Passenger education: past and future

Helen C. Muir & Lauren J. Thomas

Human Factors Group, School of Engineering, Cranfield University, UK, MK43 0AL.

The requirement for passenger education was introduced in an attempt to improve passenger survival rates in the event of an accident. In the majority of survivable accidents, in which loss of life occurs, the fatalities will have arisen either as a consequence of the impact or as a result of a post-crash fire. Crashworthiness initiatives are aimed at ensuring the structural integrity of the airframe, so that survival space is maintained after impact. Surviving passengers will need to evacuate quickly, because of the risk of a post-crash fire is always present. In these situations, providing passengers with information about how to behave is likely to improve their probability of survival.

In the event of a fire, there are frequently only two minutes between the onset of the fire and the conditions in the cabin becoming non-survivable, due to the presence of smoke and toxic fumes. It is therefore essential that passengers are given every possible assistance to evacuate as rapidly as possible. A great deal of effort has been expended by the industry in order to ensure that all of the passengers and crew are able to evacuate an airframe quickly in the event of an emergency. Requirements include the following:

a. 90 Second Evacuation Demonstration

For any new airframe a demonstration for the regulatory authority has to be conducted by the manufacturers to show that all of the passengers can be evacuated through half the available exits in 90 seconds or less. Considerable efforts are made to introduce some realism into these tests in that they use a representative cross section of the population, there is baggage in the aisle, professional cabin crew are used and the test takes place in darkness (on the assumption that the evacuation of passengers would be more difficult in accidents which happen at night).

b. Cabin Configuration 

The configuration of the cabin interior is strictly regulated with requirements for the number and types of exits, maximum numbers of seats and minimum distances between seat rows. These are requirements for maximum distances between exits and minimum dimensions for aisles, cross aisles and access to exits. A large amount of independent testing work has been undertaken to ensure that the distances specified in these regulations are adequate (Ref.1). Over time, as more knowledge has been gained, some of the distances have been modified.

c. Performance of Cabin Crew

There is considerable evidence from accidents (Ref.2) and from research that the performance of the cabin crew will be the most important determinant of the speed of an evacuation. The regulations require a minimum of one trained member of cabin crew for every 50 passengers. However, what is also of importance are not only the number of crew, but also their knowledge and experience of emergency procedures and their ability to act assertively.

Experimental research has shown that the behaviour of the cabin crew is critical in ensuring a smooth and efficient evacuation (Ref.3). Assertive cabin crew who provided concise, positive commands and instruction, and used physical gestures and contact when appropriate, achieved significantly faster passenger evacuation rates than non-assertive cabin crew. When the cabin crew left the cabin at the start of the evacuation, to simulate situations where the cabin crew are incapacitated, the passenger evacuation rates obtained were similar to those achieved by non-assertive crew.

d. Passenger Education

There is evidence from accidents that passengers who know what to do in an emergency and who follow the directions of the cabin crew have a greater probability of survival (Refs.4 & 5). The National Transportation Safety Board investigated 21 accidents that occurred between 1962 and 1984 (Ref.6). They found that "passenger's risk of injury or death in these accidents could have been reduced had they: (1) paid attention to the flight attendant's oral safety briefings and demonstrations, (2) read the safety card to familiarize themselves with the location and operation of safety equipment; and (3) been better motivated and thus better prepared to act correctly during an emergency situation" (Ref.6). In some of these cases, not only were passengers generally very poorly prepared, but sometimes they behaved inappropriately, or even contrary to cabin crew instructions.

Because of the association between paying attention to the safety information and passenger survival, the regulatory authorities require all operators to brief passengers on emergency procedures. In the United Kingdom, the Air Navigation Order requires operators to provide a briefing to passengers on the position and method of use of emergency exits, safety belts, oxygen equipment, lifejackets, floor path lighting systems and any other equipment intended for use by passengers in the event of an emergency (ANO, 1997). Similarly, in the United States, Federal Aviation Regulations require passengers to receive a briefing on smoking, emergency exits, seat belts and flotation devices (FAR 121).

Although the operators are required to provide this safety information, it is often disregarded by passengers. The reasons why passengers fail to pay attention to potentially life saving information are many and varied. For example, passengers may believe that the probability of survival in the event of a crash is so low that paying attention to the safety information is a waste of time. In fact, the vast majority of accidents are survivable. One recent study showed that, of all accidents to Part 121 carriers during the period 1983 to 2000, the overall survivability rate was 95.7% (Ref.7). Several research studies have been conducted to examine why passengers do not pay attention to the safety information provided.

One study investigated the differences between people who paid attention to passenger safety information, and those who did not (Ref.8). Using a structured interview schedule, researchers conducted telephone interviews with a selection of 231 people who had flown on commercial aircraft at least twice in the previous two years. The researchers defined "attenders" as people who had said that they had previously paid attention to safety briefings, and who also said that they intended to pay attention to the information on future flights. The "non-attenders" were defined as people who said that they did not pay attention to the safety information, and who expressed no intention to do so in the future. The results indicated that the non-attenders were more likely than attenders to be male. Non-attenders were also younger and more highly educated than the attenders. Non-attenders were more likely to have flown more often, usually flying alone and on business trips, while those who paid attention to the safety information were more likely to fly in the company of someone they knew, and were more likely to fly for pleasure. Finally, non-attenders were also more likely to report that paying attention to the safety information was a waste of time.

In another study (Ref.9), questionnaires were sent, via travel agents, to a sample of air passengers. The questionnaire asked respondents about the pre-departure safety briefing, and the role of the cabin crew on board the aircraft. One of the main findings was that passengers thought the pre-departure safety information would be more effective if it was introduced appropriately, perhaps by telling passengers that the safety equipment on all aircraft differs, and that it is therefore in their own best interests to pay attention to the safety information. Passengers also thought that the cabin crew should appear to be more interested in presenting the information, perhaps reminding people that the information could save lives. While operators may be reluctant to include such information in their safety briefings, perhaps arguing that such an introduction would be likely to cause passengers unnecessary anxiety and alarm, this is not backed up by the research evidence.

Passengers in this research also ranked various cabin crew tasks in order of importance. The responses indicated that passengers thought the three most important cabin crew tasks were responsibility for passenger safety in an emergency situation, helping passengers in an emergency, and informing passengers of the safety procedures. The service aspects of the cabin crew role, such as looking after passengers who become ill, being pleasant to passengers, serving meals and drinks and selling duty-free goods, were not deemed to be so important. Thus, passenger perceptions of the cabin crew role appeared to match the perspective of the regulatory authorities. Legally, cabin crews are required to be on board the aircraft for safety, rather than service, reasons.

However, the fact that passengers appear to acknowledge this may be something of a double-edged sword. Passengers who believe that the cabin crews are responsible for passenger safety may be less likely to take responsibility for their own safety in an emergency situation. The duties and workload of the cabin crew in an emergency may make it impossible for them to provide individual assistance to every passenger. In addition, there is always the risk that, should an emergency situation arise, the cabin crew themselves may be incapacitated.

In another study (Ref.9) a survey of passengers arriving at Gatwick Airport in the UK was conducted. They asked passengers how frequently they travelled, whether they had listened to the pre-flight briefing and then some questions about items which had either been covered in the safety briefing or were on the safety cards. The results indicated that frequent fliers (typically businessmen) frequently admitted to not having attended to the safety briefing or read the safety card. Whereas the non-frequent fliers (typically families and holiday passengers) in the majority, had listened to the safety briefing and sometimes read the safety card. However when the responses to the questions about information in the briefings were analysed, frequent fliers (the majority of whom had not attended to the briefing) got many more of the answers right than non-frequent fliers (the majority of whom had listened to the briefing).

The National Transportation Safety Board recently completed a study of 46 evacuations that occurred between September 1997 and June 1999 (Ref.10). As part of this study, questionnaires were sent to all passengers involved in the 30 most serious evacuations, which were defined as those involving suspected fire, actual fire, or use of the evacuation slides. Of the 457 passengers who returned their questionnaires, 54% said that they had not watched the entire safety briefing because they had seen it before. Another 15% said that they had not watched the entire briefing because the information it contained was common knowledge. Passengers were also divided on how effective the briefing had been. Over half of the respondents said that the briefing had not contained information specific to their evacuation. They reported that they would have liked more information on exit routes, how to use the slides, and how to get off the wing after leaving the cabin via an over-wing exit.

These pieces of research suggest that in an attempt to provide passengers with all of the relevant information we may, ironically, be failing by providing them with too much information. The business travellers and frequent fliers can sometimes find the briefings long and repetitive, whilst for the infrequent flier there is a huge amount of information, much of it new. There is therefore more information than any one individual can be expected to absorb and retain following a single presentation.

There are no regulations which state the methods to be used in providing the most effective pre-departure briefing, although guidance supplied by the Federal Aviation Administration may be regarded as best practice (Ref.11) Cabin crew who conduct live briefings and demonstrations should use their own initiative to attract passenger attention, making eye contact with passengers, being animated, and using clear and distinct diction. They should also ensure that they and their colleagues are distributed evenly throughout the cabin, and that their briefings and demonstrations can be clearly seen and heard by all passengers.

The FAA also acknowledge that some operators may opt to use video recorded pre-departure safety briefings, to ensure consistency of delivery on every flight. Video recordings allow passengers to be shown safety tasks where a live demonstration is not possible, such as the correct manner of using the evacuation slide. Video technology also means that the pre-departure briefing can be given in multiple languages, including, for example, sign language. Video recorded briefings may also increase the variety and the novelty value of the briefing, by using different faces and voiceovers. Rapidly changing images may also assist in attracting, and keeping, passenger attention.

One important issue with regard to pre-departure briefings is that they should present information which is consistent both with passenger expectations, and with what will actually occur in a given emergency situation. In one study, airlines were first asked what commands the crew would use in the event of an emergency or crash landing, where passengers would be required to assume the brace position. Common responses were that the crew would instruct passengers to "brace", "grab your ankles", or "go head down and stay down". Later, passengers were asked which commands they would expect to hear, they said that they would expect to hear commands such as "get into an emergency/crash position", "head down", "lean forward" or "we're going to crash". Approximately 30% of the research participants would not have realised that a crash was about to occur if they had heard the command "brace, brace" (Ref.12). Hence, the information provided in pre-departure briefings should be consistent with passenger expectations, and with the commands and procedures that will actually be used in a given emergency situation.

As well as the pre-departure briefing, passenger safety information can be imparted via a safety card. Safety cards are used to supplement the information provided in the pre-departure briefing. A card should be available for every passenger seat, so, unlike the information contained within a pre-departure briefing, the information on the safety card remains available for reference throughout the duration of the flight. However, the evidence again suggests that passengers fail to pay attention to the safety information provided.

The NTSB (Refs.7 & 10) safety study found that, of 431 passengers who answered the question, 68% said that they did not read the safety card. A large proportion (89%) of these passengers said that they had read the card provided on previous flights. Worryingly, of 399 passengers who answered the question about paying attention to both the safety briefing and the safety card, 44% said that they had not paid attention to either. However, most passengers who did read the safety cards said that they found them useful, particularly with regard to identifying the location of exits. Passengers also reported that the safety cards had provided information on which exits had slides, how to use the slides, and the location of emergency lighting.

To investigate the safety cards further, the NTSB collected a sample of 22 safety cards from the operators who were involved in the case evacuations (Ref.10). They found that the cards in use varied widely: 60% had used coloured drawings, 8% had used coloured photos, and 8% had used black, red and white drawings. All of the cards contained information on the brace position and the operation of emergency exits, although some did not include information on the location of exits. The remaining information provided on the cards varied widely. Some used high quality enlargements to clearly depict the operation of the exit, while others did not. Information on how to move through the exits, use the slides, and get off the wing outside an over-wing exit was also inconsistently provided.

There are industry standards which provide an indication of the types of information that should be included on safety cards, such as the recommended practice guidelines published by the Society of Automotive Engineers (SAE, 1991). However, the presentation of such information does not necessarily guarantee that passengers will pay attention to the information, or understand it fully. The NTSB has recommended that the Federal Aviation Administration set a standard for the minimum acceptable comprehension level for safety cards

(Refs.6 & 10). Currently, decisions regarding the suitability of safety cards in fulfilling their intended purpose are made at the discretion and judgment of the regulator.

Safety cards often use pictorials to convey safety information to passengers. A series of related pictorials is known as a pictogram. The underlying assumption is that pictorials and pictograms, unlike text, will be universally understood. This is of course important considering that air travel is international in nature. Safety cards ideally need to be understood by everybody, regardless of their language, culture or country of origin. Published standards are available which provide methodologies for assessing the comprehension level of such information. For example, there is an International Standard for judging the comprehensibility of graphical symbols (Ref.13). The use of such methods is likely to assist in ensuring consistent levels of passenger comprehension, so that safety cards will be understood by the widest possible audience.

In a study of safety card pictorials, participants were asked to discuss which safety cards, of a sample of 50, were most likely to aid or hinder comprehension (Ref.14). 36 pictorials from nine safety cards were used in comprehension tests, where 113 participants were asked the meaning of the pictorials. The responses were rated as incorrect, partially correct, or correct. Only 16 of the pictorials had comprehension scores of above 50%. The authors concluded that "safety card pictorials appear to represent a less than optimal universal safety language". This is of particular concern given that all pictorials would need to be understood before a pictogram could be interpreted correctly.

Safety card pictograms have also been evaluated. One such study was undertaken to investigate the extent to which people understood 13 black and white safety card pictograms. Among the 150 English, French and German research participants, the general comprehension levels were generally high. Comprehension was judged by deciding whether the interpretations given by participants were "correct and complete", "incomplete but safe", or "wrong or unsafe". However, the study also found that while participants were able to make general interpretations of the pictograms, they were often unable to correctly determine the specific details of the information provided (Ref.15).

Where text is used on safety cards to supplement pictorials and pictograms, careful consideration should be given to the phrases chosen. One study manipulated the phrases that were used on safety cards, and investigated the effect that this had on passenger behaviour on the evacuation slide (Ref.16). To use the slide effectively, passengers should jump onto it; passengers who sit on the sill take longer to evacuate. The researchers found that safety cards that included the instruction to "Jump - don't sit" resulted in 73.5% of passengers using the slide correctly. When the cards included the instruction to "Jump", 67.8% of passengers used the slide correctly. When passengers received no briefing card, only 59.9% of the passengers used the slide correctly. A passenger who sits takes approximately one third of a second longer to evacuate than a passenger who jumps. This time differential could have a significant impact on the evacuation of two or three hundred passengers.

There are some general principles or guidelines for the presentation of information on safety cards. For instance, it has been suggested that the information should integrate words with diagrams, and present pictograms in meaningful sequences.

Pictorials are preferable to photographs, as they reduce visual clutter (Ref.17). The safety cards that receive poor effectiveness ratings tend to be those that contain more text than pictorial information, and that are somewhat disorganised in their presentation of information (Ref.18). However, because the design and information content of safety cards is known to vary so widely, the only way to be sure that a safety card will be easily understood is to conduct comprehension tests.

The issue of passenger attention to safety information is particularly important where passengers are expected to perform specific duties in the event of an emergency situation. For example, passengers seated in exit rows may be required to open the Type III exit if an evacuation of the aircraft is necessary. Such a situation occurred at Manchester in 1985 (Ref.5). A Boeing 737 with 131 passengers and six crew on board was departing for Corfu. On take-off, the left engine suffered an uncontained failure, and a wing fuel tank access panel was penetrated. Leaking fuel rapidly ignited, and by the time the aircraft came to a complete stop, the cabin was filled with black, acrid smoke, which rapidly instilled fear and alarm among passengers.

At the instigation of other passengers, the passenger seated adjacent to the right-hand Type III exit attempted to open it as the aircraft came to a stop. She pulled on the armrest that was mounted on the hatch, in the mistaken belief that it was the hatch handle. The passenger seated next to her reached over and pulled the operating handle, and the hatch, weighting 48lbs, fell inwards, trapping them both in their seats. They were freed by a male passenger in the row behind, who lifted the hatch, and placed it on a vacant seat. It took approximately 45 seconds to make the Type III exit available, by which time many passengers had been overcome by the toxic smoke and fumes. The evacuation delays contributed to 55 fatalities (Ref.5).

The Type III exit hatch is not attached or hinged to the airframe. The hatch, once released, has to be brought back into the cabin, rotated, and disposed of. This mode of operation is counterintuitive in a self-help exit, since the hatch is intended to be operated by passengers. The hatches may weigh as much as 65lbs, and this makes handling particularly cumbersome. Many passengers have reported great difficulty in making Type III exits available in emergency situations. In one case reported by the NTSB (Ref.10), a passenger who attempted to open the Type III exit pulled the operating handle, and put his shoulder to the hatch to push. He had not realised that the design of the hatch meant that it had to be brought into the cabin first. In another case, a passenger operated the hatch, and then had to jump through fire to get away from the aeroplane. Passengers do not always check conditions outside the aircraft before operating the exit.

Although passengers seated in the exit row are screened for their suitability to sit adjacent to the exit, screening provides no guarantee that passengers will pay attention to the safety information. At most, passengers seated in the exit row may be instructed by the cabin crew to read the safety card and ensure that they are familiar with the manner in which the exit operates. However, the type of briefing and the level of detail provided can have a significant influence on the time it takes to make the exit available, and on the way in which passengers dispose of the hatch. If the hatch is left inside the cabin, it becomes an obstacle in the passageway to the exit, and this creates delays for evacuating passengers.

Cobbett, Liston and Muir (Ref.19) investigated the influence of four different types of briefing on the performance of Type III exit operators. Fifty-six groups of three participants were recruited to evacuate a Boeing 737 cabin simulator. All groups received a pre-flight safety briefing and safety card. Fourteen groups received no additional information, while fourteen groups received a minimum Type III exit briefing. The minimum briefing informed the participants that they were seated next to an emergency exit that they may be required to open, and that they should therefore read the instructions on the safety card and seat-back placards.

The last two groups of fourteen received detailed briefings, which included the information in the minimum briefing. Additionally, these briefings instructed passengers on when and how to operate the exit. Participants in these conditions were explicitly told the weight of the hatch, and were informed that the hatch was not hinged or attached to the airframe. The operating handles were also pointed out by cabin crew, and participants were told that the hatch should be disposed of outside the cabin. These detailed briefings were presented orally to fourteen groups, and in writing to the remaining participants.

The results indicated that passengers who had received the detailed oral or written briefings reacted to the call to evacuate significantly more quickly than participants in the no Type III briefing or minimum briefing conditions. The overall time taken to make the exit available for evacuation was significantly quicker for participants who had received the detailed written briefing than it was for participants in the other three groups. In addition, a disproportionately high number of participants from the no Type III briefing condition left the Type III exit hatch inside the cabin. Providing the participants with such detailed briefings did take significantly more time, but the evidence suggests that if cabin crew are able to comprehensively explain safety duties to exit row passengers, then this would be time well spent.

New technology may provide us with the opportunity to address some of the issues and problems discussed. Aircraft seats on almost all new airframes have individually controlled television screens as part of the on board in flight entertainment system. In time, these could be made interactive, and tailored to the seating location (for example, a different briefing for passengers in the Type III exit row). At the technology improves, and a majority of passengers become computer literate, it could be possible to encourage passengers to engage with the technology. The research literature on human memory clearing indicates that active learning is far more successful than passive learning, and interactive educational initiatives are likely to reduce passivity. There could be the opportunity to provide different briefings for different scenarios, for passengers to select their preferred language, there is also the potential for the briefing to form part of a learning game on aircraft safety. There may always be some passengers who cannot receive a briefing via the technology. In this event, they could simply be shown a video which is equivalent to the one used today and perhaps given an additional briefing from the cabin crew. There is no doubt that developments in computer technology will offer new options for educating passengers in safety information.

In addition to new computer technologies, there are also new airframes being developed. As new generation passenger transport aircraft tend to have novel configurations; these will raise unique challenges for the provision of safety information for passengers. The Airbus A380 has twin decks, each potentially capable of holding up to 350-400 passengers. Blended wing designs, such as that proposed by NASA, could include several passenger bays.

For both of these VLTA airframes, the challenge will be to enable all passengers to have awareness of their seating location relative to the airframe, together with knowledge of their nearest available exits. In airframes with twin decks, the circumstances in which passengers may or may not make use of the internal staircase(s) in evacuations will require careful consideration. In the blended wing airframes, the evacuation of passengers through exits will require carefully designed procedures and management, to ensure that contra-flows do not occur and that the behaviour of passengers remains orderly.

In conclusion, we know that providing passengers with safety education improves their probability of survival in an emergency. Over the last three decades significant progress has been made in passenger safety, but passenger education initiatives have not progressed at the same rate. For the future, new technology offers the opportunity to enhance passenger education. The aviation industry should encourage research to examine the most effective methods of employing new technologies, in order to enhance passenger education, and reduce the risk of injury and fatality in the event of an accident.

Copyright statement

References

1. Muir H, Marrison C, Evans A (1989) *Aircraft evacuations: The effect of passengers motivation and cabin configuration adjacent to the exit.* CAA Paper 89019.

2. NTSB (1996) *Report on the accident to Boeing 747-131 N93119 at New York on 17th July 1996,* NTSB, Washington DC.

3. Cobbett, A.M. & Muir, H.C. (1996) *The influence of cabin crew during emergency evacuations at floor level exits*. CAA Paper 95006, Civil Aviation Authority, London.

4. ICAO Summary 1984-2 *Report on the accident to Boeing 737 C-GQPW at Calgary Airport on 22nd March 1984,* ICAO Montreal, Canada

5. Air Accidents Investigation Branch, Department of Transport (1985) *Report on the accident to Boeing 737-236 Series 1 G-BGJL at Manchester International Airport on 22 August 1985* Aircraft Accident Report 8/88

6. NTSB (1985) *Airline passenger safety education: a review of methods used to present safety information*. Reference NTSB/SS-85/09, PB85-917014. Washington, DC.

7. NTSB (2001) *Survivability of accidents involving Part 121 US air carrier operations, 1983 through 2000.* Reference NTSB/SR-01/01, PB2001-917001. Washington, DC.

8. Johnson, D.A. (1979) *An investigation of factors affecting aircraft passenger attention to safety information presentations*. Report IRC-79-1, for the Federal Aviation Administration, Contract DOT-FA78WA-4095.

9. Fennell, P.J. & Muir, H.C. (1992) *Passenger attitudes towards airline safety information and comprehension of safety briefings and cards*. CAA Paper 92015, Civil Aviation Authority, London.

10. NTSB (2000) *Emergency evacuation of commercial airplanes*. Reference NTSB/SS-00/01, PB2000-917002. Washington, DC.

11. FAA (1999) *Passenger safety information briefing and briefing cards*. Federal Aviation Administration Advisory Circular 121-24B. Issue 2/1/99.

12. Johnson, D.A. (1998) Studies reveal passenger misconceptions about brace commands and brace positions. *Cabin Crew Safety*, 33 (3), 1-6.

13. ISO (2001) *Graphical symbols - test methods for judged comprehensibility and for comprehension*. International Standard 9186, 2nd ed, 2001-04-01. ISO, Switzerland.

14. Caird, J.K., Wheat, B., McIntosh, K.R. & Dewar, R.E. (1997) The comprehensibility of airline safety card pictorials. *Proceedings of the Human Factors and Ergonomics Society 41st Annual Meeting*, Human Factors Society, Santa Monica, CA, 801-805.

15. Jentsch, F. (1996) Understanding of aviation safety pictograms among respondents from Europe and the US. *Proceedings of the Human Factors and Ergonomics Society 40th Annual Meeting*, Human Factors Society, Santa Monica, CA, 820-824.

16. Johnson, D.A & Altman, H.B. (1973) Effects of briefing card information on passenger behavior during aircraft evacuation demonstrations. *Proceedings of the Human Factors Society Convention, Human Factors Society*, Santa Monica, CA, 215-221.

17. Johnson, D.A. (1980) The design of effective safety information displays. In Poyday, H.R. (ed) *Proceedings of the symposium: Human Factors and Industrial Design in Consumer Products*. Tufts University, Medford, MA, 314-328.

18. Schmidt, J.K. & Kysor, K.P. (1987) Designing airline passenger safety cards. *Proceedings of the Human Factors Society 31st Annual Meeting*, Santa Monica, CA, 51-55.

19. Cobbett, A.M., Liston, P. & Muir, H.C. (2001) *An investigation into methods of briefing passengers at Type III exits*. CAA Paper 2001/6, Civil Aviation Authority, London.