Rodrigo Machado discusses some of the ethical questions posed by the growing use of computational simulation modelling within the fire safety engineering field

Field research

IN RECENT years, the use of computational models which simulate both people movement and fire has been enabling the adoption of performance-based fire engineering solutions in complex buildings. These types of models are being used in a wide field of applications, from human behaviour in emergency situations to fire risk assessment. They can be powerful and useful tools in developing fire safety designs in buildings, although there are some concerns over potential misuse and over-reliance on their results.

There are currently more than 40 people movement models (commonly called evacuation or pedestrian models) and in excess of 20 fire models. As a result, many people have been trained to become modellers, and a specific field within the fire safety engineering discipline – called computational fire engineering (CFE) – has emerged in which these modellers work.

Given this expanding CFE field and the growing importance of models in strategies that can determine the safety of occupants, the fire safety engineering community must address some important questions relating to ethical issues, including:

- who should be doing modelling?
- do modellers need to be fire engineers?
- when should a model be used?
- how good is a model?
- which criteria should be used when selecting a model?
- what kinds of feasible constraints are there when applying modelling analysis to fire safety codes?

These kinds of questions are particularly important in light of the increasing number of models being developed and used in fire safety engineering, and the genuine concerns that many in the profession have over their control and application.

The appropriate use of computational simulation analyses should follow three main principles:

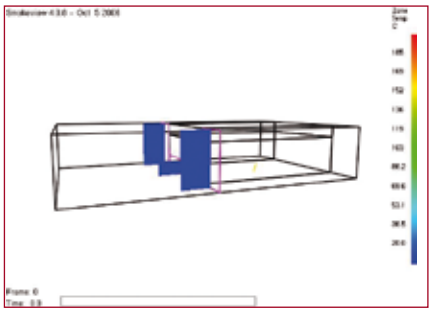
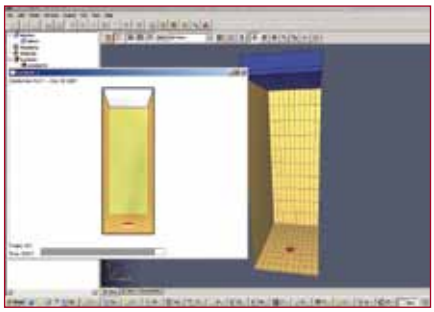
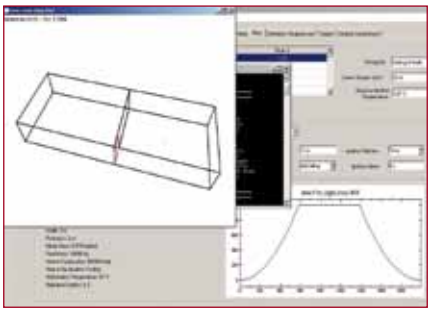
- understanding the limitations of these models
- accurate analysis of the results from the simulations
- proposition of feasible and intelligent design solutions, based on the modelling analysis (which requires knowledge of fire safety codes)

Worlds apart?

The CFE field has become a 'lively organism' within the broader field of fire safety engineering. In the UK alone, various models have been developed and validated over the last two decades, and some of these models are being constantly updated through research.

This research is carried out by groups composed of different professionals, from mathematicians to psychologists, representing academic institutions and specialised companies. The activities they conduct include:

- fire tests
- data collection from both real-scale experiments and surveys
- fire/evacuation drills
- development of algorithms which represent people movement
- studies examining human behaviour in emergency situations

However, although the CFE and fire safety engineering fields are very closely associated with each other, it sometimes seems as if they are two distinct, independent worlds, the former composed of model developers and researchers, the latter of practical fire engineers. Certainly, CFE professionals are not as well integrated with the wider fire engineering community as they could be – and this may mean that they spend time developing modelling software that, in practical terms, is not applicable.

Moreover, if someone is a modeller, it does not necessarily mean that they are a fire safety engineer. For example, most modellers are able to model complex scenarios, but may not be familiar with fire safety codes and standards, as are fire engineers.

Engineers vs modellers

The whole modelling process is not as easy as many might think. Its complexity increases according to the complexity of the design, as well as the constraints imposed by fire safety codes. For this reason, the person in charge of the modelling should be able to integrate all of the components correctly. And this integration requires, among others aspects, knowledge of fire safety codes.

In answer to the question, 'who should be doing modelling?', it should ideally be a person who is either a good modeller with knowledge of fire safety codes, or a good fire engineer with knowledge of modelling.

In an ideal world, fire engineers should be able to model properly when necessary, and modellers should have basic knowledge of fire safety codes, but this is often not the case. This can be explained by the fact that modelling is not always necessary when preparing fire safety strategies, and also that the few university courses that cover fire engineering are not design-related.

As a result, the correct practice when preparing fire safety strategies for designs is to have both CFE modellers and fire safety engineers working together, and to have in place adequate procedures to ensure this is possible.

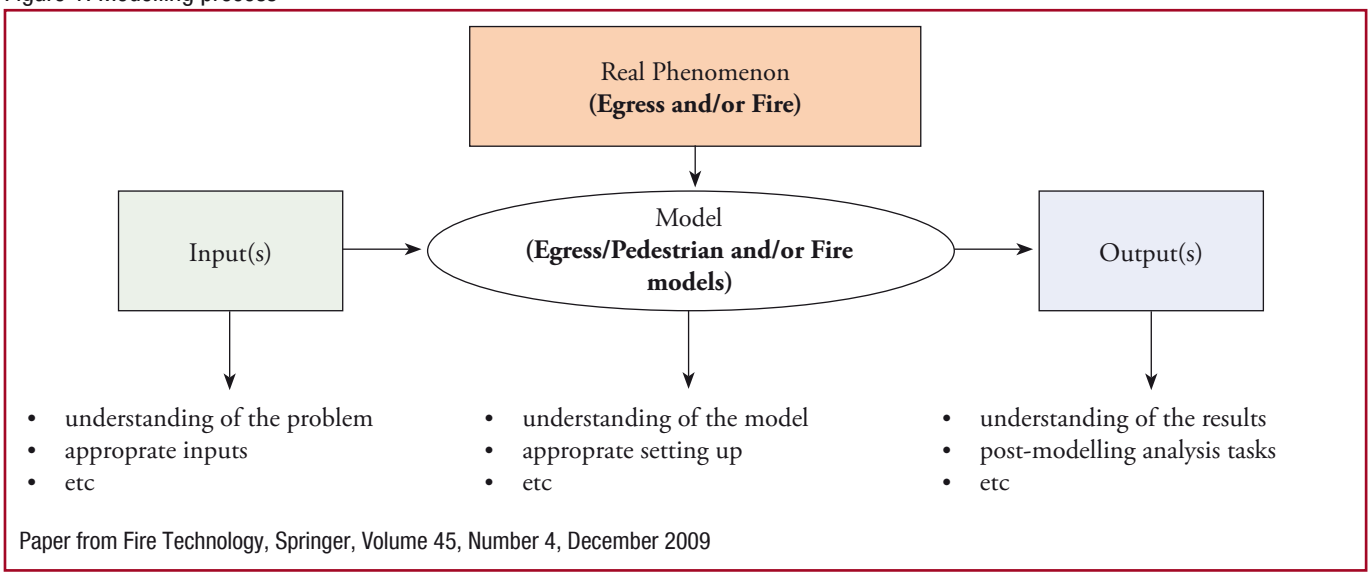
Quality concerns

Model developers often provide technical assistance on modelling (based on their models). However, it is difficult to control the quality of these models. This is because:

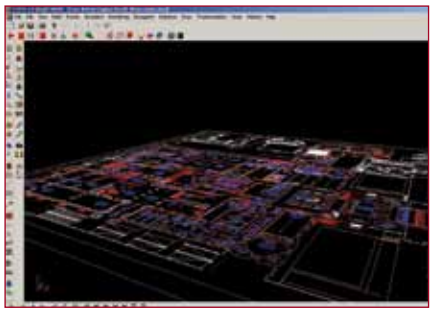
- there are hardly any restrictions on the use of models
- there is a lack of national or international standards for people movement or fire models and official guidance on how to use and/or when to apply modelling analysis
- the developers are interested in selling their products, and consequently will claim that their models offer the best capabilities, compared to competitors

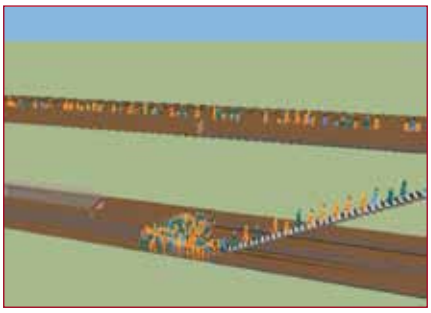
Based on these concerns, the following question can be asked: 'how can we make sure that the model is doing what it says it is doing?' This is a paramount issue to be addressed, since many model users make an assumption that what a model does is correct. After all, they may not want to question it, given the significant amount of money paid for the model. Nevertheless, the person in charge of performing the modelling should be able to use the model wisely, which includes: setting up the model, undertaking the simulations and interpreting the results.

Figure 1: Modelling process



Paper from Fire Technology, Springer, Volume 45, Number 4, December 2009





Therefore, judging model robustness and efficiency is extremely important. Basic instruction on modelling should be developed, for instance, through a simple analysis of the current models and a comparison of their capabilities and limitations, without relying solely on the information and claims of model developers.

Given the growing role of models for fire safety engineering and the concerns over their application, measures should be introduced in order to establish some safety criteria for their use (who should use them, when should they be used, etc) and also to determine, for example, whether the model's results have been skewed in producing favourable results in supporting and/or defending a specific structural design.

One suggestion is that an external oversight committee could be formed to monitor and validate each model available and give objective insight. This committee could, for instance, provide a 'code of ethics' for modelling and modellers (along the lines of the code used by the medical profession). After all, modellers, like medical doctors, can potentially hold some responsibility for fatality or injury through incompetence and/or negligence.

The proposed committee could also have a role in defining new standards for modelling, and producing instructions and guidance on the capabilities and limitations of available models. In addition, it could establish some kind of minimum qualifications (for example, Chartered Modeller) that model users must have in order to perform people movement and fire modelling. This would give confidence to customers/users that a modeller has the necessary skills to perform computational simulation analyses. In the present absence of any such committee, the onus is on fire safety engineering consultants to use models with responsibility and accuracy ■

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