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Fire Prevention

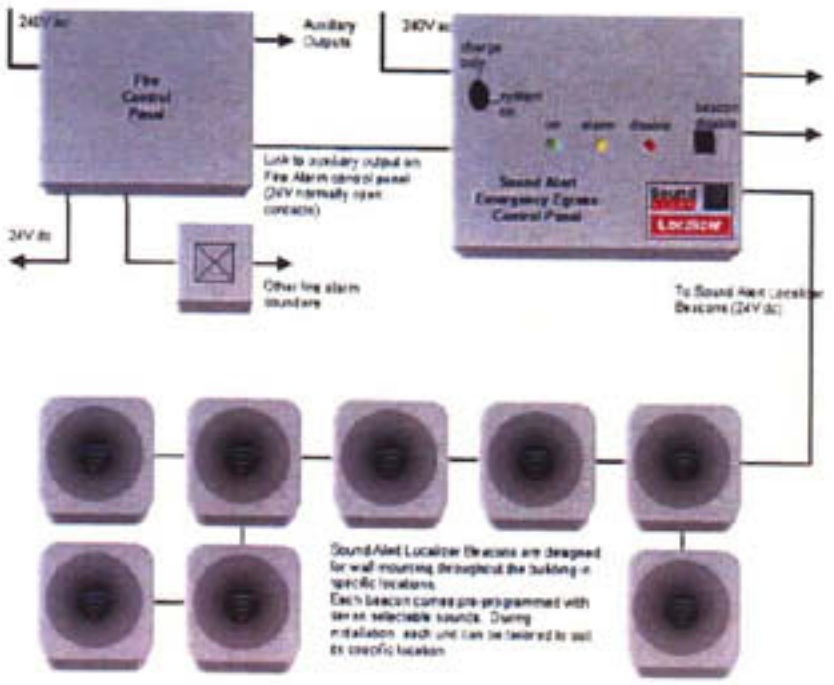
March 2000

Just the ticket

Keeping the public safe

FPA

The sound of safety



Dr Peter Rutherford and Dr Deborah Withington describe how directional sound can be used to guide people out of smoke-filled buildings

BEHAVIOURAL STUDIES have shown that, in the event of an emergency, people will instinctively try to evacuate a structure by the way in which they entered it. This is rarely the quickest or most appropriate route but people often fail to see, or refuse to use, nearby fire exits. Ultimately, circulation routes that are used for normal, everyday movement become overcrowded, slowing down the evacuation process.

Since it is impossible to guarantee un-obscured, smoke-free vision in a fire situation, the effectiveness of aids such as emergency lighting, signage and photo-luminescent materials must be questioned. A system which does not rely upon visual means of way-finding may be more successful.

Leeds University has developed a way-finding aid which uses directional sound to orchestrate evacuation. In field-trials the egress beacon has been shown to offer fast, efficient escape not only for sighted, but visually-impaired users too. It should be noted, however, that these egress beacons are by no means a replacement for current alert mechanisms but have been envisioned as a complementary system to conventional fire alert mechanisms, providing the additional benefit of locating exits.

The science

The human brain has the potential to be very accurate at sound localization. It can localize sound within an accuracy of 2-4°; as long as the sound contains a mixture of many frequencies. This broadband noise can be most easily described as the sound of a rushing river or waterfall. For accurate localization, the brain has to decode a wide variety of sound cues, which in isolation convey only limited amounts of ambiguous information. Fundamentally, these cues include the timing and intensity differences between the sound at both ears and the effect of the external ear on the spectral transformation of sound.

But there are problems. Because the cues of timing and intensity differences are virtually identical for sounds emanating either directly in front of or behind the head, front/back confusions are one of the most common difficulties associated with sound localization. Each type of sound localization cue operates over a different and relatively narrow frequency range but to provide complete localization knowledge, information from all cues must be combined. This only occurs with broadband noise.

The egress beacon

To test the egress beacon, a series of trials were conducted in different smoke-filled environments at Leeds University. A complex route was devised within a deserted grammar school, owned by Leeds University. This route included many directional decision-making points and staircases. Subjects in these trials included both sighted and visually-impaired volunteers, as well as children. (Highlights of which were shown on the BBC's *Tomorrow's World* in April 1998).

Having filled the school with artificial smoke, each subject was taken to the first floor starting point of the experiment, via an external emergency escape staircase. By doing this, subjects had absolutely no idea of the route that they were about to enter, nor did they have any idea of the intended meaning of any of the beacons. The beacons and the building's existing fire alarm were activated, and each subject, or group of subjects entered into the smoke.

Essentially, only four egress beacons, placed at strategic points (mainly above fire doors) marked the whole route. At one point, a small flight of stairs led upwards to a mid-level in the building, and a beacon was designed which, as well as having rapidly pulsing broadband noise, included an upwardly sweeping melodic complex which denoted to the subject 'go up the stairs'. At another point, the main staircase descended to the final intended exit and again a down-sweep was designed into the beacon. As beacons progressed from the starting point to the final exit, their pulse rate increased. This concept is based on human intuition which regards faster events as signaling the nearing of a final goal.

The effectiveness of the beacons was unquestionable. In the trials, no-one took a wrong turning or ended up in any room that they were not supposed to enter. All subjects reported that the implementation of the melodic complexes denoting 'up' or 'down' information informed them, not only of the presence of a staircase, but also of the intended direction of travel. Finally, evacuation times were reduced almost to the actual travel times that would have been expected under ideal visual conditions with prior knowledge of the building. Indeed, it was interesting to note that when the building was eventually cleared of smoke, without the aid of the navigation beacons, and with full visibility, several subjects got lost en route, even though they had been through it only a few minutes earlier.

The beacons proved themselves to be a crucial aid for all users under such visually impaired conditions. By providing directional information, they remove the need for having prior experience with the environment, reducing hesitancy and totally eliminating wayfinding errors.

Although provision for emergency egress is improving, there still exists a problem with solely addressing the visual needs of occupants when it is only too likely that will be taken away in the event of a fire. Only through a combination of both visual and auditory wayfinding aids will optimal safety be achieved ❑

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