

# Human Behaviour in Fire

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**Abstract:** Attempts to predict the reactions of occupants in buildings equipped with new systems such as fast detectors, smoke extractors or residential sprinklers will fail if the complexity of human behaviour is not taken into account. To achieve this, it is necessary for fire safety engineers and psychologists to work closely together.

For decades, fire safety engineers have successfully designed and installed fire safety systems in buildings. Even though adequate systems are installed, failures still occur. In some cases, problems arise because the fire safety systems were developed on the basis of misconceptions about occupants' behaviour. For example, well designed and installed fire doors have failed to fulfill their role in office buildings because occupants use door stops to facilitate free flow of people. Thus, in the event of a fire, the doors stay open. Had fire safety engineers collaborated more with behavioural scientists, this dilemma could have been foreseen. Further, it is often people's lack of knowledge about fire safety that contributes to tragedies, as confirmed by recent findings.

Discussions with people who have experienced a fire emergency and with evacuation drill participants have shown that most people knew they should not use an elevator during a fire. Most, however, had little idea why its use is dangerous. Some mentioned the possibility that elevator cables would burn and the elevator car would fall to ground level, but none cited the possibility of smoke accumulation in the elevator shaft.

In another example, some residents mentioned that in fleeing a fire in their apartment, they felt there would be no point in closing their apartment door since the door was made of wood and wood burns easily. These statements, though rational, are based on insufficient knowledge about the evolution of a fire.

## People's Reactions During Fires

This lack of knowledge about fires on the part of building occupants has a parallel in the misconceptions fire safety engineers have about people's reactions when faced with a fire.

The notion that people caught in a fire will panic and stampede has long been rejected by psychologists. Panic has rarely been observed as a human response to danger from fire. In fact, most people appear to apply rational decision-making relative to their understanding of the event at the time of a fire.

It has often been observed that occupants -- in the initial moments of a fire, upon smelling smoke or hearing the fire alarm -- do not react; they deny there is danger or they ignore the situation. This seems especially true in public buildings where occupants do not want to be seen to overreact to a false alarm or to a situation that is already under control. Such avoidance behaviour in a dangerous situation often results in a delayed start to evacuating a building or taking protective action. It is paramount to consider this delay in assessing the risk to occupants' lives in a building.

## **People Are Fearless of Smoke**

In the past, it has been assumed that people were afraid of smoke and would flee upon smelling it or seeing it. A different picture, however, has clearly been demonstrated on numerous occasions. During the evacuation that followed the bombing of the World Trade Centre in New York City, people entered smoke-filled staircases and travelled through smoke for extended periods of time. People were evidently unaware of the dangers of moving through smoke and the rapidity with which its toxic components could harm them.

This is a case where people's behaviour must be altered through education and training. But there is more to it. It is also imperative to create fire safety systems that keep common escape areas free of smoke for as long as possible. This appears especially important in such large public buildings as arenas and shopping centres where occupants are likely to delay their evacuation until they are instructed to leave.

## **Drawbacks with Computer Models**

Many fire safety engineers use computer models for testing various designs as part of decision-making. Models on fire growth and smoke spread are commonly used, as are a few dealing with occupant evacuation. Most of these evacuation models, however, are flow models for the movement of occupants and rarely include an appreciation of human behaviour. For example, in some such models, occupants are assumed to systematically leave by the shortest route, even though it is well known that distance is only one of the parameters; another, among many more, is the choice of an egress route.

A recurring misconception built into some evacuation models is that people's movement is analogous to water flowing through pipes or balls moving on a pool table. Physical flow models are misleading, because they assume that people move like unthinking objects. Instead, to more accurately represent real behaviour, acceptable evacuation models should include, for example, the possibility of movement in a familiar direction, turning back, moving toward the fire and moving at different speeds.

## **Importance of Occupant and Building Characteristics**

Behavioural scientists have found that occupant characteristics are significant determinants of safe evacuation in a fire emergency. Gender, age, alertness, mobility and training are some of the important factors that affect evacuation time and the manner in which occupants deal with an emergency. The occupants' situation in an emergency is also important: whether the occupant is alone or in a group, is a staff member or a visitor, or is active or passive, all have particular connotations.

No less important are the building's characteristics: its design, organization and fire safety system have an influence on the evacuation outcome. How easily an occupant can find escape routes and understand signs and instructions depends on the way-finding performance of the building.

The stage of fire development also has a major impact on occupants' behaviour. Smelling or seeing smoke or having to turn back because of smoke and heat often explain the reactions of occupants.

The design of a fire safety system cannot be universal, nor can it be applied indiscriminately to all buildings of the same type or occupancy. Ideally, a fire safety system should be tailored to the characteristics of the building and its occupants. For a long time, fire safety systems in multi-unit residential buildings were planned with two parents and two children per apartment in mind. Through the years, this occupant profile has changed tremendously. Nowadays, these buildings are mainly occupied by single-parent families and an increasing number of elderly people living alone. These changes must be taken into account in developing a fire safety system for a building.

## Conclusions

Notwithstanding the difficulties in describing, explaining and modelling human behaviour when people are threatened by fire, significant results have emerged from recent research. These results have been essential in the development of successful safety training programs and in the implementation of new fire safety systems, such as using public address systems to give instructions, thus reducing the time needed to start an evacuation. There is, however, much to be done to improve safety in all buildings. New engineered systems, such as fast detectors, smoke extractors or residential sprinklers, which could reduce the risk to life, are constantly being developed.

Attempts to predict the reactions of occupants in buildings equipped with these new systems will fail if the complexity of human behaviour is not taken into account. A good starting point is to proceed from what is known and develop fire safety systems that incorporate this knowledge. To achieve this, it is necessary for fire safety engineers and psychologists to work closely together. A collective effort should help achieve the common goal of improving fire safety in buildings.

### CBC MARKETPLACE: HEALTH » PUBLIC FIRE SAFETY

## You have less than a minute to escape a fire in a public place ... Could you?

Broadcast: January 4, 2000

Picture yourself on the subway on the way home from work. You smell smoke; you see flames on the other escalator going up to the street. What do you think you would do?

When it happened in London, England, most commuters did nothing to change their routine. Thirty-one died. And now there is a new breed of scientist who predicts you would do the same thing.

They are scientific firefighters, and what they have to say about human behaviour will surprise you. It could also save lives, they say, if the engineers and architects who build our shopping centres, our subways and other public places would listen.

"This is what I call management by disaster," says Guylene Proulx, one of only 200 scientific firefighters worldwide "We often wait for disasters to occur to change the regulation and to adapt and to change the plan to reflect what we've learned from a disaster."

Proulx, who works for the National Research Council in Ottawa, adds: "I truly believe that this kind of work can save lives. Absolutely. That's why I do it."

Proulx watches one particularly horrific example of human behaviour during a very public fire. At a soccer pitch in Bradford, England several years ago, people watched as an entire section of the stadium erupted in flames.

The soccer fans were so intent on the game, they ignored the flames until it was too late -- the same phenomenon Proulx studied in a London subway fire.

This research could be used to make Canadian public spaces safer, she says. If fire broke out in a cinema for example, you'd think it obvious to stop the movie.



*At a soccer pitch in Bradford, England several years ago, people watched as an entire section of the stadium erupted in flames.*



*"This is what I call management by disaster," says Guylene Proulx.*

"Yeah, that seems obvious," Proulx says, "but ... well, building managers often are not prepared to go that far because they feel they can control the situation.

"This kind of behaviour has led to pretty terrible tragedies because if the situation become out of control, then people have a very short time to get out of the building."

How short? Sometimes less than a minute. That's how much fire safety experts say you have when the alarm goes off.

Such a short interval is made worse by our tendency to ignore fire warnings, Proulx adds. About 75 percent of us assume a fire alarm is nothing more than a false alarm.

But why don't fire alarms alarm anyone? Confusion is one reason. There are too many different sounds. Proulx's research has already led to changes in the National Fire Code and the National Building Code, the bibles for architects and engineers.

The codes are essentially blueprints for safe buildings and now mandate such measures as a uniform sound for alarms in new buildings. Mandatory strips that glow in the dark in stairwells are under consideration for the next code.

That latter idea came after a close look at the escape of 25,000 office workers caught in the World Trade Center fire in New York -- 25,000 people who had to make it down 110 stories.

A myth was shattered in that fire, the myth that people in such situations panic. "From all our research... there is no panic in fire," Proulx says.

Is this research being ignored by those who design the plans for emergency evacuations? Well, if fire broke out at the Bay in downtown Toronto, you'd never hear the word "fire" over the intercom because the man in charge says privately, it'll make you think "Towering Inferno!"

According to Scott Crowley, during a fire at The Bay "you would hear a code specifically designed for the fire safety plan. We have our codes ... for internal use."

That means intercom messages like code red, code blue, and Firestone. As in, "Mr. Firestone, you're wanted at level two."

"Our procedures do not use the word 'fire,'" Crowley notes.

But Proulx says that might not be the best plan. "If you try to go around and use technical jargon ... for the public not to know what's going on, you won't have any reaction from people," she says. "To tell people the truth is the best way to have them move."



"We have our codes ... for internal use," says The Bay's Scott Crowley

Marketplace went to the Eaton Centre to see if the codes aimed at floor staff work. After all, in case of fire, these are the people researchers tell us we will turn to.

## Noteworthy public fires

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1836  
Circus fire  
St. Petersburg, Russia  
800 killed

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1845  
Theatre fire  
Canton, China  
1,670 killed

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1942  
Cocoanut Grove Nightclub  
Boston, Mass.  
489 killed

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1977  
Beverly Hills Supper Club  
Southgate, Ky.  
164 killed

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1980  
MGM Grand hotel  
Las Vegas, Nv.  
86 killed

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1985  
Stadium fire  
Bradford, England  
53 killed

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1995  
Subway fire  
Baku, Azerbaijan  
289 killed

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Marketplace went to the Eaton Centre to see if the codes aimed at floor staff work.

But staff there weren't much help. Some told us what sound the fire alarm makes, but added that the instructions that follow over the public address system are almost inaudible and unintelligible.

And even if they know there's a fire alarm sounding, other staff are unclear about what to do. "I don't know," said one. "Well, should we pack up our bags and go? No one else that I'm working with is. None of the customers are."

We asked the staff member what it would take to force them to just leave: "Fire right outside my door, probably," they responded.

Even then, finding the right fire exit might not be too easy. One set of directions *Marketplace* followed led to a door labelled "authorized personnel only." It might be a fire door, but it's not clear.

Proulx, for her part, isn't surprised at *Marketplace's* findings, "because in Canada we haven't had a big fire event in a shopping centre so far.

"If you do management by disaster, we will probably need a big disaster in a shopping centre for people to look into fire safety in premises like that."

Cadillac Fairview, which owns the Eaton Centre, offers retail tenants fire safety training four times a year. But training for store staff is up to each store's management.

The Ontario Fire Marshall's office admits it hasn't got the firefighters to check every building, every fire safety plan. And as for rewriting laws, it's a slow process.

Joshy Kallungal, with the fire marshal's office, says he "can't quite agree with that statement that, you know, we are flying by our seat of our pants ... We are gaining more information through the human behaviour studies which can enhance public safety."

So what of the assertion that Canada's fire safety practices mean a public disaster is imminent? "I don't share that view," Kallungal says. "People, and all of us, have to take some responsibility for our actions."

But staff can make the difference between life and death. Ask Captain Al Speed. Twenty years ago, his fire department tried to save people trapped in Canada's worst hotel fire at the Inn on the Park. Six died. The coroner partly blamed untrained staff at the hotel.

After that tragedy, Toronto's prestigious King Edward hotel voluntarily spent millions upgrading its alarm systems.

We asked Captain Speed to do a test run on the staff in the hotel. He gave full marks to the bellman who pointed out the fire exits, but not the front desk:

"No reference to exits, no reference to fire safety and just a total absence of any reference whatsoever," Speed said of the desk staff.

From the staff's perspective, maybe that makes sense - they don't want to talk about fire as soon as people check in to their lovely hotel. "But fires do take place in hotels," Speed says. "When it happens, it's their building. Now, what are they doing to help the people who are in their building?"

Knowing you can't depend solely on staff, here's something the chief of Canada's largest fire department expects you to do every time you check in to a hotel: a dry run through the fire exit and out the building.



*One set of directions led to a door labelled "authorized personnel only".*



*"People, and all of us, have to take some responsibility for our actions," says Kallungal.*



*We asked Captain Speed to do a test run on the staff in the hotel.*

He also says to pack a [survival kit](#) - duct tape, a flashlight and your own smoke alarm with a working battery - to give you as many resources as possible to survive a fire.

It may sound a bit awkward, but Speed expects everyone to take these steps when they travel. "People die in fires. People die in fires very often who haven't really thought of these things.

"I've seen so much tragedy in my career that I'm so conscious of it and I realize it can happen to any one of us at any time."



*"I've seen so much tragedy in my career ... I realize it can happen to any one of us at any time," says Captain Speed.*