Designers, Reviewers, Builders and Owners:

WE ARE ALL RISK MANAGERS

By Armin Wolski

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In the building design, review and construction process, the subject of risk is often given inadequate attention. For example, risks of fire, falling or earthquakes are rarely discussed or acknowledged, except in terms of code compliance. Do owners, developers and design professionals understand that meeting the seismic requirements of the code with a focus on mitigating the risk to life safety might not mitigate the risk to property to a desirable level? As the risk to life from fire is significantly greater in single-family homes than in highrise structures, are we doing too much for highrises or too little for single-family homes?

One answer to the latter question is that building codes have evolved indirectly to address perceptions of risk as much as actual risk.[1] Traditionally, risks of significant proportion (highrise buildings) have received more attention than the risks of less significance (single-family homes). In the United States, however, data indicates that the fire risk is higher in single-family homes than in highrise office buildings.[2] Perhaps it is time to consider risk more explicitly. From regulation to design to construction to maintenance, all stakeholders in the building safety arena are best served, and can better serve safety, with a broader understanding of their role in risk management.

This article is a **challenge** to the building design and construction community: Accept that **risk is a key characteristic** in the process of designing, reviewing, building and maintaining the built environment.

To date, seismic, fire and other risks to occupants or property have been relegated to discussions and review of compliance with the prescriptive code. Easy-to-use tables, simple equations and specified safety factors provide guidance for the design process. These prescriptions, based on decades of collective wisdom of thousands of professionals, are intended to provide an acceptable level of risk in the built environment to the society. In turn, the many rules negate the need for a designer or reviewer to understand or explicitly acknowledge risk. Even in more progressive building regulatory environments, where performance design methods or equivalencies are welcome, little attention is given to the subject of risk.

This article, the first in a two-part series, is a challenge to the building design and construction community: Accept that risk is a key characteristic in the process of designing, reviewing, building and maintaining the built environment. Since the building code provides the framework for managing risk in the built environment, risk concepts should be at the forefront of the discussion of code compliance and code development issues. When the community, both regulatory and design portions, embraces risk concepts, codes can improve, the design and construction process will be better informed, building stock will be safer and society will benefit.

In general, the easiest risk assessment decisions are ones in which we feel that we have the greatest certainty about the subject; very little analysis is necessary. We feel confident in our assessment about commercial aviation being statistically much safer than long-distance driving. We also feel comfortable knowing that ski technology has improved to reduce potential hazards of accidents and injuries. When we are uncomfortable with the level of knowledge, when we are uncertain about a decision, risk takes on greater significance.

In building design, architects and engineers perform risk assessments on an almost daily basis. Fire, tripping, fall protection, earthquake and glazing are

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subjects of risks to building users that are addressed in the design process. As previously mentioned, for the most part, risk management in these subject areas relies on the prescriptive code. Occasionally, a professional may "go beyond code" to address these areas where appropriate and reasonable. For example, during the design process of a balcony guardrail in an opera house, an architect may consider the improved safety provided by taller guardrails if the sightlines would otherwise not be affected.

Engineers weigh risks and benefits when they make decisions about which loads to use, which safety factors are appropriate or which sensitivity checks are necessary to the quality of their design. Yet, with all the implicit use of such risk concepts, the typical architect or engineer does not recognize risk to address fundamental building safety issues. A likely cause is that few codes and standards and fewer building authorities explicitly recognize, characterize or even refer to these building design challenges as risk problems. Many of my colleagues throughout the world have reported similar experiences.

What is Risk?

A classical definition defines risk as a measure of economic loss or human injury in terms of incident likelihood and in terms of the magnitude of loss or injury. In *An Anatomy of Risk*, Rowe defines risk as "the potential for realization of unwanted negative consequences of an event."[3] For engineers, this is translated into a mathematical form: Risk (harm/unit time) = Probability (event/unit time) x Consequence (harm/event)[4].

This mathematical definition is not quite broad enough to encompass how people think about risk. As Rowe indicates in his definition, the consequence is unwanted, but unwanted is a qualitative statement that is dependent on values. How people think about risk is arguably as important as a mathematically defined level of risk. And, as few would debate, the thinking process is rife with uncertainty.

So what is the difference between risk assessment (or risk analysis) and risk management? Risk assessment is the decision-making process of identifying the unwanted events or scenarios, or identifying the likelihood of event occurrence, and of identifying, estimating and assigning values to the consequences. Risk management, in comparison, is focused on the second part of the process, which is making decisions based on the assessment results. Risk management aims to manage risk though acceptance, avoidance, mitiga-

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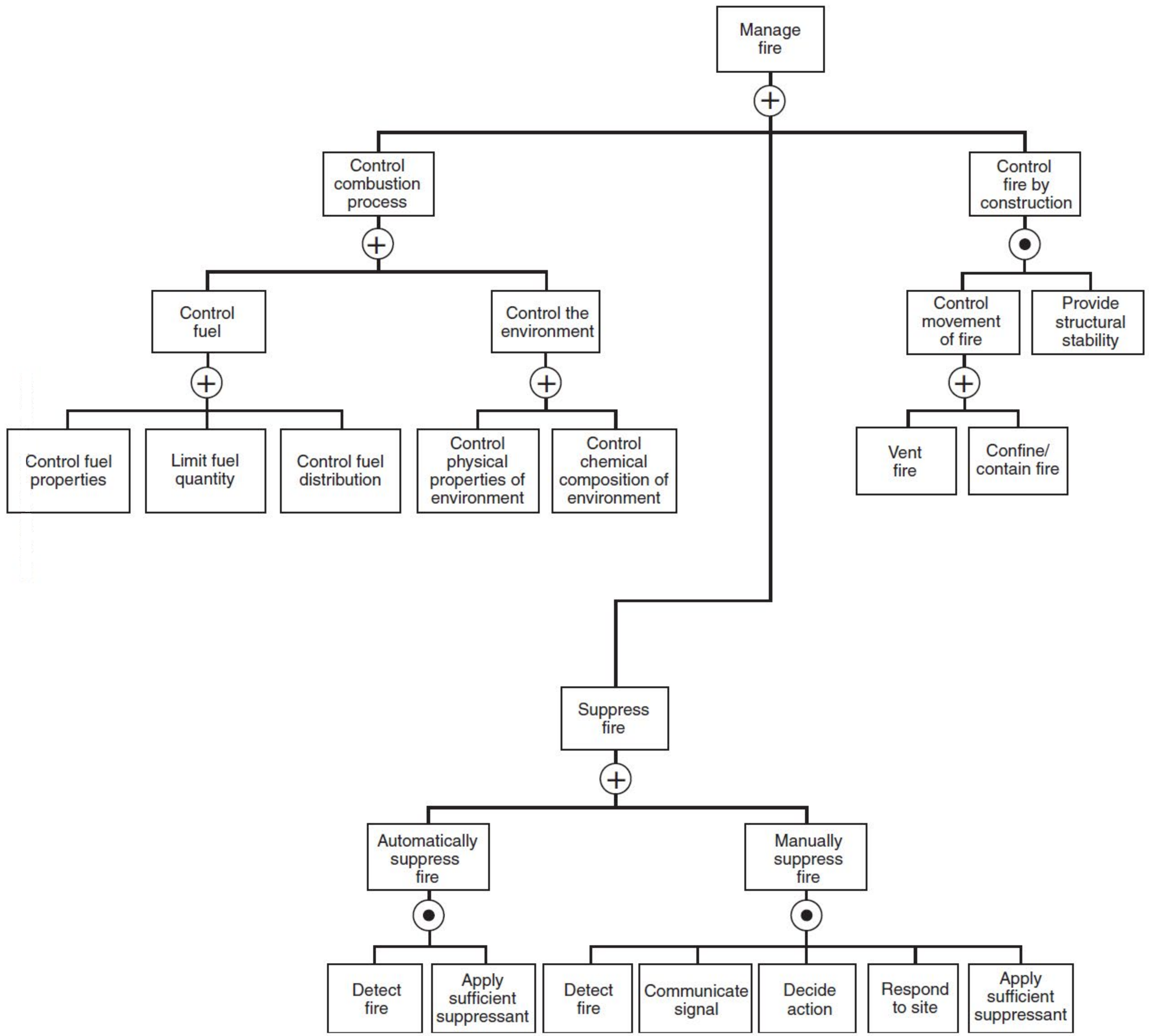
Fire Safety Concept Tree

The Fire Safety Concept Tree from NFPA 551, *Guide to the Fire Safety Concepts Tree*, is a logic tree type risk analysis tool that can be used to qualitatively evaluate design options, code changes or alternate methods of design. With some modification, the Fire Safety Concepts Tree can be used in a semi-quantitative fault tree or event tree risk analysis. This figure illustrates only one small portion of the tree. In this case, the plus sign indicates an "or" gate whereas the dot represents an "and" gate.



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tion or transfer. In some cases, the *International Building Code*® (IBC) accepts certain risks, such as the risk of fire spreading between two obviously interconnected floors. Once three floors are interconnected, however, the code requires risk mitigation efforts; the geometry is recognized as an atrium necessitating smoke control and other additional protection measures.

Uncertainties Define the Risk Problem

The decision-making process – the assessment and the management of a risk situation – is often multifaceted, with many issues to consider. We might think of these issues as a collection of uncertainties associated with a situation. Therefore, the challenge of risk management is decision-making exercised under a cloud of uncertainties. Fischhoff et al.[5] said that there are five "key uncertainties" in resolving risk problems:

1. **Uncertainty About the Problem.** What is the crux of the risk problem being solved? Is it a matter of life safety, rescue or firefighting safety or property protection?
2. **Uncertainties in Ascertaining the Facts.** What is the level of knowledge associated with the risk problem? If calculations are necessary, are the tools accurate for the given problem?
3. **Uncertainties or Variations in Values.** What do different people, groups or institutions think about the problem? Should there be a difference in the safety levels in K-12 institutions vs. a low-rise office building? Or, how do the interests of the owner, architect, engineer and authority affect the design solution?
4. **Uncertainties About the Human Element.** What do people know about the problem? Does the approach accommodate human variability? If calculations are necessary for code compliance, do we have a good understanding of the assumptions/input data? Will a high-maintenance life safety system work with owner/operators who want low-maintenance buildings?
5. **Uncertainties About Decision Quality.** Will the anticipated tools or methods provide accurate answers or analyses? Will qualified people apply the approach properly? In performance-based fire safety design, does computation fluid dynamic modeling provide appropriate answers if unqualified professionals apply it?

Addressing or resolving these key uncertainties – whether explicitly or implicitly, whether qualitatively or quantitatively – together form the process of solving a risk problem; they are risk assessment and risk

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For the purposes of illustration, these uncertainties will be applied to a building fire risk problem – a typical risk problem that requires close collaboration between many disciplines: an atrium. In atrium design, the primary stakeholders are the architect, the fire protection engineer, the mechanical engineer and the owner. The example we use is the fire risk posed by an atrium in a five-story university building. This risk can be characterized by the hazards posed by floor openings that constitute the atrium. The floor openings could permit smoke and hot gases to spread from floor to floor and, thus, endanger occupants who are far from the fire. This risk problem is generally assessed and resolved by an analysis that is dependent on deterministic tools, such as computer fire models that predict the consequences of a fire scenario. These tools provide a means to analyze the problem, sometimes in an iterative fashion, to come to a conclusion. The conclusion is typically a set of necessary architectural (fire-rated walls), mechanical (smoke fans or vents) and electrical (smoke detection) risk management features.

Each of the five key uncertainties plays a role in the atrium analysis and management solution. This common design challenge is used to explain how these uncertainties relate to the building design, and reveals how design, approvals, construction and maintenance are exercises in risk management. For this reason, it behooves the community of architects, engineers, contractors and authorities to recognize that much of their task is one of risk management and, when faced with difficult, interpretative decisions, they are well-served if they respond with an eye to risk concepts. In the longer term, such concepts are important to improving our building codes. **bsj**

In Part 2, Wolski will illustrate these uncertainties as applied to a building fire risk problem that requires close collaboration between many disciplines: an atrium.

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[1] Wolski, A., Meacham, B. and Dembsey, N.A., "Accommodating perceptions of risk in performance-based building fire safety code development," *Fire Safety Journal*, V. 34, No. 3, 2000.

[2] Hall, John R., High Rise Building Fires, *NFPA Ready Reference: Fire Safety in High Rise Buildings*, National Fire Protection Association, 2003.

[3] Rowe, W.D., *An Anatomy of Risk*, (Wiley, New York: 1977).

[4] Litai, D., "A Risk Comparison Methodology for the Assessment of Acceptable Risk," Ph.D. Thesis, Massachusetts Institute of Technology, (Cambridge, Mass.: 1980).

[5] Fischhoff, B., Lichtenstein, S., Slovic, P., Derby, S., and Keeney, R., *Acceptable Risk*, (Cambridge Press, Cambridge, Mass.: 1981) 9-46.

As always, your articles, ideas and submissions are welcome. Send them to foliver@iccsafe.org along with a daytime phone number at which to contact you with questions.