Enhancing Prescriptive Approaches Using Performance-Based Methods

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SFPE Live Member Webinar
16/6/26

Twelve Angry Men (1957)

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Contents

- Prescriptive and performance-based approaches are widely used.
- Derived prescriptive rules can only account for scenarios with known building types, uses, fire threats and population types.
- As these scenarios evolve, performance-based approaches might be used to quantify changes to prescriptive rules.
- *Modelling is involved everywhere – whichever way you go.*
- Potential for crossing regulatory streams to enhance code development.
- Challenges for engineers and limitations in models and modellers.

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All opinions raised are my own, and do not reflect on any organisations that I mention or with whom I am affiliated.

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CSRPS Research and Practice

CSRPS aims to improve societal safety, resilience, and security by advancing knowledge and computational capabilities to address critical challenges, including:

- **Computational fire safety**
- **Disaster resilience**
- **Crowd safety**
- **Protective security**
- **Pathogen dispersal**

We will do this through: Data Collection and Modelling.

Security bollards and evacuation : comparing trials and modelling

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CODE IMPLICATIONS

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Regulatory Approaches

- Broadly two regulatory approaches:
  - **Prescriptive:**
    - Set of rules that, if followed, are deemed to produce a design with a sufficient level of safety.
    - Practitioner required to understand the rules and their design implications.
    - Requires significant amount of expertise and experience to be embedded in the rules ensuring that the knowledge of contributors (e.g. stakeholders, experts, code developers, etc.) is reflected.
    - **Precludes ranking of compliant designs or numerical assessment of code changes.**
  - **Performance-based:**
    - Framework supporting performance estimation (e.g. evacuation time) to determine whether the design affords a sufficient safety margin.
    - May prescribe the scenarios examined, the assumptions made, the tools employed and/or the metrics that are reported to constrain the process and ensure baseline performance.
    - **Places greater onus on the practitioner's expertise and decisions.**

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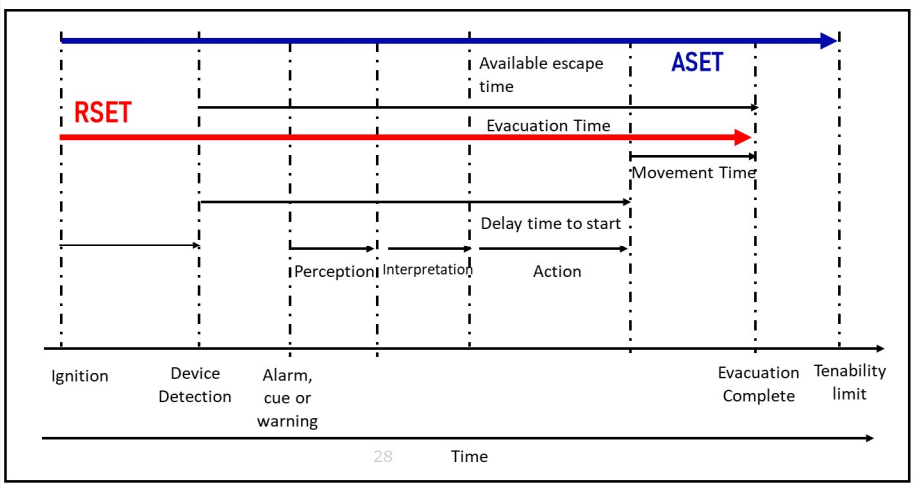
ASET v RSET



- Implies need to quantify performance.

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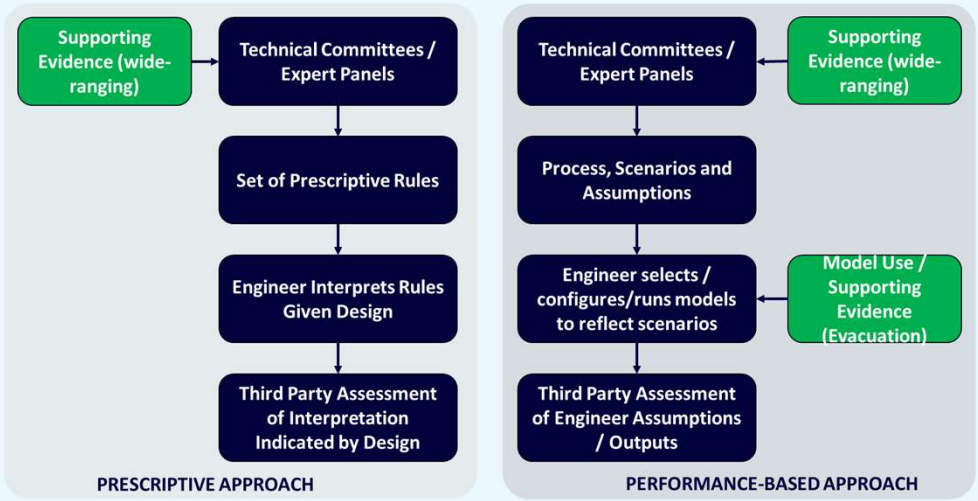
Regulatory Approaches:



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SUBJECT MATTERS: HUMAN RESPONSE

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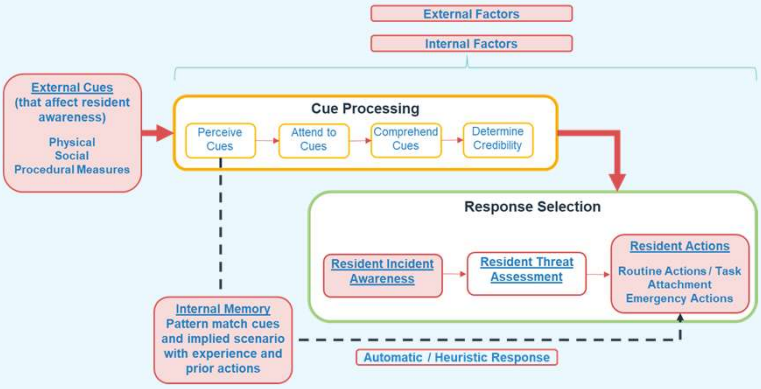
Decision-Making Process



- Decision-making is a process - not a one-off activity.
- Sensitive to information available.
- Actions will be performed to varying degrees of effectiveness.
- People do not respond uniformly or automatically or have same capabilities.
- Without support, the physical infrastructure / management procedures unlikely to be used effectively.

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So what?

- We are biological and biographical.

- Our response capability varies.

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Building as a People Movement System

(ICE)		Procedural Activities (SOS)		
		Safety (S)	*Operation (O)*	Security (S)
Phase of Movement	*Ingress (I)*	Fire Department Arrival	Ticketed Access	Ensuring appropriate exits are used for ingress
	Circulation (C)	Crowd management	Providing information on facilities and services	Managing Access to areas within the structure
	Egress (E)	Managing emergency evacuation	Leaving the building	Ensuring appropriate exits are used for egress

Implied silos are breaking down.

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MODELLING BASICS

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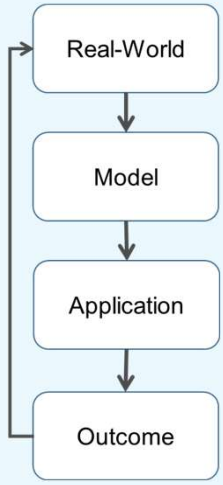
What is a model?



- A simplification or approximation of reality - **imperfect by nature – to assist understanding or explore outcomes.**
- Distance between model and real-world needs to be understood.
- **I assume I am ignorant, and my model is inaccurate.**
- Model is not used in a vacuum.
  - Sophisticated model can be undermined by inexpert user / simple model can be effectively employed by expert.
- Results are not a solution! Just adds evidence.
- **Our attempts are to be more informed and representative – but we will always ALWAYS be wrong to some degree.**

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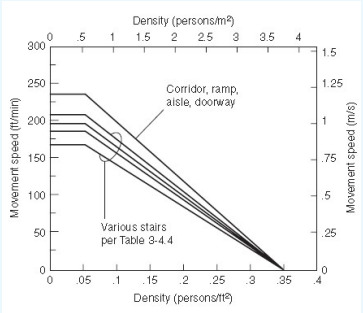
What is a model?



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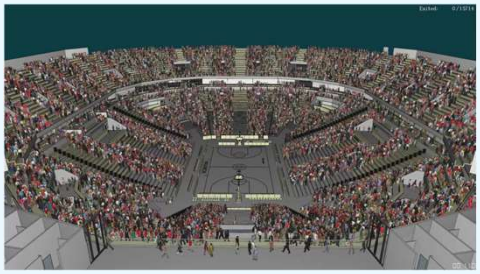
What is a model?

EGRESS WIDTH PER OCCUPANT SERVED

OCCUPANCY	WITHOUT SPRINKLER SYSTEM		WITH SPRINKLER SYSTEM[a]	
	Stairways (inches per occupant)	Other egress components (inches per occupant)	Stairways (inches per occupant)	Other egress components (inches per occupant)
Occupancies other than those listed below	0.3	0.2	0.2	0.15
Hazardous: H-1, H-2, H-3 and H-4	0.7	0.4	0.3	0.2
Institutional: I-2	Not Applicable	Not Applicable	0.3	0.2



All are simplifications. Important to be sceptical with all models and the results produced.
Much as we might hate it, we are all modellers now.

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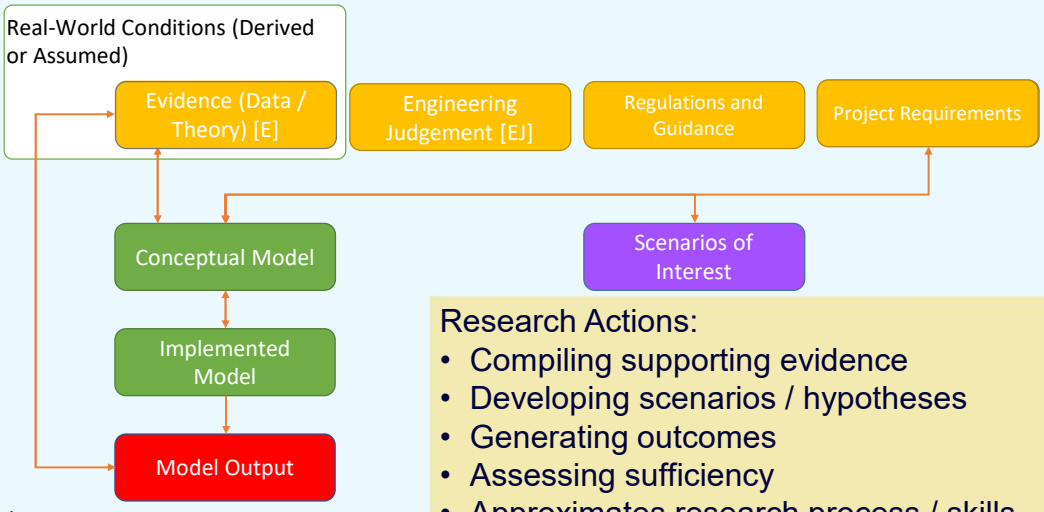
Quantifying Performance



Research Actions:
- Compiling supporting evidence
- Developing scenarios / hypotheses
- Generating outcomes
- Assessing sufficiency
- Approximates research process / skills

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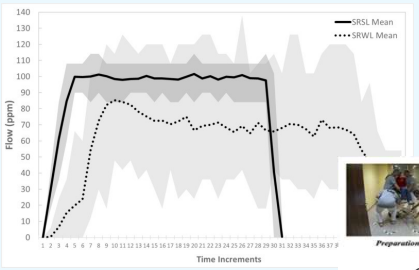
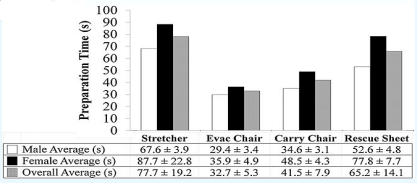
Data sources need to become your friend





	Stretcher	Evac Chair	Carry Chair	Rescue Sheet
Male Average (s)	67.6 ± 3.9	29.4 ± 3.4	34.6 ± 3.1	52.6 ± 4.8
Female Average (s)	87.7 ± 22.8	35.9 ± 4.9	48.5 ± 4.3	77.8 ± 7.7
Overall Average (s)	77.7 ± 19.2	32.7 ± 5.3	41.5 ± 7.9	65.2 ± 14.1

- It is critical that the practitioner develops a familiarity with the data available and the relevance of different resources. Likely need to develop own repository of inventory.

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IRONIC DEMOS

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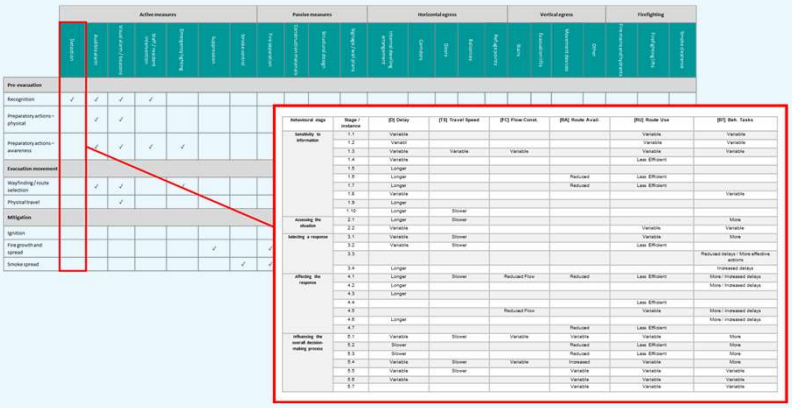
Informing Post-Grenfell Regulatory Development

- UK gov. project examining impact of residential building design on egress.
- Generate evidence to inform statutory guidance given by ADB.
- Based on assumption that evacuation is more likely given Grenfell incident.
- Initially, reviewed physical design factors and impact on evacuation



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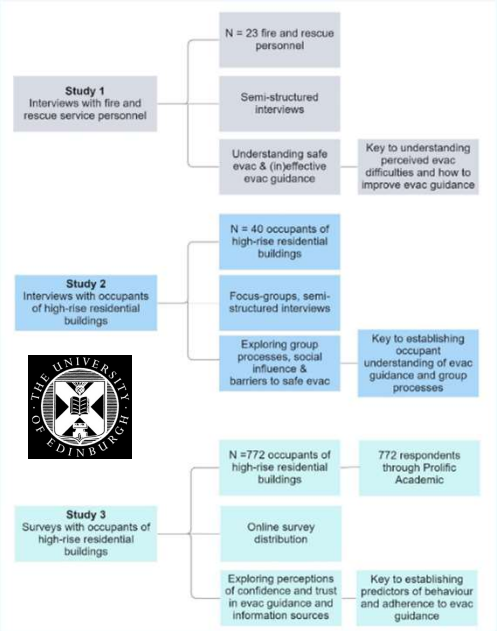
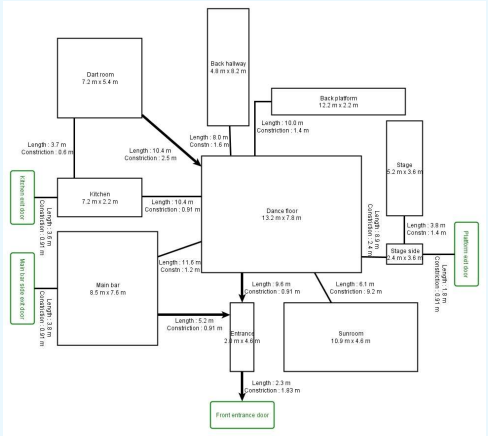
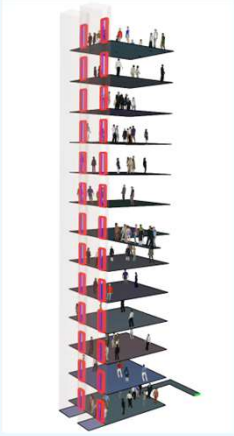
Data Collection and Model Selection



Model A : Evacuationz



Model B : Pathfinder



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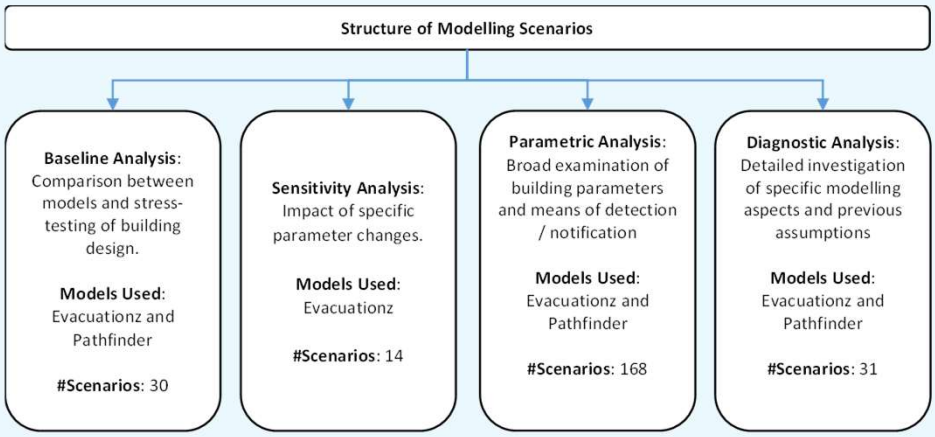
Scenario Development and Simulation



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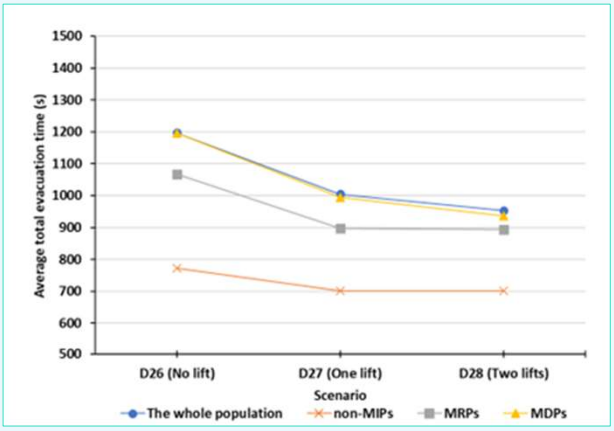
Example Results



Movement Capabilities	Building configuration	Total evacuation time (min)			
		Immediate	Tone	Voice	Reliant on inter-resident communication
No sub-population require assistance.	One stair	14.8	28.2	21.0	27.4
5% sub-population require assistance.	One stair	17.4	30.9	24.8	29.7

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Example Implications

Detection and notification

- Building-wide voice alarm coupled with flat heat detection reduced total evacuation time (across relevant scenarios) by an average of 38% vs. social notification alone.

Introduction of Lifts

- A single lift reduced total evacuation time by 15% vs. no lift; second lift reduced total evacuation time by 23% vs. no lift.
- A single lift reduced total evacuation time by 19% for stair users and by 16% for lift users. A second lift reduced total evacuation time by 19% for stair users (no difference) and by 24% for lift users.

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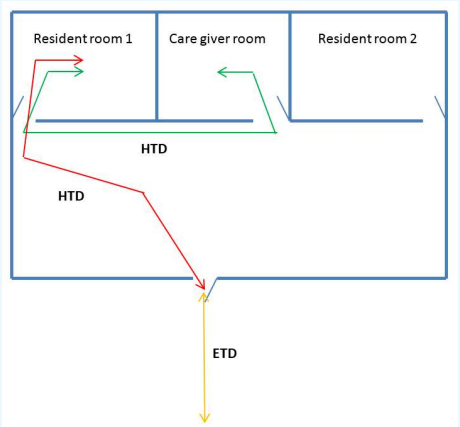
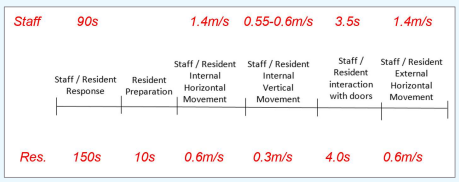
Home Care Occupancy Type





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DEMANDS ON THE USER

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The User's Mind-Set

Stage	Associated Actions	Mind-Set
The Brief	Get **Project Requirements** from Client / Regulations.	**[1] IGNORANCE**
Assumptions and Inputs	Identify **initial conditions, elements that will update conditions (e.g. evacuee behaviour) and then factors that need to be represented**.	**[2] CURIOSITY**
Building the Model	Identify **model to be applied, the scenarios to be examined and data required to support**. Determine whether the model is driven, a proxy or a prediction.	**[3] CREATIVITY**
Checking the Model	**Test assumptions, data used and model applied** are consistent within and between scenarios. Determine whether model performs as expected and is representative of real-world conditions.	**[4] SCEPTICISM**
Running the Model	**Execute the model** and compile the output produced.	**[5] PRECISION**
Compiling and Reckoning	**Report degree of confidence in the results.** Document what is in the model and what is excluded (and why).	**[6] HUMILITY**
Extracting Insights	**Identify relationships / patterns initial conditions and outcomes**, within and between scenarios. **Identify lessons** that might go beyond current project.	**[7] STOICISM**

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The User's Workload

- Are we recruiting practitioners better at generating numbers than in modelling the real-world scenarios of interest?
- **In practice, do good tool users (number producers) get more attention than good modellers?**
- Generating numbers will only provide a more refined depiction of the wrong scenario if the modeller has not understood the real-world conditions being represented.

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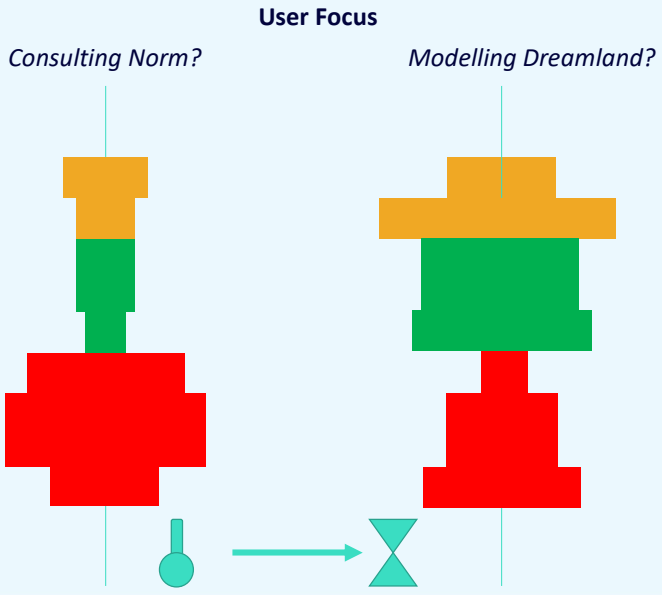
The User's Workload

	Stage
Seven Stages of Modelling	The Brief
	Assumptions and Inputs
	Building the Model – Scenarios/Progress
	Checking the Model
	Running the Model
	Compiling and Reckoning
	Extracting Insights



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The Changing Fire Safety Character

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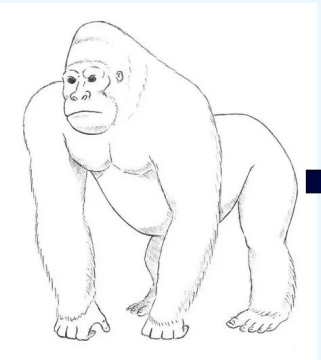
Concluding Remarks: 800lb Gorilla in the Room



- Subject matter expertise is going to become increasingly important in age of model-agnosticism and fake news.

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Concluding Remarks

- Be **transparent** – what did you assume, what did you do and why did you do it?
  - Provide for repetition.
- Be clever enough – **competent and informed** of model, sources and process.
  - Do the basics well. Be current. Ideally, collect data.
- **Be clear and concise** – eccentric and bloated, overly complicated reporting hurts and remains unread.
- **Be honest and open** – state your / the model's limitations and gaps.
- **Discriminate** – between inputs / outputs; driven outcomes and predictions.
- **Be prepared to be unpopular -** you are serving the client by serving the veracity of the model.
- Be aware that the model is not reality. Understand the difference.
  - **Never ever change view of reality to fit the model.**
- **Be curious; be sceptical.**
  - Check and be checked**. Be humble.**

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Ever tried.
Ever failed.
No matter.
Try again.
Fail again.
Fail better.
Samuel Beckett

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