Elevator Messaging Strategies

Prepared by:

Erica D. Kuligowski, Ph.D.
Bryan L. Hoskins, Ph.D.

National Institute of Standards and Technology (NIST)
Gaithersburg, MD

FOREWORD

Passenger elevators allow building occupants to quickly and efficiently overcome the natural limitations of vertical building height. It is a technology that has enabled easy access to any level of a multiple story building of any height, and has been a key factor for the proliferation of modern high-rise buildings in today's built environment. Outside of North America "elevators" are also referred to as "lifts".
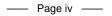
During an emergency or other situation it is normal practice to alert and instruct building occupants to take certain appropriate actions (e.g. evacuate the building). At any particular moment, building occupants may be using an elevator and they may require special instructions depending on the situation. Further, during a building emergency the use of elevators usually continues to assist with the evacuation of occupants with disabilities as well as providing building ingress for emergency responders via controlled manual use.

Since 2004, the US codes and standards organizations have been engaged in an intensive effort to allow building elevators to remain is use for occupant evacuation prior to Phase I recall. This effort, being lead by the American Society of Mechanical Engineers (ASME) has resulted in many changes to the model codes in order to address the infrastructure changes needed in building design. These changes involve subjects such as elevator shaft design, lobby design, and access and hardening of the elevator mechanical equipment. An outstanding task from this ongoing effort is the need to develop an operational and messaging strategy for the building occupants. Currently there are no requirements or widely recognized guidance for standard messages used in elevators, both for building occupants and emergency responders.

This project establishes guidance for emergency message content (audible and visual) and delivery based on the threat or hazard, the stage of the event (including pre-event), the sources and recipients of the communications, recommended message content and format, and the methods of message delivery. This report provides tools and message templates for use by elevator designers to address emergency events internal to the building, and addresses the needs of all building occupants including those with disabilities and emergency responders.

The content, opinions and conclusions contained in this report are solely those of the author.

PROJECT TECHNICAL PANEL

Ron Cote, National Fire Protection Association (MA)

David Frable, General Services Administration (IL)

Bruce Fraser, Fraser Fire Protection Services (MA)

Glenn Hedman, University of Illinois at Chicago (IL)

Jack Murphy, Fire Safety Directors Association of Greater New York (NJ)

Jake Pauls, Jake Pauls Consulting Services (MD)

Sharon Toji, H. Toji & Company (CA)

Carl Wren, City of Austin Fire Department (TX)

PROJECT SPONSOR

National Fire Protection Association

Acknowledgements

Table of Contents

1 Introduction

Since 2004, the U.S. codes and standards organizations have been engaged in an intensive effort to allow building elevators to remain in use for occupant evacuation prior to Phase I recall (when the elevator cars are automatically recalled to the level of exit discharge) during fire events. This effort, led by the American Society of Mechanical Engineers, has resulted in revisions to the model codes in order to address the infrastructure changes needed in building design to accommodate elevator usage during fire events. These revisions include changes to elevator shaft design, lobby design and access, and hardening of the elevator mechanical equipment. An outstanding task from this ongoing effort is the need to develop a communication strategy for the building occupants. Currently, there are no requirements or widely recognized guidance for standard messages used in elevators, both for building occupants and emergency responders during any type of evacuation.

In 2005, the National Institute of Standard and Technology (NIST) completed an investigation of the 2001 World Trade Center Disaster (Towers 1 and 2) which resulted in five recommendations specifically related to improved building evacuation [1]. These recommendations strengthened the ongoing efforts in evacuation elevators since one aspect of these recommendations focused on the inclusion of system designs and technologies that facilitate safe and rapid egress.

In response to recommendations and code changes allowing occupant evacuation elevators to be used during building evacuations, building occupants will be expected to change their current behavior from avoiding elevators during emergencies to using elevators, for either evacuation or relocation, during emergencies. In the years to come, it is expected that a progressive shift will be made in building construction. In addition to stairs, high-rise buildings will begin to incorporate occupant evacuation elevators as part of the elevator system and evacuation plan for the building. Some buildings in the U.S., i.e., the newer high-rise buildings, will contain occupant evacuation elevators to be used during emergencies and some will not. To address this issue, building occupants will likely require special instructions on evacuation procedures in the event of an emergency in a building equipped with occupant evacuation elevators.

Emergency messages and signage can be used to provide evacuation instructions to building occupants during an emergency. Information will be required for two distinct phases of elevator evacuation. In the first phase, building occupants will be located throughout the building taking part in activities unrelated to evacuation. In the event of an emergency, occupants will require information on what is going on and what actions they should take. For example they could be instructed to evacuate the building. Taking this one step further, occupants would also benefit from being told that occupant evacuation elevators exist in their building, that they should use them for evacuation, and the location of these elevators (especially if only a select number of the available elevators are designed for evacuation).

The second phase of elevator evacuation begins once the building occupants have arrived at the evacuation elevator lobby. At this point, they should be provided with information about the status or use of the occupant evacuation elevator(s). The information provided during this phase

needs to address both the elevator's technical requirements (e.g., is the elevator running?) and the population's psychological requirements so that individuals choose to wait for the evacuation elevator rather than taking an alternate egress route.

This report will focus on providing alternatives for emergency message providers on the second phase of elevator evacuation, i.e., ways in which to convey the status of elevator usage during building emergencies. A literature review has been conducted that specifically focuses on occupant response to status information and the appropriate ways to visualize and verbalize emergency information for efficient and appropriate public response. Additionally, some examples are provided for canned or standardized elevator voice or text messages to be used during fire emergencies.

2   Why is Status Information Important?

Occupants who have been instructed to use elevators for evacuation and have thus congregated within the elevator lobby for eventual evacuation are presented with an uncertain situation. For example, waiting occupants may wonder when the next elevator will arrive. They may also wonder if the elevators are still in service and, similarly, if they should continue waiting for an elevator to arrive or use the stairs for evacuation instead.

Maister [2] identified a number of characteristics that make waiting seem unacceptable or intolerable. While his article was intended for the service industries, many of the characteristics, listed below, should apply to occupants waiting for emergency evacuation elevators.

- First, anxiety makes waits seem longer. When people are unsure about whether they will be able to receive their service (in this case the use of an evacuation elevator) in a sufficient manner to meet their needs, time spent waiting does not help to decrease this concern.
- Second, uncertain waits are perceived as longer than known waits. People need to understand why they are waiting and how long they are expected to be waiting, which is related to the anxiety factor just discussed. If people know how long they are expected to wait, they can make an informed decision about their course of actions and know what is expected of them. If the wait is unknown, then there is no reassurance as to when (or even if) they will be served.
- Third, unexplained waits seem longer than explained waits. Providing information allows people that are waiting to understand why they are being expected to wait.
- Fourth, unfair waits seem longer than fair waits. If the system is equitable or need-based (and the waiting people agree with the greater needs of others), the wait becomes easier to tolerate. If people feel that others are unfairly being served before them, then they feel cheated by the system.
- Fifth, the more valuable the service, the longer the customer will wait. If people consider a service to be vital (or that they have no other practical option) they will wait, however long they need to. However, if people have other options, they are not willing to wait as long.

- Finally, solo waits are perceived as longer than group waits. When other people are around, the ability to share the experience makes it seem more bearable.

Many of these characteristics can be alleviated or at least reduced by providing information to occupants. Research has shown that in any uncertain situation, both emergency and non-emergency situations, humans seek information about what is going on and what they should do about it [3]. In emergencies, the act of physically seeking information can delay occupants from taking protective or safe actions and instead place them in harm's way. Additionally, when individuals do not receive information about what is going on, they can become frustrated [4], which can also delay their achievement of safety in both emergency and non-emergency situations. Therefore, it is important to provide individuals with the appropriate amount of useful information, especially in conditions in which the appropriate actions are unclear or unfamiliar [5]. Individuals waiting for elevators during an evacuation would benefit from real-time status information or updates in the elevator lobby. If provided appropriately, this information can limit occupants' needs to seek additional information as well as decrease occupants' uncertainty and frustration with elevator waits, so that they evacuate the building using the most effective and safest manner possible.

3 Non-Emergency Examples of Status Information

The U.S. population is familiar with receiving status updates on a daily basis. We can look at these scenarios to gain an understanding of how status information is provided in non-emergency conditions. On the road, drivers can be provided with information about traffic delays [6] or lane closures [7], which can aid in their decisions on route choice. Signage is also used to direct people to different route options if an area is blocked, for example by construction or an accident. In some instances, for example on major highways, drivers are given a choice of routes and the corresponding times to traverse each route, to guide their choice of the fastest or most efficient route. Research shows that drivers prefer to receive information before experiencing the conditions, and specifically the information on the nature and impact of the situation is appreciated [3].

When using mass transportation, passengers are provided with route options to reach their destination as well as the length of time they will be expected to wait for the next system, such as a bus or train, to arrive [8]. In the aviation industry, real-time information is provided for flight times and flight numbers [4]. Similar to mass transportation, individuals are made aware of the time until a specific flight arrives at the gate, and then where their baggage is located at the airport.

The hospitality industry has also embraced the provision of status information to the public, especially in those situations when individuals have options from which to choose. For example, at restaurants, individuals are often given the option of immediate seating at the bar or waiting for a table for a specific length of time. Additionally, at certain amusement parks, members of the public can reserve a spot in the express line or wait in the regular line. In each situation, individuals are provided with the length of time they should expect to wait so that they can make a decision as to which option to choose.

In non-emergency cases, such as transportation and hospitality, status information is provided to ensure that members of the public make appropriate decisions based upon their comfort levels with waits and their overall schedule for the day or trip. Often, status information is provided so that individuals can choose the most efficient (and sometimes safest) route available to them. Status information has been shown to influence the decisions that people make about the next actions they take, including motorists who change their route based on status updates [3] and rail passengers who increase their movement speed throughout the station based on real-time arrival information [9]. Also, status information can improve customer satisfaction by providing different options so that individuals achieve their goals safely, efficiently, and comfortably [10].

4 Status Information for Occupant Evacuation Elevators

The important role of status information for building occupants instructed to use elevators is to reduce their uncertainty related to waiting, which in turn, increases their level of comfort in the elevator lobby. By increasing their level of comfort, they are more likely to continue to wait for elevators as long as the elevators remain in service. Overall, studies identify the following pieces of information as beneficial to reduce the uncertainty and anxiety associated with waiting: how long occupants will be required to wait, why they are being required to wait, and what are their alternatives for evacuation.

When people are waiting, one of the most important pieces of information that they require is the amount of time until they will be served. When real-time information is not provided, people waiting over-estimate the amount of time from when they arrived until they are served [11]. Feeling like more time has passed than actually has can lead to an increase in the anxiety level. Providing information on the waiting time makes the wait seem shorter because people are not concentrating on the passage of time [12].

A countdown system is one method used to provide people with times until a service is available. When waiting for buses, countdown systems were preferred over ones that gave the time of the next bus and self-described visually-oriented people stated that their preference was for a graphic indicating the real-time location of the bus [13]. In this case, the preference is for a system that did not require people to obtain additional information, but instead allowed them to know how long they would be waiting.

Providing people with information on when they will be served can improve their overall comfort level with the situation. The provision of transport shuttle arrival times increased satisfaction with the service [14] and decreased perceived waiting time [15]. In both cases, the use of a countdown system was preferred over not knowing when the shuttle would arrive.

In some instances, providing information on how many people are ahead of them is more beneficial than providing the time itself. For longer waits, providing the queue position led to an underestimation of the actual wait time [12]. While the queue length does not give an exact time,

people are able to recognize a steady decrease in the number of people ahead of them and this allows them to gain an understanding of how the service is progressing.

Regardless of the exact method of providing the expected wait, there can be issues with how people interpret the provided information. When time is provided, it must be clear as to what time it refers [6]. For example, in highways signs, there may be confusion as to whether the "time to destination" begins at the location of the sign (which provides timing information) or the location of the traffic delay. In a second example, the inclusion of additional information, like a flashing hand in combination with a countdown can cause confusion for people that are crossing a street [16]. In both instances, even though time is provided, people did not understand what the time meant in terms of their situation. While providing the time was still beneficial, people were not sure how to properly use the information due to other, ambiguous information.

Due to uncertainties, it may not always be possible to give people an exact amount of time until they will be served. Overall, the maximum estimate of waiting time should be provided [17]. People are accepting of being served earlier than expected, but if people perceive that their spot in the queue is being skipped, they are less accepting of the wait [18]. Being served later than expected can lead to the wait appearing to be unknown or unfair and should be avoided when possible.

5 Visual Elements to Improve Emergency Communication

Providing the appropriate information, as was outlined in the previous section, is an important part of emergency communication. However, the information is only effective if it is received and processed by the affected population [19]. Specifically, in order to process the information and decide what to do in response to the information, individuals must perceive the information (i.e., hear, see, or feel it), pay attention to the information, and then comprehend or understand the meaning of the message.

There are elements that can be incorporated into visual-based emergency communication that will improve the likelihood that the elevator status message is received, paid attention to and comprehended. Some of these elements related to visual communication of elevator status, located in an elevator lobby, will be discussed in Section 5. However, for a more comprehensive review of the elements that can improve both audible and visual emergency communication, see Kuligowski et al. [20].

5.1 Perception and Attention Achievement

Whereas the content of the message or signage is very important to people, there are methods for presenting and displaying the message that increase the chances of people noticing and following the desired actions. Including these elements increases the chances of people behaving in the desired manner.

One factor that helps to increase the attractiveness of a visual display is its brightness. Stencil-faced signs with greater luminance are both important in being able to read signs in smoke [21]. The increased luminance allows the sign to stand out, especially in reduced visibility conditions. See Kuligowski et al. [20] on the various findings associated with static and dynamic lighting.

The choice of color also plays a role in determining sign visibility. The color of the sign should be different than its surroundings to ensure that the sign is noticed [22]. A sign that is the same color as the ambient environment is less likely to be noticed. By using a different color, the sign attracts the eye of someone that is looking in that general direction. Some specific examples include black on orange and white on green signs (they were detected at greater distances than black on white signs [40]) and light greens and yellows used in signage are more visible at night or in low lighting levels [23].

Another important element is the contrast of the sign or the lettering between the different components of the sign. For a light-reflecting sign, the minimum contrast between the brightness of the text and the background should be at least 30 % and is recommended to be 40 % for the daytime and 50 % for nighttime [23]. Another way of contrasting between the sign and the surroundings is with the shape of the sign. People notice larger objects when surrounded by similar, smaller objects [24]. Thus, the status signs in elevator lobbies should be made to appear differently than the ambient environment signs.

In addition to the sign itself, the environment around the sign can be modified in order to attract people's attention. Static flashing lights are able to do this [25]. The use of a flashing light near a sign can make it more noticeable for people not familiar with the building [26]. In this case, the flashing light attracts people's attention to the area around the sign. Once looking in that direction, they then notice the sign and can subsequently follow its instructions. Specifically, green flashing lights were found to influence exit choices in experiments [26]. Furthermore, because green is associated with safety, the use of green flashing lights can be used to direct people to an emergency exit [27]. Thus, green flashing lights may be useful in achieving attention for the elevator status information on the sign[1].

Finally, beyond the needs of the general population, some subpopulations will have additional requirements in order to perceive the messaging. Examples of subpopulations to consider in emergencies, specifically related to providing information about elevator status, are people with cognitive disabilities (i.e., any disability that may affect a person's ability to listen, think, speak, read, write, or follow instructions), mobility disabilities (i.e., people who use wheelchairs, scooters, walkers, canes and other devices as aids to movement), and sensory disabilities (i.e., a person with hearing or visual impairments, including total blindness or deafness). Additional subpopulations are non-English speakers and older adult populations, defined either based on being over 65 years old or have age-related impairments.

When people with sensory disabilities are present in the elevator lobby, both visual and audio messaging should be provided [28]. Simply providing a tone to draw people's attention is

---

[1] It should be noted that this report does not address the use of strobe lights and flashing green lights located in the same area. Testing should be performed to ensure that one type of flashing light does not interfere with other types already located in the building.

unlikely to be perceived as an instruction by individuals with severe hearing impairments [29]. A similar situation would occur if only visual alerts were provided and someone was visually impaired. Therefore, a tone alert and a flashing light, for example, could be provided to draw attention to the elevator status signage.

In addition to requiring multiple notification modes, the design of the dissemination technique(s) has to account for the different perception capabilities of the building occupants. Elderly people have been found to have difficulty distinguishing between blues and greens visually and hearing tones above 4 kHz [30]. Also, due to loss in visual acuity, sans serif fonts sized 12 or 14 points (or larger) are easier for the elderly to read in comparison with smaller fonts [30].

Some requirements for perception of messages have been codified. For the verbal annunciator in elevator cars, the 2010 ADA Standards for Accessible Design [31] require a minimum level of 10 dB above ambient and a maximum of 80 dB at the source. Also, visual signs need to be located at least 1015 mm (40 in) above the floor or ground and tactile characters on signs need to be located within 1220 mm (48 in) to 1525 mm (60 in) above the floor or ground [31]. For the signs to be observed by all occupants, higher-level signs can be paired with the signs required by ADA to limit the chance that the signs are obstructed from view in the elevator lobby. For safety way guidance signs, ISO 16069 states that high-level safety signs ensure visual reinforcement [32]. Depending on the height of the sign and the viewing distance, the letters on the sign can be required to be 16 mm (0.63 in) to over 75 mm (2.95 in) as the minimum height [31].

5.2 Comprehension

Once the information is received and noticed, there is the need to present the information in a way that is useful rather than overwhelming to people observing it. Providing more information, does not necessarily improve understanding. A complicated sign or symbol only leads to people spending more time trying to comprehend it and increases the chance that they will misinterpret the meaning of the sign. Keeping the image or message as simple as possible can allow people to see the sign, know exactly what is expected of them, and perform the desired action [6].

First, some of the methods used to gain people's attention can also be used to aid in their comprehension. For example, green flashing lights, as previously mentioned as being able to draw people's attention, can also be used to help them comprehend that there is an exit located there (near the light) [27].

Second, the categories of information included in the message are important. For example, people desire to know where the incident is located [3]. Individuals also are more likely to respond to information that is provided by a credible source, tells them what to do next (i.e., what action(s) to perform), and explains why they need to act; i.e., the cause of the disruption in service or emergency situation [33]. Throughout the message, the use of ambiguous words is advised against since it can cause confusion for the receiving population [6]. People need to be able to understand exactly what is going on and anything that causes confusion is not beneficial.

One factor that can improve sign/message comprehension is the use of pictorials (graphical symbols) [30]. Pictorials serve as a means to distinguish the signs from adjacent signs that only contain text. Also, the pictorials can be used as a means of quickly identifying that it is a sign that is relevant to the person's current information needs. Where pictorials are used, however, they should also be accompanied by a text-based warning. Pictorials with textual information were more effective than either method alone [34].

Where words are required, studies are provided to describe the best way to present textual information on a sign. One study found that text should be written as bullets rather than continuous text [21]. Some studies have identified methods of displaying information that are easier for people to comprehend while driving. In these instances, signs that were limited to three units of information (i.e., distinct concepts, descriptions, or actions) had better responses [23] and people were better able to remember an eight-word message when it was broken up rather than being presented all at once [23]. Also, if a sign had more than one frame, any key words associated with the message should be repeated in both frames [23]. Regarding the number of lines, signs that had only one or two total lines (even for bilingual signs) resulted in better responses [35] and signs with two lines were better understood than those with one or three [36].

Along with the display methods, the font and lettering style can influence how people comprehend a sign. There are some disagreements in the literature as to what fonts and styles are the most legible. Sans serif fonts are recommended [37], but at least one study found that Furtiger Bold was more legible than other sans serif fonts [38]. For the style of the lettering, lettering that is large and bold and combined with pictorials are more conspicuous [39]. Also, the most effective legible stroke width to height ratio for both positive and negative contrast letters is 1:5 [40]. Large and bold lettering can be seen from a greater distance. Additionally, signs with lowercase letters are easier to read than ones where only all uppercase letters are used [41]. In order to determine the size of the letters needed for a given sign, a formula was developed to determine the stroke width of letters to be read at varying distances [41].

As was the case with perceiving messages, the comprehension of messages can vary based on subpopulations. The use of vague terminology or complex message structure can impair the ability of seniors to comprehend the message [30]. Individuals with cognitive disabilities might not comprehend what is happening without repeated messages [29]. Similarly, people who understand the target language, but have a different native language can have more difficulty understanding a message when the speaker has an accent or if there is background noise [42].

To accommodate the needs of visually impaired individuals, tactile symbols are required for elevator control buttons as well as emergency communication devices [31]. The use of tactile signage is another way to allow a person with a sensory impairment to comprehend the message. The 2010 ADA Standards for Accessible Design [31] provide several requirements for designing signs that include raised characters. The characters need to be 16 mm (0.63 in) to 511 mm (20 in) in height, written in all capitals using a sans serif font, be at least 0.8 mm (0.03 in) above the surface, and the spacing should be between 1.6 mm (0.06 in) to 3.2 mm (0.125 in). In addition to these requirements, the raised characters also need to be written in Braille.

Finally, for instances where signs are needed in multiple languages, alternating messages between the different languages were not more cognitively demanding than simultaneously displaying both messages [3]. The length of time needed for 90 % of people to read a message in their native language was 2.0 s [43].

5.3 Credibility

Building occupants need to believe a visual or audible message is accurate, so that they perceive the information as credible and relevant to them [44]. One way to convey the credibility of a message is to provide information about the source of the message, i.e., from where (or who) the information originated [33]. For example, in emergencies, firefighters or the local fire department maintain credibility for a large proportion of the United States [45]. The accuracy of the message must be maintained throughout the entire incident. If conditions change, follow-up messages may be necessary. In these messages, the updated information should be conveyed as well as the cause of the change. For occupant evacuation elevators, the people waiting should be made completely aware of when they will be able to use the elevator.

Due to shared cultural backgrounds between the receiver and the source of the message, some subpopulations will consider certain sources more or less credible than other subpopulations and seek out other sources of information for confirmation [28]. This could be, in part, caused by a fear that the suggested actions might not meet their needs [29]. For the messages to be viewed as more credible, they should originate from sources with which the vulnerable subpopulations have regular interactions [29].

6 The Use of Symbols in Emergencies

In addition to written signs, symbols can be used. As mentioned previously, the use of symbols (or pictorals) helps to make a sign more apparent to the people in the building. Additionally, using symbols benefits subpopulations unable to read text in English. As with the signs, there are technical requirements that make the symbols more noticeable and understood by the target population.

A symbol showing sequential steps is the clearest way to provide instructions without words [46]. However research has shown, for dynamic traffic conditions, words needed to be included along with graphics [6]. The words add a level of understanding that the people were not able to obtain from the symbol alone. Thus, symbols and words can be used in combination to augment one another rather than relying solely on one means of conveying information.

For symbols that are used to convey information, they should be simple, have a close relationship to what they portray, have a precise meaning, and be easily perceived [47]. This parallels the research on textual messages in that the use of ambiguous figures (like ambiguous words) only leads to a lack of understanding. A complicated symbol or one that is not associated

with the desired action can lead to either lost time as the person attempts to process what the symbol means and/or noncompliance with the actions to which the symbol is intended to prompt.

Aside from the content of the sign or symbol, how people interpret it is also important. For example, a series of pictograms that was intended to be read from left to right was read from right to left by the actual users. This resulted in the opposite behavior than was desired [24]. Even though the symbols accurately portrayed the desired action, how the pictograms were interpreted was not how they were intended to be read. Had it been recognized how the symbols would be interpreted, the sign could have been designed in a manner that ensured compliance with the intended meaning.

7 Recommendations and Canned Messages

Based upon the research presented in this report on waiting and status updates, eight generic recommendations can be made on the *content* of elevator status messages to building occupants waiting in elevator lobbies. No recommendations will be made at this time on the appropriate ways in which to disseminate, or in this case, display, elevator status messages, since that is the purpose of an ongoing NIST project on emergency communications (see Kuligowski et al. [20] for further details).

The recommendations included here on elevator status message content are listed as generic since there is no one-size-fits-all approach for every building and population in the U.S. It is important for building owners, building managers, and/or building safety personnel to alter these recommendations based upon the needs of their building population, and devise a strategy that is most appropriate. Once the strategy is developed, it is also important to test the messages and visual signage provided in the elevator lobby through evacuation drills and other programs to ensure that the message is clear, appropriate, and will be followed safety and effectively. The generic recommendations on elevator status messages are listed here:

- Provide building occupants with a "countdown until service" message. Whether by time or number of floors to be served until the elevator (or set of elevators) arrives, this countdown will make the wait more comfortable to endure and in turn, can reduce the likelihood that occupants will choose stairs instead of elevators. The countdown should be based on the upper bound of the expected window because people will be pleased to be leaving ahead of schedule and become anxious if they feel like there has been a delay of some kind.

- The expected time to traverse other evacuation options in the building (e.g., a nearby exit stairway) should also be provided as a static sign located near the stair door. This will allow people to make the exit route choice that they deem most effective.

- Signage should also clearly include the available capacity of the incoming elevator (or set of elevators). This will help people to make an informed decision. If there are more

people than the capacity of a single car (or set of cars), some people may feel more comfortable taking the stairs instead of waiting for the elevator.

- If there is a scheme used to prioritize elevator service (i.e., serving the fire floor or people with disabilities before others), this information should be provided. The provision of priority strategies allows occupants to understand why they are being expected to wait.

- Any change in message should include the reason for this change. For example, if the elevators are taken out of service for any reason, that reason should be clearly stated in the elevator status message.

- The source of the message should be included in the elevator status message, especially if the source of the message holds a high level of credibility with the building population.

- Provide building occupants with information or instructions on what to do once they have reached the elevator lobby, e.g., leave the building, wait for an elevator, or use the stairs. Also, occupants should be given instructions on procedures that are specific to the elevator operation and/or the building emergency procedures related to the use of elevators. For example, occupants may be required to press the elevator call button multiple times to call multiple elevators to the same elevator lobby. One way to provide this information is via training. Another way to provide this information is to include these instructions to occupants waiting inside the elevator lobby either via static or dynamic signage.

- Alerts to grab attention and for the provision of information on elevator status should be provided via audible, visual, and when appropriate, tactile, means.

Canned or standardized messages are included here to provide examples of the recommendations listed above. First, for individuals waiting for an elevator in the elevator lobby, we have provided basic examples of the types of information that should be provided in the message, including the source (or who is giving the message), a brief explanation of the incident, what people should do about it (i.e., wait here), and the countdown timing for the next elevator (which should be constantly updated as time goes on).

This is [name/title] or [organization].
You have been asked to [e.g., leave the building] because of [event, e.g., fire]
You may choose to wait for the next elevator or use the nearest stair.
The next elevator will be here within [time (minutes)].

Research, provided earlier on visual messages and one introduced here on general messaging [48], states that messages of three lines or less, no more than 30 words, are more successful at keeping individuals' attention and with message comprehension. Therefore, additional options are provided here if message providers want to reduce the number of lines or words in the message. These options combine the elevator status timing and the safety actions of the

occupants. Both pieces of information are equally important. The inclusion of elevator countdown timing allows for an informed decision by the building occupants as well as a reduction in personal anxiety level. This timing information should be constantly updated so that individuals are aware of when the next elevator or set of elevators will arrive on their floor. Additionally, the purpose of including safety instructions is to reduce occupants' uncertainty about what they are expected to do and the potential time spent searching for next actions.

Option 1:

This is [name/title] or [organization].
You have been asked to [e.g., leave the building] because of [event, e.g., fire]
You may choose to wait [time (minutes)] for the next elevator or use the nearest stair.

Option 2:

This is [name/title] or [organization].
You have been asked to [e.g., leave the building] because of [event, e.g., fire]
You may choose to wait no more than [time (minutes)] for the next elevator or use the nearest stair.

Research also described earlier suggests that visually-presented messages provided in bullet form are more successful at conveying information when compared with messages written in continuous text. For that reason, a bulleted example message is provided below to accommodate this research finding as well as to accommodate technology with limited space to display message text.

Message from: [name/title] or [organization].
Event: [briefly describe event]
Action: Wait here, next elevator: [time (minutes)] or take stairs

The second line in the messages displayed above informs occupants about the specific situation that is happening in the building. The intent here is to help reduce uncertainty (and information seeking) about the event and let the building occupants make an informed decision based on their perceived risk. It can also help reduce the burden associated with the fairness of waiting. If, for example, the event causing the evacuation is further away from their location, waiting while the elevators evacuate other occupants on or near the fire floors may be more acceptable. If this event-based information is included in the original warning message (instructing people to evacuate or relocate, for example), then information describing the circumstances of the event may not be necessary to provide to occupants waiting in the elevator lobby. See examples below:

Continuous message example:

This is [name/title] or [organization].
Please wait [time (minutes)] for the next elevator or use the nearest stair.

Bulleted message example:

Message from: [name/title] or [organization].
Action: Wait here, next elevator: [time (minutes)] or take stairs

If the elevators are taken out of evacuation service for some reason, e.g., it is no longer safe to evacuate building occupants using the evacuation elevators, an example message is provided here asking for occupants' attention, listing the source of the message, giving the reason why the elevators are out of service, and telling people what to do next. Attention can also be achieved by sounding an alert tone and providing a visual notification simultaneously (rather than or in addition to stating "Attention please").

Attention please.
This is [name/title] or [organization].
The elevators are now out of service because [specific reason]
Please [e.g., use the nearest stair to leave the building]

The third line, discussing the reason why the elevators are now out of service, is included to explain why this change was made. Explaining the reason for this change in elevator service helps to maintain credibility in the sequence of elevator status messaging as well as prompting building occupants to understand why they need to change their actions. Both the reason for the change and the fact that the elevators are no longer in service should be included in this message.

Research also described earlier suggests that visually-presented messages provided in bullet form are more successful at conveying information when compared with messages written in continuous text. For that reason, a bulleted message option is provided below to accommodate this research finding as well as to accommodate technology with limited space to display message text.

Message from: [name/title] or [organization].
Change: Elevators are out of service
Reason: [Reason for change here]
Action: [Take stairs, for example]

In all examples provided above, the person giving the message identifies themselves by name, title, and/or organization. Knowing who is providing the message aids in its credibility. If the message source has a position of authority, his/her title can be used when giving his/her name. Ideally, the person or organization is one that the building occupants, especially vulnerable subpopulations, deal with on a daily basis. If the message is coming from an organization, it should be one that the building occupants trust to provide information about evacuations and/or elevators (e.g., building management or the fire department). Alternative ways to include the source of the message are the following:

From: [name/title] or [organization]
As [title], I want to inform you that…

8 References

[1] Sunder, S., 2005. "Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Final Report of the National Construction Safety Team on the Collapses of the World Trade Center Towers (NIST NCSTAR 1), National Institute of Standards and Technology, Gaithersburg, MD.

[2] Maister, D., 1985. "The Psychology of Waiting Lines," In Czepiel, J. A., Solomon, M. R., and Surprenant, C. F. (Eds.), The Service Encounter: Managing employee/customer interaction in service businesses, D. C. Heath and Company, Lexington Books, Lexington, MA.

[3] Dudek C. L and Ullman G. L., 2001. Guidelines for changeable message sign messages: Annotated bibliography (DTFH61-96-C-00048), Texas Transportation Institute, College Station, TX.

[4] DeVries, P. D., 2009. "Airline passenger information systems and process improvements," International Journal of Services and Standards, Volume 5, Number 1, pp. 42 – 50.

[5] Endsley, M.R., Bolte, B., and Jones, D.G., 2003. *Designing for Situation Awareness: An approach to user-centered design*, CRC Press, Taylor and Francis, Boca Raton, FL.

[6] Richards, A., McDonald, M., Fisher, G., and Brackstone, M., 2004. "Investigation of Driver Comprehension of Traffic Information on Graphical Congestion Display Panels using a Driving Simulator," EJTIR, Volume 4, Number 4, pp 417-435.

[7] Dudek, C. L., 1978. Human Factors Requirements for Real-Time Motorist Information Displays: Volume 2 State of the Art: Messages and Displays in Freeway Corridors, Federal Highway Administration, FHWA-RD-78-6.

[8] Grotenhuis, J., Wiegmans, B. W., and Rietveld, P., 2007. "The desired quality of integrated multimodal travel information in public transport: Customer needs for time and effort savings," Transport Policy, Volume 14, Issue 1, pp. 27-38.

[9] Dziekan, K. and Kottenhoff, K., 2007. "Dynamic at-stop real-time information displays for public transport: effects on customers," Transportation Research Part A 41(6), pp. 489-501.

[10] Dickson, D., Ford, R. C., and Laval, B., 2005. "Managing Real and Virtual Waits in Hospitality and Service Organizations," Cornell Hotel and Restaurant Administration Quarterly, pp. 52-68.

[11] Mishalani, R. G., McCord, M. M., and Wirtz, J., 2006. "Passenger Wait Time Perceptions at Bus Stops: Empirical Results and Impact on Evaluating Real-Time Bus Arrival Information," Journal of Public Transportation, Volume 9, Number 2, pp. 89-106.

[12] Hui, M. K. and Tse, D. K., 1996. "What to Tell Consumers in Waits of Different Lengths: An Integrative Model of Service Evaluation," The Journal of Marketing, Volume 60, Number 2, pp. 81-90.

[13] Battelle Memorial Institute & Multisystems, I., 2003. Customer Preferences for Transit AITS, Federal Transit Administration Research Report.

[14] Zhang, F., Shen, Q., and Clifton, K. J., 2008. "Examination of Traveler Responses to Real-Time Information About Bus Arrivals Using Panel Data," Transportation Research Record: Journal of the Transportation Research Board, Volume 2082, pp. 107-115.

[15] Cham, L., Darido, G., Jackson, D., Laver, R., and Schneck, D., 2006. Real-time Bus Arrival Information Systems Return-on-Investment Study, Federal Transit Administration.

[16] Singer, J. P. and Lerner, N., 2005. Countdown Pedestrian Signals: A comparison of alternative pedestrian change interval displays, Federal Highway Administration.

[17] Norman, D. A., "The Psychology of Waiting Lines" Available at: http://www.jnd.org/ms/Norman%20The%20Psychology%20of%20Waiting%20Lines.pdf

[18] Larson, R. C., 1987. "Perspectives on Queues: Social Justice and the Psychology of Queueing," Operations Research, Volume 35, Number 6, pp. 895-905.

[19] Lindell, M. K. and R. W. Perry. 2004. Communicating Environmental Risk in Multiethnic Communities. Sage Publications.

[20] Kuligowski, E. D., Gwynne, S. M. V., Butler, K. M., Hoskins, B. L., and Sandler, C. R., (*in press, available early 2012*). Developing Emergency Communication Strategies for Buildings. National Institute of Standards and Technology, Gaithersburg, MD.

[21] Collins, B. L., Dahir, M. S., and Madrzykowski, D., 1992. "Visibility of Exit Signs in Clear and Smoky Conditions," Journal of the Illuminating Engineering Society, Volume 21, Number 1, pp. 69-84.

[22] Rea, M. S., Ouellette, M. J., and Clark, F. R. S., 1985. "Design Considerations for Egress Signs Based upon Visibility through Smoke," AIA Research & Design 85, Architectural Applications of Design and Technology Research, General Proceedings, pp. 295-297.

[23] Dudek, C. L., Huchingson, R. D., Stockton, W. R., Koppa, R. J., Richards, S. H., and Mast, T. M., 1978. "Human factors requirements for real-time motorist information displays, Volume 1 – Design Guide," U.S. Department of Transportation Report No. FHWA-RD-78-5, Texas Transportation Institute, College Station, TX.

[24] Honeywill, P., 1999. "Designing Icons for the Graphical User Interface," Digital Creativity, Volume 10, Issue 2, pp. 67-78.

[25] Frantzich, H. and Nilsson, D., 2004. "Evacuation experiments in a smoke-filled tunnel," Proceedings of the 3rd Human Behavior in Fire Symposium, Belfast, UK, 229-238.

[26] Nilsson, D., Frantzich, H., and Saunders, W., Influencing Exit Choice in the Event of a Fire Evacuation, Available at: http://www.see.ed.ac.uk/~jtcullen/Best%20Thesis/Nilsson/IAFSS2008_Daniel%20Nilsson.pdf

[27] Nilsson, D., Frantzich, H., and Saunders, W., 2005. "Coloured flashing lights to mark emergency exits – Experiences from evacuation experiments," Proceedings of the Eighth International Symposium on Fire Safety Science, pp. 569–579.

[28] Phillips, B. D. and Morrow, B. H., 2007. "Social Science Research Needs: Focus on Vulnerable Populations, Forecasting, and Warnings," Natural Hazards Review. Volume 8, Issue 3, pp. 61-68.

[29] National Council on Disability, 2009. Effective Emergency Management: Making Improvements for Communities and People with Disabilities, Available at: http://www.ncd.gov/publications/2009/Aug122009.

[30] Mayhorn, C. B., 2005. "Cognitive Aging and the Processing of Hazard Information and Disaster Warnings," Natural Hazards Review, Volume 6, pp. 165-170.

[31] 2010 ADA Standards for Accessible Design, U.S. Department of Justice, 2010, Available at: http://www.ada.gov/2010ADAstandards_index.htm.

[32] ISO 16069, 2004. Graphical symbols — Safety signs —Safety way guidance systems (SWGS), International Standards Organization.

[33] Mileti, D. S. and Sorensen, J. H., 1990. Communication of Emergency Public Warnings. ORNL-6609, Oak Ridge: National Laboratory.

[34] Jaynes, L. S. and Boles, D. B., 1990. "The effect of symbols on warning compliance," Proceedings of the Human Factors Society 34th Annual Meeting, Santa Monica, CA, pp. 984-987.

[35] Jamson, S. L., Tate, F. N., and Jamson, A. H., 2005. "Evaluating the effects of bilingual traffic signs on driver performance and safety," Ergonomics, 48(15), pp. 1734-1748.

[36] Lai, C-J., 2010. "Effects of color scheme and message lines of variable message signs on driver performance," Accident Analysis & Prevention 42(4), pp. 1003-1008.

[37] Rousseau G. K., Lamson, N., and Rogers, W. A., 1998. "Designing warnings to compensate for age-related changes in perceptual and cognitive abilities," Psychology & Marketing, 15(7), pp. 643-662.

[38] Waller, R. H. W., 2007. "Comparing typefaces for airport signs," Information Design Journal 15, pp. 1-15.

[39] Wogalter, M. S., Conzola, V. C., and Smith-Jackson, T. L., 2002. "Research-based guidelines for warning design and evaluation," Applied Ergonomics, Volume 33, Issue 3, pp. 219–230.

[40] Kuhn, B. T., Garvey, P. M., and Pietrucha, M. T., 1997. "Model guidelines for visibility of on-premise advertisement signs," Transportation Research Record, 1605, pp. 80-87.

[41] Sanders, M. M. and McCormick, E.J., 1993. "Chapter 4: Text, Graphics, Symbols and Codes," In Human Factors in Engineering and Design (7th ed.), New York: McGraw-Hill, pp. 91-128.

[42] Cooke, M., Garcia Lecumberri, M. L., and Barker, J., 2008. "The foreign language cocktail party problem: Energetic and informational masking effects in non-native speech perception," The Journal of the Acoustical Society of America, Volume 123, Number 1, pp. 414-427.

[43] Anttila, V., Luoma, J., and Rämä, P., 2000. "Visual demand of bilingual message signs displaying alternating test messages," Transportation Research Part F, 3, pp. 65-74.

[44] Balcombe, R., Mackett, R., Paulley, N., Preston, J., Shires, J., Titheridge, H., Wardman, M., and White, P., 2004. The demand for public transport: a practical guide, Transportation Research Laboratory: London, UK, Transportation Research Laboratory Report TRL593.

[45] Mileti, D. S., 1975. *Natural Hazard Warning Systems in the United States: A research assessment*. Program on Technology, Environment and Man. Boulder, CO: Institute of Behavioral Sciences, University of Colorado.

[46] Burt, C. D. B., Henningsen, N., and Consedine, N.. 1999. "Prompting correct lifting posture using signs," Applied Ergonomics, 30(4), pp. 353-359.

[47] Dymon, U. J., 2002. Emergency and Hazards Mapping Symbology, Technical Report to the Michael Baker Corporation and Federal Emergency Management Agency (FEMA), Kent State University, Kent, Ohio, USA.

[48] Chandler, R., 2010. Emergency Notification. Santa Barbara: Praeger.