CabinetOffice

Emergency Planning College

Understanding Crowd Behaviours:

Guidance and Lessons Identified

UNIVERSITY OF LEEDS

EPC
EMERGENCY PLANNING COLLEGE

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DISCLAIMER

Please note, the recommendations made in this report regarding good practice for event preparation and crowd management are an interpretation of best practice made on the basis of knowledge and expertise gained from literature and interviews. They are not definitive rules of event preparation and crowd management.

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Foreword

Foreword

I am pleased to be able to commend this guidance to you. It was sponsored and funded by the Civil Contingencies Secretariat, project-managed by the Emergency Planning College and written by a team of specialists in organisational psychology from Leeds University Business School. It is the product of a year's research involving a detailed literature review and primary research with practitioners and specialists in the field. It summarises our knowledge, articulates our current understanding of good practice in crowd management and gives planners clear direction, and supporting information, regarding the safe assumptions that may be made about crowd behaviour. As such, this guidance fills what had been a significant gap in our canon of guidance, and contains information that will be of value to a broad cross-section of the public safety and resilience community.

Bruce Mann

Director

Civil Contingencies Secretariat

Acknowledgements

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A Guide for Readers

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You should read this report if you are involved practically in the field of crowd events.

- This is the practical report, which provides a comprehensive set of good practice guidelines for crowd events and management, and for emergency situations and evacuations.

- It also provides a comprehensive set of good practice guidelines for simulating crowd behaviours, as a useful tool to aid event preparation.

- This report should be of specific interest to all those involved in the field of crowd events – e.g., event planners and managers, emergency services, and local authorities.

- The lessons identified from the in-depth literature reviews and expert interviews are also detailed. This allows the reader to understand the origins of the good practice guidelines.

- Finally, this report also suggests directions for future research, so that practice may be improved.

EXECUTIVE SUMMARY

Executive Summary

- This research was sponsored and funded by the Cabinet Office, as part of the canon of civil protection literature and guidance, and is published on their UK Resilience website (http://www.cabinetoffice.gov.uk/ukresilience.aspx).

- For ease of reading, the research has been divided into a series of four, inter-related reports, namely: -

  - **Understanding Crowd Behaviours: Guidance and Lessons Identified**

  - **Understanding Crowd Behaviours: Supporting Evidence**

  - **Understanding Crowd Behaviours: Simulation Tools**

  - **Understanding Crowd Behaviours: Supporting Documentation**

- This Executive Summary provides an overview of the whole research project (i.e., of all four reports), summarising the Research Aims, Methodology, Key Messages, Good Practice Guidelines, Lessons Identified and Recommendations for Further Research.

- For completeness, this Executive Summary is included at the beginning of each report.

- In addition, a separate guide has been prepared for readers of the reports, which aims to help identify which reports may be of most relevance and use.

  - **Understanding Crowd Behaviours: A Guide for Readers**

- **We recommend that anyone with a professional interest in crowd behaviours should read this Executive Summary.**

Research Aims

- To review – and identify gaps in – existing research, theoretical literatures, and available knowledge on crowds and their behaviour, in both normal and emergency situations.

- To review how the leading simulation software tools accommodate crowd behaviours, and consider how approaches to modelling and simulating crowd behaviours might be enhanced for the future, incorporating both psychological and technical concerns.

- To identify ways forward for the field of crowd management, particularly in relation to planning for very large scale crowd events, which will take place over consecutive days and across multiple locations.

- To produce a set of professional guidelines for emergency planners and responders, specifying reasonable assumptions which can be made with regard to crowd behaviours in normal and emergency situations, against which current assumptions can be tested, and with which future planning can be informed.

Methodology

- A rigorous methodology was undertaken during this research, to gain a wealth of information regarding crowds, their behaviours and methods of simulation, from a wide range of sources (see **Understanding Crowd Behaviours: Supporting Documentation**, 'Research Methodology', pages 43 to 56).

- In-depth literature reviews examining over 550 academic papers, books and official reports were carried out (see **Understanding Crowd Behaviours: Supporting Evidence**, 'Part 3 – Review of the Literature', pages 54 to 242). These specifically concerned: -

    o The key theories of crowd behaviours, with particular focus on the underlying assumptions and rules governing human behaviour, in both normal and emergency situations.

    o Relevant disasters and mishaps involving crowds, with particular emphasis on crowd behaviours, and the often interconnected nature of contributory factors.

    o The key methods used to model and simulate crowd behaviours.

- In addition, three of the leading simulation techniques currently available were reviewed – through utilising accessible literature and conducting interviews with both users and creators of the tools – focusing on their underlying behavioural assumptions and rules (see **Understanding Crowd Behaviours: Simulation Tools**).

- 27 semi-structured interviews were conducted with a wide range of individuals acknowledged to be experts in the field of crowds and crowd behaviours, including leading academics, experienced police officers, and key crowd event and management practitioners (see **Understanding Crowd Behaviours: Supporting Evidence**, 'Part 4 – Expert Interview Findings', pages 243 to 275).

  - o The interviewees were specifically chosen for their wealth of experience, ranging from a few to over 30 years. The majority had over ten years' experience in the field.

  - o They had a range of roles and responsibilities, including overseeing public order at major events, emergency planning, operational planning and safety management.

  - o Experience of major crowd events amongst the interviewees included Notting Hill Carnival, The Matthew Street Festival, Glastonbury, Liverpool Capital of Culture 2008, Hogmanay, New Year's Eve in London, large scale marches in London (such as Stop the City, Stop the War, May Day protests), and events at Wembley Stadium.

- In addition the lead author of this report: -

  - o Attended two crowd-related courses held at the Emergency Planning College, on Crowd Dynamics, and on Public Safety at Sports Grounds and Events.

  - o Spent a day with police officers at the Metropolitan Police Public Order Training Centre, Gravesend, and a day with Lothian and Borders Police during a visit from the Queen.

- Particular attention has been paid to examining very large scale crowd events, which will take place over multiple days and across multiple sites (see **Understanding Crowd Behaviours: Supporting Evidence**, 'Part 1 – Very Large Scale Crowd Events', pages 10 to 21), focusing on: -

  - o The differences between very large scale, multi-day, multi-site events and other, more frequent or one-off events, specifically with regards to preparation and crowd management.

- o The new and additional risks that arise in light of these differences and the findings of this research, which will need careful and rigorous analysis and mitigation by appropriate professionals.

- Analysis has also been undertaken of the problems occurring at the opening of Heathrow Terminal 5 (see **Understanding Crowd Behaviours: Supporting Evidence**, 'Part 2 – A Cautionary Tale: Heathrow Terminal 5', pages 22 to 53), since this provides an excellent recent example of a major infrastructure and operational investment which was badly planned and managed. There are important lessons to identify from this case study.

Key Messages

The key messages to take away from this report are: -

- A great deal is known about crowds and how to plan for and manage crowd events. However, this has not been captured and articulated in a single guidance document until now.

- Key advice for successful crowd management includes: -

  - o Thorough planning and preparation, using a wide range of "what if...?" scenarios, including unexpected scenarios.

  - o Adoption of a system-wide approach.

  - o Coordination between all agencies involved.

  - o Utilisation of personnel who have plentiful first-hand knowledge, skills and experience in planning for and managing crowd events.

  - o Communication with the whole crowd – both audio and visual – particularly in emergency situations.

  - o Leadership and guidance to initiate crowd movement in emergencies.

  - o Acknowledgement that seemingly small problems occurring in combination can have a significant impact on event success.

- Nevertheless, there are significant gaps in our understanding of crowd behaviours and in the current capability of crowd simulation tools.

- These gaps are exemplified by the special circumstances of very large scale, multi-day, multi-site crowd events, which will be very different to more frequent, one-off events in a number of ways and, therefore, are likely to involve new or additional risks which will require careful analysis and mitigation.

- In particular, focusing on these very large scale, multi-day, multi-site events, there is a need to consider the potential risks surrounding: -

    o The different types of crowds and their likely behaviours.

    o The behaviours of non-ticket holders who will be attracted to the events, for a range of motives (both legal and illegal).

    o The boundaries – i.e., the scope and scale – of the system we are trying to plan for and manage.

    o The range of "what if...?" scenarios that need to be considered.

    o The knock-on effects of an incident over consecutive days.

    o The importance of coordination between all agencies, across widespread geographical locations.

    o The need to ensure all personnel – from all agencies and in all locations – are consistently and effectively educated, trained and briefed, for both normal and emergency circumstances.

    o The development of new capabilities and facilities for simulation tools, in order to accommodate the above issues.

- There are also some important lessons to identify from the experiences of the Heathrow Terminal 5 opening, in particular that: -

    o Combinations of failures in preparation and management can come together to create major inconvenience to the users of new facilities.

    o These factors include apparently mundane failures such as delays in the completion of the building programme, corner-cutting in training and familiarisation, initial software problems with new computing facilities, a failure to listen to the end users, and so on.

    o These can happen on such a scale as to represent a public relations debacle for the companies and authorities concerned and for the UK more generally.

o Careful preparations need to be made for such everyday contingencies.

Good Practice Guidelines

- A comprehensive set of good practice guidelines has been collated and established for all professionals and practitioners involved in the field of crowds, including crowd events, crowd management, crowd control and emergency services (see **Understanding Crowd Behaviours: Guidance and Lessons Identified**, 'Guidelines for Good Practice', pages 10 to 39). These guidelines focus on: -

  o Good practice for crowd management.

    ▪ For example, concerned with: thorough planning and preparation; minor risks combining to create major problems; multi-agency teamworking; utilisation of experienced personnel; cross-agency coordination; strategies for communicating with the crowd; differentiation of different types of crowd; and awareness of different behaviours from different types of crowd.

  o Good practice for emergency situations and evacuations.

    ▪ For example, concerned with: leadership and guidance during an emergency situation; initiating crowd evacuation as quickly as possible; strategies for communicating with the crowd and providing information; and awareness of how individuals are likely to behave during an emergency.

  o Good practice for crowd simulation techniques.

    ▪ For example, concerned with: trying to model more accurately crowd movements and behaviours; incorporating different types of crowd and crowd member; including family or other small groups within simulation models, rather than just focusing on individuals; and modelling interactions between crowds and other groups, and between crowd members.

Lessons Identified

- A comprehensive set of lessons identified has been produced (see **Understanding Crowd Behaviours: Guidance and Lessons Identified**, 'Lessons Identified', pages 40 to 85), concerning: -

    o Definitions and types of crowd.

    o Assumptions about crowds – including crowd movement and self-organisation, crowd behaviours in normal and emergency situations, crowd disorder, and ways of improving crowd management.

    o Ways in which crowds and their behaviours can be simulated.

Recommendations for Further Research

- Recommendations for future research and practice have been suggested (see **Understanding Crowd Behaviours: Guidance and Lessons Identified**, 'Recommendations for Further Research, pages 94 to 134), with the main priorities concerning further work on: -

    o The development of a rigorous risk assessment tool, which will enable its users to identify the full range of risks associated with different kinds of events and circumstances involving crowds.

    o How new risks associated with the building and subsequent operation of a range of new facilities and sporting events, over an extended period, can be managed and mitigated – i.e., drawing on the lessons that can be identified from an analysis of what is different about very large scale, multi-day, multi-site crowd events, and of the multiple problems which contributed to the problematic opening of Heathrow Terminal 5.

    o Stewarding and its impact on crowd behaviours. At present, there appears to be no research investigating the interactions between crowds and stewards, despite stewards undertaking a crucial role during crowd events and often being the first point of contact for crowd members.

    o Individuals who wish to be part of an event but do not have tickets to attend the event itself – i.e., non-ticketed event crowds – and the impact which their behaviour has on the preparation for, and overall management of, an event.

o The scope of "what if...?" scenarios used during preparations to think about potential problems and to test out the suitability and sufficiency of the plans in place. A wide range of scenarios should be tested, considering not only major risks such as bomb threats, but also less dramatic, but probably more likely, risks such as tripping hazards or software problems, which have the potential to contribute towards more major incidents. Moreover, scenarios should be extended to consider the wider event environment, along with the knock-on effects of incidents occurring in succession or combination.

o The next generation of simulation tools, incorporating issues such as: behaviours of groups within a crowd; different types of crowd and crowd member; interactions between crowds and other groups and between fellow crowd members; emotions; tipping points; unexpected scenarios; different system scopes; multi-purpose behaviours; incomplete information; and theoretical underpinning.

o A definition and comprehensive typology of different kinds of crowds, considering dimensions such as: the purpose and duration of the crowd; level of movement possible within the crowd; the event atmosphere; levels of crowd membership identification and heterogeneity; levels of interaction, both within the crowd and with external groups; the size of groups within the larger crowd; and the amount of luggage or baggage crowd members have.

GUIDELINES FOR GOOD PRACTICE

Guidelines for Good Practice

- This section presents a comprehensive set of good practice guidelines for all involved in the field of crowds, including crowd events, crowd management, crowd control and emergency services[1].

- The guidelines draw on the lessons identified from the in-depth literature reviews and expert interviews (see 'Lessons Identified' section, pages 40 to 85, for further details), and concern : -

    o   Good practice for crowd management.

    o   Good practice for emergency situations and evacuations.

    o   Good practice for crowd simulation techniques.

- Although much is already known about preparation for, and management of, crowd events, this knowledge has not been captured and articulated in a single guidance document until now.

- Thus, the guidelines presented in this report comprise a more inclusive, wide-ranging set of recommendations for successful crowd events than has previously been documented, drawing on both literature and expert opinion.

- Furthermore, to the best of our knowledge, the guidelines concerned with crowd simulation techniques are unique to this report, having not previously been collated and presented as guidance.

- There is a real need to agree and establish good practice for crowd event preparation and management. This should help ensure there is a consistent delivery of good crowd management practice by all involved in the industry, across each and every crowd, and should enhance consistency in terms of personnel training.

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[1] Please note, the good practice guidelines presented in this report are our interpretation of best practice based on the knowledge and expertise gained from in-depth literature reviews and expert interviews. They are not definitive rules of event preparation and crowd management.

Guidelines for Crowd Management

Guidelines for Crowd Management

1. **Recognise that crowd management – i.e., the facilitation of crowd activities – is operationally distinct from crowd control – i.e., the actions taken to control the crowd once behaviours become undesirable.**

2. **Remember that crowd management is preferable to crowd control – prevention is better than cure.**

   Ensure management is well-planned and well-organised, in order to anticipate and prevent – or quickly resolve – problems.

   Try to use crowd control methods only as a last resort.

3. **Ensure that crowd safety concerns are equal in priority to security concerns.**

4. **Plan and prepare thoroughly for every crowd event.**

   Consider factors including the event type, the act profile, location and timing, likely crowd composition, which agencies need to be involved, how the event will be publicised, what the aims and objectives of the event are, what a successful event should look like, what resources will be needed to achieve this success, what problems could potentially arise, and what contingencies need to be implemented to deal with those problems should they arise.

   Consider the forecast for the number of people expected at the event, for instance, based on attendance in previous years, event publicity, whether the event is ticketed, and police intelligence.

5. **Test all equipment, technology and communication systems thoroughly prior to the event and again on the morning of the event.**

    Ensure back-up systems are available – particularly communication systems – should the original ones fail.

6. **Be aware of becoming complacent – just because an event was successful in previous years or in a different location, does not automatically mean it will be a success in the future.**

    Profile each event according to the specific situation and circumstances at the time, but underpin this with knowledge and experience gained from previous events of a similar nature.

7. **Adopt a systems approach when preparing for and managing a crowd event, taking not only the event itself into account, but also considering potentially influential factors in the wider area.**

    Consider the event from multiple perspectives, e.g., event planners and managers, emergency services, local authorities, transport authorities, volunteer stewards, and the crowd.

    Incorporate a wide range of factors, including social, organisational and technical.

8. **Avoid forming inflexible expectations and assumptions about likely crowd behaviours, as they may cloud judgement of issues that arise on the event day.**

    Assess each event on its own merits, and consider the atmosphere and actual crowd profile on the day.

9. **Utilise police intelligence surrounding the event and the likely crowds it will attract, throughout the planning and preparation stages.**

    Once again, however, do not let preconceptions about likely crowd composition and behaviour colour judgement.

10. **Conduct a thorough and detailed risk analysis during event preparations.**

    Use brainstorming sessions or table-top exercises to help identify a wide range of potential risks.

    Prioritise these risks according to their likelihood and severity.

    Devise contingency plans to help manage and mitigate the risks.

11. **Develop and use a comprehensive range of "what if...?" scenarios during preparation, to consider management strategies and contingency plans to deal with potential problems.**

    Use brainstorming sessions or table-top exercises to generate scenarios, both hypothetical and previously experienced ones.

    Consider the knock-on effects of an incident.

    Consider the wider impact of an incident.

    Consider what is likely to happen if forecasts of expected crowd numbers are incorrect

    Avoid focusing exclusively on preconceived major risks, e.g., bomb scares, and consider more unusual, unexpected scenarios.

    Also consider seemingly mundane issues, e.g., problems with software systems, failure of new technologies, inefficient security procedures and personnel unfamiliar with the environment. These have the potential – should they occur in combination – to contribute towards a serious incident.

12. **Visit the event site prior to the event and again on the day of the event, to thoroughly assess the geography of the location and to determine where problems could arise, such as crowd congestion and reduced rates of flow.**

13. **Work with the geography of the location and make use of physical street furniture wherever possible.**

    Be aware that many event locations – particularly for larger scale, multi-day events – may also involve temporary street furniture, such as marquees or traffic calming measures. Any temporary fixtures such as these should be acknowledged and incorporated into preparations.

    Consideration should be given to any forthcoming, permanent changes to be made to the geographical layout of a future event site. For instance, large scale building and construction works are ongoing for the London 2012 Olympic Games, both in London itself and in the other locations across the country; therefore, these alterations must be incorporated into plans.

14. **Carefully consider where to locate crowd facilities, such as toilets and concessions stands, in order to make them easily accessible, thereby enhancing the crowd's enjoyment of the event.**

15. **Utilise personnel who have plentiful first-hand knowledge, skills and experience in planning for and managing crowd events.**

16. **Adopt a multi-agency approach incorporating all relevant parties, to enable a wide range of knowledge and expertise to be drawn upon, and to ensure that all perspectives are carefully considered.**

Include police, ambulance and fire services, local authorities, stewards, and event organisers.

Try to form this event team as early in the process as possible. This should help to build a sense of team solidarity, enable all individuals to learn from each other and create a common body of knowledge, and should allow the various capabilities of the different parties to be assessed.

17. **Adopt a clear and robust command and control structure, following a logical strategy, for each crowd event, to oversee and coordinate all activities.**

18. **Aim to coordinate all activities and all personnel from a central control point, particularly when an event is spread across several locations.**

Utilise a central control point responsible for the overall management of an event across multiple locations.

Ensure all activities and personnel located across multiple locations are coordinated.

19. **Try to be flexible, in order to deviate from the original plan and implement contingencies if needed.**

20. **Brief all parties thoroughly prior to an event, particularly stewards who are most likely to be first point of contact for crowd members.**

    Ensure all parties, particularly stewards, are also familiar with the environment, in order to give crowd members accurate and helpful information.

21. **Lay down clear communications protocols to ensure all parties communicate efficiently and effectively with one another.**

    Ensure all parties are aware of which other agencies they need to communicate with at which points during an event.

    Make sure all parties are aware of the chain of communication.

22. **Make sure all parties are confident in their own roles and responsibilities, in both normal and emergency situations, and are aware of who is in command of the operation overall.**

    Also ensure that all parties are aware of the roles of others involved in the event, and understand how the actions of one party can impact on the actions of another party.

    Coordination between all agencies throughout the event is crucial.

23. **Ensure key personnel are sufficiently trained in crowd management and emergency evacuation techniques.**

24. Communicate with the whole crowd at all times.

Information communicated to – or withheld from – a crowd influences their behaviour, therefore efficient communication is vital for successful crowd management.

Communicate with the whole crowd, not just those at the front.

Ensure individuals at the rear of the crowd are aware of what is happening at the front of the crowd.

Make use of stewards to communicate information, as crowds may be more receptive to stewards than to authority figures (i.e., 'us' versus 'them' mentality).

25. Ensure communication is both audio and visual, and is specific, accurate, comprehensive, timely, and from a credible source.

Given that not all crowd members may be English speaking, it may be necessary to provide information in a range of languages and/ or to make use of visual representations.

26. Provide prospective event crowds with information prior to the event, so that they are aware of what to expect.

This information can be communicated via media advertising and announcements, literature and programmes distributed with event tickets, or via a website, for instance.

Information should cover how crowd members can arrive at the event, where they should go when they get to the venue, what facilities are available once inside the venue, and what items (e.g., potential hazards such as glass bottles and umbrellas) will not be permitted into the event.

27. Try to understand the crowd in order to improve management effectiveness.

Consider who the crowd are, i.e., their likely composition and profile, based on previous events.

Consider their purpose for attending the event, i.e., their aims and objectives in attending the event.

Consider how they are likely to move around the event.

Consider the most appropriate form of intervention if needed, dependent on these previous factors.

28. Avoid making assumptions about likely crowd behaviour – violence in particular – based upon prior expectations or biases.

Treat each crowd in accordance with their actual behaviour at the event.

29. Manage the crowd's expectations in order to manage their behaviour more effectively.

Provide the crowd with information.

Communicate with the whole crowd when appropriate.

Listen to the crowd and try to facilitate their needs and solve any problems wherever possible.

30. Facilitate the crowd, in order to draw on their natural, internal mechanisms, such as self-policing.

Consider how the crowd can be helped to achieve their aims.

31. Remember that the crowd is not homogenous, but comprises a wide range of diverse individuals, with different wants, needs and expectations.

32. Do not treat the crowd as one mass, but as a collection of smaller groups.

Differentiate distinct groups within the crowd.

Take action appropriate to the composition and likely behaviours of each group.

33. Be aware that crowd members who are more familiar with an environment are more likely to behave as individuals, rather than as members of a collective crowd.

Consider whether it is appropriate, under the specific circumstances of the event, to treat those individuals as a collective entity moving in unison.

34. Use multiple forms of crowd monitoring during an event, in order to assess the crowd and their behaviour from multiple perspectives.

Examples include officers on the ground, undercover officers in the crowd, stewards, roof-top spotters, CCTV, helicopters, and Commanders overseeing from a command centre.

35. Remember that individuals who are highly familiar with a particular venue or environment – e.g., regularly recurring crowds at football matches – are more likely to move through the environment in the same way or follow the same routes each time.

36. Be aware that in unfamiliar surroundings or unfamiliar circumstances, people will behave differently, for instance, stopping and starting more frequently, moving more slowly, and relying heavily on signage and stewarding.

Ensure signage is plentiful, highly visible, easily comprehensible and accurate.

Ensure stewarding levels are sufficient, with contingencies in place to increase these levels in emergency circumstances.

37. Try to make line-of sight paths as long as possible, to allow individuals to easily see their destination and, thereby, move quickly and directly towards it.

38. Be aware that crowds will not fill a space evenly, but will cluster, exploit short-cuts and exhibit herding behaviours.

Carefully consider the locations where crowd clusters are most likely to occur, e.g., around concessions stands or in areas with a good view, and where short-cuts are most likely to be taken.

Provide additional stewarding at these points to help control crowd flow and direct individuals towards less crowded areas. However, make sure that these stewards are positioned appropriately, so as not to cause further obstruction.

39. Acknowledge that clogging and jamming are more likely to occur in a crowd of higher density.

Continually monitor the crowd for signs of problems occurring.

Be prepared to act quickly, to resolve problems before they arise or become unmanageable.

40. Identify points of weakness in the environment, where increased density is more likely to occur.

Consider bottlenecks, corners, intersections, areas of counter flow, ingress (entry) and egress (exit) points, points of interest, and crowd facilities.

Provide additional stewarding at these points to help control crowd flow and direct individuals towards less crowded areas. However, make sure that these stewards are positioned appropriately, so as not to cause further obstruction to crowd flow.

41. Ensure adequate means are in place to control crowd flow and density distribution.

Continually steward and direct the crowd to avoid overcrowding.

Strategically place obstacles, such as railings or columns, along the length of a space (either open or closed) to act as wave breakers, preventing large crowd pressures building up and encouraging lane formation.

Ensure a separate door is used for entry and exit, to separate opposing crowd flows.

If possible, ensure exits are wide enough to accommodate groups of people, so as to prevent the group having to disperse upon exiting and, subsequently, having to wait for all group members before leaving.

42. Recognise that family groups and groups of friends will prefer to move together as a unit. Therefore, if group members become separated, they are likely to try to reform their group before exiting.

Try to facilitate movement as a group wherever possible.

Provide plentiful and highly visible meeting points, where groups can reform.

Provide easily accessible, clearly visible and well sign-posted information centres, where groups can arrange to meet should they become separated, or where announcements can be made for lost individuals.

Where possible, ensure exits are wide enough to accommodate groups of people, so as to prevent the group having to disperse upon exiting and, subsequently, having to wait for all group members before leaving.

43. Recognise that hierarchically organised groups – such as parents with children – are likely to behave differently to non-hierarchically organised groups – such as groups of friends.

Try to facilitate movement as a family unit wherever possible.

Provide plentiful and highly visible meeting points, where families can reform.

Provide easily accessible, clearly visible and well sign-posted information centres, where families can arrange to meet should they become separated, or where announcements can be made for lost children.

44. Remember that individuals will typically move through an environment in the following ways: -

They will usually aim to minimise their time and costs, to avoid congestion and to maximise their speed.

They prefer not to take detours or to move in the opposing direction to the main crowd flow, even if the direct route they subsequently choose is crowded.

Crowd members will typically take the fastest route.

If multiple route choices of the same length are available, individuals will generally take the one which offers the best lines of sight and the straightest route, with the least changes in direction, for as long as possible.

But, if an alternative route of equal length is more attractive – for instance, in terms of being better lit, less noisy or a more attractive environment – people may opt for this instead.

They will try to keep a certain distance from other people and from walls or obstacles in order to avoid collisions.

As they turn corners, crowd members will typically slow down and move further into them, making corners densely packed.

Crowd members will typically follow the person in front of them when congestion occurs.

When moving in opposing directions, individuals will often self-organise and form distinct lanes, easing crowd flow.

45. Be aware that the potential for more potent – and troublesome – collective behaviour is more likely to be exhibited in environments which contain regularly recurring crowds, such as football matches.

Crowds such as these are more likely to have a stronger sense of shared social identity – as members of a united group – which can have a powerful influence over their collective behaviour.

46. Be aware that there is greater potential for male-dominated crowds to behave in a more aggressive manner in comparison to female-dominated crowds, mixed gender crowds or crowds with a high proportion of family groups.

47. Be aware of the potential for intoxication to increase crowd violence and to physically destabilise crowds.

Implement drinking restrictions at events deemed to be high risk.

Monitor closely crowd members who are considered to be dangerously intoxicated and, therefore, have the potential to cause trouble.

48. Be vigilant to the knowledge that interactions between a crowd and other groups – such as authorities – will influence the way in which that crowd behaves.

Consider how particular interactions are likely to affect crowd behaviour.

Adopt a management or policing style appropriate to the event type and likely crowd profile.

Ensure the level of visible police or security personnel – and their uniforms – is appropriate to the event type and likely crowd composition.

Keep additional police or security resources, who are equipped for disorder, on stand-by in case problems arise, but try to ensure they are out of sight of the crowd.

Be prepared to delay intervention if the situation permits, to give the crowd an opportunity to self-police.

Consider interventions by stewards rather than police if appropriate, as the crowd may be more compliant ('us' versus 'them' mentality).

49. Increase the identifiability of individual crowd members to try to reduce the likelihood of antisocial behaviour in a crowd.

Use CCTV in a highly visible manner that is apparent to crowd members – i.e., ensure they know they are being watched.

Use spotlights on troublesome areas of the crowd.

Verify the identity of those purchasing tickets for events.

Allocate tickets in identifiable seats or areas within venues.

50. Always conduct a debrief at the end of a crowd event.

Consider what was successful, what went wrong, and what changes can be made for future events.

If an event is occurring over consecutive days, conduct a debrief at the end of each day, to enable necessary changes to be made for subsequent days.

Produce a set of lessons learned.

Follow up on any actions which need to be taken

Transfer the lessons learned into official policy.

Disseminate these lessons to all members of the team involved in crowd events.

Guidelines for Emergency Situations and Evacuations

Guidelines for Emergency Situations and Evacuations

51. **Conduct a thorough and detailed evacuation analysis at the location of the event to make evacuation plans more resilient and to reduce evacuation times.**

Evacuation analyses need to be conducted for buildings, event locations and the wider surrounding areas.

52. **Recognise that evacuation involves three key stages – 1) interpretation, 2) preparation, and 3) action – all of which impact on evacuation efficiency.**

Interpretation concerns the time taken to acknowledge there is a danger.

Preparation concerns the time taken to decide on the most appropriate course of action.

Action concerns the time taken for individuals to undertake the physical evacuation.

53. **Acknowledge that accurate interpretation during an emergency is particularly critical, and is influenced by the quality and accessibility of communication.**

54. **Respond immediately to the first signs of an emergency.**

Never underestimate the seriousness of the situation.

Communicate with the crowd as soon as possible to make them aware of the situation and initiate evacuation.

55. When an emergency occurs, communicate with the crowd and provide information about the threat or emergency, along with clear instructions about how to exit.

This should help accurate interpretation and initiate crowd movement.

56. Ensure warnings about an emergency are both visual and auditory, and are specific, timely, historically valid, credible, comprehensible, and convey the nature and extent of the danger.

This should make the warnings more believable and increase accurate interpretation.

57. Recognise that panic is actually very rare and that instead, behaviours typically remain structured, organised, helpful, cooperative and coordinated.

Make use of individuals' willingness to help fellow victims.

Provide structure for crowd members during an evacuation, to help maintain their organised behaviours.

58. Do not withhold information from the crowd during an emergency for fear of causing panic.

Providing more information about the nature of the threat or emergency will help the crowd respond more effectively.
    (See 'Understanding Crowd Behaviours: Supporting Evidence', Footnote 11, page 151, for a possible exception).

Do not delay warnings for fear of causing panic – this merely delays emergency evacuation.

59. Avoid telling people "not to panic" – this may actually increase anxiety, as crowd members may feel they are expected to panic.

60. Remember that in an emergency, individuals will want to behave as 'normal' for as long as possible.

Provide additional communication and instructions to make the crowd aware that the emergency is real and to initiate evacuation movements.

Ensure leadership is strong, to take control of the situation, to initiate movement and to direct suitable crowd behaviour.

61. Remember that in an emergency, individuals will want to follow their usual routes for as long as possible.

Provide additional communication and instructions to make the crowd aware of the most appropriate evacuation routes.

Ensure leadership is strong, to take control of the situation, to initiate movement and to direct suitable crowd behaviour.

Provide additional guidance about the most appropriate means of evacuation.

Ensure stewarding is sufficient to physically guide the crowd towards emergency exits.

62. Maximise visibility of exit routes and emergency exit signs.

The more visible they are, the more attractive they are likely to be to crowd members, and the faster crowd members should be to follow those routes.

63. Ensure a sufficient number of stewards, or volunteers from within the crowd, are aware of the emergency evacuation procedures, and so can act as leader figures for the crowd to follow in the event of an emergency.

Leader figures – either from the authorities or from within the crowd itself – play an important role in preparing crowd members for the evacuation process.

Carefully consider the spatial positioning of these individuals who are knowledgeable about appropriate behaviour in an evacuation, so that the decisions and actions they take can have maximum influence over the crowd.

Leaders positioned in the core, rather than the periphery, of the crowd – i.e., in close proximity to other crowd members – are more likely to be influential over crowd movement.

64. Recognise that crowd members are typically motivated to move towards familiar people during an emergency, which may slow their rate of evacuation.

Family members prefer to evacuate together as a group, and will wait to exit until all family members are able to do so.

Parents are more likely to put the safety of their children first.

Groups of friends prefer to evacuate together as a group.

Provide additional communication, instructions and guidance to make the crowd aware of the most appropriate evacuation routes, to try and enhance evacuation rates.

Ensure leadership is strong, to take control of the situation, to initiate movement and to direct suitable crowd behaviour.

Ensure stewarding is sufficient to physically guide the crowd towards emergency exits.

65. Recognise that crowd members are typically motivated to move towards familiar places during an emergency, which may slow their rate of evacuation.

Individuals prefer to leave by a familiar route – e.g., the way they came in – as opposed to an emergency exit.

Provide additional communication, instructions and guidance to make the crowd aware of the most appropriate evacuation routes, to try to enhance evacuation rates.

Ensure leadership is strong, to take control of the situation, to initiate movement and to direct suitable crowd behaviour.

Ensure stewarding is sufficient to physically guide the crowd towards emergency exits.

66. Recognise that individuals' choice of escape route will be influenced by the actions of others.

Crowd members will typically follow other evacuees during an emergency, resulting in herding behaviour, when one exit becomes clogged whilst another exit is highly underused.

Ensure plentiful stewarding is available to guide people towards underused emergency exits.

Encourage crowd members to form queues at emergency exits. This should enable faster crowd flow and increase evacuation effectiveness.

67. Take advantage of the stereotypical gender roles typically retained during an emergency.

Enlist the help of male crowd members to provide assistance to fellow evacuees during emergency egress.

Enlist the help of female crowd members to provide emotional support to fellow evacuees once contained away from the danger.

68. Recognise that crowd members are likely to feel united by an emergency situation and will typically exhibit coordination, cooperation and helping behaviours, and make personal sacrifices.

A sense of shared social identity is often created in the event of an emergency, enabling crowd members to act as a source of strength for one another.

Make use of the crowd's resilience and willingness to help.

Provide clear instructions about how crowd members can be of assistance.

69. Ensure key personnel are adequately trained for an emergency, to enhance their reaction and response times.

70. Regularly practice evacuations, to improve efficiency.

Guidelines for Crowd Simulation Techniques

Guidelines for Crowd Simulation Techniques

Based on the literature reviewed and expert interviews conducted, we suggest that the next generation of crowd simulation tools should aim to be able to accommodate the following[2]: -

- In an attempt to better represent reality – both visually and in terms of human behaviours – simulation tools should ideally be populated by intelligent autonomous agents, which are capable of perceiving their environment, making independent decisions and performing realistic human behaviours[3].

- Tools should focus on increasing the realism and accuracy of crowd behaviours and movement. This is more important than emphasising improvements to visual aesthetics.

- Crowd models should be underpinned by real-time observations of crowds and how they move.

- Experts involved first-hand with crowds on a regular basis should be consulted during the development of a simulation tool, so that their knowledge and experience of crowd behaviours can be utilised.

- Simulation tools should be continually validated by observing and analysing varying types of crowd event.

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[2] We are not suggesting that every simulation tool should be able to accommodate all the features listed. Rather, we are proposing a list of possible requirements for the next generation of tools. The particular emphasis will depend on particular anticipated uses of the new tools. We also acknowledge that our views are not necessarily shared by current tool developers in this area.

[3] For the purposes of this review, we have chosen to focus on agent-based models – i.e., models populated by intelligent, autonomous agents – as the state-of-the-art tools for simulating crowd behaviour. However, it is important to acknowledge that alternative modelling techniques – such as spreadsheet (regression) models (e.g., Milazzo et al., 1998), which use simple equations to measure and predict factors such as ingress and egress rates, crowd flow rate, speed of movement, and density – whilst less realistic in terms of mimicking crowd behaviour, can still be of great value when preparing for a crowd event.

- Agents' movements should be underpinned by the principle of least effort, aiming to minimise time, costs and congestion whilst maximising speed.

- Crowd behaviours should be modelled at three levels to accurately mirror the behaviours of a crowd in reality: 1) the individual level; 2) interactions between individuals; and 3) the group level.

- Simulation tools should aim to accommodate different types of crowd, with characteristic behaviours attributed to each different type.

- Different types of crowd member, each with distinct characteristics, should be represented within a simulation tool.

- Individual attributes, such as age, gender, size, mobility, luggage and walking speed, should be able to be assigned to agents, in both a random and specified manner, to best represent the population to be modelled.

- Simulation tools should ideally be able to accommodate, and accurately model, movements and behaviours typically observed in crowds, including: -

  o Uneven density distribution in a given environment, such as clustering around a particularly attractive place, such as a food outlet.

  o Taking the most direct route to avoid detours and changes in direction.

  o Moving with the general flow of the crowd.

  o Taking the fastest route.

  o Considering the attractiveness of a route – for instance, in terms of being better lit, less noisy or a more attractive environment – if alternative routes of equal length are available.

  o Motivational behaviours, such as stopping to look in a shop window or taking a rest.

  o Contact between crowd members, such as pushing or falling over.

  o Communication between crowd members.

  o Exploration behaviours, since some crowd members are unlikely to have complete information about, or a complete understanding of, their environment.

- - Ways in which people avoid collisions by keeping a certain distance from other people and from environmental borders, such as walls or obstacles.

- Tools should aim to simulate how groups – such as families or groups of friends – behave in a given environment: -

  - Groups prefer to move together as a unit.

  - Typically, individuals in the same group will walk at the same speed and follow the same goals.

  - If group members become separated, they are likely to try to reform their group before exiting.

  - Families – particularly parents with children – are likely to behave differently to individuals or groups of friends.

- Simulation tools should be able to model interactions between crowd members, in terms of communication and information sharing, and in terms of physical contact, such as pushing.

- Simulation tools should attempt to accommodate interactions between crowds and other groups, such as the police or stewards, and the impact which these interactions have on crowd behaviours.

- Simulation tools should be able to accommodate antisocial behaviours often observed during crowd disorder, including: -

  - Increased levels of aggression in male-dominated crowds.

  - Increased levels of antisocial behaviour with increased intoxication.

- Simulation tools should aim to be able to accurately model self-organisation phenomena observed in crowds, including: -

  - The 'faster is slower' effect – i.e., when passing through a bottleneck, the faster people wish to move, the more densely packed they become and the slower they can actually move.

  - Clogging and jamming in densely packed crowds.

  - Lane formation for crowd members moving in opposing directions.

- o The 'freezing by heating' effect – when lanes formed may break down due to continuous overtaking manoeuvres in high density crowds, nervous crowds or large disturbances.

- o Oscillations, or variations, in the direction of crowd movement at bottlenecks in counter-flow.

- o Following the person in front when congestion occurs.

- o Flow patterns at intersections, such as short-term roundabouts.

- o Ring structures when a crowd is observing a particular event or gathers around a particular point of interest.

- o 'Corner hugging' – when crowd members slow down and move further into corners when turning them, becoming more densely packed.

- Simulation tools should be accurately able to model crowd behaviours typically observed during an emergency situation, including: -

  - o Motivation of crowd members to move towards familiar people and places.

  - o Preference to leave by a familiar route – i.e., the way they came in – as opposed to an emergency exit.

  - o Tendency to move in the same direction as others.

  - o Evacuation of family members as a united group.

  - o Parents putting the safety of their children before their own.

  - o Stereotypical gender roles, with women generally receiving more help than men, and more men offering to help than women.

  - o Competitive behaviour, if evacuation time is limited.

  - o Herding behaviour, when one exit may become clogged whilst another exit is highly underused.

  - o Queuing behaviour, increasing the effectiveness of an evacuation.

LESSONS IDENTIFIED

Lessons Identified

- This section draws together the key learning points elicited from the in-depth literature reviews and expert interviews, to present a comprehensive set of lessons identified in relation to crowds, their behaviours, and ways in which these can be simulated.

- The guidelines for good practice detailed in the previous section are derived from these lessons.

- More specifically, lessons have been abstracted relating to: -

    o Definitions and types of crowd.

    o Assumptions about crowd behaviours.

    o Methods of crowd simulation.

Definitions and Types of Crowd

Defining a Crowd

- There is no single, agreed, detailed definition of 'a crowd'. Given the wide range of different crowd types, it may be more appropriate to devise multiple definitions, relevant to the varying types.

- There are, however, plentiful general (and often vague) descriptions of crowds, groups or collectives, concerned with the notion of a crowd as 'a large gathering of people'.

- These definitions share common characteristics, conceptualising a crowd as a sizeable number of people gathered at a specific location for a measurable time period, with common goals and displaying common behaviours.

- It is beneficial to distinguish a physical crowd – i.e., a group of people who simply share a location – and a psychological crowd – i.e., a group of people who share a social identity.

- Key criteria which may jointly characterise a crowd – i.e., which are usually seen to comprise a crowd – include[4]: -

    o   Size – there should be a sizeable gathering of people.

    o   Density – crowd members should be co-located in a particular area, with a sufficient density distribution.

    o   Time – individuals should typically come together in a specific location for a specific purpose over a measurable amount of time.

    o   Collectivity – crowd members should share a social identity, common goals and interests, and act in a coherent manner.

    o   Novelty – individuals should be able to act in a socially coherent manner, despite coming together in an ambiguous or unfamiliar situation.

- Thus, a gathering of 20 people standing in close proximity at a specific location to observe a specific event over a one-hour period, who feel united by a common identity and, despite being strangers, are able to act in a socially coherent way, could be considered a crowd.

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[4] A deliberate decision has been made not to include specific figures in relation to size, density and time – see Understanding Crowd Behaviours: Supporting Evidence, Footnote 7, page 62, for further explanation.

Types of Crowd

- There is no one typical crowd, but a range of crowd types, each with their own characteristics and typical behaviours.

- It is important to distinguish different crowd types, in order to successfully prepare for and manage a particular crowd at a particular event.

- It is also important to differentiate distinct crowd types within a larger crowd, and to treat each type appropriately.

- Thus far, very little research has been conducted into crowd types. A paper by Berlonghi (1995) identifies eleven different types, including: -

  o A spectator crowd – i.e., a crowd watching an event that they have come to the location to see, or that they happen to discover once there.

  o A demonstrator crowd – i.e., a crowd, often with a recognised leader, organised for a specific reason or event, to picket, demonstrate, march, or chant.

  o A dense or suffocating crowd – i.e., a crowd in which people's physical movement rapidly decreases – to the point of impossibility – due to high crowd density, with people being swept along and compressed, resulting in serious injuries and fatalities from suffocation.

  o A violent crowd – i.e., a crowd attacking, terrorising, or rioting with no consideration for the law or the rights of other people.

  o An escaping crowd – i.e., a crowd attempting to escape from real or perceived danger or life-threatening situations, including people involved in organised evacuations, or chaotic pushing and shoving by a panicking mob.

- The expert interviewees described types of crowd according to the type of event at which they were present, such as crowds at marches and demonstrations, crowds at sports events, crowds at concerts, and crowds at celebrations.

- Within each type there is then a whole range of crowd member types. For instance, a demonstration crowd may be comprised of: -

  o Totally compliant protesters – i.e., passionate but do not cause trouble.

- o Slightly more difficult protesters – i.e., no disorder but may commit civil disobedience.

- o Protesters who are willing to commit disorder if they become caught up with the emotion of the crowd and are pushed by other fellow members.

- o Professional/subversive protesters – i.e., intent on causing and provoking disorder.

- o Individuals who are not genuine protesters, but will use a protest as a cover to commit disorder.

Figure 1. Example of a spectator crowd
(Photo courtesy of Liverpool Culture Company, Liverpool City Council)

Assumptions about Crowd Behaviours

Assumptions about Crowd Behaviours

- The following assumptions – based on the observations of human behaviour detailed in the literature, on the theories of crowd behaviours reviewed, and on the vast experience of the expert interviewees – can be made in relation to crowds and how they are likely to move and behave.

- These assumptions can be made in relation to: -

    o Crowd movement and self-organisation.

    o Crowd behaviours.

    o Crowd behaviours during emergency situations.

    o Crowd disorder.

    o Improving crowd management and control.

Crowd Movement and Self-Organisation

- Individuals typically move according to the principle of 'least effort' (e.g., Still, 2000), aiming to minimise time and costs, avoid congestion and maximise their speed.

- Individuals prefer not to take detours or to move in the opposing direction to the main crowd flow, even if the direct route they subsequently choose is crowded (Helbing, Molnár, Farkas & Bolay, 2001).

- Typically, people will take the fastest route (e.g., Ganem, 1998; Kurose, Borgers & Timmermans, 2001).

- If multiple route choices of the same length are available, individuals will generally take the one which offers the straightest route and the best lines of sight, with the least changes in direction, for as long as possible (e.g., Nishinari, Sugawara, Kazama, Schadschneider & Chowdhury, 2006). Goffman (1971) terms this the 'law of minimal change'.

- If, however, an alternative route of equal length is more attractive – for instance, in terms of being better lit, less noisy, or being a more attractive environment – people may opt for this instead of taking the fastest or most direct route (e.g., Nishinari et al., 2006).

- Provided there is sufficient time to reach their destination, individuals prefer to walk at an individually desired speed, corresponding to their most comfortable – i.e., least energy-consuming – walking speed.

- In order to avoid collisions, people try to keep a certain distance from other people and from environmental borders, such as walls or obstacles. This distance decreases if the individual is in a hurry or if crowd density increases, for instance, around a particularly attractive place, such as a food outlet.

- Individuals act more or less automatically and typically do not reflect on their behavioural strategy in each new situation, but instead learn optimal behaviours over time by trial and error (Helbing et al., 2001).

- Crowds do not fill a space evenly, but rather cluster, exploit short-cuts and exhibit herding behaviour (e.g., Still, 2000) (see Figure 2 overleaf).

Figure 2. Uneven filling of space by a crowd
(Taken from Still, 2000, p.55)
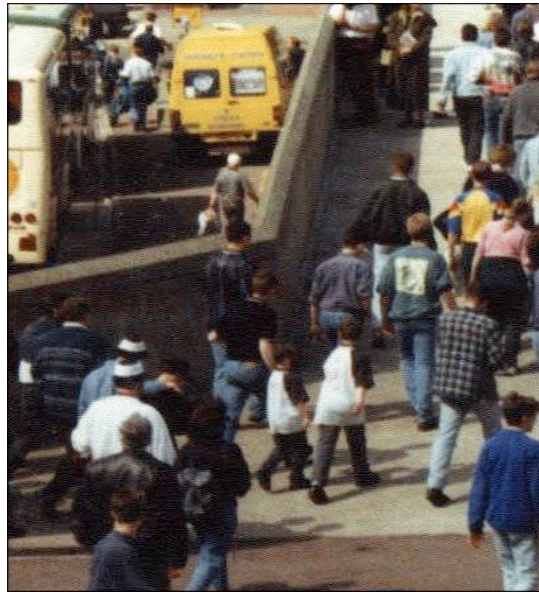
- When congestion occurs, people typically follow the person in front of them, thereby creating flow patterns (Loscos, Marchal & Meyer, 2003).

Figure 3. Flow patterns in a dense crowd
(Taken from Still, 2000, p.15)

- Family groups and group of friends prefer to move together as a unit. For example, people who arrive at an event together prefer to move around the event together and to leave together (e.g., Pan, Han, Dauber & Law, 2006).

- If group members become separated, they are likely to try to reform their group before exiting. However, this may produce movements contrary to the main flow of the crowd which can hinder the flow as a whole (e.g., Pan et al., 2006).

- Hierarchically organised groups – e.g., parents with children – are likely to behave differently to groups that are not organised according to a hierarchy – e.g., groups of friends (Pan et al., 2006).

- Crowds are able to make cohesive, united decisions regarding their direction and speed of movement even when only a few members have the information necessary to make such decisions (e.g., Couzin, Krause, Franks & Levin, 2005).

  - The possession of this information may be as a result of positioning within the crowd – e.g., certain locations within the crowd may offer individuals better access to signage – or as a result of differences in experience and learning – e.g., some crowd members may be more familiar with the environment (e.g., Dyer, Ioannou, Morrell, Croft, Couzin, Waters & Krause, 2008).

  - The degree to which these informed individuals can then be influential over the crowd is largely dependent on their spatial positioning, with those in the core – i.e., in closer proximity to other crowd members – likely to be of greater influence (e.g., Aubé & Shield, 2004; Dyer et al., 2008). This is particularly important during an emergency evacuation when decisions need to be made quickly.

Self-Organisation Phenomena

- When passing through a bottleneck, the faster people wish to move – i.e., the more impatient they are – the more densely packed the crowd becomes and the slower individuals can move (e.g., Helbing, Farkas & Vicsek, 2000a; Parisi & Dorso, 2005, 2006, 2007). This is known as the 'faster is slower' effect.

- Jams build up when densely packed crowds attempt to move (e.g., Helbing et al., 2000a, 2001; Takimoto & Nagatnai, 2003; Helbing, Johansson & Al-Abideen, 2007).

- As large, dense crowds push forward towards a narrow exit, clogging and arching are observed – i.e., the exit becomes clogged and the crowd forms an arch-shape, radiating from the exit (e.g., Helbing et al., 2000a, 2005; Yu, Chen, Dong & Dai, 2005).

Figure 4. Arching effect observed at a narrow exit
(Taken from Yu et al., 2005, p.3)
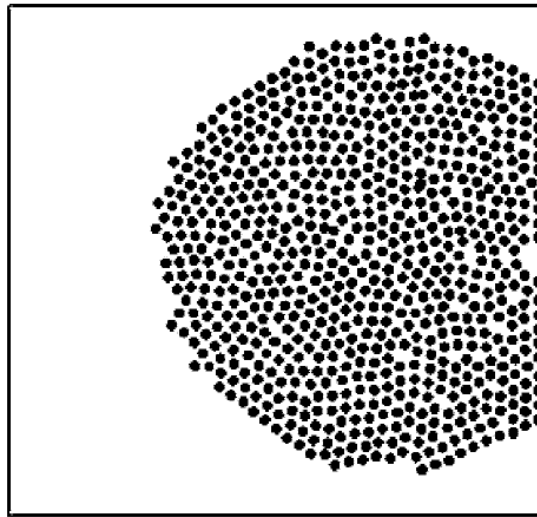
- When people move in opposing directions, they can self-organise to create distinct lanes – one for each direction of movement (e.g., Helbing & Molnár, 1995; Helbing et al., 2001; Couzin & Franks, 2003; Helbing, Buzna, Johansson & Werner, 2005) (see Figure 5 overleaf). This helps reduce collisions and increase speed.

Figure 5. Lane formation
(Taken from Helbing et al., 2001, p.364)

- However, in high density or nervous crowds, any lanes formed may break down due to continuous overtaking manoeuvres (e.g., Helbing et al., 2000b). This is known as the 'freezing by heating' effect.

- As crowd members turn corners, they tend to slow down and move further into them, becoming more densely packed and appearing to 'hug' the corner (Still, 2000; Aubé & Shield, 2004). This is known as 'corner hugging'.

Figure 6. Corner hugging
(Taken from Still, 2000, p.56)

- Variations, or oscillations, in the direction of crowd movement occur at bottlenecks in counter-flow, as the direction of crowd members able to move against the opposing flow and pass through the bottleneck alternates between right-to-left and left-to-right (e.g., Helbing & Molnár, 1995; Kretz, Grünebohm & Schreckenberg, 2006a; Kretz, Grünebohm, Kaufman, Mazur and Schreckenberg, 2006b; Kretz, Wolki & Schreckenberg, 2006c).

    o For example, in the top diagram in Figure 7, crowd members are able to move against the opposing crowd flow and pass through the exit from left-to-right. However, mounting pressure from the crowd moving in the opposite direction prevents this movement being sustained. Subsequently, crowd movement through the exit switches and those members wishing to pass from right-to-left are able to do so, as shown in the bottom diagram in Figure 7. This process continues, resulting in oscillating crowd movements.

Figure 7. Oscillations in crowd movement at a bottleneck in counter-flow
(Taken from Helbing et al. 2001, p.370)
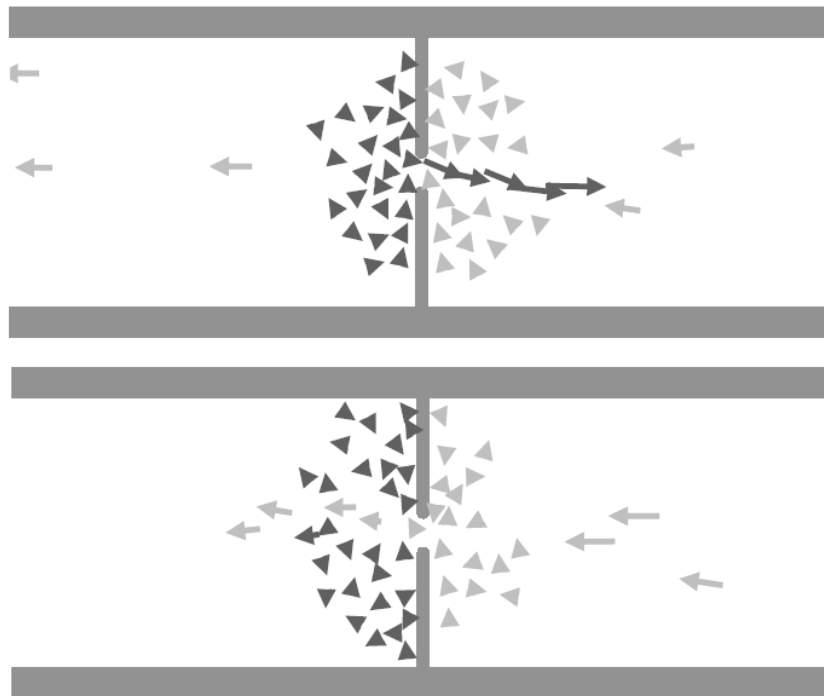
- When a crowd is observing a particular event or gathers around a particular point of interest – such as a street artist – ring structures result, radiating outwards from the point of interest (e.g., Milgram & Toch, 1969).

- Crowd movement at intersections is eased by the emergence of flow patterns, such as short-term roundabouts (e.g., Helbing, 2001; Helbing et al., 2001; Helbing et al., 2005).

Figure 8. Roundabout flow pattern observed at an intersection
(Taken from Helbing et al. 2001, p.371)
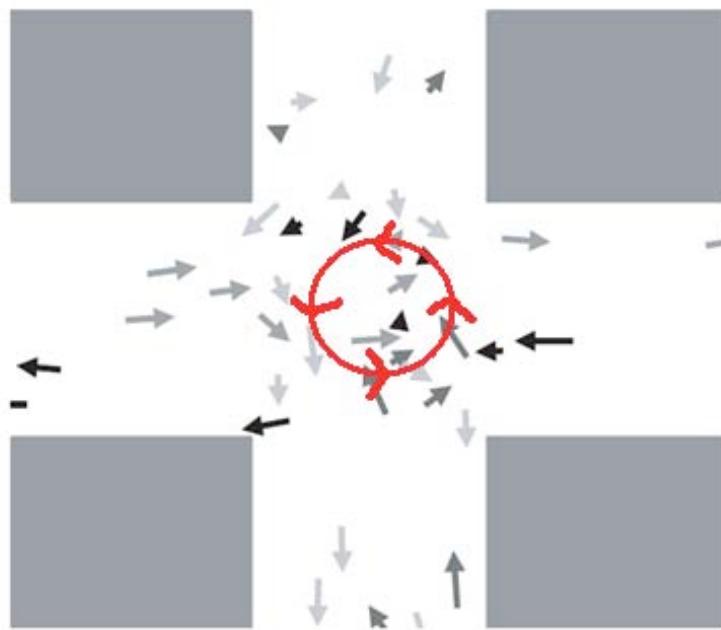
Crowd Behaviours

- Social facilitation theory (Zajonc, 1965; Cottrell, 1972) suggests that in the presence of others, individuals' performance on easy or well-learned tasks improves. This is due to increased arousal – as a result of the presence of others – driving the innate, dominant behaviours that individuals habitually perform when in a particular environment.

  - For example, crowd members will typically use the exit route with which they are most familiar, particularly during emergency situations.

  - According to social facilitation theory, this is because individuals, when in a particular environment and aroused by the presence of other crowd members, are more likely to perform their habitual behaviours, e.g., using a particular entrance and exit route.

- Social loafing theory suggests that individuals, when part of a crowd, exert less effort than when they are working alone because their efforts within a group are more anonymous (Latané, Williams &Harkins, 1979). Indeed, loafing is particularly likely when group members are strangers and, thus, do not initially identify with each other, as is typical in a crowd (Karau & Williams, 1997; Worchel, Rothgerber, Day, Hart & Butemeyer, 1998).

  - Hence, social loafers within a crowd are likely to let other crowd members make key decisions regarding movement, for example, and are happy to do as the majority do.

- A crowd's ability to spontaneously behave in a socially coherent manner without any apparent pre-planning, communication or direction can be explained by the social identity model of crowd behaviour (e.g., Reicher, 1984a, 1984b, 1987, 2001; Stott & Reicher, 1999; Drury & Reicher, 2000).

  - The theory proposes that individuals do not lose their sense of identity, but simply shift from an individual identity to a shared social identity (e.g., Reicher, 1996b, 1997a; Drury & Reicher, 1999). Accordingly, individuals do not lose control over their behaviours, but shift from behaving in terms of their individual identity to behaving in terms of the norms and values espoused by their shared social identity (Stott & Reicher, 1998a; Drury & Reicher, 2000).

  - Hence, through defining an appropriate shared identity, crowd members are able to act as a united group, in a socially coherent manner.

- o In addition, the salience of a particular social identity at a given time affects both group processes – such as cohesion and social influence – and cognitive processes – such as stereotyping, social judgement and self-perception (e.g., Turner, Oakes, Haslam & McGarty, 1994; Spears, Oakes, Ellemers & Haslam, 1997; Ellemers, Spears & Doosje, 1999).

- o Thus, at a football match, for example, crowd members will most likely identify themselves primarily as football fans, and behave according to that social categorisation. Alternatively, at a music concert, crowd members will most likely identify themselves as music fans, and behave accordingly.

- o Furthermore, even within a crowd, individuals are more likely to be influenced by, and feel attracted to, other crowd members with whom they share a social identity – i.e., members of the same psychological crowd. Conversely, individuals are less likely to be influenced by those who espouse a different social identity, whether part of the same physical – but not psychological – crowd, or whether part of a distinct group (e.g., Turner et al., 1994).

- o Therefore, if a social identity is particularly salient in a crowd, it is more likely that individuals within that crowd will form a stronger sense of cohesion as a united group and that their actions will be more influential over the crowd's behaviour as a whole. Hence, a crowd's ability to spontaneously act in a socially coherent manner.

- As an extension to the social identity model of crowd behaviour, the elaborated social identity model of crowd behaviour can be drawn upon to explain inter-group interactions (ESIM; e.g., Reicher, 1996a, 1996b, 1996c, 1997a, 2001; Stott & Reicher, 1998a; Drury & Reicher, 1999; Stott & Drury, 1999).

  - o This model proposes that the way in which one group understands a situation – and subsequently acts according to that understanding – will directly impact on the way in which another group understands and reacts to that situation, and so forth (e.g., Reicher, 1997a). Hence, interactions between a crowd and other groups – such as authorities – will influence the way in which that crowd behaves (e.g., Drury & Reicher, 2000).

  - o Conversely, although rarely mentioned in the literature, it should also hold that the actions of the crowd will influence the way in which the authorities behave.

- Similarly, this model suggests that a crowd's intentions and actions are determined by the way in which its members collectively identify themselves (e.g., Reicher, 1996a; Stott & Reicher, 1998a; Drury & Reicher, 1999, 2000; Stott & Drury, 1999). However, these actions and intentions, and their subsequent consequences, may become uncoupled.

- For example, the crowd's actions – irrespective of their intentions – may be incorrectly interpreted by another group, subsequently leading that group to react in an unanticipated way. As a result of this inadvertent interpretation and reaction, the crowd's intentions may not always be realised. Consequently, the actions of the crowd may lead to unintended consequences (e.g., Drury & Reicher, 2000).

- For instance, a crowd at a football match – who collectively identify themselves as football fans with the primary intention of simply watching the match– may act in a lively, boisterous manner as they enjoy the game. However, another group, such as the police, may – possibly as a result of prior expectations – incorrectly interpret this behaviour as being indicative of imminent crowd disorder. As a result of their interpretation, the police are likely to react as they deem appropriate, i.e., so as to minimise this imminent disorder. Thus, the football crowd's intentions are unlikely to be realised and unintended consequences arising from their initial actions – such as reacting in opposition to the police and committing disorder – may result.

- Once again, the reverse should also hold true, such that the crowd may – as a result of previous experience – incorrectly interpret the actions of the police – e.g., as being overly aggressive rather than to maintain control – and react accordingly – e.g., committing disorder.

- The social identity model of deindividuation effects (SIDE) offers an explanation for increased normative behaviours under conditions of increased deindividuation (e.g., Reicher, Spears & Postmes, 1995; Spears, 1995; Postmes & Spears, 1998).

  - The theory suggests that increased anonymity experienced when part of a crowd does not lead to a loss of identity – and, subsequently, to a loss of behavioural control – but instead decreases the salience of individual identities in favour of shared social identities (Reicher, 1984a; Reicher, Levine & Gordijn, 1998). Thus, the crowd behaves according to the norms and values espoused by the shared social identity.

  - Moreover, increased anonymity has been shown to be related to increased stereotypical behaviours – in accordance with in-group norms – particularly when individuals identify strongly with their group (e.g., Lea & Spears, 1991; Spears & Lea, 1992).

- Group-based self-categorisation – i.e., self-categorisation at the local group level rather than according to wider, pre-defined social categories (Postmes & Spears, 1998) – has been shown to increase individuals' attraction to their group. Thereby, the group's shared social identity becomes more salient and conformity to group norms is increased (Lea, Spears & de Groot, 2001).

- Certain factors can be thought of as behavioural moderators, affecting the extent to which individual crowd members are susceptible to the social influence of the crowd as a whole. These factors may be stable – i.e., they are a (relatively) fixed and unchangeable part of a given individual – or situational – i.e., their presence in a given individual varies from one situation to the next.

  - Gender, for example, is likely to influence how crowd members behave. For instance, crowds of men, or those which are male-dominated, are more likely to behave in an aggressive manner than crowds of women, or those which are female-dominated (e.g., Webb, Neale & Phillips, 1995; Knight, Fabes & Higgins, 1996).

- Specific crowd characteristics can also be used to help assess how a crowd is likely to behave (e.g., Berlonghi, 1995), including: -

  - The extent to which leadership is established. A crowd with a prominent leader figure may be more prone to antisocial tendencies. For instance, a crowd involved in a demonstration or protest typically has a clearly identifiable leader.

  - The extent of organisation within a crowd. A more organised crowd is more likely to exhibit pre-planned, antisocial behaviours.

  - How cohesive and psychologically united the crowd is. A crowd which shares a sense of social identity and cohesion is more likely to act as a united group and, therefore, may react against opposing groups.

  - Levels of volatility and emotional intensity. A crowd displaying higher levels of emotional intensity and volatility, for example during a sporting event, is more likely to behave in an undesirable manner if the outcome of the event is not as they desire.

Crowd Behaviours in Emergency Situations

- Panic in an emergency situation – typically characterised by anti-social, self-centred and irrational behaviours – is actually very rare (e.g., Sime, 1983, 1995; Johnson, 1988; Feinberg & Johnson, 2001; Fischer, 2002; Schoch-Spana, 2003; Mawson, 2005; Drury & Cocking, 2007; Cocking & Drury, 2008; Drury, Cocking & Reicher, in submission).

- Crowd behaviours during an emergency typically remain structured and organised, with helping, cooperation and coordination behaviours often displayed (e.g., Johnson, 1987; Donald & Canter, 1992; Chertkoff & Kushigian, 1999; Drury & Cocking, 2007; Cocking & Drury, 2008; Cocking, Drury & Reicher, in press; Drury, Cocking & Reicher, in press).

- Behaviours become more self-centred when time to escape is limited and, therefore, orderly evacuation is not possible (e.g., Sime, 1983, 1999; Johnson, 1998).

- Crowd members are typically motivated to move towards familiar people during an emergency (e.g., Mawson, 1978, 2005).

  o Thus, family members prefer to evacuate together as a group, and will wait to exit until all family members are able to do so (e.g., Sime, 1983; Aguirre, Wenger & Vigo, 1998; Feinberg & Johnson, 2001; Cornwell, 2003).

  o Parents are more likely to put the safety of their children before their own (Still, 2000).

  o However, the drawback of this is that families may be slower to begin evacuation which, ultimately, can threaten their survival (Mawson, 2005).

  o Similarly, groups of friends prefer to evacuate together and remain united as a group (e.g., Sime, 1983; Johnson, 1988) which, once again, reduces the rate of evacuation as compared to that of individuals.

- In addition, during an emergency situation, crowd members are also typically motivated to move towards familiar places (e.g., Mawson, 1978, 2005).

- o For example, individuals prefer to leave by a familiar route – i.e., the way they came in – as opposed to an emergency exit (e.g., Sime, 1983, 1985; Johnson & Feinberg, 1997; Benthorn & Frantzich, 1999; Pelechano & Malkawi, 2008).

- Individuals' choice of escape route is also influenced by the actions of their fellow evacuees – e.g., people typically move in the same direction as others during an emergency (e.g., Sime, 1983; Lo, Fang, Lin & Zhi, 2004; Yang, Zhao, Li & Fang, 2005; Lo, Huang, Wang & Yuen, 2006; Zhao, Yang & Li, 2008).

- Social, organisational and place-related norms appear to be maintained during an evacuation (e.g., Best, 1977; Canter, Breaux & Sime, 1980; Donald & Canter, 1992; Aguirre, 2005). For instance, gender roles are typically retained, with women generally receiving more help than men, and more men than women typically offering to help (e.g., Johnson, 1987; Johnston & Johnson, 1988; Johnson, Feinberg & Johnson, 1994).

- When united by an emergency situation, a physical crowd – i.e., a group of individuals in the same location, each with his or her own personal identity – may be transformed into a psychological crowd – i.e., a group of people united by a common social identity as members of a particular category (e.g., Reicher, 2001; Drury & Cocking, 2007; Cocking & Drury, 2008).

- This shared social identity then enables crowd members to act as a source of strength for one another and exhibit collective behaviours – i.e., coordination, cooperation, helping behaviours and personal sacrifices (e.g., Johnson & Feinberg, 1997; Levine, Prosser, Evans & Reicher, 2005; Raphael, 2005; Drury & Cocking, 2007; Cocking & Drury, 2008; Cocking et al., in press; Drury et al., in press).

- Three key factors are involved with the evacuation process: 1) interpretation; 2) preparation; and 3) action (e.g., Canter, Breaux & Sime, 1990; Cepolina, 2005). All three factors must be considered when preparing for a crowd event and when constructing emergency evacuation plans.

- Thus, evacuation time concerns the time taken to initiate movement – that is, the time taken to recognise there is a danger (i.e., interpretation) and to then decide which is the most appropriate course of action (i.e., preparation) – and the time taken for individuals to actually move towards an exit (i.e., action) (e.g., Kimura & Sime, 1988; Johnson & Feinberg, 1997; Graat, Midden & Bockholts, 1999).

- Accurate interpretation during an emergency situation is particularly critical, and is heavily influenced by the quality and accessibility of communication (e.g., Drury & Cocking, 2007; Cocking & Drury, 2008).

- Communication and provision of information about the threat, along with clear instructions about how to exit, are vital to initiate crowd movement and enhance the efficiency of an emergency evacuation (e.g., Johnson, 1988; Johnston & Johnson, 1989; Proulx & Sime, 1991; Proulx, 1993; Johnson & Feinberg, 1997; Muir, 2004; Raphael, 2005; Ripley, 2005; Drury & Cocking, 2007; Cocking & Drury, 2008; Cocking et al., in press).

> *"If you're by yourself, you'll generally make a right decision given the right information. The problem with crowds is that if you're surrounded by other people, your visual information may be reduced, your auditory information may be reduced, you may not know the venue or site you're on, and you are unlikely to know everything about an incident."*
>
> Simon Ancliffe
> Movement Strategies

- Providing more, rather than less, information about the nature of the threat or emergency should help the crowd respond more effectively (e.g., Proulx & Sime, 1991; Wessely, 2005; Cocking et al., in press)[5]. Withholding information only serves to increase the crowd's mistrust of authorities, which decreases evacuation efficiency (Drury & Cocking, 2007).

- In order to be believed and interpreted accurately, warnings must be specific, timely, historically valid, credible, comprehensible, and convey the nature and extent of the danger (e.g., Proulx & Sime, 1991; Sime, 1999; Dombroski, Fischhoff & Fischbeck, 2006).

- Warnings must also be visual and audio – sirens alone are insufficient (e.g., Proulx & Sime, 1991; Benthorn & Frantzich, 1999; Sime, 1999).

- Delaying warnings or telling a crowd "not to panic" – for fear of causing panic – merely delays emergency evacuation and increases levels of anxiety, which ultimately, may increase the risk of causalities (Proulx & Sime, 1991; Sime, 1994, 1999; Durodié & Wessely, 2002; Mawson, 2005).

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[5] See Understanding Crowd Behaviours: Supporting Evidence, Footnote 11, page 151, for a possible exception to this advice.

- Individuals trained for an emergency, or familiar with how to behave in an emergency situation, should be able to react and respond more quickly (Donald & Canter, 1990). The evacuation process can be improved by regularly practicing evacuations (Fahy & Proulx, 2002; Drury & Cocking, 2007).

- Leader figures – either from the authorities or from within the crowd itself – play an important role in the evacuation process. Individuals who are clearly told or shown what to do by a leader figure, are likely to respond in a more timely and appropriate manner, since communication lessens the uncertainty of the situation (Donald & Canter, 1990; Aubé & Shield, 2004; Dyer et al., 2008).

- The relatively rare occurrence of emergencies means that individuals are typically unfamiliar with the most appropriate forms of action in such situations. People are predisposed to believe a situation is normal for as long as possible, and so behave as usual for as long as possible, thereby delaying evacuation (e.g., Donald & Canter, 1990, 1992; Yoshida, 1996; Proulx & Reid, 2006).

- This behavioural tendency can be explained by place scripts theory, which suggests that individuals develop and follow scripts or schema – i.e., sequences of behavioural patterns in which they automatically engage when in a familiar environment – which become ingrained and remarkably resistant to change, even in emergency situations (Donald & Canter, 1992).

  - Therefore, clear information and specific instructions are needed for individuals to override their schema and evacuate as appropriate (Donald & Canter, 1990, 1992).

  - Strong leadership is essential to initiate crowd movement, through exhibiting appropriate evacuation behaviours which crowd members can observe and replicate (e.g., Aubé & Shield, 2004; Dyer et al., 2008).

- Additional factors which may influence evacuation rate include (e.g., Sime & Proulx, 1991; Sime, 1992a, 1992b, 1994; Still, 2000): -

  - Mobility – i.e., an individual who is less mobile is likely to need longer to evacuate in an emergency.

  - Physical position in the environment – i.e., an individual lying down is likely to have a slower rate of reaction and movement than an individual standing up.

  - Density of the crowd – i.e., crowd movement will be slower in a more densely packed environment.

- Alertness – i.e., an individual who is less alert, for instance as a result of tiredness or intoxication, is likely to react more slowly in the event of an emergency.

- Visibility of exit routes and emergency exit signs – i.e., the more visible the signage and emergency exit routes, the more attractive they are likely to be to crowd members and the more likely – and at higher speed – crowd members are to follow those routes.

- Complexity of the environment – i.e., the more complex the environment, the more indecisive individuals are likely to be and the longer it is likely to take to evacuate.

- When individuals compete with others crowd members to evacuate through a particular exit, inefficient evacuation or non-adaptive behaviours often result (e.g., Muir, Marrison & Evans, 1989; Muir & Cobbett, 1996; Pan, Han & Law, 2005; Pan et al., 2006, 2007).

Figure 9. Competitive crowd behaviour
(Taken from Pan et al., 2007, p.127)
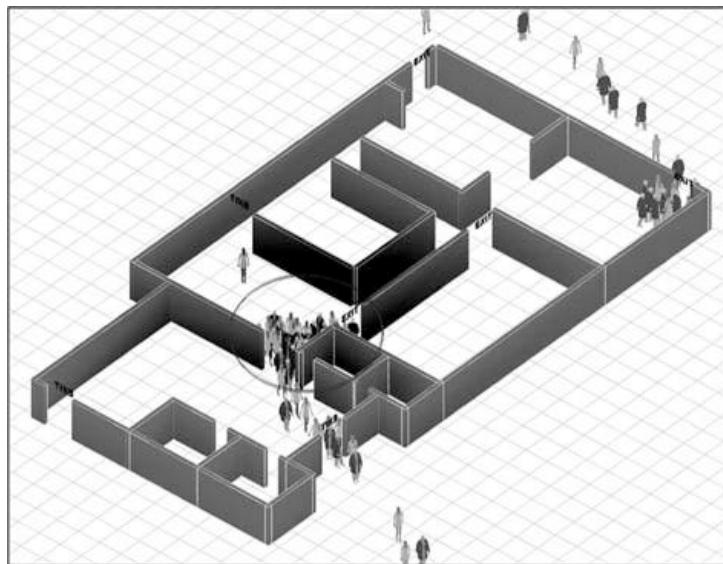
- If an evacuation route is obstructed by other crowd members, individuals may initiate a queue or join an existing queue. A more effective evacuation, as a result of crowd members leaving in an orderly and single-file manner rather than exhibiting competitive behaviour, is often achieved (e.g., Pan et al., 2005; Pan et al., 2006, 2007). This is demonstrated in Figure 10 (overleaf).

Figure 10. Queuing behaviour
(Taken from Pan et al., 2007, p.128)
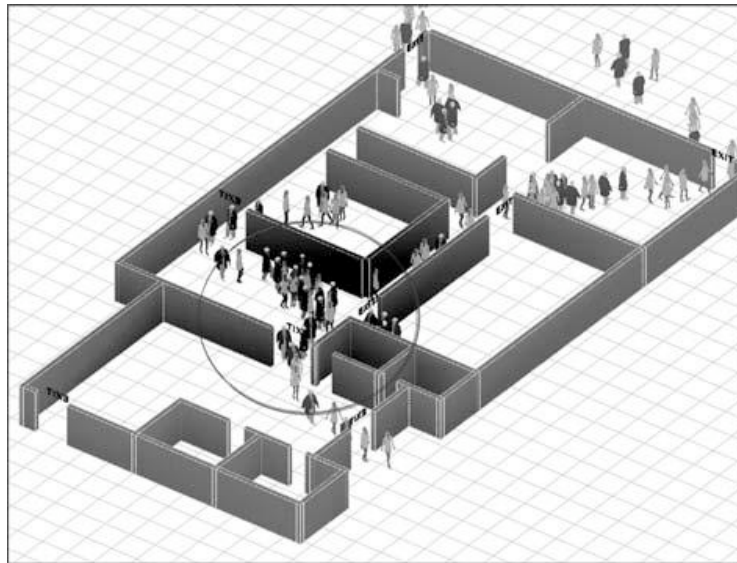
- Alternatively, during an evacuation, one exit may become clogged whilst another exit is highly underused, because crowds typically prefer to use the exit with which they are most familiar (e.g., Low, 2000; Pan et al., 2005; Pan et al., 2006, 2007). This phenomenon is known as 'herding' behaviour.

Figure 11. Herding behaviour
(Taken from Pan et al., 2007, p.128)
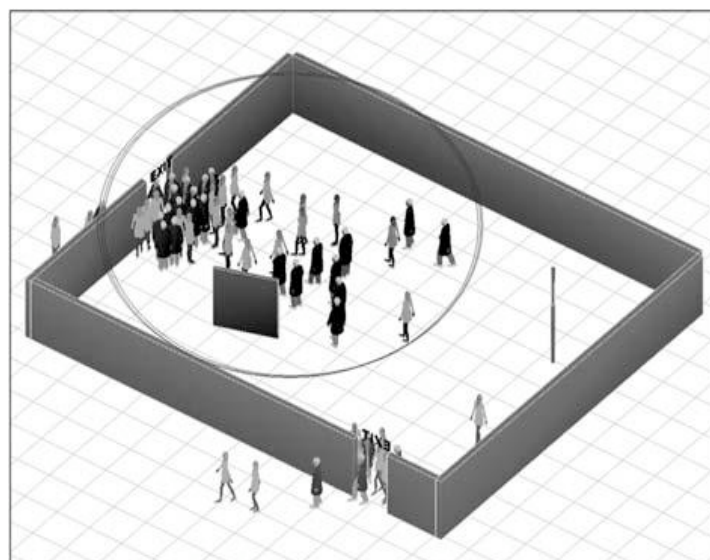
Crowd Disorder

- One perspective put forward in relation to crowd disorder suggests that, when individuals come together as a crowd, a sense of 'mob mentality' is often created. Under the 'cover of the crowd', these individuals – who are predominantly law-abiding when acting alone – feel a sense of empowerment to commit disorder or incite disorder in others.

> *"Something happens to make these people empowered and emboldened."*
>
> Temporary Assistant Commissioner
> Chris Allison
> Metropolitan Police

- This phenomenon can be explained by de-individuation theory (Festinger, Pepitone & Newcombe, 1952), which proposes that, as anonymous members of the crowd, individuals lose their sense of self-awareness, self-observation, self-responsibility and individualised identity (e.g., Duval & Wicklund, 1972; Diener, 1980; Prentice-Dunn & Rogers, 1982, 1989). This results in weakened moral restraints (e.g., Zimbardo, 1970) and increased susceptibility to environmental cues and the crowd's emotions (e.g., Diener, 1979, 1980; Diener, Luck, DeFour & Flax, 1980). Ultimately, this leads to unsocialised and antisocial behaviours (e.g., Festinger et al., 1952; Singer, Brush & Lublin, 1965; Zimbardo, 1970; Zimbardo, Haney, Banks & Jaffe, 1982; Mann, Newton & Innes, 1982).

- This sense of anonymity is heightened – and, therefore, antisocial behaviour is more likely to occur – in the dark, in larger crowds and when the physical distance from the opposing group is increased (Diener et al., 1980; Mann, 1981; Mullen, 1986).

> *"People use the cover of the crowd to do stuff that they would never have the bottle to do as an individual, but when they were in that crowd they felt they had the power to do it, they had the mentality, they were willing to take a step further."*
>
> Temporary Assistant Commissioner
> Chris Allison
> Metropolitan Police

- Alternatively, the antisocial behavioural tendencies of crowds could be explained by emergent norm theory (e.g., Turner & Killian, 1957, 1987), which suggests that crowd behaviours are governed by norms which emerge from the distinctive actions – i.e., rare actions, such as antisocial behaviours – of prominent crowd members. As more members adhere to these norms, they become more influential and pressure to behave in an antisocial manner increases.

- Male-dominated crowds have been shown to display more aggressive behaviours in comparison to female-dominated crowds (Webb et al., 1995).

- Intoxication, considered to be a situational moderator of a crowd's social influence on crowd members' behaviour, is also highly influential over the levels of antisocial behaviour within a crowd. For instance, increased levels of intoxication have been shown to be associated with increased levels of aggression and violence (e.g., Tomsen, 1997; Moore, Flajslik, Rosin & Marshall, 2008), possibly as a result of the masculine social identity becoming more prevalent under the influence of alcohol, or due to a perceived invasion of personal space, resulting from increased collisions. In addition, increased intoxication is also associated with decreased physical stability of the crowd as a whole, since more intoxicated individuals are more likely to stumble or collide with other crowd members (Moore et al., 2008).

- The impact of interactions between crowds and other groups, such as the police, on crowd behaviours – and the tendency for conflict in particular – can be explained by the elaborated social identity model of crowd behaviour (ESIM; e.g., Reicher, 1996a, 1996b, 1996c, 1997a, 2001; Stott & Reicher, 1998a; Drury & Reicher, 1999; Stott & Drury, 1999).

- Indeed, there is plentiful evidence in support of the ESIM, from studies of crowd events including football hooliganism, (e.g., Stott & Reicher, 1998b; Stott, Hutchison & Drury, 2001; Van Hiel, Hautman, Cornelis & de Clercq, 2007; Stott, Adang, Livingstone & Schreiber, 2008a), disorder at public demonstrations (e.g., Reicher, 1996a, Drury & Reicher, 1999; Stott & Drury, 1999, 2000) and mass environmental protests (e.g., Drury & Reicher, 2000).

- ESIM proposes that social identity should be defined in terms of social positioning – i.e., an individual's position in a set of social relations within a given society or culture (Drury, Reicher & Stott, 2003a). During a crowd event, the social position of crowd members will change, as a result of interactions between the crowd and external groups. This change in social positioning should lead to a change in the crowd's shared social identity, given that the latter is defined in terms of the former (Drury et al., 2003a). Subsequently, this should lead to a change in the behaviours endorsed and undertaken by the crowd (e.g., Drury & Reicher, 2000, 2005; Polletta & Jasper, 2001).

- Thus, if there is an imbalance between the way in which the crowd and the police perceive the crowd's social position – e.g., if the police perceive the whole crowd to be troublesome whereas the crowd perceive themselves to be peaceful protesters – conflict is more likely to result (e.g., Drury & Reicher, 2000, 2005; Drury et al., 2003a; Drury, Stott & Farsides, 2003b; Drury & Winter, 2004; Waddington, 2007).

- The theory also suggests that the way in which one group understands the situation – and subsequently acts according to that understanding – will directly impact on the way in which another group understands – and reacts to – the situation, and so forth (e.g., Reicher, 1997a).

- Hence, conflict is also more likely if the police not only view the whole crowd as troublesome but treat them as such. The crowd, perceiving their treatment by police to not only be illegitimate but also indiscriminate, may come to adopt a more inclusive self-categorisation and form a united mass, overpowering any previous barriers between differing groups within the crowd – most notably the peaceful majority and the troublesome minority (e.g., Drury & Reicher, 2005; Drury, Cocking, Beale, Hanson & Rapley, 2005). Consequently, the united crowd will feel empowered to act against the police and express hostility and antisocial behaviours (e.g., Stott & Reicher, 1998a; Drury & Reicher, 1999, 2005; Stott & Drury, 2000).

- Therefore, the perception of the police may become self-fulfilling – i.e., in perceiving and treating the whole crowd as troublesome and, thereby, acting to prevent disorder, the police may actually serve to create disorder (Drury et al., 2003a; Stott & Adang, 2003, 2004; Stott, Adang, Livingstone & Schreiber, 2007).

> *"Outsiders' fears of violence lead them to react in ways that antagonises everyone and create the condition where people who want to have a fight become more influential, people listen to them more."*
>
> Professor Stephen Reicher
> University of St Andrews

- The risk of conflict may be reduced by using low-profile and information-led policing based on the crowd's actual behaviour as opposed to heavy handed tactics based on prior expectations and assumptions of violent intentions (e.g., Stott & Adang, 2003, 2004; Stott et al., 2006, 2007, 2008a; Stott, Livingstone & Hoggett, 2008b). Moreover, conflict may be minimised if the police attempt to differentiate between individuals behaving legitimately and illegitimately, and to treat each accordingly (e.g. Adang, 2003; Stott & Adang, 2003; Adang & Stott, 2004).

- Crowds may also display 'self-policing' behaviours, wherein – provided they perceive police actions to be legitimate – the majority attempt to maintain their non-confrontational, non-violent social identity by differentiating and marginalising inappropriate behaviour from the hooligan minority (e.g., Stott et al., 2007; Waddington, 2007; Stott et al., 2008b).

- Further factors, which may act as catalysts to turn a manageable, well-behaved crowd into an unruly, uncontrollable crowd (Berlonghi, 1995), in addition to those concerned with anonymity, social conformity, gender, intoxication, social identity and social interactions mentioned above, include: -

    o Operational circumstances, such as lack of parking or event cancellations.

    o Event activities, including loud noises or special effects.

    o Performers' actions, for instance, violent or offensive gestures towards the crowd.

    o Spectator factors, including drinking alcohol, cheering, or throwing objects.

    o Social factors, such as rioting, gang activities or racial tension.

    o Weather conditions, including rain, heat, humidity or lack of ventilation.

    o Natural disasters, such as floods, earthquakes or tornadoes.

Improving Crowd Management and Control

In accordance with the information gained from the expert interviewees, in addition to the wealth of literature reviewed, the following factors appear to be critical in enhancing the efficiency and success of crowd management and control: -

- Crowd management – i.e., the facilitation of crowd movement and activities – is preferable to crowd control – i.e., the actions taken to control the crowd once behaviours become undesirable (e.g., Sime, 1999; Stanton & Wanless, 1995).

- Safety demands – i.e., crowd management – should be seen as equal in priority to security demands – i.e., crowd control (Sime, 1995). Authorities should aim to facilitate the crowd's needs and expectations, rather than simply trying to control it.

- Thorough planning and preparation is essential. This should include careful consideration of the event type, the act profile, the likely crowd composition, the event location and timings, how the event will be publicised and which agencies need to be involved. Additionally, preparation should cover what the aims and objectives of the event are, what a successful event should look like, what resources will be needed to achieve this success, what problems could potentially arise, and what contingencies need to be implemented to deal with those problems should they arise.

> *"Preparation! Preparation! Preparation!"*
>
> Professor Keith Still
> Crowd Dynamics

> *"A big part of crowd management is about knowing your crowd and that comes by pre-planning and...doing that research on the crowd, seeing what happens and going to other venues to see how the crowd reacts."*
>
> Sue Storey
> Emergency Planning Manager
> Nottinghamshire County Council

- However, it is important to be aware of prior expectations and assumptions about likely crowd behaviours, based on anticipated crowd profile, biasing judgements on the day of the event. Each event and crowd should be assessed on its own merits – i.e., consider preconceptions carefully but do not let them colour judgement.

- Police intelligence surrounding the event, indicating the likely crowds it will attract and the potential for disorder, should be drawn on throughout the planning and preparation stages.

- Avoid becoming complacent – just because an event was successful in previous years or in a different location, does not automatically mean it will be a success in the future. Thorough planning and preparation is still needed.

- The event should be considered from a system-wide perspective, taking into account not only the event itself, but also potentially influential factors in the surrounding area.

- "What if...?" scenarios should be used throughout the preparation process, to consider management strategies and contingency plans to deal with potential problems which may arise.

> *"Information is actually one of the greatest assets."*
>
> Edward Grant
> Senior Lecturer in Events Management
> University of Derby

- The event site should be visited prior to the event and again on the day of the event, to thoroughly assess the geography of the location, its capacities and to determine where potential hazards and areas of trouble, such as crowd congestion and reduced rates of flow, could be.

- Careful consideration should be given to the location of crowd facilities – such as toilets and concession stands – in order to make them easily accessible, and also to the positioning of barriers, to ensure they assist with crowd management rather than causing obstructions.

- A multi-agency approach, drawing on the expertise and perspectives of a wide range of individuals – i.e., police, fire and ambulance services, local authorities and event organisers – should be used, in order to assess and manage the event from multiple perspectives. Agency personnel should aim to work together from the initial stages of the project, in order to develop trust and enhance team solidarity.

> *"If you haven't got the right people involved at the right time, no amount of money is going to rescue you."*
>
> Edward Grant
> Senior Lecturer in Events Management
> University of Derby

- Using personnel with first-hand experience in planning for and managing crowd events, and drawing on their knowledge and understanding of how particular crowds are likely to behave, is critical.

> *"There's definitely a skill there. Some of the police, particularly, that I work with and some of the safety officers have this amazing knack of saying 'get that bloke in the yellow shirt out because if he starts again this crowd is going to go'...and they know instinctively. They can view a crowd and pick out who's the ring leader, and they'll eject that person and it'll just calm it straight down."*
>
> Sue Storey
> Emergency Planning Manager
> Nottinghamshire County Council

- A solid command and control structure should be in place, to oversee and coordinate all activities throughout an event (e.g., Fennell, 1988; Taylor, 1990; Dickie, 1995; Sime, 1995; Langston, Masling & Asmar, 2006).

- All parties involved must be aware of their roles and responsibilities before, during and after the event under both normal and emergency conditions (e.g., Fennell, 1988). They must also be aware of the roles and responsibilities of other agencies, and understand how the actions of one party may impact on the actions of another party.

- All personnel must also be flexible, in order to deviate from the original plan and implement contingencies if needed (e.g., Scraton, 1999).

- Means of controlling crowd flow and density distribution – for instance by continually stewarding and directing the crowd – is vital to avoid overcrowding and its potential consequences (e.g., Pauls, 1984; Fruin, 1985, 1993; Dickie, 1995; Sime, 1995).

- Accurate, timely and comprehensive communication with the whole crowd, both audio and visual, and before and during the event, is vital for a successful event (e.g., Pauls, 1984; Fennell, 1988; Johnson, 1988; Johnston & Johnson, 1989; Proulx, 1993; Johnson et al., 1994; Sime, 1995; Raphael, 2005).

- Information communicated to – or withheld from – the crowd can influence their behaviour, hence communicating with the crowd is essential in maintaining order and managing behaviour (e.g., Proulx & Sime, 1991; Wessely, 2005; Drury & Cocking, 2007).

> *"Every human endeavour stands or falls by communication."*
>
> Superintendent Roger Evans
> Metropolitan Police

- Communication from stewards is often the most effective and most well received, as crowd members perceive stewards to be most similar to themselves, as opposed to police or other authority figures (i.e. 'us' versus 'them' mindset).

- Understanding the crowd's identity, given that their behaviour is influenced by that identity, is important to facilitate crowd management (e.g., Reicher, 1996b; Raphael, 2005).

> *"Every crowd is different, but if you understand it you're more able to manage it and cope with it in a more effective way."*
>
> Temporary Assistant Commissioner Chris Allison
> Metropolitan Police

- It is important to remember that the crowd is not a homogenous mass, but a collection of smaller crowds and individuals with their own needs, wants and expectations, which need to be managed (e.g., Reicher, 2001).

- Prior expectations and assumptions about crowd behaviours can be very dangerous (e.g., Taylor, 1990; Lea, Uttley & Vasconcelos, 1998; Scraton, 1999). Each crowd should be treated in accordance with its actual behaviour at the event (e.g. Stott & Adang, 2003, 2004).

- The way in which authorities, such as the police, react towards and treat a crowd will impact on how the crowd behaves (Drury & Reicher, 2000; Stott & Drury, 2000; Drury & Stott, 2001; Drury et al., 2003b). Distinct groups within the crowd should be differentiated and treated appropriately, in order to minimise risks of disorder (e.g., Adang, 2003; Stott & Adang, 2003; Adang & Stott, 2004).

- The extent to which authority figures, such as the police, and security personnel are visible during an event should be appropriate to the event type and crowd profile.

- Multiple forms of crowd monitoring, looking for signs of imminent trouble or disaster, should be used to continually monitor and observe the crowd.

- Response to the signs of an imminent emergency should be immediate (e.g., Borodzicz, 2005) and the seriousness of the situation should never be underestimated (e.g., Canter, Comber & Uzzel, 1989).

- A debrief of some sort should always take place at the end of a crowd event, to examine what was successful, what went wrong, and what changes can be made for future events. If an event is occurring over several days, a debrief should take place at the end of each day so that necessary changes can be implemented for the following day. Actions and lessons identified should be transferred into policy and disseminated to all involved.

- Evacuation training and crowd management training are important (e.g., Fennell, 1988; Donald & Canter, 1990; Aubé & Shield, 2004).

- The key risks involved with crowd events, which can be controlled by event planners and managers, include insufficient preparation, lack of experienced personnel, lack of familiarity with the event, and an ineffective control system.

- Based on the assumptions made about crowd behaviours, the literature proposes that the following techniques can be implemented in order to improve crowd flow: -

  o A separate door for entry and exit should be used to separate opposing crowd flows (e.g., Helbing et al., 2001; Helbing & Molnár, 1997).

  o A series of obstacles – such as railings, trees or columns – placed centrally along the length of a space (open or enclosed), can be used to act as wave breakers, preventing large crowd pressures building up and encouraging lane formation (Helbing et al., 2005). Obstacles such as these are flexible but have the same psychological and physical effects as a separating wall. However, the resulting walkways along either side of the divide must still be of sufficient width to accommodate crowd flow.

Figure 12. Appropriately placed columns to encourage lane formation
(Taken from Helbing et al., 2005, p.14)

  o Ensure exits are wide enough to accommodate groups of people, so as to prevent the group having to disperse upon exiting and, subsequently, having to wait for all group members before leaving (Pan et al., 2006).

  o Line-of sight paths should be made as long as possible, allowing individuals to see their destination and, thereby, more likely to choose the most direct route and to move quickly (e.g., Hillier, Penn, Hanson, Grajewski & Xu, 1993; Davies, Yin & Velastin, 1995; Notake, Ebihara & Yashiro, 2001).

  o Corners in corridors should be rounded, rather than angular, and obstacles smoothly contoured (e.g., Davies et al., 1995).

- o Pushing and shoving from the rear of a crowd – where people are unaware of what is happening at the front of the crowd – should be prevented by ensuring communication is adequate, with information visible to all crowd members and not just those at the front (Pan et al., 2006).

Methods of Crowd Simulation

Methods of Crowd Simulation

- There are two main types of model for simulating crowd movement detailed in the literature: -

    o Macroscopic

    o Microscopic

- Macroscopic level models focus on the model system as a whole and concern collective observable behaviours which emerge from the crowd, e.g., the behaviour of the crowd as a whole (e.g., Yamori, 1998; Pelechano & Malkawi, 2008).

- Microscopic level models focus on the individual level and concern the behaviour, actions and decisions of individuals within the crowd and their interactions with others (e.g., Courty & Corpetti, 2007; Pelechano & Malkawi, 2008).

- Utilising a combination of both macro and micro levels is reported to be most beneficial (e.g., Yamori, 1998; Tecchia, Loscos & Chrysanthou, 2002; Zarboutis & Marmaras, 2007) since it enables valuable knowledge about the patterns of individuals' behaviours to be examined, which subsequently leads to the emergence of particular phenomena in the overall system. In other words, modelling the movements of individual agents should help uncover how the crowd moves as a whole.

Macroscopic Models

These include: -

Regression Models

- These predict pedestrian flow under specific circumstances, dependent on the infrastructure (e.g., stairs, corridors), from statistically established relations between flow variables (e.g., Milazzo, Rouphail, Hummer & Allen, 1998).

  - For example, simple spreadsheet models are an incredibly useful means of measuring and predicting flow variables such as ingress and egress rates, flow rate, speed of movement, and density.

Route Choice Models

- These describe pedestrian way-finding, based on the premise that pedestrians chose their route in order to maximise utility, in terms of travel time, effort, comfort, etc (e.g., Hoogendoorn & Bovy, 2003).

Fluid Dynamics or Gas Kinetics Models

- These describe the movement of individuals within a crowd as being continuous and fluid-like – analogous with fluid or gas dynamics – with changes in density and velocity over time (e.g., Henderson, 1971; Takimoto & Nagatnai, 2003).

- More precisely, Hughes (e.g., 2000, 2002, 2003) likens the flow of a crowd to that of a fluid, but with the addition that crowd members have the ability to think rationally, and to behave in a rational and goal-directed manner (e.g., Lee & Hughes, 2007).

Microscopic Models

These include: -

Rule-Based Models

- For example, Reynolds' (1987, 1999) 'boids' model.

- This likens crowd behaviours to the movement of flocking birds, underpinned by rules of separation, alignment, cohesion and avoidance.

Social Forces Models

- For example, Helbing et al. (2000a, b) and Helbing, Farkas, Molnár and Vicsek (2002).

- Each individual is represented by a self-driven particle subject to social and physical forces. Accordingly, individuals – each with a certain mass – like to move in a certain direction at a certain speed, adapting their velocity within a certain time period, whilst keeping their distance from other individuals and obstacles.

Cellular Automata Models

- For example, Blue and Adler (2000) Wąs (2005), Yang et al. (2005), Dudek-Dyduch and Wąs (2006) and Yamamoto, Kokubo and Nishinari (2006, 2007).

- These divide the environment into a uniform grid of discrete cells, with agents able to move between unoccupied neighbouring cells.

Agent-Based Models

- For example, Epstein and Axtell (1996), Johnson (2001), Bonabeau (2002), Sanchez and Lucas (2002), Wong and Luo (2005) and Bandini, Federici, Manzoni and Vizzari (2006).

- These are the most complex and realistic of the simulation models, wherein a system (i.e., environment) is modelled as a collection of intelligent, autonomous, decision-making entities known as 'agents' (Bonabeau, 2002).

- Each agent is capable of perceiving and assessing its environment, generating intentions, making independent decisions and performing rational, realistic behaviours according to various sets of underlying simulation rules (e.g., Epstein & Axtell, 1996; Fraser-Mitchell, 1999; Musse & Thalmann, 2001; Bonabeau, 2002; Feng & Liang, 2003; Treuille, Cooper & Popovic, 2006; Pelechano, Allbeck & Badler, 2007; Durupinar, Allbeck, Pelechano & Badler, 2008).

- Individual attributes, such as age, gender, mobility, size and walking speed can also be assigned to agents – in both a random and specified manner – so as to best represent the population to be modelled (e.g., Musse & Thalmann, 2001; Villamil, Musse & Luna de Oliveira, 2003; Sung, Gleicher & Chenney, 2004; Sakuma, Mukai & Kuriyama, 2005; Shao & Terzopoulos, 2005, 2007; Paris, Donikian & Bonvalet, 2006).

- According to Bonabeau (2002), the benefits of agent-based modelling over other approaches are its abilities to: -

  - o Capture emergent phenomena – i.e., events or actions which arise from the interactions of individual agents.

  - o Provide a natural description of the system – i.e., a more realistic representation of the environment.

  - o Be flexible – i.e., altering the underlying rules to test out varying situations *in silico*.

- Agent-based modelling is particularly beneficial in situations involving (e.g., Bonabeau, 2002): -

  - o Heterogeneous populations, i.e., when all individuals within that population (potentially) differ.

  - o Complex human behaviours, such as learning or adaptation.

  - o Complex, non-linear, discontinuous or discrete interactions between agents, e.g., when the actions of one agent have a dramatic impact on the actions of another agent, such as when part of a crowd.

  - o Pre-determined environmental space and non-fixed agent positions, such as evacuation from a building.

- In theory, agent-based models should – by definition – outperform the other types of model discussed above (e.g., Berrou, Beecham, Quaglia, Kagarlis & Gerodimos, 2005) by their abilities, for instance, to: -

  o Predict crowd flow and travel time in bottlenecks.

  o Form more realistic estimates of size and shape of queues at congestion points.

  o Simulate crowd flows merging together during evacuation scenarios.

  o Simulate cross-flows and counter-flows in crowd movements.

  o Understand the distribution of individual travel times, as opposed to the mean (i.e., average travel time).

  o Map accurately space utilisation, density and speed as a function of time.

- Crowd behaviours should be modelled at three levels to mirror the behaviours of a crowd in reality (Pan et al., 2006, 2007), namely: -

  o The individual level.

  o Interactions between individuals.

  o The group level.

- The physical forces within a crowd – i.e., pushing and shoving – have a direct impact on movement and behaviour and, therefore, should be an integral part of any simulation model (Henein & White, 2005, 2007). These forces occur for a reason, are directed and location specific, propagate through the crowd like a shockwave and, once exerted, are typically out of an individual's control, thereby carrying dangerous consequences (Fruin, 1993; Henein & White, 2005, 2007).

Simulation Tools

- The most realistic simulation tools currently available on the market comprise agent-based models, and are populated by intelligent, autonomous agents, capable of making independent decisions and reacting to environmental conditions[6].

- Real-time observations of crowds and how they move, in addition to talking to 'experts' involved with crowds first-hand on a regular basis, is vital to develop a realistic simulation model.

- Simulation tools can be used to assist with issues such as design, safety and security, and strategic planning, for market sectors including transport, retail, sports and public realm.

- The principle of least effort appears to be the most utilised algorithm underpinning agent movement in simulation tools, where agents move so as to minimise time, costs and congestion whilst maximising speed.

- 3D software tools offer the most realistic visualisation of an environment.

Figure 13. Screenshot from a Legion 3D visualisation
(Taken from http://www.legion.com/news/3Dstory.php)

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[6] However, it is important to acknowledge that other modelling techniques – whilst being less realistic and less able to mimic the behaviour of crowds in real life – are still valuable and can provide useful information about alternative aspects of crowd behaviour, such as flow rate and density.

- Different types of crowd, with different characteristics – for instance commuter crowds, tourist crowds and evacuation crowds – are acknowledged within higher level simulation tools – such as Legion – based upon observations and experience rather than research literature.

- However, there does not appear to be a set number of crowd types in each simulation tool, but rather the characteristics of key crowd types can be modified to accommodate the type of crowd required.

- Similarly, there does not appear to be a set number of crowd member types in the simulation tools currently available on the market. Instead, simulation tools appear flexible and able to accommodate differing kinds of crowd member.

- Agents can be assigned individual attributes – such as size, gender, age, luggage, walking speed, disabilities, and familiarity with the environment – in both a random and specified manner, dependent on the particular population to be modelled.

- Assumptions are made regarding likely crowd behaviours in particular environments – based on observations and experience of crowds – such as how early crowds will arrive for an event, at what speed and in which direction individuals are likely to move, and where people are most likely to congregate. There does not appear to be a fixed number of rules underpinning crowd behaviours, but rather simulation tools appear flexible and able to adapt in order to accommodate anticipated crowd behaviours in specific circumstances.

- Whilst well designed simulation tools can be very useful to assist with the preparation and management of a crowd event, it is important to recognise that simulations are not the reality of a situation and do not provide any definitive answers. Therefore, preparations should not rely solely on crowd simulations; instead, simulations should form a part of the overall preparation process.

> *"Simulations alone are not the means to an answer. They are visualisations of how the movement pattern you have assumed with the demand you have assumed through an environment that you have assumed represents reality."*
>
> Simon Ancliffe
> Movement Strategies

- Simulation tools are continually being validated by observing and analysing crowd events.

- A key weakness of current simulation tools is the vast amount of time and computing power they require.

Future Models of Crowd Behaviours

We believe that the next generation of simulation tools to model crowd behaviours should ideally aim to[7]: -

- Include more psychological aspects of human behaviour, such as memory, emotions and stress.

- Improve the realism and accuracy of crowd behaviours and movement, in addition to improving visual aesthetics.

- Consider the impact of contact between crowd members, such as pushing or falling over.

- Realistically simulate communication between crowd members and the impact this has on crowd behaviours.

- Design simulations which acknowledge that crowd members are unlikely to have complete information about, or a complete understanding of, their environment and, therefore, may choose to explore.

- Consider interactions between crowds and other groups, such as the police or stewards.

- Simulate how groups, e.g., families or groups of friends, behave in a given environment, incorporating the role of psychological 'groupness', i.e., a strong sense of shared social identity.

- Include multi-purpose behaviours, i.e., behaviours undertaken during a crowd event – such as stopping to look in a shop window or taking a rest – which have purposes additional to the primary purpose of attending the event itself.

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[7] These areas reflect the directions that we, as organisational psychologists, believe the next generation of simulation tools should be aiming to take. However, we fully acknowledge that this may not be the opinion of all individuals experienced with using simulation tools.

THE NEED FOR A SYSTEMS APPROACH

The Need for a Systems Approach

- This section describes why we believe it is necessary to adopt a systems approach to the study and management of crowds.

- More specifically, this section will: -

    o Outline the key principle of socio-technical systems theory

    o Discuss why it is important to adopt a system-wide view

Socio-Technical Systems Theory

Socio-Technical Systems Theory

- When designing any new organisational system, socio-technical systems theory (e.g., Cherns, 1976, 1987) argues that it is critical to focus jointly on A and optimise A both technical and social factors as early in the process as possible.

> *..the design and performance of new systems can be improved, and indeed can only work satisfactorily if the and treated as interdependent aspects of a work system.*
>
> (Clegg, 2000, p.464)

- Thus, an organisation can be thought of as comprising a wide range of interrelated factors, all in a state of dynamic interplay (Clegg & Shepherd, 2007).

  - For instance, an organisation may consist of a range of individuals with varying competencies, attitudes and motivations, who are keen to pursue varying goals.

  - These individuals use differing working practices, job designs and technological systems to perform their differing job roles and responsibilities.

  - Finally, all this takes place within is then set within larger professional and national cultures.

  - Hence, all factors within the organisational system are co-dependent and interact with one another.

- Therefore, if the success of a system is to be maximised, the whole system A including, for example, individual workers, work processes, and technology A should be considered as a single system (e.g., Hendrick, 1997).

Figure 14. The interrelated factors involved in an organisational system
(Challenger & Clegg, 2009)
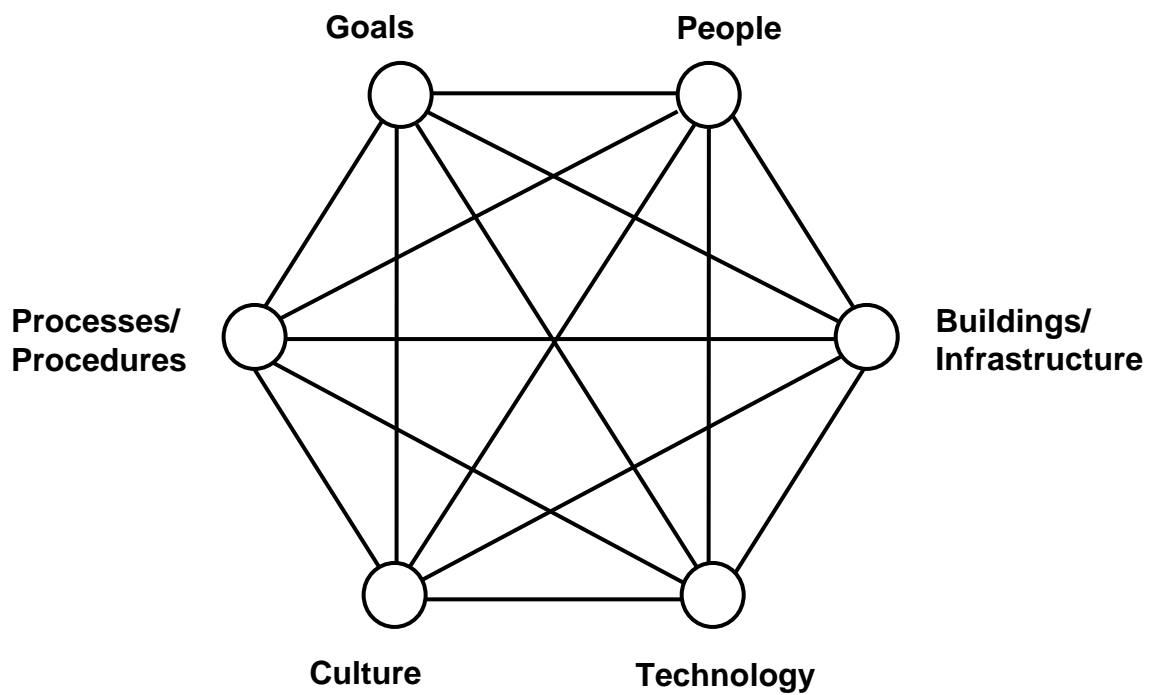
The Importance of Adopting a System-Wide View

The Importance of Adopting a System-Wide View

- Failing to adopt a system-wide view of an organisational issue can have serious consequences for the success of any initiative, since changes to one part of the system may necessitate subsequent changes to other parts of the system (e.g., Holman, Axtell, Clegg, Pepper, Waterson, Cantista & Older Gray, 2000; Clegg & Walsh, 2004).

- Moreover, it is highly unlikely that any individual or group will understand all of the component parts when considering the whole system. Therefore, it is vital that the design of any new system involves multiple stakeholders with a wide range of knowledge, skills and expertise – such as end users, management, human resources, designers, strategists and clients (Clegg, Older Gray & Waterson, 2000).

- All too often, however, new systems are driven by new technology and, consequently, are 'techno-centric' in their mindset (Clegg et al., 2000). In other words, they typically focus on the 'technical system' – i.e., tools, techniques, procedures, skills, knowledge – at the expense of considering the 'social system' – i.e., the people in the organisation, their relationships, and their attitudes and expectations.

- Nevertheless, there is plentiful evidence (e.g., Symon & Clegg, 1991; Waterson, Axtell & Clegg, 1997; Clegg & Shepherd, 2007) to suggest that change driven by technology without due consideration of the social and organisational factors can result in failure.

Crowd Management and Control

- Specifically in relation to crowd management and control, many researchers (e.g., Canter, 1989; Fischer, 1990, 1991; Smith, 1993; Elliott & Smith, 2006) suggest that there is a culture of technocracy. Thus, the focus of crowd control and safety issues is placed heavily on technology and technical solutions, rather than considering the wider, more social aspects.

> *seen as a technical question determined by barrier strengths, the width of passageways and other technical considerations then the mind set becomes one that seeks only technical*
>
> (Elliott & Smith, 2006, p.371)

- For instance, Canter (1989) describes how the mismatch between technical and social aspects of crowd management is made evident in calculations of exit widths.

> *..technical solutions to complex space problems*
>
> (Elliott & Smith, 2006, pp.370)

- Typically, engineering calculations to determine the use of exits from a venue are made according to the total width of all exits available in relation to the total crowd capacity A i.e., a calculation of average exit use.

- However, crowd members are highly unlikely to divide themselves evenly between the exits available, instead preferring to use the exit which is in closest proximity or with which they are most familiar.

- Therefore, using a technically driven approach to assess venue usage, without taking other aspects into account A such as how individuals actually behave A results in calculations that are inaccurate and misleading.

RECOMMENDATIONS FOR FURTHER RESEARCH

Recommendations for Further Research

- This section presents possible directions for future research and practice, specifically concerning: -

  - A rigorous risk assessment tool.

  - The management and mitigation of new risks.

  - Stewards and crowds.

  - Non-ticketed event crowds.

  - "What if...?" scenarios.

  - The next generation of simulation tools.

  - A typology of crowds.

- The recommendations made are applicable to the preparation for, and management of very large scale crowd events, which will take place over consecutive days and across multiple locations (as detailed in **Understanding Crowd Behaviours: Supporting Evidence**, 'Part 2 – Very Large Scale Crowd Events', pages 10 to 21).

A Rigorous Risk Assessment Tool

A Rigorous Risk Assessment Tool

- One clear priority is to develop a rigorous risk assessment tool that can be used by all those involved with planning for and managing events and circumstances involving crowds.

  o The aim would be to develop and deploy a new tool that would enable its users to identify systematically the risks involved with differing crowd events.

- The tool should be underpinned by the findings of this report and other, further research, and should be applicable to the full range of different kinds of crowds and crowd members.

  o Thus, for example, the tool should draw on the typology of crowds that has been developed (see 'A Typology of Crowds' below, pages 128 to 134), and be applicable to crowds in a wide range of circumstances, including passing through transport terminals, attending festivals, participating in demonstrations, attending one-off sporting events, and attending very large scale, multi-day, multi-site events.

  o It should also be capable of considering not only the behaviour of individuals within crowds, but also groups of people, such as families and friends travelling to, or attending, events together.

- It is important that the risk assessment tool is developed with the help of its potential users, to ensure it is both user-friendly and fully meets their various needs.

- In addition, it is also important that the tool is applicable to different "what if...?" scenarios, so as to ensure it is capable of capturing and identifying most, if not all, of the potential risks which may arise at a crowd event (see also the following section on 'What if...? Scenarios', pages 105 to 111).

- Finally, it is probably desirable to develop the tool in a computer-based format. One particular benefit of this approach is that it would enable the creation of an ongoing database of such risk analyses that would be useful for practitioners and educators working in this area.

The Management and Mitigation of New Risks

The Management and Mitigation of New Risks

- A related area for further investigation concerns how new risks associated with the building and subsequent operation of a range of new facilities and sporting events over an extended period can be managed and mitigated.

- This can be informed by drawing on the lessons identified from our analysis of what is different about – and what new or additional risks are potentially involved in – very large scale, multi-day, multi-site crowd events.

- For example, we believe there is a real need: -

    o   To consider the boundaries – i.e., the scope and scale – of the system to be planned for and managed, in order to encompass a system-wide perspective, thereby not only considering the event site itself, but also the surrounding areas.

    o   To understand the behaviours of family and friendship groups who are likely to behave differently to individuals, and who are also likely to be pursuing multi-purpose behaviours (e.g., going to an event, having a day out, having a meal or buying some souvenirs).

    o   To ensure all personnel involved in the event – from all agencies and in all locations – are consistently educated, trained and briefed, for both normal and emergency circumstances.

- Lessons identified from our analysis of the multiple problems which contributed to the problematic opening of Heathrow Terminal 5 can also be drawn upon.

- For example, we believe there is a real need to understand in more detail the risks associated with: -

    o   Apparently mundane problems, which may, on their own, have little impact but which can, when occurring in combination or succession, come together to create a serious incident or a major inconvenience to the users of new facilities.

    o   We also need to understand better how such risks can be managed and mitigated.

Stewards and Crowds

Stewards and Crowds

- The extensive literature reviews uncovered no research concerned with stewards. Whilst there was plentiful research concerned with police – specifically regarding their interactions with crowds and the impact of their actions towards crowds on crowd behaviours (e.g., e.g., Adang, 2003; Stott & Adang, 2003, 2004; Drury et al., 2003a; Adang & Stott, 2004; Stott et al., 2007) – there was no equivalent investigation of stewards.

- Nevertheless, the expert interviews highlighted the key role stewards play in crowd events, and stressed the importance of making sure stewards are fully briefed about their roles and responsibilities prior to an event.

- Given that stewards are often the initial point of contact for crowd members, and that their behaviours towards, and interactions with, a crowd are highly likely to influence how the crowd behaves, it is essential that research be conducted in this area.

- Moreover, considering the critical role undertaken by stewards, particularly at very large scale, multi-day, multi-site events, this omission in the literature represents a significant gap in our knowledge and understanding. Therefore, research in this area should be a priority.

- Potential areas of investigation could concern: -

  o The interactions between stewards and crowds.

  o Comparisons between these interactions and the interactions between the police and crowds.

  o The impact of stewards' actions towards crowds on crowd behaviours.

  o Comparisons between these impacts and those as a result of police action.

  o The interactions between stewards and police.

Non-Ticketed Event Crowds

Non-Ticketed Event Crowds

- The issue of individuals who wish to be part of an event but do not have tickets to attend the event itself, also appears to be relatively unexplored.

- How these individuals are likely to behave, and the impact their behaviours may have on preparation for and management of the event, is an area worthy of further investigation.

- For instance, over 100 000 Glasgow Rangers football fans descended on Manchester for the UEFA Cup Final against Zenit St Petersburg on Wednesday 14th May 2008.

  o This was substantially more people than could be accommodated in the venue itself – the City of Manchester Stadium – which had a match capacity of 44 000, of which 13 000 seats had been allocated to fans of Glasgow Rangers (UEFA, 2008).

  o Consequently, the vast majority of these fans did not have tickets, but still wanted to be involved in the event without attending the match itself.

  o To accommodate such non-ticketed crowds, the Manchester officials provided a giant screen in the city centre on which the match would be shown.

  o However, due to a technical fault, the transmission failed, at which point the assembled crowd began rioting, causing mass disorder and creating huge problems for the authorities tasked with controlling the event (BBC, 2008).

- Hence, potential areas of investigation could concern: -

  o Underlying reasons why non-ticketed event crowds form.

  o Likely behaviour of non-ticketed event crowds.

  o Influences over the behaviour of non-ticketed event crowds.

  o Behaviour of non-ticketed event crowds in comparison to crowds attending the event itself.

  o How non-ticketed event crowds may be discouraged from forming or directed to particular locations.

- The UEFA Cup Final incident also highlights the need for event preparation and management strategies to include careful consideration of: -

    o How individuals – who do not have tickets, but wish to be part of an event – are likely to behave.

    o How their behaviour should best be managed.

    o How their behaviour is likely to impact on the event itself.

    o Potential problems which may arise.

    o Contingency plans to deal with these problems.

"What if…?"
Scenarios

"What if...?" Scenarios

- The expert interviewees all agreed that "what if...?" scenarios are exceptionally useful during the preparation for a crowd event. They provide opportunities to test out the suitability and sufficiency of the plans in place, to think about potential problems, and to develop adequate contingency plans to manage and control these problems should they arise.

- Further investigation of "what if...?" scenarios is a highly worthwhile area of exploration for future research, the findings of which can then be relayed into practice.

- For instance, a key area to consider is the *range* of "what if...?" scenarios typically used during preparation for a crowd event.

  o Are relatively common, minor problems considered, such as "What if there is crowd congestion during ingress?", "What if there is a power failure?", or "What if it rains?".

  o Are more major problems also considered, such as "What if there is a bomb threat?", "What if there is a fire?", or "What if disorder erupts?".

- Consideration should also be given to more unexpected scenarios.

  o In the present day, with the perception of issues such as terrorism being prevalent, associated problems – such as bomb threats or suicide bombers – are likely to be considered as a top priority during event preparation.

  o However, it is important not to focus solely on these extreme threats, based upon prior expectations of crowd events and the current political climate, but also to recognise more unusual – but potentially equally catastrophic – scenarios. For instance: -

    - What if there is a gas leak or explosion?

    - What if a nearby building collapses?

    - What if there is a fire outside the venue but poisonous smoke drifts into the venue?

    - What if a lorry transporting flammable materials has an accident outside the venue?

- Scenarios concerned with less visible, less dramatic risks should be included in the preparation for any crowd event alongside those concerned with highly visible, more dramatic incidents.

  - Individuals' perceptions of risk are skewed, with highly visible, more memorable risks – such as terrorist attacks – being perceived as more dangerous than less visible, less memorable risks – such as more mundane transport or software failures.

  - Indeed, Professor John Maule (Professor of Human Decision Making at Leeds University Business School), speaking on the BBC's Horizon Programme (*"How to Survive a Disaster"*, Tuesday 10th March 2009, BBC2, 9pm[8]) reported that the risks of more memorable events re-occurring are consistently miscalculated.

> *"Threats like plane crashes and terrorism, while they don't occur very often, they leave very dramatic memory traces...and because of that those traces are highly accessible. We know, therefore, that people consistently overestimate the likelihoods of those events."*
>
> Professor John Maule
> Leeds University Business School
> Speaking on the BBC Horizon Programme
> 10th March, 2009

  - Thus, in reality – and contrary to individuals' perceptions of risk – these more memorable risks which attract individuals' attention are actually less likely to cause harm than the less memorable, more everyday risks, such as failures in software systems.

  - As such, it is important to incorporate these less visible and less dramatic, but more probable, risks into "what if...?" scenarios during event preparations.

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[8] For further details see http://www.bbc.co.uk/programmes/b00j7p7z and http://news.bbc.co.uk/1/hi/magazine/7933386.stm

- o For example, the mindsets that were prevalent at the time of the Hillsborough Stadium Disaster in 1989 were all focused on the problems of crowd disorder and hooliganism. These mindsets were shaped by the press, the police and the general public, and directed preparations and practice towards order and control, rather than towards safety.

- o Presently, in an era where the dominant mindset may be around security and the problems of terrorism, it is important to ensure that scenarios planning and other techniques are used to ensure event planners also focus on a wide range of risks.

- Thus, seemingly minor issues – such as problems with software systems, failure of new technologies, inefficient security procedures and personnel unfamiliar with the environment – should also be given careful consideration.

  - o The probability of a serious problem arising, if one of these issues was to occur on its own, may be relatively low. However, if several of these issues were to occur in combination or in succession, it is much more likely that they will jointly contribute to a significant problem.

  - o This situation was exemplified in the problematic opening of Terminal 5 at Heathrow Airport on 27th March, 2008 (see **Understanding Crowd Behaviours: Supporting Evidence**, 'Part 2 – A Cautionary Tale: Heathrow Terminal 5', pages 22 to 53).

- Scenarios should not be confined to the event itself, but should also consider wider aspects, such as problems in the surrounding area or transport systems.

  - o What if there is a fire in a nearby building and the whole area needs to be evacuated?

  - o What if parts of the transport system under-perform?

  - o What if a lorry transporting flammable materials has an accident outside the venue, and the road needs closing and the area evacuating?

- A further key area for "what if...?" scenarios to include concerns the knock-on effects of an incident.

  - o For instance, what are the knock-on effects if there is a bomb scare?

  - o What if security levels have to be raised at subsequent events?

- o What if ingress and egress times increase?

- o What if queuing time is increased?

- o What if travelling time to and from the venue is increased?

- Hierarchical task analysis (HTA; e.g., Annett, Duncan, Stammers & Gray, 1971; Kirwan & Ainsworth, 1992) could be used, alongside such "what if...?" scenarios, to think of potential knock-on effects of problems at a crowd event (e.g. Zarboutis & Marmaras, 2007). Indeed, a specialised type of HTA called 'task analysis for error identification' (e.g., Baber & Stanton, 1994) is specifically intended to identify problems that may occur in given situations.

Figure 15. Example of hierarchical task analysis for a metro train on fire
(Taken from Zarboutis & Marmaras, 2007, p.929)
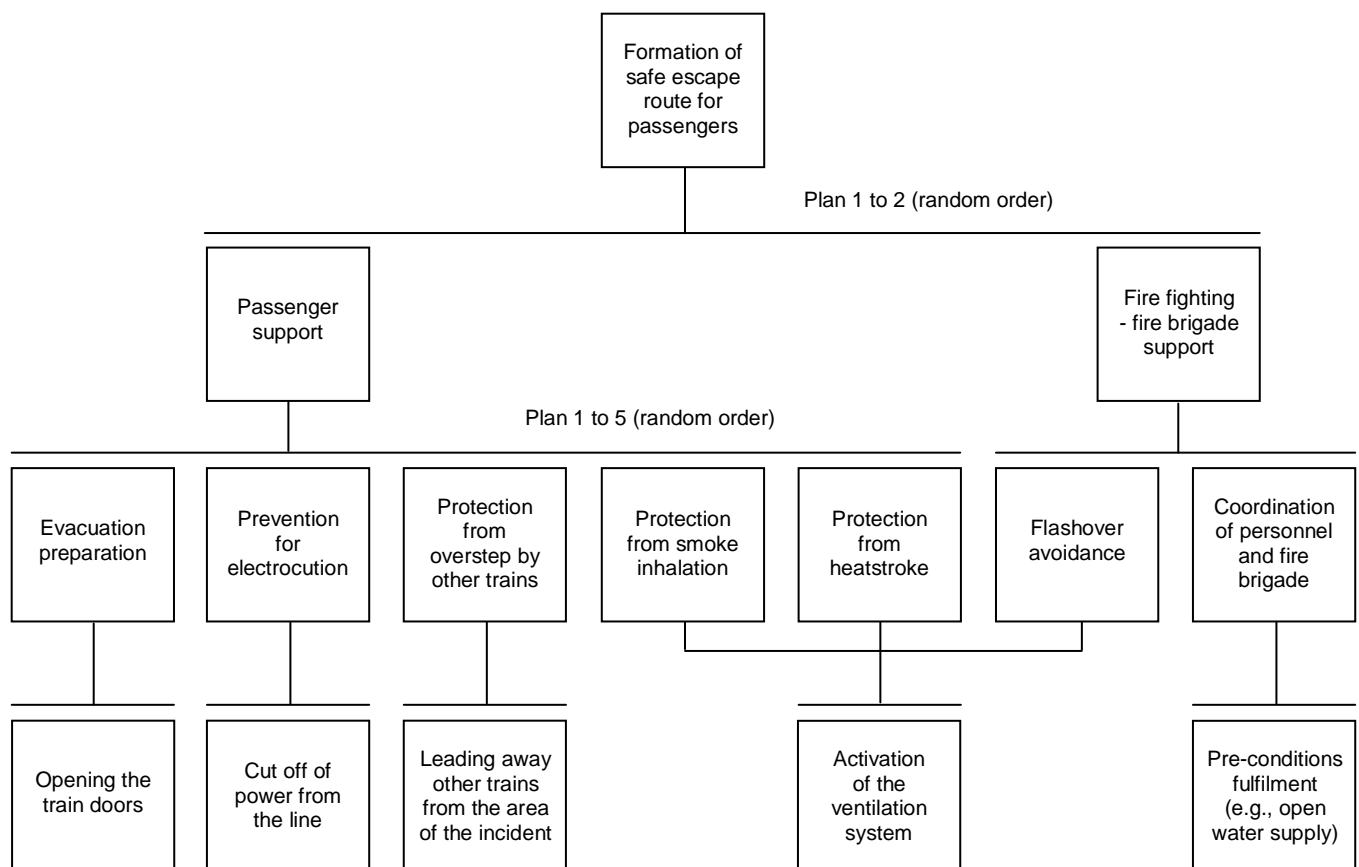
- o HTA involves the decomposition of specific tasks into subtasks, sub-subtasks and so on, until the desired level of detail for analysis is reached.

- o Each subtask – or operation – incorporates a specific goal. Plans are then developed at each level of analysis, detailing how each of these goals can be achieved. For example, a plan may indicate the sequence in which subtasks should be completed in order to achieve the goal specified in the task at the prior level of analysis.

- Thus, HTA could be used in conjunction with "what if...?" analyses, as a tool to aid preparation for crowd events.

  - o For example, "what if...?" scenarios could be used to brainstorm a wide range of problems which could potentially arise at a crowd event, as discussed previously.

  - o HTA could then be applied to each scenario individually, to systematically break-down the sequence of events which may contribute to that scenario occurring, including tell-tale signs indicative of an imminent problem. Plans could also be detailed to indicate how best to manage these sub-events, should they arise.

  - o The same process could also then be carried out to identify – and develop contingency plans for – sub-events which may arise if the given scenario was to occur.

- Similar systematic methods of analysis are frequently used for risk assessment and safety evaluation.

  - o For instance, hazard and operability studies (HAZOPs) are used in process industries – e.g., chemical and nuclear industries – to identify potential problems which may arise as a result of deviations in the intended operations of a plant (e.g., Kletz, 1974; Kennedy & Kirwan, 1996, 1998).

  - o Likewise, fault tree analysis (FTA) is conducted in the field of safety engineering to determine the probability of a safety hazard occurring, through systematically identifying a sequence of events which could, either alone or in combination, lead to a serious incident (e.g., Kirwan, 1994; Lee, 1996).

- Ultimately, whatever the specific method utilised, research should aim to develop a systematic way to help crowd event planners, managers and responders to consider as many different scenarios as possible, relating to a whole continuum of problems and knock-on effects.

- For instance, some kind of definitive structure for "what if...?" scenarios – detailing the order in which scenarios should be developed, how to derive knock-on scenarios, and which areas should be considered, for example – could be developed. This would seek to ensure that all possible eventualities are considered consistently by all involved in planning and managing crowd events, at each and every crowd event across the country.

The Next Generation of Simulation Tools

The Next Generation of Simulation Tools

- Based on the literature reviews, the opinions of the expert interviewees and the in-depth analyses of three of the leading simulation software tools (Legion, Myriad II and Mass Motion), this section considers key areas on which the next generation of simulation tools should focus[9].

- These areas include: -

    o Groups

    o Types of crowd and crowd member

    o Interactions between crowds and other groups

    o Interactions between crowd members

    o Emotions

    o Tipping points

    o Multi-purpose behaviours

    o Incomplete information

    o Unexpected scenarios

    o Different system scopes

    o Theoretical underpinning

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[9] These areas reflect the directions that we, as organisational psychologists, believe the next generation of simulation tools should be aiming to take. However, we fully acknowledge that this may not be the opinion of all individuals experienced with using simulation tools.

Groups

- Frequently, individuals in a particular environment move around as part of a group – for example, as a family group, a group of friends, a group of colleagues or a tourist group with a guide – of varying composition and varying size.

- However, this proportion of groups will, of course, vary depending on the type of crowd. For instance, drawing on the typology of crowds that has been developed (see 'A Typology of Crowds' below, pages 128 to 134), it is likely that: -

    o Commuter crowds – with a primary purpose of travel, passing quickly through various environments with little interaction or communication – will predominantly comprise singletons as opposed to groups.

    o Football crowds – with a primary purpose of attending a sports or entertainment event, with increased levels of interaction and group cohesion – will attract singletons, families and groups of friends.

    o Very large scale, multi-day, multi-site event crowds – with a primary purpose of having a day out as opposed to attending a regular sports or music event – may comprise a higher proportion of family groups and groups of friends.

- Therefore, future simulation tools should be able to accommodate groups within a larger crowd, of varying kind and varying size.

- Typically, members of a group will: -

    o Move throughout an environment as a group unit.

    o Want to remain together as a group, for example, waiting for one another if a group member is missing, or waiting until all members are able to evacuate before leaving in an emergency situation.

    o Walk at the same speed.

    o Follow the same goals.

- Moreover, the behaviour of a family group – organised in a hierarchy with parents and children – is likely to differ from that of a non-hierarchical group, such as a group of friends. For instance, parents are more likely to put the safety of their children before their own and so will alter their behaviour accordingly. Simulation tools should ideally be able to model this accurately.

- Simulations should also aim to incorporate the psychological role of being part of a group with a shared social identity – i.e., psychological 'groupness' – and the impact which this has on crowd behaviours.

Types of Crowd and Crowd Member

- At present, the extent to which different types of crowd and crowd member are accommodated by simulation tools appears to be variable, with some types well catered for – such as commuter crowds – whilst others are less prominent. We believe this is a central area for future simulation tools to focus on improving.

- Based upon the potential typology of crowds proposed in this report (see pages 128 to 134), it would appear that current simulation tools accommodate the following dimensions fairly well: -

    o Crowds which form with the primary purpose of observing sports or entertainment events, or of travelling from A to B.

    o Crowds which have a reasonably transient duration (e.g., crowds passing through a train station) or a medium to long-term duration (e.g., crowds at a football or cricket match).

    o Crowds which gather for an event with a fixed start time (e.g., a sporting event with a clear kick-off and end point).

    o Crowd members who are able to move freely around an event site (e.g., at a music festival) or are passing through a transport terminal.

    o Crowds which have a relatively low heterogeneity of membership (e.g., commuters, who are often travelling alone, know where they are going and exhibit purposeful behaviours).

    o Crowds which are comprised primarily of singletons or couples.

    o Crowds which have a variable amount of luggage or baggage, from non-existent to large amounts (e.g., at an airport).

- Conversely, the following factors appear to be less well catered for and, therefore, should be primary areas of concern for the next generation of simulation tools: -

    o Crowds which form spontaneously (e.g., a queue) and crowds which have a mixed primary purpose, engaging in multiple behaviours at the same event (e.g., shopping or stopping to talk to friends).

    o Crowds which have a longer term duration, gathering for an event on consecutive days (e.g., at a three-day music festival).

- o Crowds which attend events where high levels of conflict are anticipated, as a result of behaviour at previous events (e.g., football crowds).

- o Crowds which have a relatively high level of membership identification, comprised of individuals who feel united by a shared social identity.

- o Crowds which frequently interact with other groups (e.g., police or stewards) and crowd members who frequently interact with one another.

- o Crowds which are comprised of group units, such as families or groups of friends.

Interactions between Crowds and Other Groups

- Crowds do not exist in isolation but engage in dynamic interplay with other groups, such as the police or stewards.

- These interactions between a crowd and other groups influence the way in which that crowd behaves, particularly in relation to the likelihood of crowd disorder occurring.

- Conversely, the behaviour of these other groups, such as the authorities or stewards, will also be influenced by the behaviour of the crowd.

- Therefore, it is important that future simulation tools are designed to be able to model such interactions.

Interactions between Crowd Members

- Crowd members rarely remain silent throughout an event, but rather communicate and share information with fellow crowd members, whether strangers or familiar, particularly in an emergency situation.

- The next generation of simulation tools should, therefore, attempt to acknowledge that communication and information sharing takes place between crowd members, and should be able to accommodate such behaviours. Simulations should, ideally, also consider the impact which this communication has on the overall behaviour and movement of the crowd.

- Body-to-body contact regularly occurs between individuals in a densely packed crowd, resulting in pushing, shoving and falling over, and potentially in trampling and crushing.

- Thus, future crowd simulation models should aim to incorporate physical contact between crowd members and the consequences which are likely to result. There are encouraging signs that this is starting to occur (Moore et al., 2008), albeit slowly.

- Additionally, research suggests that crowd behaviours in an emergency situation typically remain structured and organised – with helping, cooperation and coordination behaviours often displayed – as crowd members feel united by the disaster and, despite being predominantly strangers, come to share a social identity.

- If simulation tools are to accurately represent crowd behaviours in emergency situations, it is important that this sense of solidarity is acknowledged and that such helping, concerned and supportive behaviours should attempt to be modelled.

Emotions

- It is highly likely that individuals' emotions will influence the way in which they move and behave.

    o For instance, the extent to which an individual feels stressed is likely to influence the speed at which he or she moves – e.g., more likely to move quickly if feeling highly stressed – or exhibits aggressive behaviours – e.g., more likely to push past people if feeling highly stressed and in a hurry.

    o Alternatively, the extent to which an individual feels frustrated or inpatient is likely to impact on the extent to which he or she will be prepared to queue – e.g., less likely to be prepared to queue for a lengthy period of time if feeling highly frustrated.

    o The extent to which an individual feels upset may also influence his or her behaviour in terms of illogical or disorganised movements – e.g., the more upset an individual, the less likely he or she is to be fully concentrating on his or her movements and the more disorganised he or she is likely to be.

- At present, simulation tools do not appear to consider individuals' emotional states. However, we believe that this is a key area in which the next generation of simulation tools should be aiming to develop.

Tipping Points

- Tipping points are the critical levels at which momentum for action or change cannot be stopped A i.e., the points of no return (e.g., Gladwell, 2000).

> *the moment of critical mass,*
> *the threshold, the boiling point.*
>
> (Gladwell, 2000, p.12)

- The notion of tipping points can be used to explain why change often happens quickly and unexpectedly (Gladwell, 2000). In the same way as a virus can spread rapidly through a population, so too can behavioural change, particularly within a group. For instance, a small action by one individual within a crowd can influence the actions of other individuals within the crowd, and so on, until the behaviour becomes widespread. Thus, small, initial changes have the potential to make significant differences overall (Gladwell, 2000).

- Research suggests that in the event of an emergency situation, individuals A given the relatively rare occurrence of emergencies A are predisposed to believe that a situation is normal for as long as possible, and so behave as usual for as long as possible, in accordance with their ingrained place scripts or schema (e.g., Donald & Canter, 1990, 1992; Proulx & Reid, 2006).

    - For ins'r Csa pcvCe'' a CeO wuu underground fire in 1987, passengers tried to carry on as normal A following their usual routes and intended courses of action A for as long as possible (Donald & Canter, 1990, 1992).

- Thus, evacuation is often delayed until additional information and instructions are provided which, when they reach a critical threshold, should act as a tipping point and enable individuals to override their schema and evacuate as appropriate.

    - '' a CeO wuu underground fire, for example, only when CpUlpcr iuCcucr ima' r . Wcvu'' avaCawcB'ap m?'' aU route being blocked by the fire, or by information provided via the public announcements, did they abandon their schema and adopt more appropriate behaviours (Donald & Canter, 1990, 1992).

- Future simulation tools should aim to acknowledge this typical behaviour in an emergency situation and ensure it can be accommodated and accurately modelled.

- Moreover, evacuation time concerns not only the time to move towards a point of exit, but also the time taken for crowd members to interpret warnings, evaluate information they receive, decide on the most appropriate course of action and then to initiate movement (e.g., Canter et al., 1990). Factors such as timeliness, accuracy, credibility and source of communication all influence this reaction time (e.g., Proulx & Sime, 1991; Drury & Cocking, 2007).

- Additionally, in accordance with the tipping points phenomenon, this reaction time is also likely to be influenced by the behaviour of fellow crowd members. Thus, the actions of just a few crowd members beginning to evacuate should be sufficient to influence the behaviour of others within the crowd, and so forth, thereby increasing the overall speed of the evacuation process.

- Thus, simulation tools should attempt to incorporate reaction time, along with varying influential factors, such as tipping points, when running evacuation simulations.

Multi-Purpose Behaviours

- When attending an event, crowds do not only move from A to B towards a target goal using the most direct route, but also engage in other, more personally motivated, multi-purpose behaviours en route.

    o For example individuals may stop to talk to another individual, stop to look in a shop window, search for a toilet, want to find a concessions stand or bar, or may want to take a rest and sit on a bench.

- The extent to which crowd members engage in behaviours such as these – along with the kind of multi-purpose behaviour – will vary according to the type of crowd. Again, drawing on the crowd typology proposed below (see 'A Typology of Crowds', pages 128 to 134), it is likely that: -

    o Commuter crowds will engage in very little multi-purpose behaviour, but instead will remain focused on their original purpose of travelling from A to B.

    o Football crowds will engage in a moderate amount of multi-purpose behaviours – for example, in addition to observing the match, crowd members may also try to find a concessions stand or purchase souvenirs.

    o Very large scale, multi-day, multi-site event crowds will engage in a high level of behaviours with a purpose other than observation of sporting or music events, such as eating, socialising with friends, searching for a toilet, shopping, sightseeing or observing street entertainment.

- Hence, behaviours such as these should, ideally, all be replicable in the next generation of simulation tools, if they are to accurately represent crowds of differing type and their behaviours.

Incomplete Information

- It is probable that a proportion of crowd members will enter a crowd event with limited or incomplete information about the environment, but will gain further knowledge from exploring the environment or by communicating with others.

- This proportion is likely to be dependent on the type of event, e.g., crowd members who regularly attend recurring events – such as football matches – are more likely to have a better knowledge of the environment compared with crowd members who are attending a one-off event in an unfamiliar location.

- Future simulation tools should acknowledge that some crowd members are unlikely to have complete information about, or a complete understanding of, their environment and, hence, should attempt to enable agents to engage in exploration behaviours in order to gain further knowledge.

- Alternatively, individuals within the crowd may become lost as a result of incomplete information. Simulation tools should also be able to accommodate this.

Unexpected Scenarios

- Even in light of thorough planning and preparation for a crowd event, it is always possible for an unexpected scenario to arise, such as a gas explosion at a nearby plant. If a contingency plan has not been developed for such an incident, decisions must be made then and there by those in overall control of the event, and actions must be taken immediately.

- Simulation tools should be able to cope with such surprise scenarios and model realistically how both those in authority and members of the crowd are likely to react and behave.

Different System Scopes

- The next generation of simulation tools should be able to accommodate multiple environments and multiple crowd events in the same simulation model, rather than solely modelling one particular event in one particular environment.

- For instance, many crowd events – such as Glastonbury – take place over consecutive days and comprise many events occurring simultaneously, which are distributed over a wide range of locations.

- Thus, if a simulation tool is to accurately represent crowd events such as these, it should be capable of simulating multiple events at multiple locations over several days in one overall model.

- Moreover, a crowd event does not occur in isolation, but forms part of the wider environment and is, therefore, both influenced by and influential over aspects in that wider environment. For example, the transport system, other events taking place nearby, local shops, restaurants and bars, and individuals going about their daily business, all are factors which should be considered.

- Thereby, it is important that the scope of simulation tools is broad enough to be able to incorporate wider environmental factors such as these, to enable more comprehensive models to be constructed.

Theoretical Underpinning

- A further area which currently appears to be lacking in simulation tools is the inclusion of a strong theoretical basis on which to build models of crowd behaviours. Integrating theory and practice, by developing tools according to the propositions made by crowd theories in conjunction with observations of crowd behaviours, should help improve the accuracy and credibility of simulation tools.

- Many of the crowd behaviours described above, as areas for future simulation tools to incorporate, are underpinned by theories substantiated by academic research.

  - For instance, the impact which interactions between crowds and other groups, such as the police, have on crowd behaviours is based on the elaborated social identity model of crowd behaviour (ESIM; e.g., Reicher, 2001), for which there is plentiful supportive evidence. According to this theory, the way in which an outside group, such as the police, perceives and subsequently acts towards a crowd will, in turn, influence the way in which that crowd reacts.

  - In addition, the notion of tipping points – i.e., the critical thresholds at which momentum for action or change cannot be stopped (e.g., Gladwell, 2000) – resonates with the theory of place scripts (e.g., Donald & Canter, 1992). This theory suggests that individuals develop, and follow, scripts or schema – i.e., sequences of behavioural patterns in which they automatically engage when in a familiar environment – which become ingrained and remarkably resistant to change, even in emergency situations. Only when individuals receive sufficient information and cues about the incident occurring – i.e., when they have sufficient information to reach the tipping point – are they able to override those schema and behave appropriately for the emergency situation.

- Therefore, we believe that greater effort should be made to consider theories underlying crowd behaviours in the next generation of simulation tools.

A Typology of Crowds

Definition of 'A Crowd'

- As discussed, there appears to be no agreed definition of 'a crowd' at present. However, there do appear to be characteristics common to the various descriptions, concerning size, density, time, collectivity and novelty.

- Therefore, a potential definition of a crowd could be[10]: -

> A Crowd...
>
> *A sizeable gathering of people in a given location, with a sufficient density distribution, who have come together for a specific purpose over a measurable period of time and who, despite being predominantly strangers or in an unfamiliar situation, feel united by a common identity and are, therefore, able to act in a socially coherent manner.*

- This definition could be used as a baseline classification of a crowd, with additional, more specific factors added to describe distinct types of crowd.

- For instance, the definition could be modified to better represent a crowd at a sports event: -

    o *A sizeable gathering of people in a sports ground, with a sufficient density distribution, who have come together specifically to observe a sports event over a period of several hours and who, despite being predominantly strangers or in an unfamiliar situation, feel united by the common identity of being sports fans and are, therefore, able to act in a socially coherent manner.*

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[10] A deliberate decision has been made not to include specific figures in relation to size, density and time – see Understanding Crowd Behaviours: Supporting Evidence, Footnote 7, page 62, for further explanation.

- Alternatively, the definition could be modified to appropriately represent a crowd at an airport: -

  - *A sizeable gathering of people – most likely with a high level of baggage – with a sufficient density distribution, who have come together in an airport over a period of several hours, specifically to board an aeroplane, and who, despite being predominantly strangers, feel united by the common identity of travelling and are, therefore, able to act in a socially coherent manner.*

- A crowd gathered for a demonstration or protest could be described as: -

  - *A sizeable gathering of potentially passionate and committed people in a particular location – most likely with banners or placards – with a sufficient density distribution, who have come together over a period of several hours specifically to protest or demonstrate for a particular cause and who, despite being predominantly strangers or in an unfamiliar situation, feel united by the common identity of their cause and are, therefore, able to act in a socially coherent manner.*
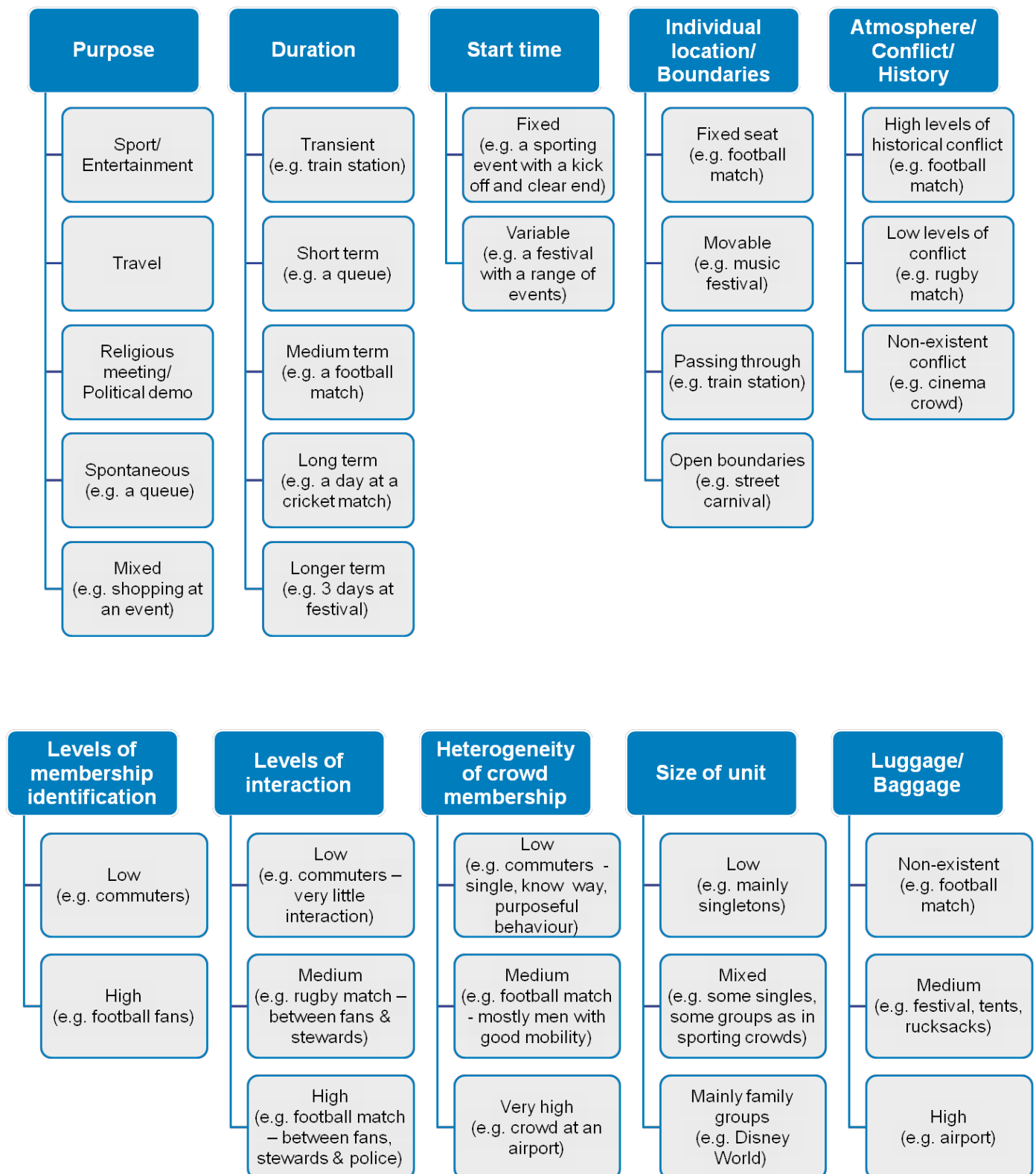
Types of Crowd

- As revealed by the in-depth reviews of literature (for further details see **Understanding Crowd Behaviours: Supporting Evidence**, 'Part 3 – Review of the Literature', pages 54 to 242), there appears to be very little research into types of crowd and crowd member.

- Only two relevant papers – Momboisse (1967) and Berlonghi (1995) – were found, the former identifying four types of crowd and the latter identifying eleven types of crowd, categorised primarily according to the primary purpose of their existence.

  o For instance, Berlonghi (1995) termed crowds 'spectator', 'demonstrator', or 'escaping', to correspond with their primary purposes, respectively, of: watching an event that they have come to observe; protesting, demonstrating or marching for a specific cause; or attempting to escape from danger or life-threatening situations.

- However, neither paper extended the classifications to include different types of crowd member.

- Similarly, the expert interviewees categorised crowds according to the type of event they were attending. For example, crowds were classified as 'crowds at marches and demonstrations', 'crowds at sports events', 'crowds at concerts', and 'crowds at celebrations'.

- Moreover, the interviewees acknowledged that within each type of crowd there is a whole range of crowd member types, predominantly categorised according to their level of compliance.

- Therefore, given the paucity of consideration for this area, there is a real need for future research to focus on identifying different types of crowds – categorised according to a broad range of dimensions – along with the characteristics and behaviours they are likely to exhibit.

- Ultimately, this should assist event planners and managers with their preparation for, and management of, a particular crowd event with a particular type of crowd comprised of particular types of crowd member.

Potential Dimensions for a Crowd Typology

- The following dimensions could be used to categorise different types of crowds: -

    o   The purpose of the crowd.

    o   The duration of the crowd.

    o   The start time of the event.

    o   Individuals' locations within the event or event boundaries.

    o   The event atmosphere and levels of conflict, including historical conflict.

    o   Levels of identification with crowd membership – i.e., the extent to which crowd members share a sense of social identity.

    o   Levels of interaction between crowd members and between crowds and other groups.

    o   The heterogeneity of crowd membership.

    o   The size of group units within the larger crowd.

    o   The amount of luggage or baggage.

- Figure 16 (overleaf) demonstrates the various categories which could potentially comprise each of these dimensions, and against which crowds could potentially be categorised.

- This is important because one key application of a typology such as this would be in relation to the next generation of simulation tools, which could aim to incorporate different types of crowd according to a typology (as discussed previously in 'The Next Generation of Simulation Tools' section, pages 112 to 127).

Figure 16. Potential typology of crowds

Purpose	Duration	Start time	Individual location/ Boundaries	Atmosphere/ Conflict/ History
Sport/ Entertainment	Transient (e.g. train station)	Fixed (e.g. a sporting event with a kick off and clear end)	Fixed seat (e.g. football match)	High levels of historical conflict (e.g. football match)
Travel	Short term (e.g. a queue)	Variable (e.g. a festival with a range of events)	Movable (e.g. music festival)	Low levels of conflict (e.g. rugby match)
Religious meeting/ Political demo	Medium term (e.g. a football match)		Passing through (e.g. train station)	Non-existent conflict (e.g. cinema crowd)
Spontaneous (e.g. a queue)	Long term (e.g. a day at a cricket match)		Open boundaries (e.g. street carnival)	
Mixed (e.g. shopping at an event)	Longer term (e.g. 3 days at festival)			

Levels of membership identification	Levels of interaction	Heterogeneity of crowd membership	Size of unit	Luggage/ Baggage
Low (e.g. commuters)	Low (e.g. commuters – very little interaction)	Low (e.g. commuters - single, know way, purposeful behaviour)	Low (e.g. mainly singletons)	Non-existent (e.g. football match)
High (e.g. football fans)	Medium (e.g. rugby match – between fans & stewards)	Medium (e.g. football match - mostly men with good mobility)	Mixed (e.g. some singles, some groups as in sporting crowds)	Medium (e.g. festival, tents, rucksacks)
	High (e.g. football match – between fans, stewards & police)	Very high (e.g. crowd at an airport)	Mainly family groups (e.g. Disney World)	High (e.g. airport)

- A typology such as this also has strong implications for crowd event planners and managers. It could be used as a framework to help think through the numerous characteristics and likely behaviours which different types of crowd may have and, consequently, should help to guide event preparation.

- It also serves to reinforce the importance of thorough planning, in order to be fully aware of a crowd's profile and adapt preparations accordingly.

  o For instance, in accordance with the typology, a crowd at a football match could be categorised as: having a primary purpose of attending a sports event; with a medium term duration, a fixed start and end, and individually assigned seats; the potential for high levels of conflict and interaction; an increased likelihood of crowd members identifying themselves as a united group; a moderate amount of heterogeneity of membership, with singles, couples and groups; and a negligible amount of luggage.

  o In contrast, a crowd at a very large scale event, for instance, could be categorised as: having a mixed purpose (i.e., attending a sporting or music event, having a day out, or souvenir shopping); with a longer term duration; a variable start and end, and open boundaries for crowd members to locate themselves; little potential for conflict; little likelihood that the crowd will identify themselves as one, united group; a medium amount of interaction (e.g., between stewards and crowd members asking for directions); a moderate amount of heterogeneity of membership, with singles, couples and groups; and a medium amount of luggage.