Compliant fire design using BIM

BRANZ-backed research shows how BIM can automatically factor in some compliance requirements, helping to strike a balance between process and human expertise in fire safety design.

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COMPLIANT FIRE SAFETY design of buildings generally involves auditing processes against relevant regulatory requirements and standards. In New Zealand, this is typically achieved using the prescriptive Acceptable Solutions (C/AS1 to C/AS7) or the more performance-based Verification Method C/VM2 and applicable standards.

Gathering information is time consuming

The essential input parameters for a fire design include occupancy types and intended activities, building geometry, and construction types and materials. Gathering this information is a major task in the conventional design process as it involves manually taking the information from printed drawings and written specifications.

BIM gives easier access

As the ISO-standard building information modelling (BIM) is increasingly adopted, these design input parameters become more accessible with standard software tools available from the building model. Several commercial and open-source tools are used for this purpose.

Easier access to design input parameters gives fire engineers more time to focus on achieving effective and economical solutions.

Multiple compliance paths or compliant design options exist in every fire design. Evaluating these in a conventional design process is a time-consuming, manual undertaking. As any manual task is subject to human error, fire designs, particularly those that are more performance based, are usually subject to peer reviews. Ultimately, all fire designs must be audited and approved by the building consent authority and the Fire Service, where appropriate.

Uses BIM model view to be more manageable

A BIM model is necessarily large and complex since it can capture every object in the building project from concept design through to construction and operation stages. A BIM model view is used to make the schema more manageable and for efficient information access.

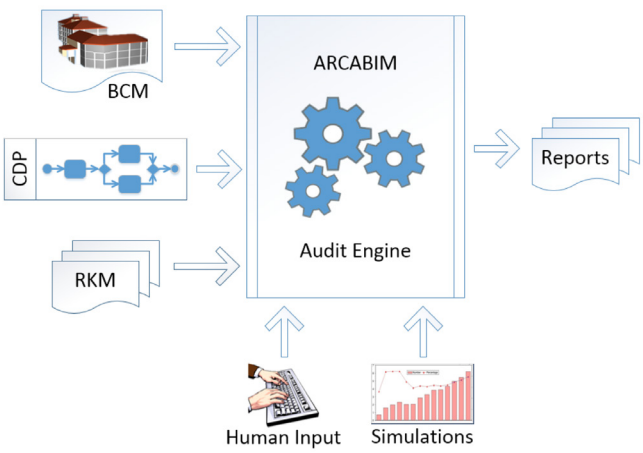

Figure 1: Automated compliance audit framework.

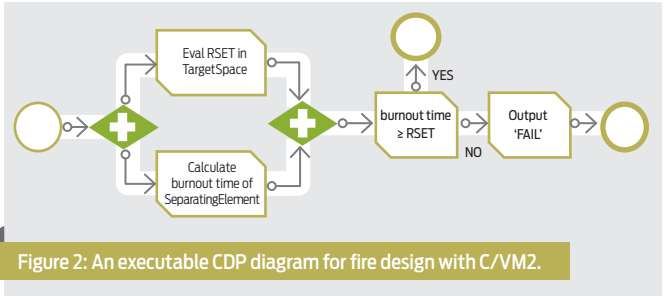

Figure 2: An executable CDP diagram for fire design with C/VM2.

A model view is a subset of a BIM model for a specific application containing only specific information needed for that application. For example, there may be separate model views for energy analysis, cost estimating or the compliance audit of a particular discipline such as fire safety, structures or mechanical and electrical services.

A model view for compliance audit applications may be referred to as the BCM (building compliance model). For a more specific application such as the compliance audit of fire design, the term FCM (fire compliance model) may be used.

The open standard information delivery manual (ISO 29481-1:2010) provides a methodology for exchange requirements for specifying the information to extract from the BIM model to create the required model view. For standardisation, the task of specifying the exchange requirements for fire safety designs should be undertaken by a professional body such as the Society of Fire Protection Engineers.

Research into automating compliance

BRANZ-supported research at the University of Auckland investigated conventional compliant design processes automated using BIM in conjunction with an open standard regulatory knowledge model (RKM) to represent regulatory requirements and standards.

An RKM representing C/VM2 was developed (see *Build* 142, Automating compliance audit). To maintain user familiarity with the document, the schema of the RKM was designed to closely mimic the structure of the regulatory document it represents.

Research into automated compliance audit spans 40 years with plenty of emphasis on rule-based representations of regulatory requirements. These are often hard coded into the compliance audit system so are inflexible and costly to change for regulatory amendments.

Human input still essential

One problem with the conventional rule-based approach is that not all regulatory requirements can be represented as rules. For instance, performance-based regulatory criteria often require engineering analysis and simulations to evaluate and therefore cannot be predefined as rules.

More importantly, human intuition and human expert knowledge often play a significant role in design, but they cannot be easily captured as rules. The current research suggests that the key to automating compliance audit is to strike the right balance between the level of intervention by human experts and automation by machines.

Expert designed workflows executed by process engine

The framework developed during the research incorporates a process/audit engine, ARCABIM, that can execute formal compliant design procedures (CDP) expressed in the open standard BPMN (business process model and notation) (see Figure 1).

The compliant design procedures approach allows a human expert to describe any design procedure graphically using standard BPMN-compliant workflow diagrams similar to flow charts (see Figure 2). Once described correctly, they can then be executed accurately and reliably by a process engine.

The added benefit of having formally documented compliant design procedures is that it helps the peer-review process. It also provides the building consent authority with the formal documentation on selected compliance paths and the philosophy behind a proposed design.

Only basic scripting skills needed

A high-level domain-specific query language, RKQL, has also been developed in the research. This allows anyone with basic computing skills to write scripting instructions for use with compliant design procedures to extract information from BIM and RKM.

Apart from querying data, RKQL also has the capabilities of instructing ARCABIM to perform certain calculations using the information extracted, to evaluate certain rules or to generate input files for external simulations.

Official libraries needed

Ideally, an official library of compliant design procedures representing the industry standard design practice should be published by a professional body or a government agency.

Similarly, a library of RKMs should be published by a government agency such as the Ministry of Business, Innovation and Employment as a digital equivalent of the paper-based regulatory documents.

Practical application

Once fully implemented, ARCABIM will allow a design engineer to use the compliant design procedures approach to extract information from BIM and RKM and audit their design automatically for compliance. Having an audited compliant design as part of the building consent submission will help the approval process.

This approach is also applicable to compliance audits against any kind of requirement specifications including proprietary standards and client briefs.

For more Visit www.cs.auckland.ac.nz/people/jdim006.

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