INFUSING INTELLIGENCE AND DYNAMICITY TO STATIC EXITS SIGNS USED FOR EVACUATION INCIDENTS IN LARGE VENUES

The Problem

Guiding people to safety and away from danger is why emergency exit signs exist. **But many of today's signage systems lack the ability to respond to a changing threat environment or to attract the immediate attention of the people needing assistance**. These signs may be required by building standards and safety legislation, but their potential to be overlooked or to send people into harm's way makes them inherently unreliable in many situations for which they are intended.

According to[1] the passive nature of these emergency systems has contributed to the toll of avoidable deaths in fire and other emergencies. Tragedies involving the failure of legally compliant emergency signage systems to fulfil their basic purpose include the King's Cross Underground fire (UK, 1987), the Düsseldorf Airport fire (Germany, 1996), the Rhode Island Night Club fire (US, 2003) and the Nairobi Westgate Shopping Mall terrorist attack (Africa, 2013) [1–4]. In the Rhode Island and Düsseldorf incidents, many people failed to see the legally compliant emergency exit signs and so did not utilise appropriate emergency exits or delayed using them, resulting in tragic consequences. In the King's Cross, Düsseldorf and Nairobi incidents, the emergency exit signs could not adapt to the developing situation and so did not redirect people away from compromised emergency exit routes, again resulting in death. Even in the New York World Trade Center (US, 2001) disaster, the evacuation of many people was delayed because they could not find the stairs, despite the exits being marked by emergency signs [5].

The Root cause of the problem

The main reasons behind these incidents can be justified by the research conducted by Research conducted by FSEG concerning way-finding behaviour during a simulated emergency evacuation demonstrated that **most people have difficulty perceiving and hence utilising signage information** [6]. About 38% of people perceive the standard 'green running man' emergency exit sign positioned directly in front of them.

While most others may look directly at the sign, they do not actually 'see' it. **It is suggested that most people are blind to standard emergency exit signs due to learned irrelevance** [7], **in which being continually exposed to, say, emergency exit signs without ever needing to use them trains the brain to ignore the signs**. However, the research also showed that if the emergency exit sign was actually perceived by an individual, there was an almost 100% acceptance of the information, suggesting that if the signs could be made more noticeable, they could effectively direct people along the intended route.

[1] https://www.sfpe.org/publications/sfpeeuropedigital/sfpeeurope3/issue3feature1

THE NEED FOR ACTIONS

From all the above it is highlighted the crucial need for the humble emergency exit sign to upgrade for the 21st century adapting itself to modern evacuation methodologies. The need for exit signs that attract attention when they need to be conspicuous, to redirect people in an evolving emergency and to identify not just an exit route but the optimal exit route has driven the development of a new generation of advanced signage system supported by an intelligent evacuation platform able to give solution before during and after an evacuation incident. So far, a few companies have commercialized active exit signage for the purposes of evacuation, to name a few: a) CLEVEREVAC[2], EVACLITE[3] as well as the FP7 EU project GETAWAY [4] mission was to develop such dynamic exit signs. However, none of these solutions are actually integrated with a sophisticated and holistic evacuation platform orchestrating the dynamicity of this signage according to the dynamic evolution of a potential evacuation incident, and here is where the EVAGUIDE solution comes into play:

The EVAGUIDE active signage as a pathway towards a new generation of evacuation practices

The EVAGUIDE platform is a **Safety and Security Management System whose main aim is to support the large facility owners and operators with Planning, Implementing, Simulating and Assessing complex evacuation scenarios**.

Its primary focus is to be integrated with the existing infrastructure of large venues where tens of thousands of people gather in one confined structure. In case of an emergency this large crowd needs to evacuate in a short time period, often under adverse conditions such as fire in parts of the structure, smoke from fumigants or from fire leading to low visibility, or at night, where visibility is low or none (if parts of the lights fail). A crucial component of the whole platform is the EVAGUIDE's active digital signage comprising the actual hardware equipment of the signage (an LCD display attached to a raspberry PI mini PC) and the Dynamic Direction Indication application running within this PC.

The **EVAGUIDE's digital active signage provides not only dynamic visual instructions during the evacuation process but also prerecorded audio messages redirecting the crowd to the best evacuation route**. The sections below give an indication on who the EVAGUIDE dynamic digital signage works.

[2] https://www.cleverevac.com.au/

[3] https://www.evaclite.com/

[4] https://cordis.europa.eu/project/id/265717/reporting

HOW IT WORKS

DYNAMIC DIRECTION INDICATION SOFTWARE - DYNAMIC EXIT SIGNS

The Dynamic Direction Indication Software is an application that is executed in every dynamic exit sign device installed in the large venue and it displays live evacuation directions in real time. Every digital sign is part of the EVAGUIDE platform and it is connected to it through a Communication Middleware communicating and exchanging data continuously with the other EVAGUIDE subsystems. The specific application is responsible to inform periodically the EVAGUIDE Core Engine about the activation and the health status of each one of the dynamic exit signs updating the pointing direction that is displayed on the dynamic exit sign screen according to the current active evacuation route. This is accomplished through the continuous communication of this application with the Exit Sign Management Service of Core Engine system that executes the direction calculation algorithm.

Many direction types can be supported, including multiple paths, and they are presented in Figure 1 below. The key purpose is to cover all the possible paths in a corridor, in a door or in staircases and provide accurate and secure navigation to the spectators. The following figures present the physical deployment of several dynamic exit signs installed to the football stadium of PAOK FC in Thessaloniki that were adjusted according to the demonstrated scenario use case.

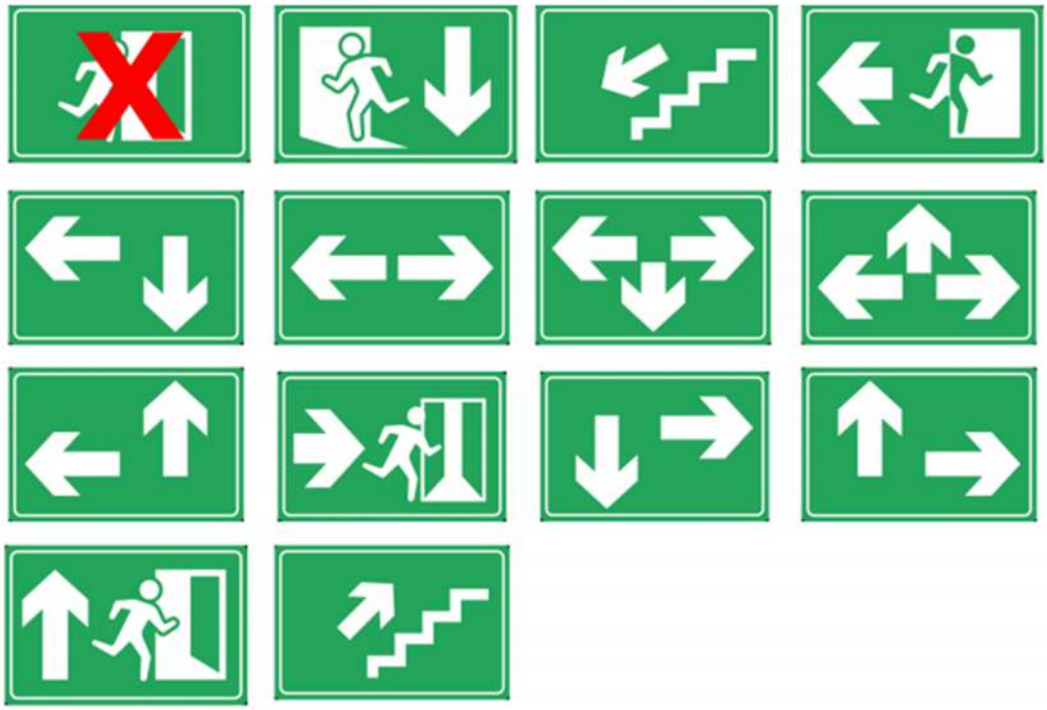

Figure 1: Directions signs supported

Figure 2: EVAGUIDE Exit signs installed at PAOK FC stadium in Thessaloniki during project pilot activities

As it is depicted in figure 2, the dynamic exit signs offer flexibility and good space management, since they can be easily placed in different positions and locations in the stadium in order to be visible, either on the wall or in the corridors or on the ceiling.

INTEGRATION WITH PUBLIC ANNOUNCEMENT (PA) SYSTEM

One of the key functionalities offered by the EVAGUIDE platform is the **ability to be connected and to have access to the audio system of the stadium (i.e. Public Announcement (PA) system infrastructure) since it can automatically publish and play pre-recorded audio messages in order to inform people about a hazardous event and providing them live instructions on the best evacuation route**. To be noted that there is the possibility that these audio instructions to be played also by the EVAGUIDE digital signage in real time locally as well, providing local evacuation instructions to specific venue areas, as depicted in the figure below. In order to achieve this a specific audio application has to be installed in the mini PC as well, communicating in real time together with EVAGUIDE core engine.

Figure 3: Audio application set up in remote test in February

References

[1] D. Fennell, Investigation into the King's Cross Underground Fire (London: Her Majesty's Stationery Office, 1998).

[2] P. M. Weinspach et al., Analysis of the Fire on April 11th, 1996. Recommendations and Consequences for Düsseldorf Rhein-Ruhr Airport (Düsseldorf, Germany: Staatskanzlei Nordrhein-Wstfalen, 1997).

[3] W. Grosshandler et al., Report of the Technical Investigation of the Station Nightclub Fire, NIST NCSTAR 2: Vols. I–II (Gaithersburg, MD: National Institute of Standards and Technology, 2005).

[4] BBC, Nairobi Siege: How the Attack Happened (2013). Available at: http://www.bbc.co.uk/news/world-africa-24189116.

[5] E. R. Galea, "High-Rise Building Evacuation Post 911 – Addressing the Issues," in Tall Building Fire Safety Conference 2014, Proceedings of the 2nd International Conference (Greenwich, UK: CMS Press, 2014), 75–89.

[6] H. Xie et al., "Experimental Analysis of the Effectiveness of Emergency Signage and Its Implementation in Evacuation Simulation," Fire and Materials, 36, no. 56 (2012): 367–382, doi:10.1002/fam.1095.

[7] T. McClintock et al., "A Behavioural Solution to the Learned Irrelevance of Emergency Exit Signage," in Proceedings of the 2nd International Symposium on Human Behaviour in Fire (London: Interscience Communications Ltd, 2001), 23–33.

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