

# Ensuring Safe Evacuation – The Next Steps



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# Learning Objectives

- Understand the Strategic role of a fire engineer – all stages
- Understand alternative methods and approaches to design and validate safe egress solutions
- Understand value of Performance Based Design in large public assembly projects v prescriptive code approach
- Introduction to Software Tools for Evacuation Modelling

# Overview / Summary

## Section 1: Prescriptive Code Vs Performance Based Design

- Performance Based Design - Fire Engineering
- Fire Safety Code guidance

## Section 2: MassMotion – evacuation modelling

- The Software
- Applications

## Section 3: Case Studies

- Evacuation modelling

# Dermot O'Donnell – Speaker Bio

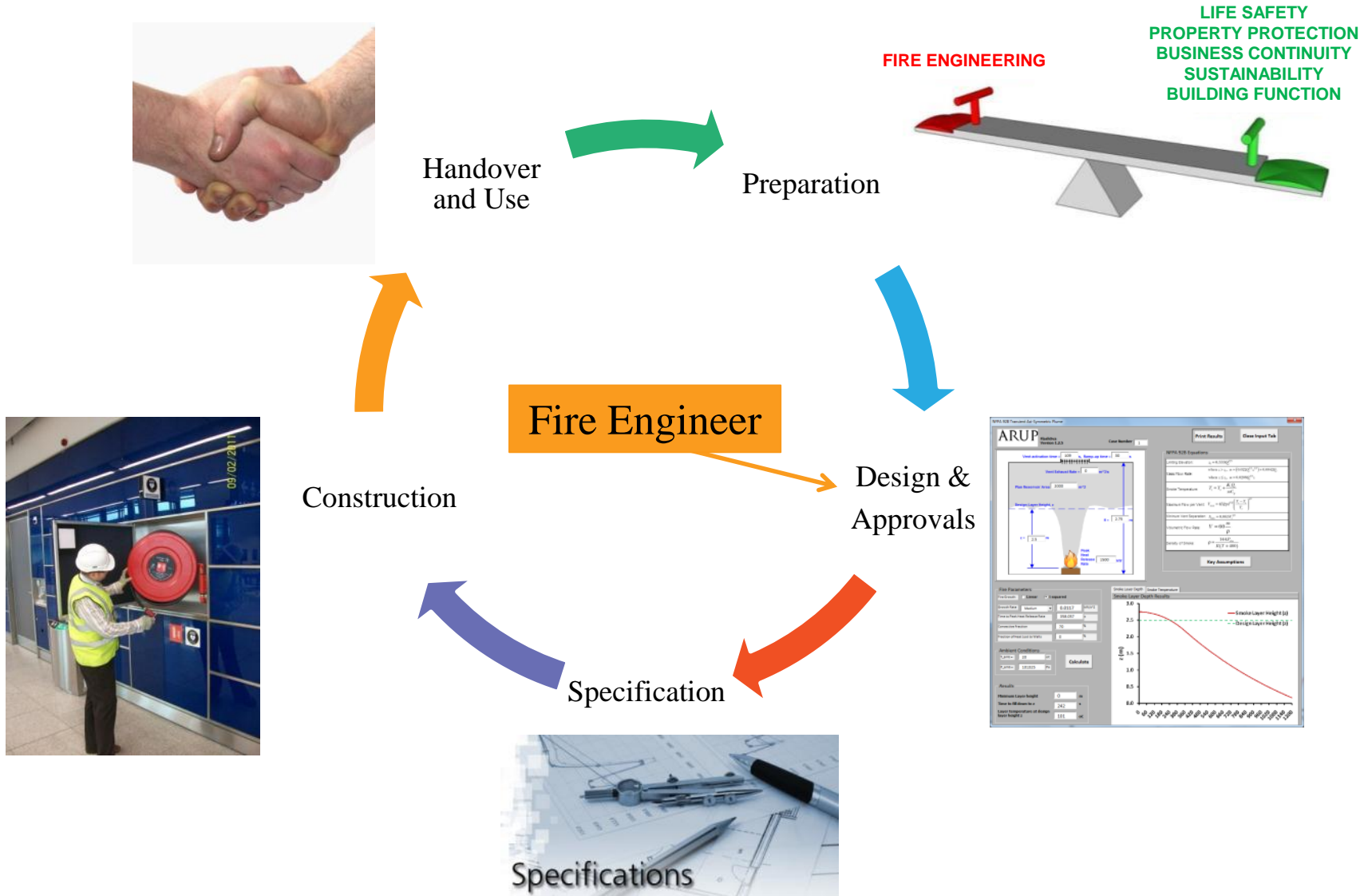
Dermot is a Senior Fire Engineer and a Chartered Engineer with Engineers Ireland. He holds an Honours Degree in Building Services Engineering from Dublin Institute of Technology.

Dermot has a wide range of experience in fire engineering in Ireland, UK, Continental Europe, Russia and the Middle East.

His experience ranges from code knowledge to the development and application of holistic performance based designs. Dermot also has substantial experience in on-site implementation of his and others fire life safety designs.

Dermot is also an practiced in evacuation and people movement analysis. He is involved in the continuing development of Arup's commercially available evacuation modelling software MassMotion as a tester and European champion within Arup.

# The role of a Fire engineer

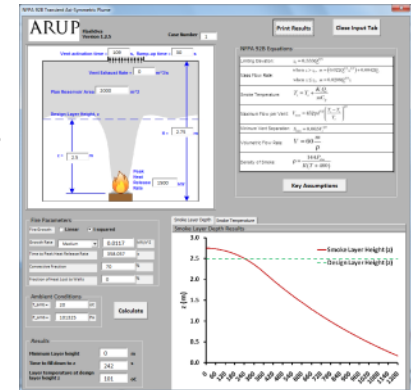
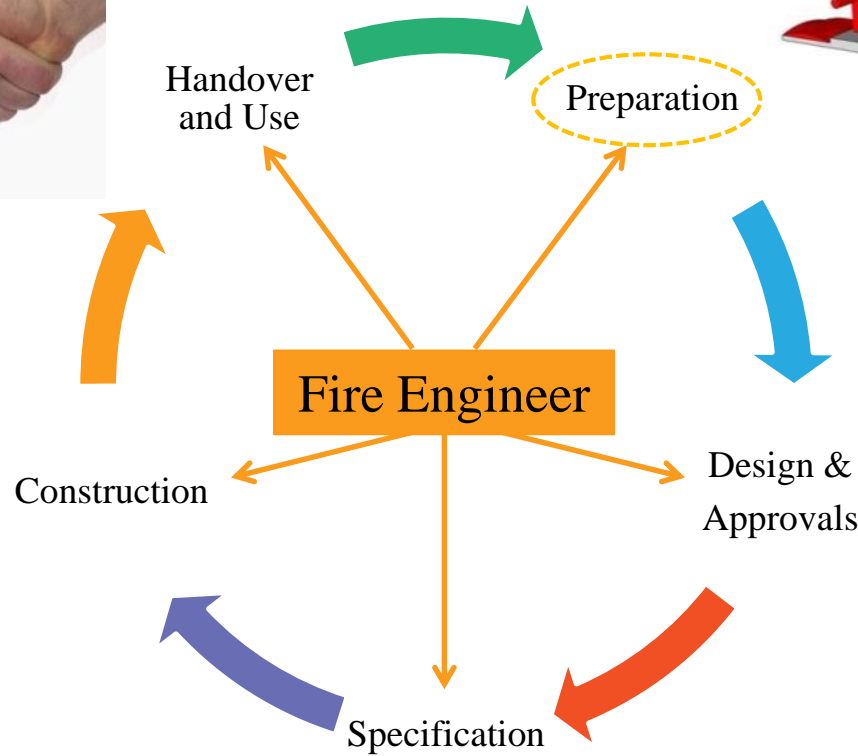
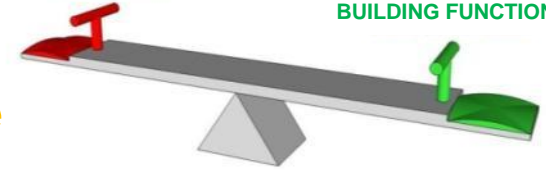


# The role of a Fire engineer



**FIRE ENGINEERING**

**LIFE SAFETY  
PROPERTY PROTECTION  
BUSINESS CONTINUITY  
SUSTAINABILITY  
BUILDING FUNCTION**



Specifications

## **Message 1:**

Early consultation and an integrated and coordinated approach are critical to ensure a successful strategy.





# Validating Egress Strategy





# Overview

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## Section 2: MassMotion – evacuation modelling

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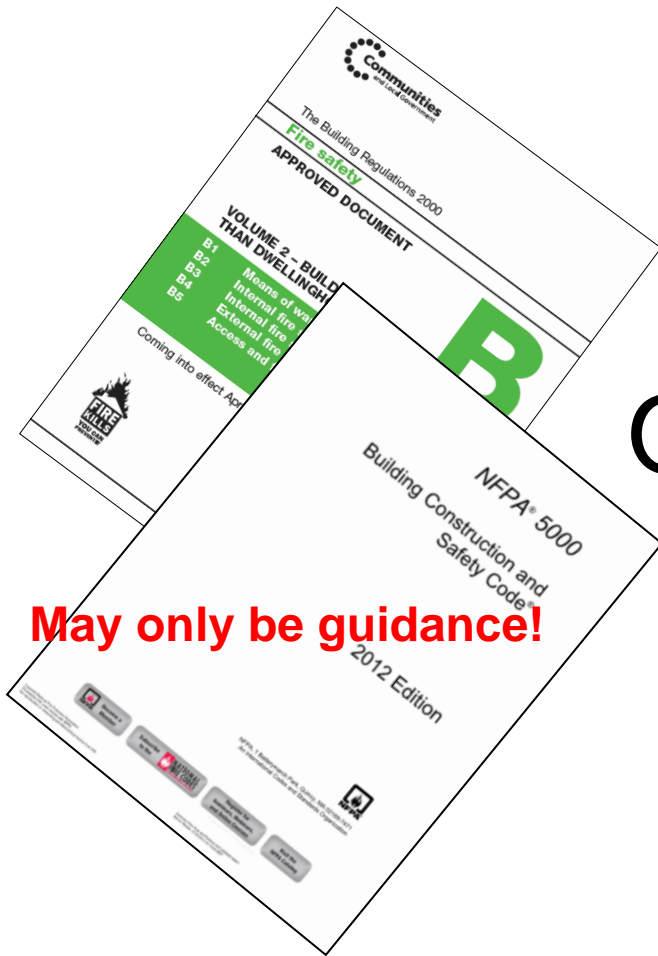
## Section 3: Case Studies

- Evacuation modelling

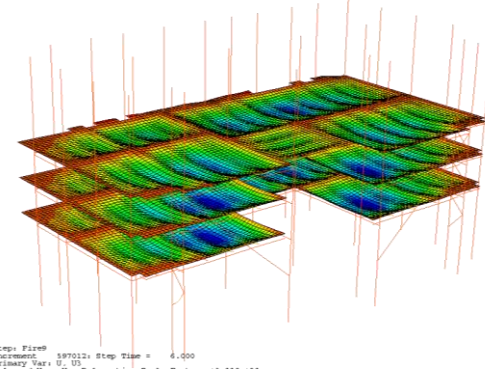
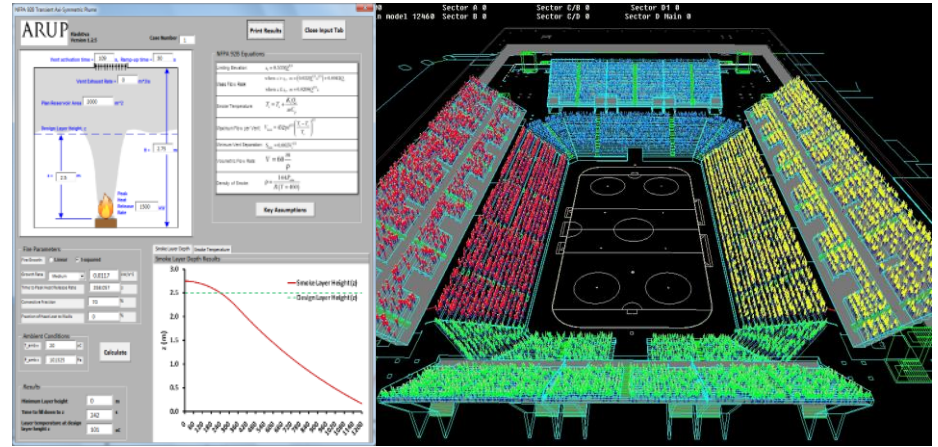


# **Section 1 – Prescriptive Code Vs Performance Based Design**





OR



A design is either **prescriptive** or **fire engineered**

Why use Fire Engineering/Performance based design?



# So why use Fire Engineering?

- Cost savings – removing unnecessary features
- Operational and business continuity
- Quality and functionality of space – enabling architecture
- Improving commercial viability of the building – end user requirements/obligations/security
- Sometimes a prescriptive solution is simply not possible.

# Fire Escape Principles



# Prescriptive Guidance – Traditional Assumptions for Buildings

What are the exit flow rates based on?

What is safe queuing time for occupants to escape?



# Prescriptive Guidance – Traditional Assumptions for Buildings

What are the exit flow rates based on?

Research from the 40's

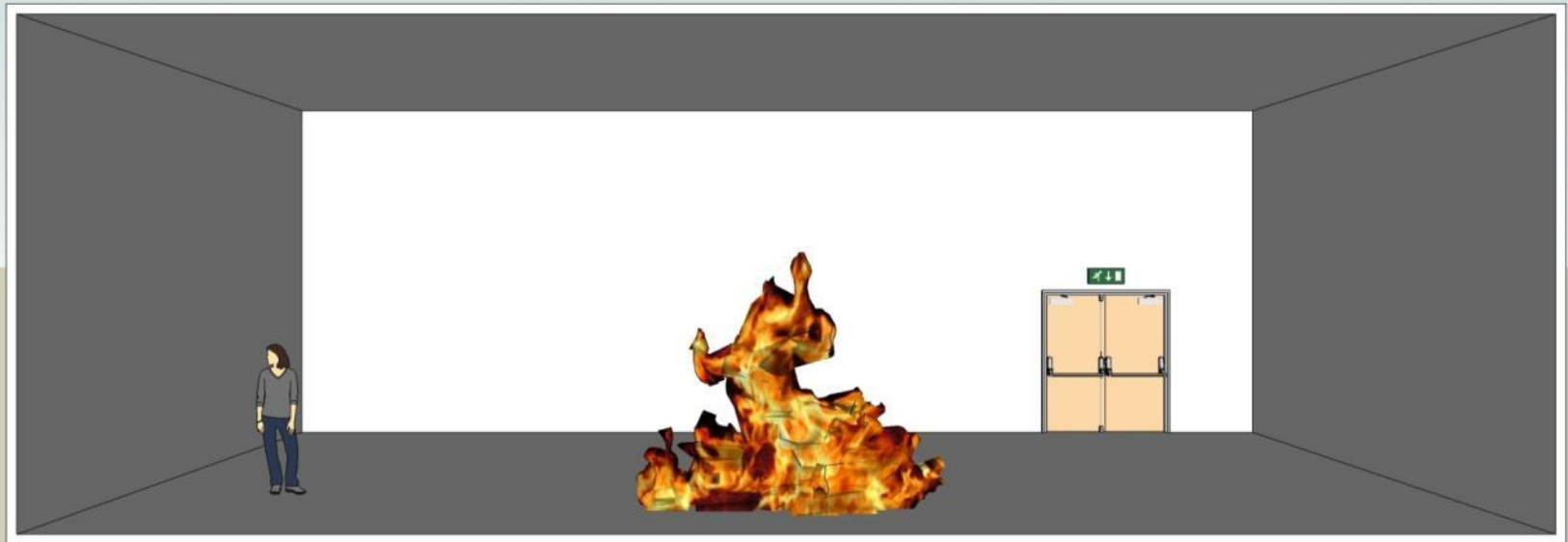
What is a safe queuing time for occupants to escape?

~ 2.5 minutes





# Performance based design – high ceiling



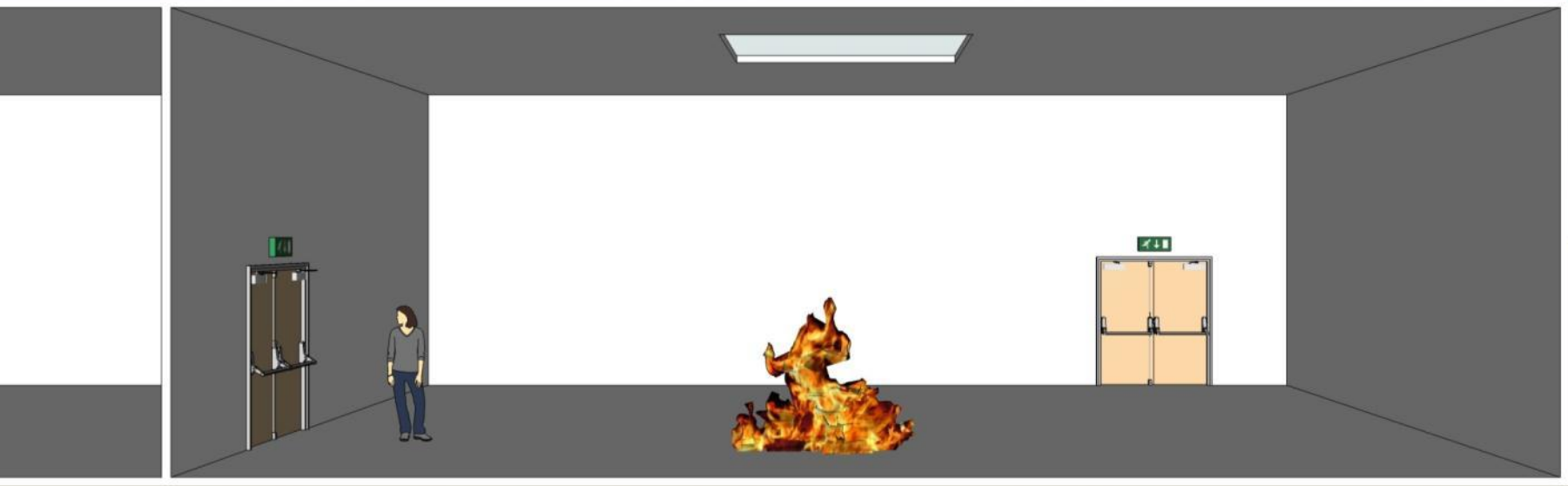
# Performance based design – controlled fire load



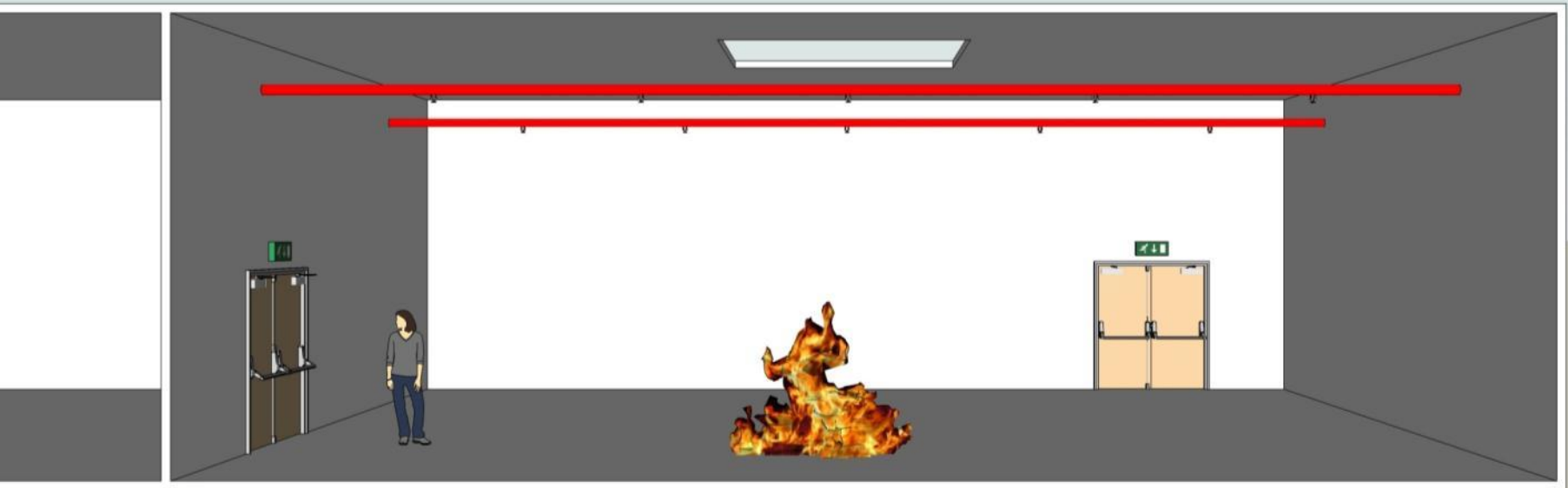
# Performance based design – progressive escape



# Performance based design – ventilation



# Performance based design – sprinklers



Conventional Prescriptive Design	Performance based design
No or limited allowance for compensatory features	Fire Safety Features allow for relaxations in escape requirements
It's a one solution fits all approach	It allows flexibility in the design and can consider specific operational requirements
It can break down when considering complicated evacuation strategies or high populated spaces	It can be used for high populations, various scenarios and changing parameters
It can lead to significant over <u>or</u> under design	Potential to reduce the numbers of escape routes/Rationalise the design

## Message 2:

Evacuation modelling can bring tailored solutions and flexibility where prescriptive guidance can't.



## Section 2

MassMotion – evacuation modelling



# Mass Motion – The Software

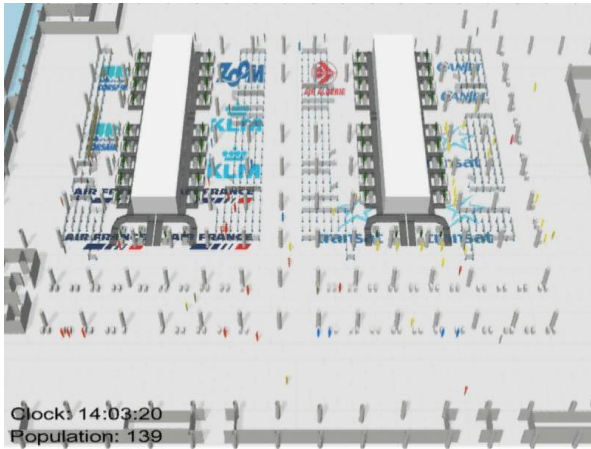
- Product of Oasys-software (Arup In-house software firm).
- Pedestrian simulation for designing and optimizing high occupancy facilities.
- Create and model large scale (1,000,000+ individuals).
- Used in demanding pedestrian environments including
  - mass-transit stations,
  - performance venues,
  - airports,
  - stadiums.
- Communicates complex problems in a highly visual manner.



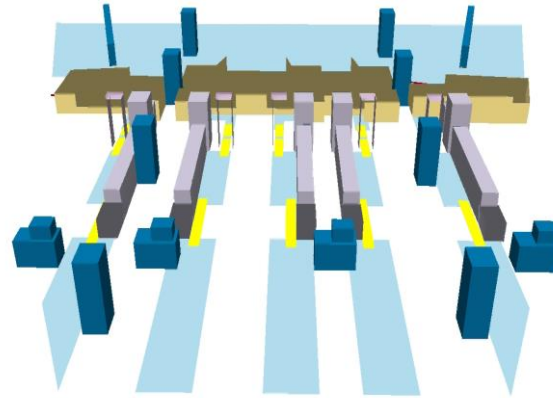
UNION STATION  
FUTURE EVENING PEAK

# MassMotion capability

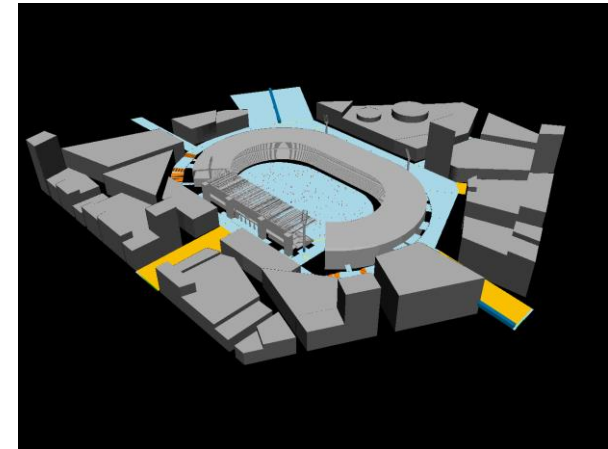
## Transport facilities



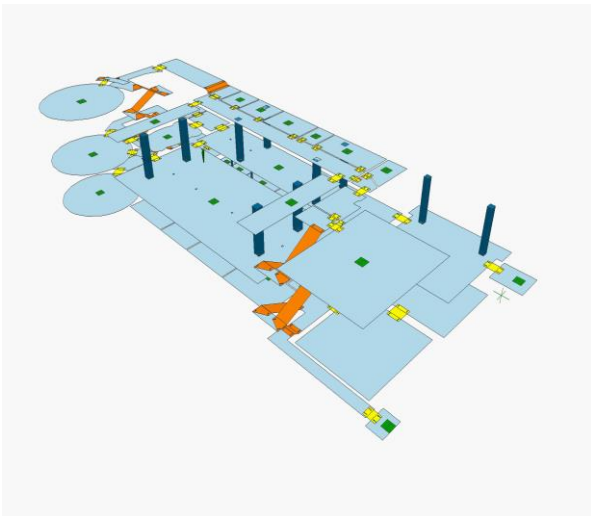
## Process modelling



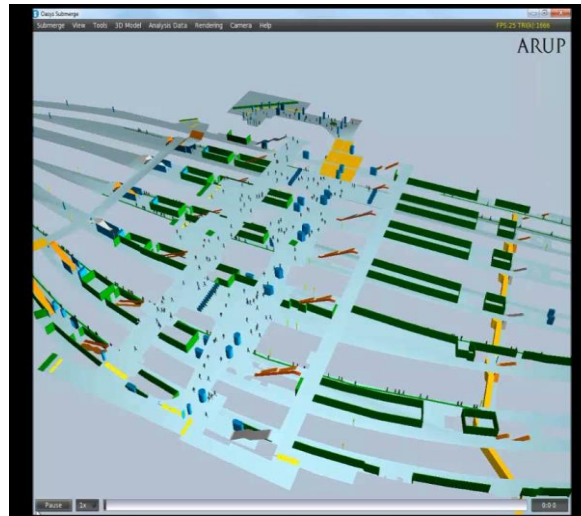
## Crowd management



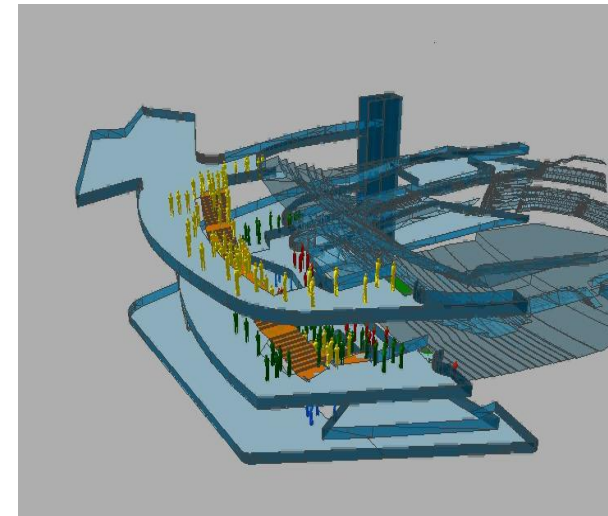
## Existing buildings



## Live construction environments



## Stadia and venues





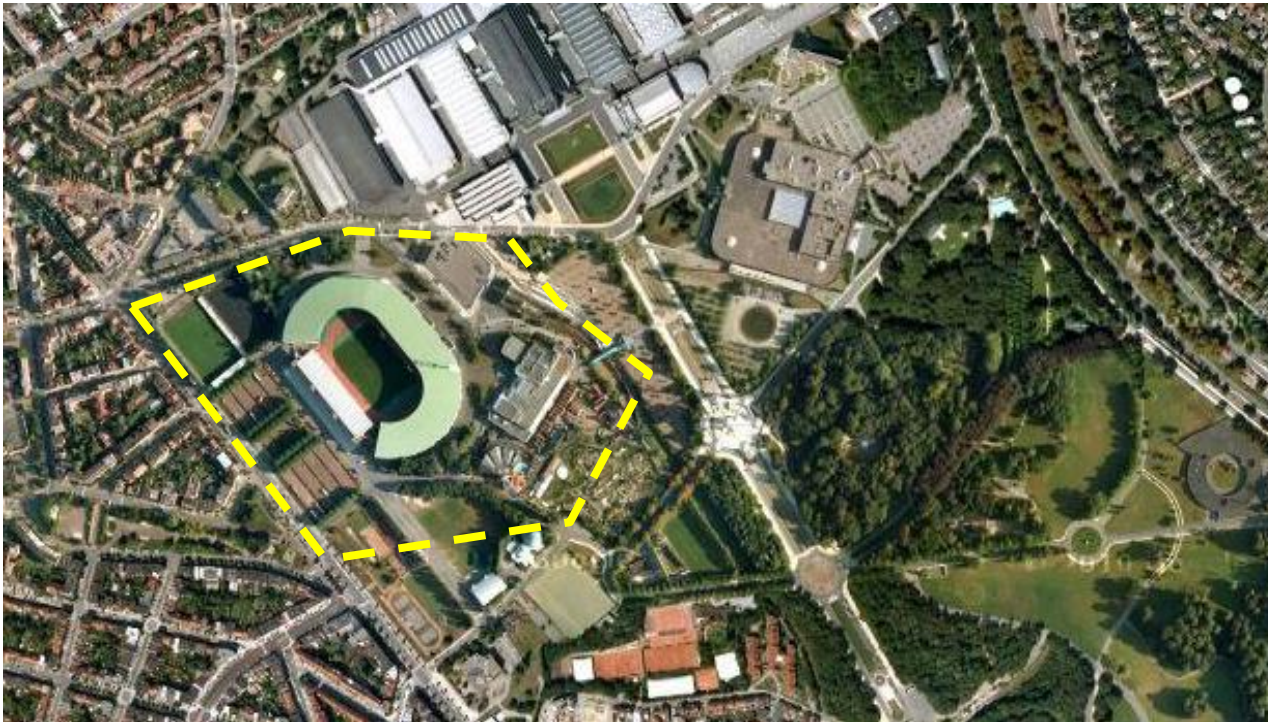
## Section 3

Case studies – Evacuation



# European Stadium – Overview

- Land surrounding existing stadium to be developed.
- Currently ample space provided around the stadium for escape.
- Proposed master plan meant reducing the available space surrounding the stadium for escape.



# European Stadium – Aims and Challenges

## Masterplan client

- Maximising the potential land space for future construction by developing a design with a minimal amount of restrictions.

## Stadium management

- Providing maximum future flexibility to cater for concerts, sports events and retail areas surrounding the stadium.

## Masterplan architect

- Realising their vision for the expo centre while maintaining sufficient emergency provisions.

## Local police

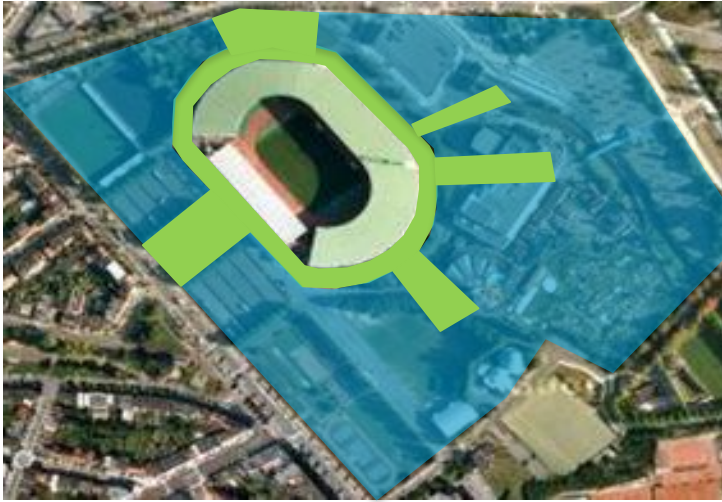
- Incorporating security locations at the entrances to the stadium.
- Providing locations for flexible fan segregation.

## Emergency services

- Providing access to and from the stadium for ambulance and fire services in the event of an emergency.



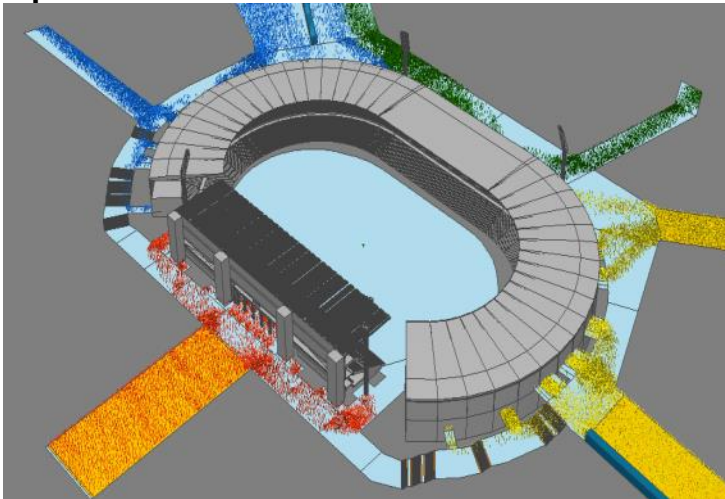
# European Stadium – Our approach



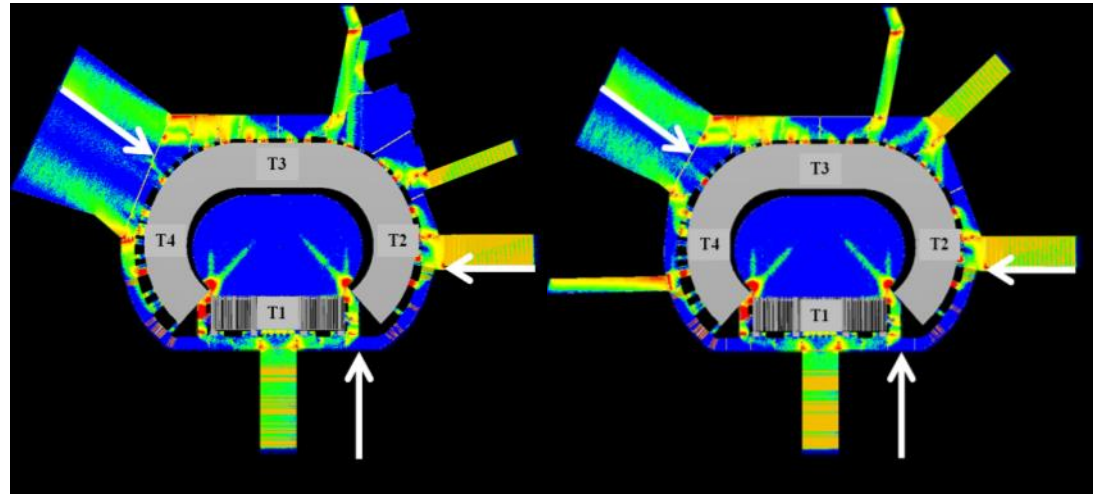
Proposed master plan with constrained space



Modelling approach simulated 80,000 persons for a concert mode

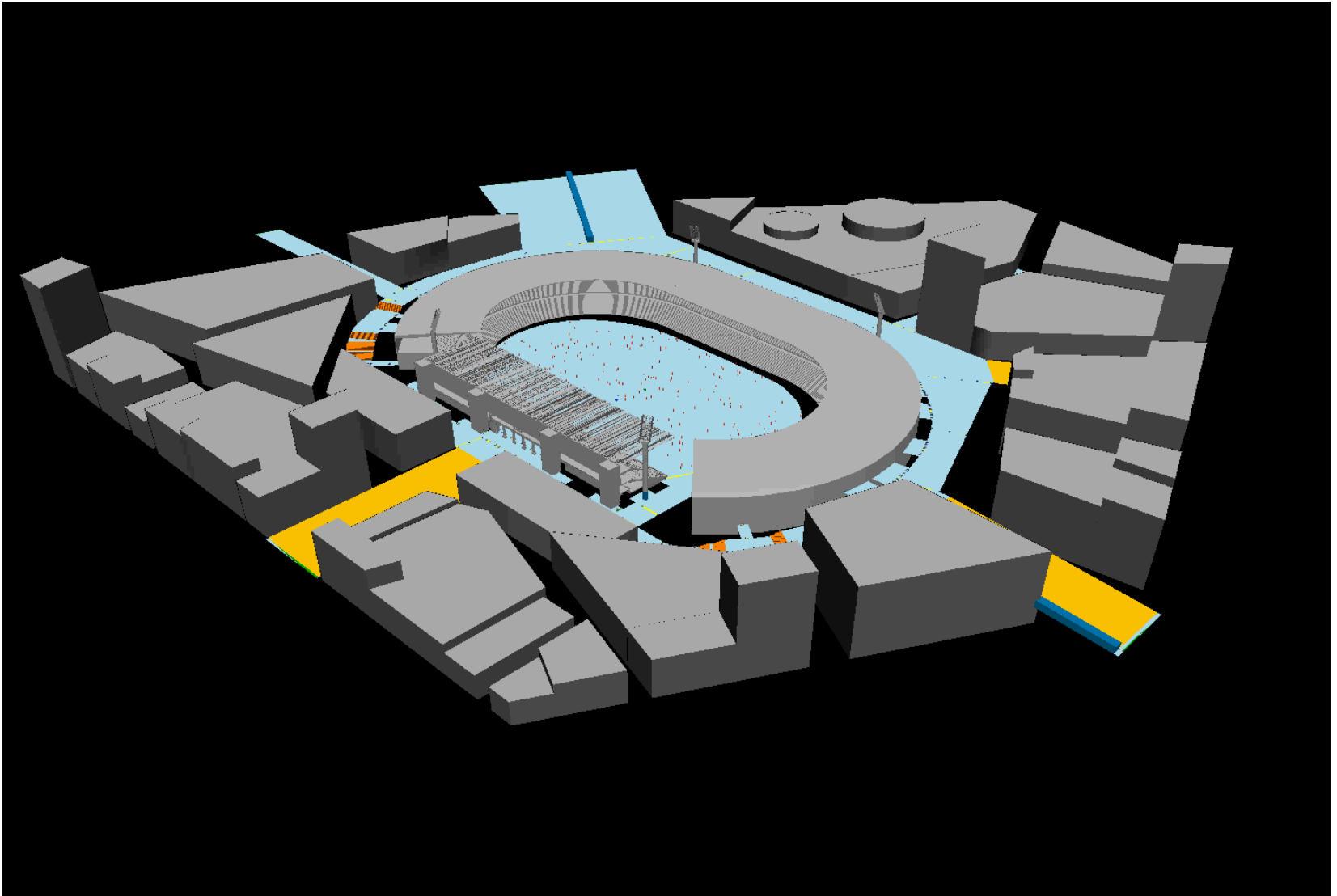


MassMotion model visual



Crowd density maps for different phases

# European Stadium – Simulation Video



# Birmingham New Street, UK - Overview

- Existing sub surface rail station with 12 platforms with a shopping centre located above.
- Accommodates over 140,000 passengers per day. Designed to accommodate half this number.
- Major refurbishment works currently on-going to train station and shopping centre.
- Construction value ~ £600M running from 2009 – 2015.





# Birmingham New Street, UK – Aims and Challenges

## Operational continuity

- All construction works are undertaken in a “live” transport hub and shopping centre.

## Construction phasing

- The construction phasing programme provided demanding time scales for assessment of each new phasing option and required quick response.

## Fire and population scenarios

- A large number of evacuation and fire scenarios needed to be assessed for each phasing option during the on-going construction programme.

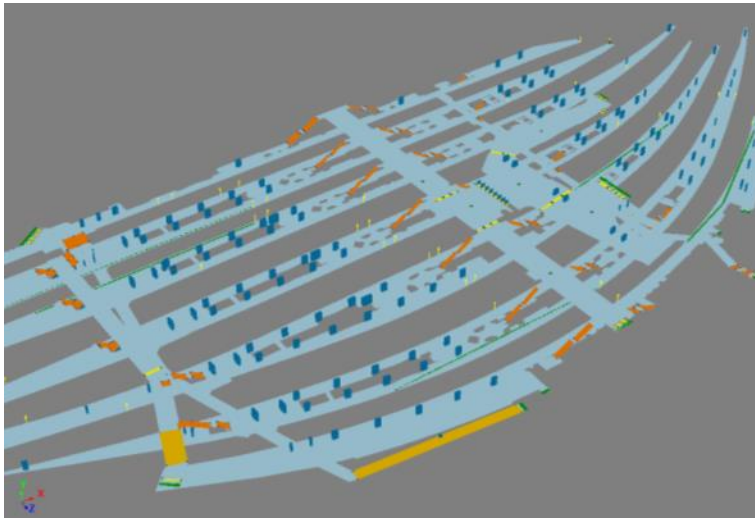
## Traditional methods

- Traditional hand calculations took significant time to complete and presented difficulties in meeting the demanding deadlines.

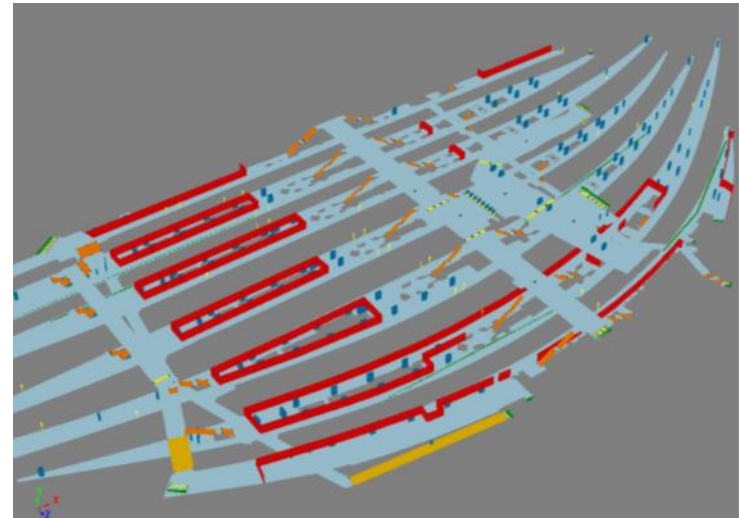
## Stakeholders

- The results of the assessments needed to provide all stakeholders confidence that their decision making would not affect escape from the live building.

# Birmingham New Street, UK – Our Approach

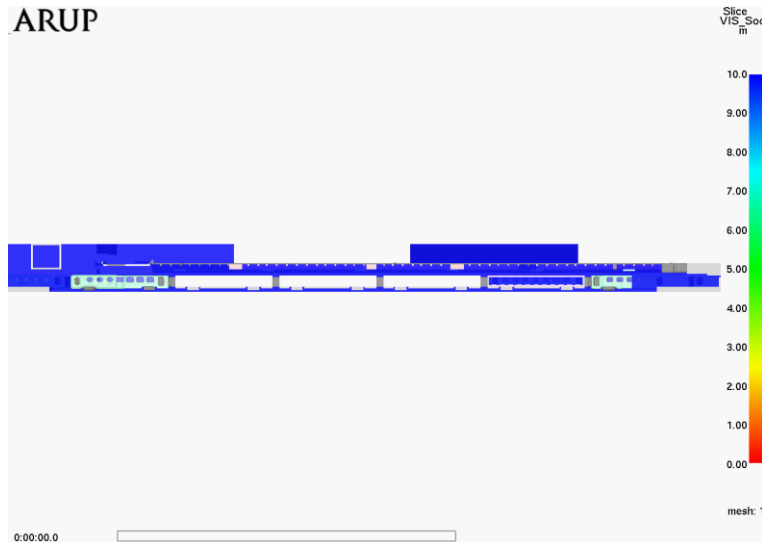


Typical model of existing situation

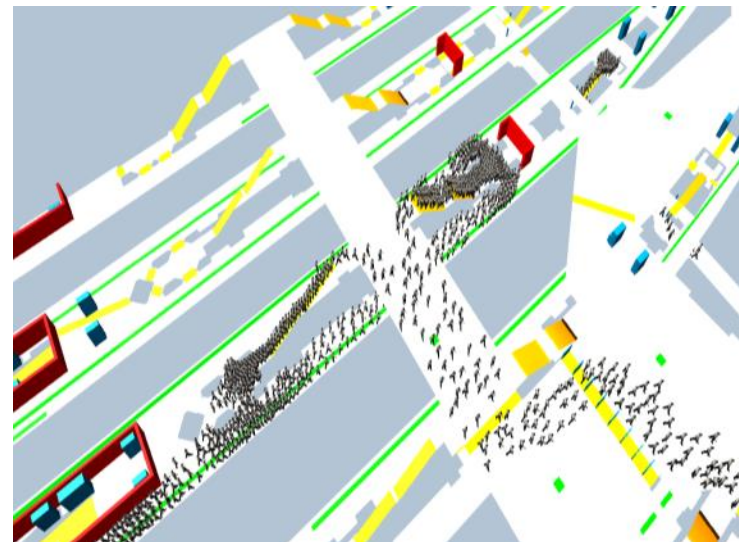


Typical model of one construction phasing option

ARUP

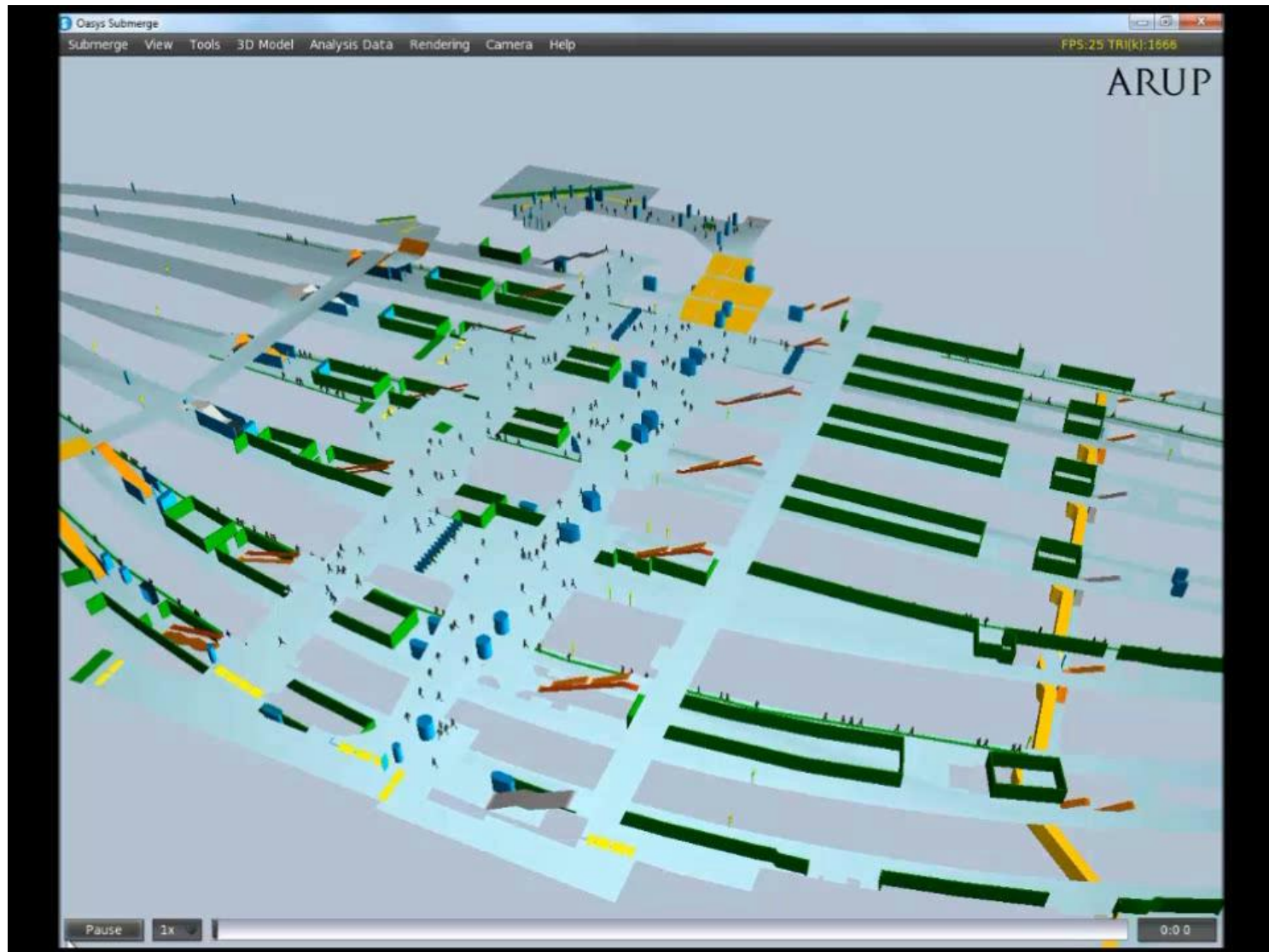


Typical results from CFD analysis for ASET



Typical results of one construction phasing option

# Birmingham New Street, UK – Simulation Video



# Summary of Applications (Fire)

- Large exhibition spaces – Indoor/outdoor events
- Airports
- Construction phasing
- Phased Evacuation/Progressive horizontal Evacuation
- Masterplanning
- Transport facilities – Rail/Underground
- Sports Stadia
- Duplicate Services – Ped Planning, Security etc

## Message 3:

Modelling can bring value to numerous projects



# Summary and Conclusion

- Fire Engineering Input at initial stages can assist in **identifying** and **realising** the goals,
- A **coordinated** approach is necessary,
- Evacuation Modelling can bring **benefits** and **opportunities**
- It can be used on **various** types of **projects** of **all scales**
- Provides clear visual representation of all possible scenarios
- It allows for **flexibility** tailored to **complement** as opposed to conflict with the operational strategy.

# Thank You

Safety Design in Buildings    
Muscat Conference InterContinental Muscat Monday, December 8, 2014

