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How BIM and Fire Safety Engineering could become a smooth integration, rather than a flaming mess

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This article aims to highlight the ongoing issue of the slow uptake of Building Information Modelling technologies in the Fire Safety Engineering profession, whilst recognizing the challenges, and also highlighting opportunities, future standards and potential avenues for tackling the issues.

The problem

One of the unique things about fire safety engineering (FSE) is that it combines so many different disciplines to safeguard life and property. What other profession combines chemistry, structural analysis, forensics, material science, construction methods, thermal physics, human behavior, biomechanics, toxicity, and computer modelling? However, this diverse range of disciplines may also be part of the reason why we don't yet seem to have a standardized, information-rich, modelling workflow. In addition, the vast majority of mainstream FSE tasks follow prescriptive rules which are different for every country (and often regions), which means that it's not really cost-effective for Building Information Modelling (BIM) providers to create bespoke tools. As a result, most engineers (on a daily basis) will often use a disparate set of long-established tools, and mark up the results on a pdf file.

It's strange: while many engineering disciplines have now integrated BIM as their source data platform of choice, it still seems that the FSE profession is somewhat isolated and unloved in the BIM world. Some major BIM platforms have integrated structural, HVAC mechanical, energy and electrical tools, with few specific tools for the fire safety engineers; where many still regard the process of annotating pdf files as a modern "digital workflow". The "flaming mess" of the intentionally controversial title is meant to be a superficial description of the state of BIM connectivity and the tools commonly being used by the FSE community at the moment. There are some features in BIM packages which can really help, but many engineers just don't know about: like travel distance and pathway planning tools, fire rating properties, facilities to support occupancy calculations from loads and areas, with calculations for minimum exit door widths already possible. These features have been available for several years, (with example guidance becoming available by the author ([on this web page](#))) so why are consultants not using them to engineer fire safety solutions? The problem and challenges have been recognized for more than ten years by Begley[1], and the SFPE[2], amongst others. Indeed, there is an active SFPE Foundation-funded research project[3] which will further document the issues and identify tools and future opportunities.

The BIM process lifecycle

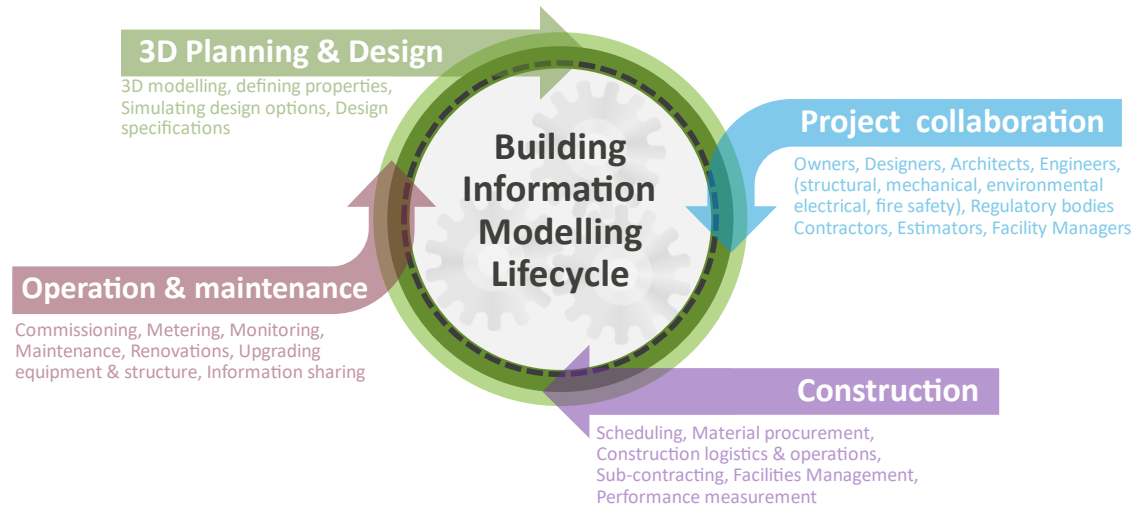


Figure 1. The BIM process lifecycle, shown as a schematic diagram.

In order to formulate a long term solution, we should consider that BIM describes a process, which only *starts* at the design stage, and should continue after commissioning, as shown in Figure 1. The design team creates an initial design, which may be updated as the team collaborates and iterates through the review and feedback for each discipline. The “Project collaboration” phase will include review by regulatory authorities via exported pdf files, the BIM files themselves or with recently developed methods of sharing each BIM view as a web URL, available for markup and feedback by regulatory bodies. The construction phase may also lead to design adjustments, and additional changes may also occur during commissioning, operations and maintenance. The model should be hosted on the cloud, and updated with upgrades & renovations carried out over future years, or when the building usage changes. These ongoing data updates encapsulate a “living model”, and define a true “digital twin” where the digital facsimile of the building is a mirror of the current building, with additional data layers such as metered feeds, performance and schedules all logged. Any work which impacts the building fabric and performance (like breaking fire stops, changing doors, modifying routes) should ideally be logged. In this way, at any stage, the design could be simulated and assessed. It should encapsulate the “golden thread of information” that was termed in the Hackitt report[4], and is intended to be updated for life safety reasons.

Mechanisms of integrating Fire Safety Engineering into the BIM workflow.

Multiple efforts are underway to support fire safety engineers to tackle tasks around the BIM platform. In order to tackle issues highlighted by a recent SFPE article[5], there are several commercial BIM-based tools available to tackle individual tasks, and even some automated prescriptive code compliance tools[6] usually for very few specific regions. These are at different levels of maturity, in different areas, and it still feels like a relatively immature field. In the long term, however, it is expected that the model data will improve, in line with the ability of functional systems to process that data, and eventually create the much more complete workflow where all data necessary for the FSE workflow can be sourced from, and preserved with, the BIM model.

A future vision, with standards

IFC (Industry Foundation Classes)[7] are the international BIM standard file format. Currently two working groups, under the umbrella of buildingSmart International (bSI) are focussed on delivering new standards to support expanded IFC file formats, to support a round-trip FSE workflow, shown in Figure 2.

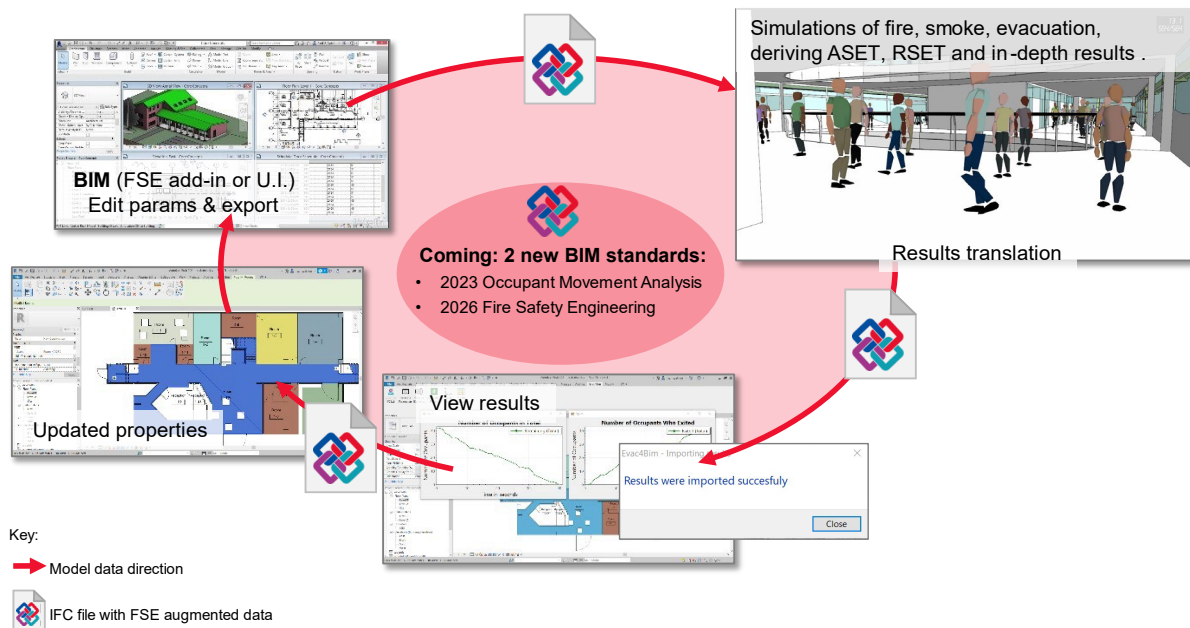


Figure 2. An illustration of the potential round-trip for FSE data, with upgraded IFC standards at the center.

Many of the core data needs for prescriptive routes for FSE analysis and compliance can be met through current IFC standards, but additional parameters, encapsulating the needs of performance-based analyses will be supported by the Occupant Movement Analysis (OMA) data enhancements (under initial review from the bSI Technical committee), and the Fire Safety Engineering[8] project which is starting at the moment, both project-led by the University of Greenwich Fire Safety Engineering Group, aligned with a strategy for data sharing[9]. Table 1 outlines key technical and organizational tasks required to deliver this long-term vision of a fully connected workflow, where the BIM model can store all of the core data for the fire safety engineering workflow, and pass it to external analytical tools, which in turn enable the inspection of results, with key data being passed back to the original platform. This full data

loop will enable design iterations, potentially reflect building maintenance and upgrades, and essentially form the longer-term digital twin to avoid model rebuilds and preserve data for life safety analyses.

Table 1. Task list to support integrated occupant movement & fire safety engineering analysis workflows.

Task		Who?	Status
1.	Submit Occupant Movement Analysis IDS standard to bSI	OMA working group (coordinating with bSI)	Currently in progress, submission 2023.
2.	Develop & submit Fire Safety Engineering IDS standard to bSI	FSE working group (coordinating with bSI)	Starting now, targeting 2026
3.	Inspect, collaborate and approve new IFC IDS specifications (standards).	bSI Technical Committee	Review of OMA IDS requirements in initial review stages
4.	Add additional fire safety engineering tools and data to BIM models, using add-ins with APIs and expanded data dictionaries.	BIM vendors, working with 3 rd party app/add-in providers on building code and region-specific basis.	Some tools already developed include travel distance calculations and sprinkler design. Yet more integration is required.
5.	Expand IFC export/import capabilities of BIM tools to include new IFC standards	BIM vendors	Will be requested when first OMA standard is approved and released.
6.	Expand IFC import (and export) capabilities of analytical and FSE simulation tools	CFD, Evacuation and Air pressurization simulation software providers.	Some draft import capabilities already begun as part of IFC prototyping work: Yakhou et al.[10]
7.	Professional bodies can help promote the use of new data standards to their members, which will further help harmonize the engineering workflows.	Professional bodies: SFPE, IAFSS recognize new IFC standards, potentially involving ISO.	Process will begin with the first approval and publication of the first OMA IFC standard approval and publication.
8.	Consider the submission of enhanced BIM (IFC) files for regulatory approval in the future, as a logical development of current pdf-base submissions.	Approving/regulatory authorities (Fire services, building code councils etc.)	Coming soon (?)

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The tasks itemized in Table 1 are intended to aid organizations, authorities, institutions and companies, to become aware of the areas of work which are required from each if we are to achieve the long-term aim of a fully connected BIM workflow.

Conclusion

This article has highlighted key problem areas, and the actions that are either underway or required to deliver a fully connected BIM-based digital workflow for fire safety engineers, at a relatively high level. The “task list” shown in Table 1 is intended to prepare companies and institutions for “what is coming” and what may be required in the next few years ahead if we are to deliver that long term vision. All parties need to work together with the common aim of avoiding the kind of data loss that can ultimately contribute to failed designs and loss of life. Additional research projects such as the current “Integration of Fire Protection Systems in Building Information Modeling[3]” will be required to inform and engage the community along the pathway to achieving a fully integrated fire safety engineering workflow more closely.

About the Author:

Peter Thompson has 27 years experience in commercial software development for building physics, BIM, building energy performance, and evacuation modelling. He now works as a senior research engineer at the University of Canterbury, and as visiting lecturer at Lund University. He previously worked in the

development team for a major BIM vendor for 8 years, and is on the review panel for the SFPE Foundation-funded “BIM Integration Research Project”[3]

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