Introduction to Crowd Science

Prof. Dr. G. Keith Still FIMA FICPEM SFIIRSM MEWI FIPM FHEA
Capt. Marcel Altenburg MA PGDip

Crowd dynamics and crowd behaviour

Focus on anticipating problems, preparing safety plans and preventing accidents and incidents
Crowd management plan

Introduction to Crowd Safety and Risk Analysis
Bridging course from industry to academia

MSc (Level 7)
Crowd Safety and Risk Analysis

Short courses (on-line)
Identity validation, Introduction to crowd safety, Writing a crowd management plan, crowd risk analysis, behavioural based safety, CCTV operators, site and event modelling

Common open event questions (RAMP)

We don’t know how many people may come to the event…
...what is the best way to plan for a major event?

What direction will crowds approach and depart the area?
Route question (transportation hubs to and from event site)

What is your event capacity?
How much Area do you have? How will the area be used?

How quickly will these spaces fill?
What crowd Movements do we expect?
Over what period of time?

What type of crowd are we expecting?
People, demographics, families?
**Routes - parade distribution/pressure**

No immediate rail access

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**Leicester Caribbean Carnival**

The premier multi-cultural event - Midlands (UK) 100,000

For 25 years high profile, city wide revenue
Low crime and disorder

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**Areas - Victoria Park – 90,000m²**

10,000 m²
8,400 m²
7,000 m²
Model of the change of venue

Google Earth - using simple powerpoint graphics.
The visuals do all the work

Site rejected - the event will not fit in the space!

Crowd fill predictor - movement

Modelling New Year (London 2006 - 2016)

<table>
<thead>
<tr>
<th>Areas (see image)</th>
<th>Area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - Waterloo to Embankment Station</td>
<td>11,955</td>
</tr>
<tr>
<td>B - Embankment to Westminster Station</td>
<td>23,304</td>
</tr>
<tr>
<td>C - Parliament Square</td>
<td>2,092</td>
</tr>
<tr>
<td>D - Westminster Bridge</td>
<td>4,138</td>
</tr>
<tr>
<td>E - Belvedere Road</td>
<td>11,241</td>
</tr>
<tr>
<td>F - Royal Festival Hall</td>
<td>3,000</td>
</tr>
<tr>
<td>G - Waterloo Bridge</td>
<td>9,143</td>
</tr>
</tbody>
</table>

Manchester City v West Ham: 8/01/2014, 7.45pm

- Sales = 30,381
- Attendance = 29,863
- Max Flow = 760
- Total entries through K = 3485
- Max Flow through K = 100

Movement
People (profile)

Composition, demographics, history
Previous behaviour (linked to performer/venue)

What do we know of this crowd?

Using models for decision support

Modelling work for the Sydney Olympics
Site analysis, crowd management plan

Control room systems
Capt. Marcel Altenburg MA PGDip

Captain and Unit Commander in the German Federal Armed Forces
12 years leading and training ground combat troops

Leading role in control rooms and situation rooms
Military and civilian

MA in Human Science
Hamburg University and Helmut-Schmidt-University, Germany (2008-2012)

MSc Student in Crowd Safety and Risk Analysis
Manchester Metropolitan University (since 2015)

Enterprise Delivery Fellow at MMU
16th Jan 2017 (4 days before the inauguration)
2 years working with me on international projects
Using Google Earth to estimate the distance

Using Google Earth to approximate the field of view
This maps to a ground area calculation
**Approximate field of image view (1,410 m²)**

1410 m² x 5 people per square metre = 7,050 people

**Anthropomorphic analysis**


The average height is 5 ft 7 in.
The average weight is 137 lbs


The average height is 5 ft 9 in
The average weight is 166 lbs

+20% body mass, we can assume a 6 people per square metre packing density for smaller body sizes (even in Winter)

**4 March 1861**

Head Count (Approximation)

7,350 people

Boasting of 3,000,000 people

“Can you guys do this LIVE?”

“I think I’ve been treated very rough. I will say the Times is about the roughest of all.”

Donald Trump to the New York Times
Routes for the inauguration 2017

What area will the crowd occupy?

New York Marathon 42.195km

42 km x 2 sides = 84,000m
x 2 (people per metre) = 168,000 people
x 11 deep (both sides) = 1,848,000 people
x 18 deep (both sides) = 3,024,000 people
Obama (2009) 175,000m² occupied space

Estimated 1.8 million people (would require 720,000 square metres)

Obama 2009 = 175,000 m² so 400,000 - 500,000 people (@ 2.5 pm²)

From the White House website we had the area allocations

We can map these areas using Google Earth Pro

Measure the space
Evaluate the capacity
Evaluate the routes
Evaluate the transport and parking capacity

Then monitor the crowd build up on the day
How the space is filling over time

Crowd Dynamics

Bowl = 39,346 m²
-10% for spaces
35,000 m² of seating
All seated 2 people per square metres
70,000 people (approx)

Penn Avenue = 7,300m²
Union Square = 20,000m²
Maryland Ave. = 5,300m²
Mall Standing = 33,200m²
Total area = 65,800m²
At 2pm² = 131,600
At 3pm² = 197,400

The Bowl
70,000 people

Between 200,000 and 267,400 people

If 100% occupied space
250,000 tickets
We can see the white flooring
Used in 2013

Only part of the mall area was covered

The Mall area was smaller 200,000 m²

It could hold 500,000 people (@ 2.5 pm²)
If fully occupied

For safety, the sections are divided
Barriers and the media tent

Movement (metro and parking - live)

Compare against 2009

D.C. METRO RIDERSHIP

As at 11 a.m. ET on previous inauguration days (in millions)

<table>
<thead>
<tr>
<th>Date</th>
<th>Ridership</th>
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<tbody>
<tr>
<td>Jan. 20, 2005</td>
<td>197,000</td>
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<td>Jan. 20, 2013</td>
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100%
Time lapse of the 2017 inauguration

Measuring the satellite images

From the 2009 satellite images we can measure the high density areas. The front 1/3rd (beyond the reflecting pool) was full in both events. The back 2/3rds were empty for 2017.

The high density areas were 1/3rd of 2009

At 11am 193,000 trips (2017)

The New York Times published the article, using the above graphics. We had confirmation in the visuals, the area analysis, the crowd build up over time and the metro data. All point to 1/3rd the Obama crowd.
New York Times (21st Jan 2017)

Great job guys, could you count the Women’s March today?

How big would this crowd be?

Will this become a story?

0100 our job was complete
13 hours of live analysis

Routes, Areas, Movement, People
Areas and crowd shapes (noon)

Crowd density (packing - noon)

Women’s March - the gathering
Inauguration

Women’s March

“We’re going to need a bigger scale”

Janelle Monáe

145%
Women’s March
180,000 sqm

Inauguration
61,000 sqm

New York Times - graphics department

Washington metro ridership
Saturday’s march in Washington overwhelmed the city’s Metro subway system, with enormous crowds reported and some stations temporarily forced to turn away riders.

D.C. METRO RIDERSHIP
As of 11 a.m. ET on previous inauguration days and Jan. 21

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Source: Official Twitter feed of the Washington Metropolitan Area Transit Authority (WMATA)
C. Chan 22/01/2017

Metro Ridership as of 11am: 275k. For comparison, that's more than 8x a normal Sat & even busier than most weekdays.
#wmata #womensmarch

BUS PARKING PERMITS SOUGHT IN DC

TRUMP INAUGURATION: 393
WOMEN’S MARCH: 1,200
OBAMA 2009 INAUGURATION: 3,000

SOURCE: D.C. OFFICIALS
We had a call from the CIA building

“Switch on the TV - you need to see this”

“I made a speech, I looked out..”

It was a mostly empty field
Not packed to the Washington Memorial,
3rd to 9th only partially full
6 blocks not 20
It was raining throughout
Global news coverages - rained throughout

Dubya, still clowning around after all these years

George W. Bush made international headlines trying to pull on a poncho during the speech

A moment of light relief in an otherwise downbeat, doom and gloom, speech

Saturday 21st Jan 2017

Kellyanne Conway - Counsellor to the President

Trolls - these are NOT at the same time

We can see Obama and Trump on the screens!
"I will not allow you, or anyone like you..."

As we elevate the image

We can see the spaces (higher viewing angle)

48.8m by 109.7m = 5,353.36 m²
Pitch full = 13,383 people

Here’s How We Know 440,000 People Attended The Women’s March In D.C.

Aerial photos, modeling, and counting defied bad weather to get solid estimates for the D.C. protest. But inauguration turnout remains cloudy.

Independent validation (hi-resolution images)

Crowd counting estimates vs hard count
Sir Anthony Hopkins as Prof. Dr. G. Keith Still
Michael Fassbender as Capt. Marcel Altenburg

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Thank you for listening