Automating compliance audit

A RELIABLE COMPUTER SYSTEM that could automatically check designs for compliance and provide instant feedback on regulatory compliance aspects of design would not only be useful, but arguably, an essential part of a cost-effective design process.

It would allow designers and engineers to evaluate more design options within a given time and eliminate costly design changes during the consenting process when non-compliant items are picked up.

Building consent authorities would be able to conduct speedy, reliable and consistent preliminary compliance audits, picking out most compliance issues and leaving only a few for human interpretation and final approval.

Too hard to date

While computer-aided regulatory compliance auditing has been extensively researched over the past 40 years, there are no commercially viable solutions to date.

The slow progress has been due to the challenge of adopting an industry standard digital model for sharing building information among project stakeholders. However, the emergence of an ISO standard building information model (BIM) opens up new potential.

Apart from BIM, an essential ingredient for a computer-aided compliance audit is a computable representation of the regulatory knowledge, which is often hard coded and integrated as part of the compliance audit system.

This black box approach makes a system inflexible and expensive to maintain with on-going regulatory amendments. Further, most related research has focused on prescriptive building codes that are simpler to convert into rules than some of the performance-based criteria in the New Zealand Building Code.

Two parts to digital model

An open model can represent regulatory constraints, rules and other data associated with any compliant design procedure. As it is independent of the compliance-checking system, designers, engineers and regulators can easily maintain it.

This digital model is an input component to the checking system and has two parts. The first part is a set of compliant design procedures that can be described graphically using the Business Process Model and Notation (BPMN) digital workflow diagram that a computer system can execute.

Each task in the procedure can be instructed to look up external data, execute computer code and evaluate rules and conditions, before proceeding to the next task. These are typical industry standard-compliant design procedures (see Figure 1) that are usually followed by designers to assess means of escape from fire, evaluate fire scenarios or check accessibility compliance in a building.

The second part is a library of computable rules and constraints associated with the tasks within the procedures. These could

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Figure 1: A segment of C/VM2-compliant design procedure.
be a set of the designer’s own constraints and rules or a computerised version of the New Zealand Building Code, published and maintained by MBIE.

Research starting small
A research objective is to produce specifications with guidelines that encode the entire Building Code. As a case study, current research is focusing on encoding the new Verification Method (C/VM2) for fire engineering design that allows analysis using external simulation tools.

Extracting information from BIM
Building information can be shared digitally using the ISO standard industry foundation classes (IFC) data model, a non-proprietary open standard format built into all BIM tools.

For fire engineering design checks, the information required includes:
- the geometry of stairs for evacuation simulation
- spatial data such as the location and positioning of doors and windows
- the geometry of spaces including floor areas, distances, wall and internal surfaces
- physical and thermal properties of their lining materials.

Users must manually add information not available from the model, such as the space usage classification, special doors and specific-purpose objects.

Compliance checking framework
The main inputs of the checking system are the BIM model (see Figure 2) and the digital regulatory model, as well as additional information supplied by the user.

Once developed, it will be able to execute a set of compliant design procedures on a BIM model against a set of encoded regulatory constraints and rules.

The output will be a list of non-compliant items with some descriptions on the nature of the violation and a list of warnings or items requiring further assessment by an expert.

Interfacing with simulation tools
To check performance-based criteria, particularly qualitative ones, it is necessary to access external computation or simulation tools for part of the answers. Therefore, the framework will be able to provide the data required to run external simulation tools and interpret the results for further evaluation.

The initial case study focuses on interfacing with BRANZ’s B-RISK and the EvacuationNZ model developed at the University of Canterbury to assist with the evaluation of the performance-criteria in C/VM2.

Progress to date
A preliminary set of guidelines for encoding regulatory knowledge will be available by the end of 2014 as well as a prototype system to query real BIM models and check the building design for fire safety against the C/VM2 document.

For more See http://cs.auckland.ac.nz/~jdim006.