of the Building Smart Alliance, a program sponsored by the National Institute of Building Sciences (NIBS) and supported by practitioners throughout the facilities industry.

In essence, BIM is a project-based interactive electronic database that is shared by all stakeholders involved in the design or operation of a particular building or facility. This typically includes the owner, architect, engineer, contractor, operations and maintenance personnel and others who have a legitimate interest in the life of a project and are authorized electronic access to the BIM for that particular project.

Through the use of software, BIM provides the ability to electronically insert, extract, update, modify, store and track detailed information relative to the design, construction, specification, cost, operation, maintenance, use, and management of a facility. It can also include information about applicable codes and standards, product installation manuals, parts inventory, maintenance schedules, warranties and virtually any information desired about the building or its contents. It can even be used to provide immediate information to emergency responders for pre-planning or emergency operations. Basically, it serves as an electronic archive for all of this information and has the capability to search, correlate and analyze this information in whatever format is available and interoperable with the standard(s) and software contained within the BIM.

One of the most popular features of BIM is the capability to illustrate every aspect of a facility in three dimensions (3D) on a monitor or projection screen. Thus, instead of using conventional detailed architectural drawings or CAD two dimensional (2D) layouts, BIM can electronically demonstrate precisely how the different elements of a building come together and relate with each other, including its architecture, structure, mechanical, electrical and other systems and features.

BIM allows a user the ability to take an electronic “virtual tour” of a new building while it is being designed. For example, a code official can “visually” evaluate the means of egress in 3D. Furthermore, BIM can include a fourth dimension (4D) to analyze scheduling and a fifth dimension (5D) to analyze cost. Other dimensions to perform code analysis, energy audits, etc. are being developed and there appears to be no limit to the potential capability of this technology.

Despite the higher initial cost, the use of BIM has been demonstrated to provide significant overall cost savings because of the more efficient management of information related to facility design, construction and life-cycle operation[i]. This appears to be especially true in large projects, but has successfully been applied to smaller projects.

1.2 Fire/Life Safety Application

In terms of fire and life safety drawings and how they relate to BIM, a number of organizations are in the process of establishing standards and guidelines. At a high level, the buildingSMART alliance (www.buildingsmartalliance.org) “has been created to spearhead technical, political, and financial support for advanced digital technology in the real property industry… (Operating) within the independent non-profit National Institute of Building Sciences (NIBS)…this public/private initiative expands on goals of the North American Chapter of buildingSMART International formerly the International Alliance for Interoperability (IAI-NA), whose Industry Foundation Classes (IFCs) have initiated open standards for national and international links throughout the industry. It provides developers and users of BIM, the digital tools that are increasingly helping to share highly accurate information throughout a facility's life cycle.”

Similar to traditional 2D CAD drawings, the level of detail required and subsequently translated via the medium will vary from project to project while depending upon user sophistication. To address this, the United States National Building Information Modeling Standard (NBIMS) has defined a Minimum BIM and proposes the use of a Capability Maturity Model (CMM).

A CMM is intended to measure the degree to which a model implements a mature BIM standard. A CMM will calculate a quantitative score to be measured on a sliding scale that ranges from below the BIM standard to a fully realized open and interoperable lifecycle BIM resource. An example is shown in Image 1.

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The Interactive BIM Capability Maturity Model

Area of Interest	Weighted Importance	Choose your perceived maturity level	Credit
Data Richness	84%	Expanded Data Set	*1.7*
Life-cycle Views	84%	No Complete Project Phase	*0.8*
Change Management	90%	Initiation	*1.8*
Roles or Disciplines	90%	Two Roles Partially Supported	*2.7*
Business Process	91%	Separate Processes Not Integrated	*0.9*
Timeliness/ Response	91%	Most Response Info manually re-collected - Slow	*0.9*
Delivery Method	92%	Network Access w/ Basic IA	*2.8*
Graphical Information	93%	NCS 2D Non-Intelligent As Designed	*2.8*
Spatial Capability	94%	Not Spatially Located	*0.9*
Information Accuracy	95%	Initial Ground Truth	*1.9*
Interoperability/ IFC Support	96%	Forced Interoperability	*1.9*
	National Institute of BUILDING SCIENCES Facilities Information Council National BIM Standard	**Credit Sum**	**19.2**
		Maturity Level	Not Certified

ADMINISTRATION	Points Required for Certification Levels		
	Low	**High**	**Not Certified**
	40	*49.9*	*Minimum BIM*
	50	69.9	**Certified**
	70	79.9	**Silver**
	80	89.9	**Gold**
	90	100	***Platinum***
	Remaining Points Required For:	Certified	30.9

Image 1 – Sample CMM

http://www.buildingsmartalliance.org/client/assets/files/bsa/BIM_CMM_v1.9.xls

At the end-user level, several organizations within the US have developed guidelines that support the direction taken by the buildingSMART alliance, with one of the more recent being the VA BIM Guide published in April 2010.

Similar to other guidelines, this document associates standardized trade colors for the purpose of clash detection (e.g. red for fire protection and fuchsia for fire alarm) and also presents specific requirements with respect to modeling. These specific requirements include:

a) The use of BIM authoring software element libraries when creating model objects. Model objects contain parts and components as opposed to a 3D geometry.

b) The model objects should be based upon Industry Foundation Class (IFC) parameters and associated data applicable to building system requirements. These elements should support the analytic process including size, material, location, mounting heights, and system information, where applicable. As an example, a sprinkler may contain several parameters such as K-factor, RTI, operating temperature, model number, manufacturer, and maintenance requirements.

These model elements should be derived from either the manufacturer or user generated. If user generated, the author should utilize appropriate BIM tool templates and assign the components as a part and part of a family or group.

Other products are being developed by the buildingSMART alliance to help coordinate this information. These information exchange (ie) tools will allow designers to specifiy and manufacturers to populate product information using open BIM standards. Two products related to this aspect are COBie (Construction Operations Building information exchange) and SPie (Specifiers Property information exchange).

The document is generic in its language to facilitate use of all commercially available platforms that support open BIM standards and builds of the foundation of the United States National CAD Standard (NCS) in terms of layers and line weights, etc. This standard defines the specific Discipline Designator associated with Fire Protection (F) and the subsequent Model Fire Types. An example of Model File Layers/Levels taken from the A/E/C CAD Standard is shown in Image 2.

Discipline: Fire Protection
Model File Layers/Levels

Level/Layer Naming		Graphic Defaults				Model File Types			
AIA Format	Level/Layer Description	Line Style	Line Width (mm)	AutoCAD Color #	MicroStation Color #	Life Safety Plan	Fire Suppression Plan	Fire Alarm/Detection Plan	Details
General Information									
F-ANNO-DIMS	Witness/extension lines, dimension terminators, dimension text	0	V	V	V	X	X	X	X
F-ANNO-KEYN	Reference keynotes with associated leaders	0	V	V	V	X	X	X	X
F-ANNO-NOTE	General notes and general remarks	0	0.35	2	4	X	X	X	X
F-ANNO-NPLT	Non-plotting graphic information	0	0.18	5	1	X	X	X	X
F-ANNO-PATT	Patterning, poche, shading, and hatching	V	0.18	8	9	X	X	X	X
F-ANNO-RDME	Read-me information	0	0.18	5	1	X	X	X	X
F-ANNO-REFR	Reference files and raster attachments	NA	NA	NA	NA	X	X	X	X
F-ANNO-SYMB	Miscellaneous symbols	V	V	6	5	X	X	X	X
F-ANNO-TEXT	Miscellaneous text and callouts with associated leaders	0	V	V	V	X	X	X	X
Aqueous Film Forming Foam System									
F-AFFF-EQPM	Equipment	0	0.35	82	18		X		
F-AFFF-PIPE	Piping	0	0.35	82	18		X		
CO2 Sprinkler System									
F-CO2S-EQPM	Equipment	0	0.35	6	5		X		
F-CO2S-PIPE	CO2 piping or CO2 discharge nozzle piping	0	0.35	6	5		X		
Control Panels									
F-CTRL-PANL	Control panels	0	0.50	23	46	X		X	
Floor Information									
F-FLOR-IDEN	Room name, space identification text (copied from Architectural - Floor Plan model file)	0	0.25	3	2	X	X	X	
F-FLOR-NUMB	Room/space identification number and symbol (copied from Architectural - Floor Plan model file)	0	0.25	3	2	X	X	X	
Halon System									
F-HALN-EQPM	Equipment	0	0.35	22	22		X		
F-HALN-PIPE	Piping	0	0.35	22	22		X		
Inert Gas									
F-IGAS-EQPM	Equipment	0	0.35	162	33		X		
F-IGAS-PIPE	Piping	0	0.35	162	33		X		
Means of Egress Lighting									
F-LITE-EMER	Emergency fixtures	0	0.50	23	46	X			
F-LITE-EXIT	Exit fixtures	0	0.50	203	45	X			
Egress Requirements									
F-LSFT-EGRE	Egress requirements designator	0	0.35	6	5	X			
F-LSFT-OCCP	Occupant load for egress capacity	0	0.35	6	5	X			
F-LSFT-TRVL	Maximum travel distances	0	0.35	6	5	X			
Fire Protection/Suppression/Alarm/Detection Equipment									
F-PROT-ALRM-INDC	Indicating appliances	0	0.50	83	42			X	
F-PROT-ALRM-MANL	Manual fire alarm pull stations	0	0.50	23	46	X		X	
F-PROT-EXTI	Fire extinguishers	0	0.35	2	4	X			
F-PROT-EXTI-CABN	Fire extinguisher cabinets	0	0.35	2	4	X			
F-PROT-HOSE	Fire hoses	0	0.35	2	4	X			
F-PROT-HOSE-CABN	Fire hose cabinets	0	0.35	2	4	X			
F-PROT-SMOK	Smoke detectors and heat sensors	0	0.50	23	46			X	
Fire Ratings									
F-RATE-DOOR	Door fire ratings	0	0.50	4	7	X			
F-RATE-WALL	Wall fire ratings	0	0.50	4	7	X			
Smoke/Pressurization Control									
F-SMOK-DMPR	Dampers	0	0.35	22	22	X		X	

Image 2: Sample Model Layer/Level Scheme

At this point there has been no single standard that has been identified as being the industry leader; however, most Federal organizations require the NCS.

2.0 Fire Protection Engineering Input

To date there has been limited interaction between the fire protection engineering community and the BIM software and platform development. The BIM community and individual software developers have generally focused on the larger design disciplines (e.g. architecture, structural, and mechanical/electrical engineering) along with the development of tools to transition from design and construction to building operation.

By comparison, fire protection engineering is a much smaller application and has therefore not been a priority for the BIM software and tools development. However, as BIM tools continue to evolve there is significant opportunity for the fire protection engineering community to become involved in the process and to influence how software/tools incorporate the fire protection engineering discipline. This includes fire suppression systems design, fire alarm and notification systems design, life safety and code compliance, and performance-based design.

2.1 Life Safety Drawings

Typical Life Safety Drawings have historically incorporated items such as locating rated walls, identifying occupant loads, egress paths (means of egress, common paths of travel, dead ends), exit signs and fire extinguishers.

The enhanced features of a BIM model will be able to quickly identify additional features that are not readily identified in typical CAD drawings; such as door hardware (e.g., self closers, positive latching, astragals, delayed egress, access control, door holders, magnetic door locking devices, etc.).

Many of these items will already be built into the families of the architectural model. Therefore, the role of the fire protection engineer may take on that of consultant to the architect. The fire protection engineer would provide the data to the architect. This would allow the architect to develop the fire safety information into the architectural model rather than the fire protection engineer self developing the life safety plans.

On the other hand, it may be preferable for the fire protection engineer to link the data from the architectural model to develop a separate life safety model that could be transferred down to a 2-D drawing for use by the code official. If the architectural model changes, corresponding changes would have to be made to the life safety model.

Regardless of which method is chosen, it is imperative that the two disciplines work closely together to ensure their plans are coordinated.

The architectural model will greatly enhance the input data immediately available to the fire protection engineer for evaluation of code compliance. However, in the short term, because of code nuances, the evaluation of the data and conclusion reached will not be immediately available from the model.

The architect and fire protection engineer will need to collaborate on the parameters/properties that need to be included in the families and types associated with life safety objects.

2.2 Fire Suppression System Design

Although, fire sprinkler system design is fairly evolved, there are still basic limitations such as the typical lack of populated symbols libraries including many missing symbols for basic systems components. Sprinkler system capability has typically been included within the BIM software as part of a larger mechanical/electrical/plumbing (MEP) package, which is generally focused on other MEP design elements, although the BIM platform is typically used for conflict checking of sprinkler system piping and equipment with other design entities.

Another option for sprinkler system design is to use a third party design program that is compatible with the base design BIM platform/software. These third party programs include benefits such as integrated hydraulic calculations, although the often changing BIM platforms can sometimes make compatibility with remaining design team documents/models difficult.

The lack of specific software capabilities often results in the FPE using BIM software as a basic drawing tool as opposed to being able to benefit from the basic BIM principles and the collaborative platform. There is potential to develop specific tools within the BIM platform to automatically incorporate system design and performance characteristics such as hydraulic and water supply calculations, remote area calculations, etc.

2.3 Fire Alarm Design

In general, the currently available BIM software packages have very limited capabilities in relation to fire alarm system design. There are typically limited symbols lists and similar to suppression system design, the lack of software capabilities often results in the FPE simply using the BIM software as a basic drawing tool. There is potential to be able to develop specific tools within the BIM platform to automatically incorporate system design and performance characteristics such as conduit fill, battery and power calculations, etc.

2.4 Performance-Based Design

There are generally no direct performance-based design capabilities within currently available BIM software packages; however, given the flexibility and premise for embedding/connecting calculations, there is some far reaching potential to incorporate inputs such as atrium smoke control analysis calculations, fire effects, and egress modeling directly into BIM models. While the development of these types of embedded capabilities is likely well into the future, there is current potential/capability to export BIM model information for direct import into some fire models to create building geometries and similar physical parameters. As the necessary file standards are further defined, the ability to transfer more detailed parameters and properties should also be possible.[ii]

3.0 BIM Level of Design and Information

As noted previously, the intent of BIM is to provide a project-based interactive electronic database for use by the design team, construction team and owner as well as any other stakeholders. Typically, BIM consists of “design” and “information” with design equating to 3D building design and information equating to specific information about the building systems and operation.

3.1 Design

There has been significant development in the overall design features of BIM; however, the features specifically for fire protection engineering are lacking. In the section “BIM Methods and Capabilities”, there is discussion around the two main BIM capable computer aided design (CAD) programs. In the Public sector, the US Army Corps of Engineers and the US General Services Administration are requiring most of their projects to be designed in a BIM-compatible program. This allows for 3D modeling of the building elements and clash detection/interference checking. From a fire protection engineering standpoint, however, the level of 3D modeling is still immature.

- Life safety drawings are typically drawn in 2D and not modeled in BIM as they are not considered “construction” drawings.
- Fire sprinkler drawings are typically “performance-based” and do not include a layout of all sprinkler and piping. As such, only risers, fire pumps and other equipment necessary for coordination/sizing are included in the model. (See the SFPE Position Statement P-01-05 *The Engineer and the Technician Designing Fire Protection Systems* for more information).
- Fire alarm drawings typically consist of a layout of all devices and panels and are therefore included in the model.
- Other fire suppression systems (e.g. foam, kitchen hood, clean agent) are only included in the model to the level of detail shown in the design.

Based on this, the level of fire protection and life safety system design shown in the model directly correlates to what is shown on the drawings. If the design is to be performance-based, then the engineer will typically only model those features that are needed for coordination. If the design includes more detail, those features will be modeled. Fire protection installation contractors (e.g. sprinkler, fire alarm) are left to develop the detailed installation drawings in 3D for clash detection/interference checking. The 3D model then translates into the 2D sheet files that are submitted as shop drawings to the engineer/AHJ for review.

One of the major roadblocks to BIM design for fire protection systems is the lack of support by BIM program developers and fire protection system manufacturers. The major BIM program developers have relegated fire protection design to other discipline programs. Manufacturers of fire protection equipment typically provide 2D CAD details of their equipment (e.g. valves, pumps, tanks); however, there are very few 3D BIM compatible details. As such, fire protection engineers are forced to develop their own 3D BIM compatible details.

3.2 Information

As previously noted, there has been significant development in the design features of BIM; however, the information features are still significantly lacking. In regards to fire protection and life safety systems and features in a building, information can consist of the following:

- Intelligent building features (e.g. walls, windows, ducts)
- Specification for protection and life safety systems
- Product data sheets for individual components
- Operations and maintenance instructions/schedules for fire protection and life safety systems
- Inspection, testing and maintenance reports relative to the fire protection and life safety systems
- Photographs of fire protection and life safety components/systems
- Any other document, photograph, etc. that provides value to the stakeholders in operating and maintaining the facility

With few exceptions, both Public and Private sector projects have not fully incorporated the information portion of BIM. This appears to be mainly due to two reasons: the limited ability of end users to fully access and utilize the information and cost. End users (e.g. facility managers, owners, sustainability/commissioning providers) do not seem to be adopting the ability to utilize all the features of the model. For example, the US Army Corps of Engineers requires BIM design on most projects but does not require interaction with specifications, operations & maintenance data, photographs, etc.

Cost can be a factor in fully implementing BIM due to the current economic climate. Stakeholders are requiring BIM design to assist/speed the construction process but are not taking the extra step financially to populate the model with information. However, with the model developed, additional information can be added in the future as need and economics allow.

4.0 BIM Methods and Capabilities

4.1 <u>Overview</u>

Currently nearly 50 software packages support open BIM Standards and read and write ifc's. There are four primary international BIM vendors: Autodesk, Bentley, Graphisoft and Nemetschek. In the United States as of the date of publication, the two main BIM platforms are Autodesk Revit and Bentley.

Although each platform is independent, the overall use is similar. Each platform is comprised of multiple individual packages targeted for specific disciplines. Fire protection engineering, however, can cross multiple packages. Passive fire protection can be evaluated and designed within the architectural package. Sprinkler, fire alarm, clean agent, special suppression, or smoke control systems can be evaluated and designed in the MEP package. Structural fire protection to some degree would be a component of the structural package.

Each platform utilizes a central "Model" with all relevant building components. Each discipline utilizes the Model as the background upon which their individual systems are designed. For example, the architect will typically develop the overall building model which includes buildings walls, floors, ceilings, etc. The fire protection engineer will develop the fire protection model which may include the automatic sprinkler piping, sprinklers, etc.

To allow multiple designers to work on a model, they can open local copies of the central model to perform design work. Within the model, worksets can subdivide the model components so that only certain designers can modify certain components.

The model can produce a 3D model to aid in clash detection/interference checking and coordination among trades. The 3D model can be used to create traditional 2D engineering and architectural construction documents. The traditional components of 2D construction documents such as legends and schedules can be linked to the model to allow for accurate representation of information within the construction document set. The links within the model can allow for improved efficiency and design accuracy to prevent conflicting errors within the construction documents.

Specialized components can be created to represent actual fire protection products. Presently sprinklers, sprinkler piping, and fire alarm notification appliances are the most common products available. Many manufacturers have component "families" developed with attached design parameters that will allow for integration within the building model. Additional components that require multi-discipline coordination, such as fire pumps, dry valves, fire alarm panels, smoke control fans and dampers can be linked together. This linking will allow for the BIM model to better represent an actual building in its intended function.

The challenge for BIM software is to integrate all the present day independent design tools within the BIM model. Some of the present day design software requires extensive interface and designer manipulation to communicate information from one design tool to the next, others work quite seamlessly. The nature of BIM is to integrate all the design tools into one virtual package that allows the entire design staff to work on one virtually all-inclusive smart model.

Although BIM can be used to demonstrate some level of performance based design, there are many specialized design packages that engineers currently use to validate fire protection design. Computational Fluid Dynamic (CFD) models are an extremely powerful method of demonstrating tenability and for the validation of smoke control systems. CFD models can also be used to evaluate buildings structural ability to withstand certain fire scenarios. Egress models can evaluate occupant flow and characteristics while hydraulic software can evaluate a fire sprinkler system's ability to provide the minimum water delivery levels. At the present, many of these specific design tools are limited in terms of their incorporation into BIM; however, this should change as BIM continues to increase its base of use.

BIM has evolved to a point where it is capable of running on the latest personal computer platforms. In order to keep up with design performance, continued upgrades to system components, hardware and operating systems will allow designers to improve efficiency. A model size can easily reach 200MB or greater, so computing power is important to maintain stability.

5.0 Cost to Develop and Input BIM Data

The cost to develop and input BIM data can be substantial; hence the reason why a large portion of this fire protection engineering data is not yet readily available. The development of data for other disciplines has been spearheaded by manufacturers who don't want their products to be excluded from upcoming designs. This is similar to the development of electronic specifications and details in the recent past – manufacturers began to develop these products as engineers and designers gravitated towards those who had these products readily available for use.

Certain independent firms are in the process of developing BIM data for manufacturers. As with any technology, the cost of developing and inputting this data will drop as the process becomes more mainstream. Eventually, manufacturers will have to have this information available for design professionals or risk being excluded from future designs. The manufacturers are also adopting open BIM standards so that they do not have to develop and maintain multiple proprietary libraries.

6.0 Owner's Value

BIM capabilities have allowed the architectural, engineering, and construction industry produce accurate representative models of the built environment. The multidimensional database capabilities of BIM software allows for detailed construction coordination, advanced system commissioning, and evaluation of building systems performance.

Present day building construction methodology may generically be represented by segmented design and construction phases. For example, an owner determines a new facility is needed. An architect develops the general building envelope while the consulting engineer designs the building systems. The intent is to completely build the building electronically first and work out problems in an electronic environment before constructing the facility. Once the architect and engineer develop a set of construction documents as a byproduct of the model, then a contractor begins facility construction.

During the construction phase, it is expected that unforeseen conditions and coordination issues will be kept to a minimum since problems were more easily distinguishable during the production of the model. These conflicts historically increased both the overall project cost and construction timeline, so it is in the best interest of the design team to minimize these occurrences to reduce overall project cost while resulting in a higher quality facility. Projects are now built without any change orders and with a minimum number of Requests For Information (RFIs).

The design and construction of a facility requires the integration of several different design professionals, contractors and other interested parties. Communication between all interested parties can be challenging, and the use of BIM software can more clearly and concisely communicate design intentions and coordination problems in the field. The AIA led concept of Integrated Project Delivery encourages all trades to communicate while the facility is still in the model phase.

The value of BIM Software is in allowing a built environment to be analyzed and reworked for the entire building lifetime. The overall performance of the building systems can be reviewed and validated within the model, allowing the owner to troubleshoot potential problems or shortcomings in building performance especially when the model is used for commissioning and handover to the operating engineers.

Fire protection and life safety components can be better represented in a BIM model. For instance, the graphical and physical representation of a smoke control system can be evaluated and validated with a number of different fire scenarios within the model. Building construction type and location of passive fire protection elements can be accurately depicted and tracked so that they are maintained by the building owner. BIMs can be used to evaluate performance of life safety systems in a forensic investigation.

During building commissioning BIM can assist in recording the standards of performance for building systems, and to verify that what is designed and constructed meets those standards. BIM also assist all building stakeholders in documenting the continuity of the project as it moves from one project phase to the next.

The usefulness of BIM to the owner generally will not only reduce construction cost, but will continue to reduce owner's cost through the life of the building. Troubleshooting deficient or underperforming systems can be evaluated in the BIM model without completing intensive physical onsite testing that would disrupt operation and prove to be more cost intensive. This will not replace physical testing of equipment, however, in certain scenarios it will reduce the time and cost associated with system testing by allowing the end user to modify certain system variables in order to evaluate the effect on system performance.

The sophistication of a single computer model to evaluate multiple building systems allows for easier and more efficient interdisciplinary coordination. Integrating BIM capabilities into the design and construction process will also shift present day design schedules and practices.

Adding BIM capabilities to a project will lengthen consulting schedules in the short term. There are intrinsic barriers to architects, engineers, contractors, and the Authorities Having Jurisdiction in learning new software. There are infrastructure and hardware limitations on basic desktop computers that limit interested parties from upgrading components.

Interested parties should stay current with the latest computing power to improve system performance increase efficiency. Training of staff to convert from previous design tools to new BIM software requires a significant investment by all parties.

The overall return of investment to the owner should be realized as the use of BIM becomes more prevalent in the design and construction industry. Fire protection and life safety design should continue to be an integral part of BIM software. Continued attention needs to be made to improve the modeling of sprinkler, fire alarm, clean agent, and smoke control systems, structural/passive fire protection, and egress analysis. The continued integration of all these components along with the many other building systems will allow for a more comprehensive tool for the life of the building.

7.0 Practical Use of BIM Data

The use of the BIM process to construct a building will provide the owner at the end of the construction process with a wealth of knowledge about his building. The initial design decisions being done in BIM provide some practical applications to fire protection and life safety systems.

The 3D design aspects of the BIM process allows for the early clash detection with other systems. The location of sprinkler system risers, bulk mains, and major branchlines can be a great advantage in a fast track lean design. The benefit of defining and designing each sprinkler branchline and sprinkler location may not be offset by the increase in design effort and cost. Sprinkler locations on a ceiling can be easily coordinated in both 2D and 3D design, if needed.

In addition to clash detection, the 4D and 5D information process for the fire protection systems and life safety systems BIM models are currently not available. This information would include scheduling, time constraints, material takeoffs and cost considerations. While the direct input into the BIM model for fire protection features is not currently available, this 4D and 5D BIM information can be loaded manually. This information is available to the contractor from the suppliers and subcontracting installation teams.

The BIM model information will provide the owner with final cost data for fire suppression, detection and alarm systems, and to some extent life safety parameters; however, current BIM models do not have the modules available to easily import this information. As time goes on, information will become more available and model elements will be developed by the manufacturers for use by the general industry.

Currently, the primary function BIM design process is used for in the fire protection field is clash detection. The next level of benefits is not integrated into the current BIM software packages.

8.0 Future Developments

As BIM becomes utilized on more private and public projects, the design and information input into the model will continue to grow. Fire protection engineers will need additional support from fire protection manufacturers and BIM program developers to keep pace with the level of design and information provided by other engineering disciplines to the model. Some major areas of improvement include:

- Additional support from program manufacturers to develop BIM programs and training specifically for fire protection systems. Fire protection specific BIM programs or add-ons should be developed with features that are useful to fire protection engineers and designers. Features may include:

  - Automatic cut pipe length notation
  - Ability to download sprinkler design directly to a hydraulic calculation program,
  - Intelligent information about a specific piece of equipment (i.e. click on a sprinkler and immediately be presented with the orifice, orientation, k-factor, SIN, etc.)
  - Strobe candela rating selection and visibility model
  - Intelligibility and audibility calculation based on actual building model
  - Door hardware (e.g. self-closing, positive latching, astragals, delayed egress, access controlled, door holders, etc.)

- Development of BIM compatible details for major fire protection equipment.

  - Details would have intelligence in that they would include size, model number, flow characteristics, power requirements, etc.

- Consistent level of design among fire protection engineers.

  - While there are exceptions when a detailed design is necessary, inconsistent level of design causes stakeholder confusion.

    - Some stakeholders may be expecting full layout design of a sprinkler system in the model while the fire protection engineer is developing a performance design.
    - Other stakeholders may be expecting performance design with full layout design by the installation contractor. If the fire protection engineer performs a full layout in the model, the stakeholder ends up paying additional cost that was not anticipated.

- Ability to both assist in the development of commissioning plans and aid the actual commissioning process.

- Development of interfaces between BIM and commonly used FPE programs such as CFD, Evacuation and FEM programs. The interfaces should be based on the Industry Foundation Classes (IFC) standards.

- Development of interfaces that will assist fire service plan an effective intervention strategy (i.e. fire lanes, access to fire department connections, use of standpipe connections, ladder truck placement).

9.0 Closing Statement

As BIM develops, SFPE will support and encourage the incorporation of fire protection engineering provisions into future technologies as current fire protection engineering involvement is minimal. The incorporation of exiting provisions, building code requirements and fire modeling components should be considered in addition to fixed systems such as sprinkler and fire alarm systems.

SFPE will work with and encourage private industry to ensure that these tools are available to all fire protection engineers as the technology evolves and becomes more mainstream. The incorporation of life safety egress provisions into the software will only serve to further push the acceptance of fire protection engineering in more common engineering realms.

Moreover, SFPE supports the American Institute of Architects (AIA) Position Statement 31, entitled *Interoperability* that states:

> *All industry-supporting software must facilitate, not inhibit, project planning, design, construction, commissioning and lifecycle management. This software must support non-proprietary, open standards for auditable information exchange and allow for confident information exchanges across applications and across time. This is best accomplished through professional, public- and private sector adoption of open standards.*[iii]

10.0 Further Reading

- Dimyadl, Spearpoint & Amor. (2008, September). Sharing Building Information using the IFC Data Model for FDS Fire Simulation from the 9th IAFSS Symposium, Karlsruhe, Germany.
- National Institute of Building Sciences (NIBS) – http://www.nibs.org.
- Building SMART Alliance - http://www.buildingsmartalliance.org
- National BIM Standard Committee – http://www.buildingsmartalliance.org/ index.php/NBIMS
- Whole Building Design Guide – BIM Library http://www.wbdg.org/design/bim.php
- McGraw-Hill Construction SmartMarket Reports - http://www.construction.com
- United States National CAD Standard Store http://www.buildingsmartalliance.org/index.php/ncs/ordering/ncsdownload/
- Department of Veterans Affairs BIM Guide http://www.cfm.va.gov/til/bim/BIMGuide/downloads/VA-BIM-Guide.pdf
- National BIM Standard Version 1 Part 1 http://www.wbdg.org/bim/nbims.php
- US Army Corps of Engineers – BIM Road Map for Implementation http://www.cecer.army.mil/techreports/ERDC_TR-06-10/ERDC_TR-06-10.pdf

- U.S. General Services Administration BIM
  http://www.gsa.gov/portal/content/105075

11.0 SFPE BIM Task Group

The Society of Fire Protection Engineers would like to thank the SFPE Building Information Modeling Task Group for drafting this position statement.

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Jim Kinslohr – Henderson Engineers, Inc.
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[i] McGraw Hill Construction Smart Market Report “The Business Value of BIM, Getting Building Information Modeling to the Bottom Line” 2009 For further info, go to: http://bim.construction.com/research/pdfs/2009_Bim_SmartMarket_Report.pdf

[ii] Dimyadl, Spearpoint & Amor. (2008, September). Sharing Building Information using the IFC Data Model for FDS Fire Simulation from the 9th IAFSS Symposium, Karlsruhe, Germany.

[iii] American Institute of Architects (2010, February 2). Position Statement 31. Interoperability.