International Journal of Public Health & Safety

Stewart, Int J Pub Health Safe 2016, 1:3

Commentary Open Access

Passing Ability and Clearance Space: The Overlooked Factor in Human Movement Modelling

Arthur D Stewart*

Faculty of Health and Social Care, Robert Gordon University, Aberdeen, UK

Most individuals give little thought to whether or not people are able to pass one another in a restricted space. This is because in the vast majority of situations, building design ensures corridors are sufficiently wide to accommodate passing, without either party touching the other or the wall fabric. Narrow the corridor and one party is forced to turn side-on; narrow it more and both must turn side on. These sideways-passing scenarios are enacted quite subconsciously, where individuals automatically select movement which ensures contact is avoided, and preserves personal space between both people. However, the question needs to be asked: how narrow is too narrow to permit passing at all? The answer has important implications both in civic and industrial settings for individual, corporate and public safety.

These questions were addressed in a recent publication [1] examining UK offshore workers. Using data from 3D scanning, both in form-fitting clothing and also in survival suits which are worn during helicopter travel and installation abandonment procedures, the study mapped different passing scenarios onto theoretical corridors of restricted width. In a 100 cm corridor, 95.5% of individuals randomly selected from the workforce will be able to pass one another (assuming the individuals are touching, but that the body surface remains uncompressed). In an 80 cm corridor, the probability of two individuals passing reduces to just 3.2%, with both individuals turning sideways. Set against the context where permissible space may be this small or even less, coupled with industrial hazards relating to height, heat or cold, physical snagging or chemical exposure, it quickly becomes apparent that the probability of issues involving emergency procedures, such as the and recovery of a casualty, rises in proportion to the size of the victim and inversely with the available space.

Impetus for this research was triggered by the fact that since the last anthropometric survey of UK offshore workers conducted in 1984, mean male worker's body mass has increased by 19% and global obesity prevalence has trebled. As a result, today's individuals are anatomically much larger, and have reduced clearance space when moving through the existing infrastructure. However, gains in anatomical size with increased weight are non-uniform throughout the body, and crucially, a disproportionate increase in abdominal depth in larger workers means that the advantage of turning sideways in order to pass within a restricted width is progressively diminished. Poignantly, the design of corridors which accommodated the workforce at the time of the Piper Alpha disaster in 1988 in which 167 individuals died, may critically restrict movement of the workforce three decades later, in an emergency evacuation.

Beyond offshore installations the urban landscape can be mapped and modelled with a view to optimizing human movement. Under most circumstances, the capacity of the environment to accommodate individuals is much greater than the absolute requirement for space, but exceptions to this generalization may exist in a range of situations. At large public gatherings, visitor attractions, sports events, as well as in busy transportation hubs, crowds gather as a matter of normality, and adapt behaviorally to the constraints on movement intentions. The science of modelling crowd movement is complex, but two factors are relevant to discussions of personal space and safety. A useful approach is that of proxemics based on 'shells' of personal space [2] which recognizes public, social, and intimate proximity between individuals. However, under some circumstances individuals may 'recalibrate' their personal space envelopes, for instance in queuing and mass transportation situations. It has been estimated that once crowd density reaches 4.0 people per square meter of ground space, contact between individuals is inevitable [3].

There are many other examples of building where designs were not based on people flow are widespread. For example, in historic buildings, designed for defense rather than mass visitation, visitor flow is characterized by narrow corridors and steep stairways. Creative use of existing infrastructure such as altering usage pathways and the use of unidirectional corridors, as championed by naval architecture, may optimize movement. Even where this applies in public settings, guidelines will be over-ridden in emergency situations, such as a missing child, medical collapse or security threat. In an evacuation it is foreseeable that emergency response personnel are tasked with moving towards the incident, while members of the general public seek to progress away from it as rapidly as possible. In such scenarios, where a combination of narrow passageways, physical hazards and the probability of alarm and panic are prevalent, passing scenarios may become critically important in determining the speed of egress, and whether or not an unusually large individual can effectively block a passageway to other pedestrians.

Since the turn of the millennium, two factors have become more significant which profoundly influence safety in terms of building evacuation. The first is that extremely large morbidly obese individuals are considerably less rare than before, such that major tourist attractions may be visited by several individuals weighing in excess of 150 kg per day. Not only do such individuals require the most room, but they are inevitably the most challenged in terms of mobility, and also carry a much greater risk of an adverse health event than those of lesser weight. The second is that, sadly, acts of terrorism affecting public places and gatherings have become commonplace, such that understanding the constraints within which people move in the built environment has never been more important. Modelling passing scenarios represents a hitherto overlooked area of research which should form part of building management and public events planning, which can optimize successful egress in a range of scenarios, leading to enhanced safety.

***Corresponding author:** Arthur D Stewart, Faculty of Health and Social Care, Robert Gordon University, Sir Ian Wood Building, Garthdee Road, Aberdeen, AB10 7GJ, UK, Tel: +44(0)1224262551; E-mail: a.d.stewart@rgu.ac.uk

Received July 20, 2016; **Accepted** October 17, 2016; **Published** October 21, 2016

Citation: Stewart AD (2016) Passing Ability and Clearance Space: The Overlooked Factor in Human Movement Modelling. Int J Pub Health Safe 1: 115

References

1. Stewart A, Ledingham R, Furnace G, Nevill A (2015) Body Size and ability to pass through a restricted space: Observations from 3D scanning of 210 male UK Offshore Workers. Appl Ergon 51: 358-362.
2. Manenti L, Manzoni S, Vizzari G, Ohtsuka K, Shimura K (2010) Towards an agent-based proxemic model for pedestrian and group dynamic. WOA 2010; CEUR Workshop Proceedings.
3. Klupfel H, Schreckenberg M, Meyer-König T (2004) Models for crowd movement and egress simulation. In: Hoogendoorn S, et al. (eds). Traffic and granular flow. Springer, Berlin, Germany. pp: 357-372.