

Tech, Trust, and Transparency

Exploring futures for fire safety equity

Arup

1946

Founded by Sir Ove Arup

18,000+

People

£2.2bn

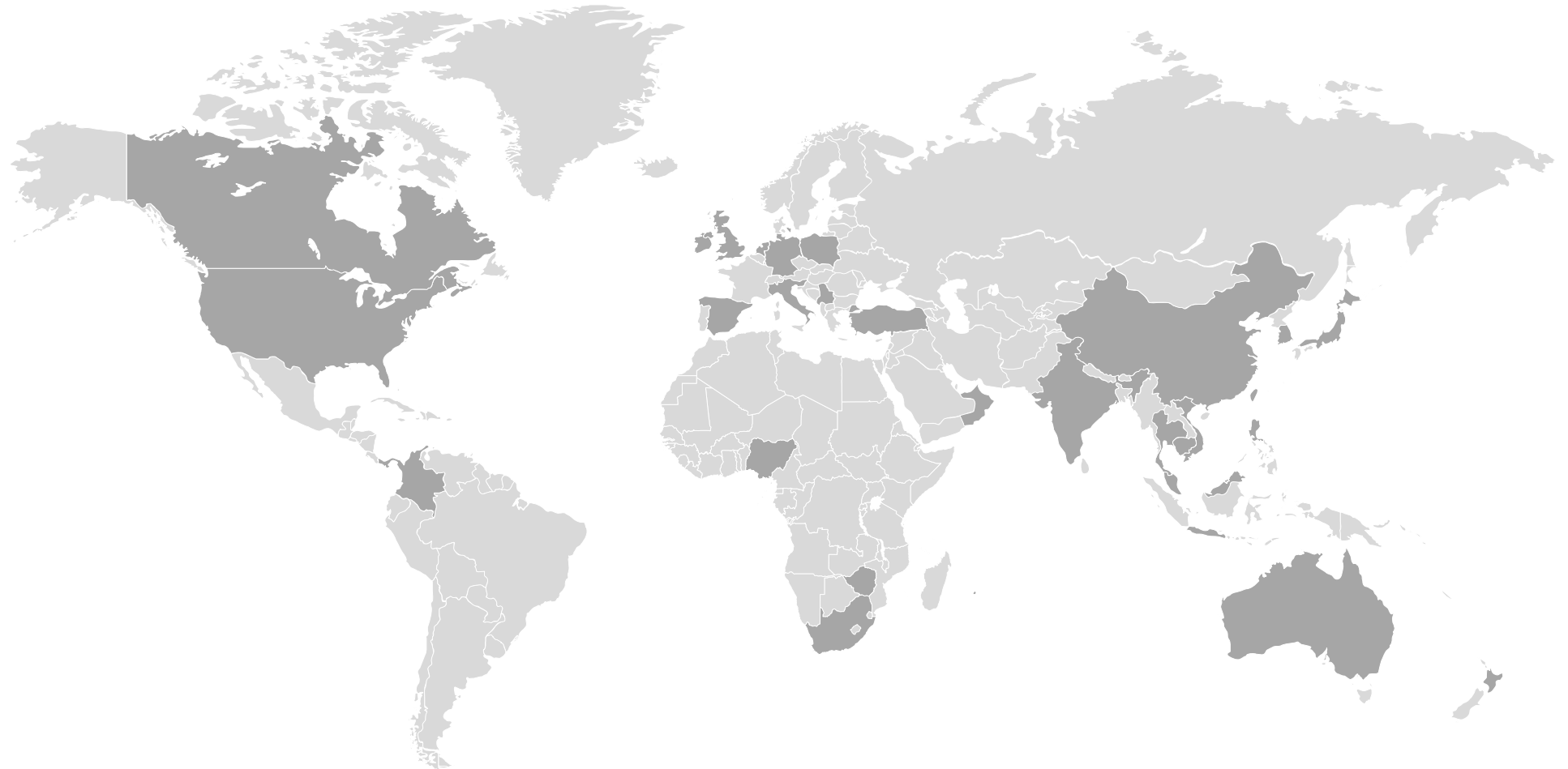
Turnover (2022/23)

94

Offices

34

Countries



Arup Fire Safety Engineering

1974

Founded in the UK by
Margaret Law

300+

People

40

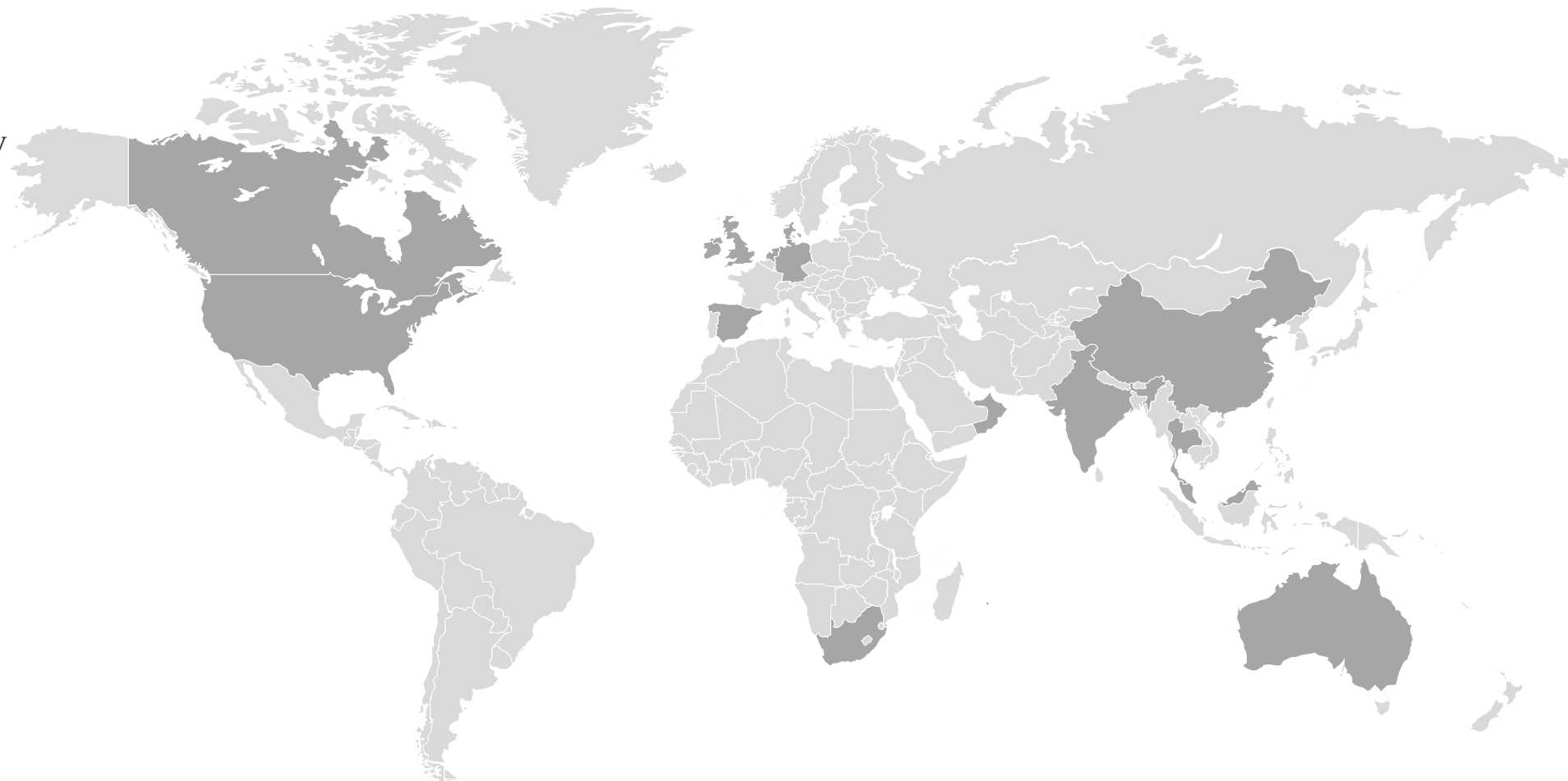
Offices

18

Countries

3000+

Projects annually



Mike Deevy



A leader in Arup's
fire team based in
London

Project Director

Leader in data and
digital technology
for Arup's
technical
specialists

An exploration of how AI and digital technology can change the way projects are delivered now and what this means for fire safety equity.

01 *Using AI to access multidisciplinary knowledge & information*

02 *Using Agents for engineering tasks*

03 *A framework to create AI surrogates*

04 *Some thoughts about what this means for fire safety equity*

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Examples: finding...



CONTRADICTIONS
ACROSS DOCUMENTS



PROJECT
INFORMATION



SPECIALIST
KNOWLEDGE

Example: contradictions across documents

- An LLM assessed 66 main works specification documents for contradictions prior to final draft submission.
 - Individual reports had already been checked by individual document owners and by the client.
 - An independent expert has also gone through the entire set.
 - The LLM assessed the third draft.
- The LLM found 42 contradictions.

Contradictions by Severity			
Severity	Intra-Document	Inter-Document	Total
Critical	0	2	2
High	8	5	13
Medium	14	9	23
Low	2	2	4
TOTAL	24	18	42
Contradictions by Type			
Contradiction Type	Count		
Temperature rating mismatch	3		
Conflicting acceptance criteria	2		
Exception undermines general principle	1		
Incomplete specification	1		
Conflicting deflection limits	1		
Incomplete specification (placeholder)	1		
Moving target mechanism	1		
Incomplete coverage assessment	1		

Example: project information

Arup uses a platform “Fuse” that allows all organisations involved in project to access its Common Data Environments (e.g. ProjectWise, GIS, BIM, SharePoint etc). “Fuse” also provides access to an LLM that assists in finding project information.

[Chat](#)[Search](#)[Knowledge Base](#)[User Guide](#)

Chat with your project

1. Be critical and always check the sources.
2. Include context and remove ambiguity.
3. Consult the Knowledge Base if you want a full list of source documents.
4. Please click [here](#) to read the terms and conditions.

Test out an example or ask anything...

What can you tell me about the project?

What are the project deliverables?

[New Chat](#)[Settings](#)[Source](#)

Type a new question



Example: project information

what are the key documents that describe the contractors duties in relation to safety and equality



Here are the **key contract documents** that outline the duties of contractors in relation to **safety** and **equality** for the Lower Thames Crossing Tunnels project:

1. Safety-Related Key Contract Documents

1.1. Lower Thames Crossing - Tunnels and Approaches Contract General Requirements

- **Document Reference:** [1](#), [2](#)
- **Key Requirements:**
 - Contractors must comply with **road-user safety objectives** and the safety baseline defined in the Stage 3 Safety Plan.
 - Contractors are required to demonstrate compliance with the **DCO safety objectives**, including:
 - Minimum 26% reduction in **Fatal Weighted Injuries (FWI)** per billion vehicle miles for the project.
 - Minimum 29% reduction in FWI for the A2 and A13 within the limits of the works.
 - Achieving a minimum **three-star iRAP rating** between the M2 and M25.
 - Contractors must maintain a **Combined Safety and Hazard Log Report** to demonstrate compliance with safety objectives.
 - Contractors must comply with the **Equality Act 2010**, the Client's **Respect at Work Policy**, and ensure subcontractors also comply.
 - Contractors must implement control and security management procedures to protect the **Client's information security**.

1.2. Code of Construction Practice (CoCP)

- **Document Reference:** [3](#)
- **Key Requirements:**
 - Contractors must produce a **Construction Logistics Plan**, which includes a **Community Safety Strategy** to reduce risks to vulnerable road users.
 - Contractors are required to hold certifications for safety management systems, including **ISO 45001:2018** for occupational health and safety.

New Chat

Settings

Source

Type a new question



1

of 1



- Establishment of a Safety Control Review Group (SCRG) which provides a forum for reviewing and accepting 'safety work' in accordance with the requirements set out in the DMRB. This ensures that the Project identifies, mitigates and manages safety risk.

Utility avoidance

- Elimination of worker safety risks by adjusting the highway alignment to minimise the diversion of significant services including gas mains and electricity cables.
- Arranging for other services to be diverted, away from the works areas, or protected, in advance of the highway construction.

Structural design development

- Allowing for modular offsite construction and designing-in enough space for different construction methods in compounds.
- Allowing for integration of services through bridges as necessary, to improve coordination of safety and buildability.

Onsite considerations

- Live design coordination with onsite ground investigation works.
- Continuous review of construction buildability and space allocation to ensure safety provisions are incorporated into the Order Limits for the DCO.

4.2 Adverse effects on health, safety and wellbeing

DMRB GG 103 Requirement: E/1.4 Design shall identify and respond to any adverse effects on health, safety and wellbeing from projects.

- A detailed report on the findings of an assessment of the likely effects of the construction and operation of the Project on human health and equality can be found in the Health and Equalities Impact Assessment (HEqIA) (Application Document 7.10).
- The designers used a Design Risk Management Tool that considered both health and safety issues. Using this, an additional health hazard risk assessment was developed which considered the human factors and health hazards during some key construction activities. Health is regarded as an

Example: specialist knowledge (Phoenix)

What is Phoenix?

Phoenix is a multidisciplinary, AI-powered chatbot providing immediate access to *trusted multidisciplinary knowledge*.

It allows engineers and specialists to search across a vast collection of curated guidance documents, standards, reports, and forums with ease.

This means faster, more accurate information retrieval.

Example: specialist knowledge

"What factors should be considered when planning the installation of photovoltaic cells in buildings?"

When planning the installation of photovoltaic (PV) cells in buildings, several factors should be considered:

1. System Sizing and Energy Goals:

- Determine the desired percentage reduction in annual grid energy costs (e.g., 1% or 3%). [3]
- Calculate the required PV system size (e.g., kW capacity) and panel area based on energy load profiles and goals. [4]

2. Available Space:

- Assess the available roof or ground area for PV installation. For example, a 1% energy cost reduction may require 11,300 square feet of panel space, while a 3% reduction may require 35,000 square feet.

3. Structural Considerations:

- Ensure the structural integrity of the installation site, such as a rooftop or parking garage, to support the weight and mounting requirements of the PV system.

4. Orientation and Tilt:

- Optimize the orientation (e.g., south-facing) and tilt angle (e.g., 38 degrees) of the panels to maximize solar energy capture. [5]

5. Technology and Efficiency:

- Select appropriate PV technology, such as polycrystalline panels, and consider their efficiency (e.g., 20.4%).

6. Cost and Payback Period:

- Evaluate the capital cost of the PV system and calculate the simple payback period based on expected energy savings. For instance, a 3% energy cost reduction system may cost \$1.87 million with a 12-year payback period.

7. Energy Savings and Carbon Impact:

- Estimate annual energy savings and operational carbon reductions. For example, a 3% energy cost reduction system could save

Phoenix onboarding at Arup

Discipline	Data Ingestion	Knowledge management	UAT & Go Live
Fire Safety			
Ground Engineering			
Acoustics, Audio –Visual & Theatre			
Water Engineering			
Cyber Security			
Material			
Building Performance & Systems			
Building Retrofit			
Resilience			
Structural Engineering			
Electrical Engineering			

Data Ingestion

- Sources
 1. Discipline SharePoint Site
 2. Multidisc forum data
- # of Files – 4653 (~19 GB)
- PDFs only (for now)



Confirmed



In progress

Phoenix user: Freya the Fire Safety Engineer



“I’m a Fire Safety Engineer with 10 years of experience working on a variety of projects such as High-rise commercial buildings, transport hubs and complex mixed-use developments. I’m responsible for designing fire and life safety strategies, checking means of escape and door widths, interpreting guidance and producing defensible design notes”

“I need the right answer, the right clause, and the assumptions laid out clearly.”

Pain Points and worries

- “I lose a lot of time trying to find the correct information from the correct person”
- “Assumptions may be implicit rather than written down”
- “Rework due to drawing changes is a nightmare”
- “I’m heavily context switching between drawings, standards, and notes”
- “I worry about material errors due to small mistakes in my calculations, I’m human after all”
- “Clause references can be missed or misquoted”
- “Can I trust Generic AI answers?”

What a good day looks like

- Clear inputs
- Fast checks
- Minimal rework during review
- Confident that her work is accurate, explainable and traceable

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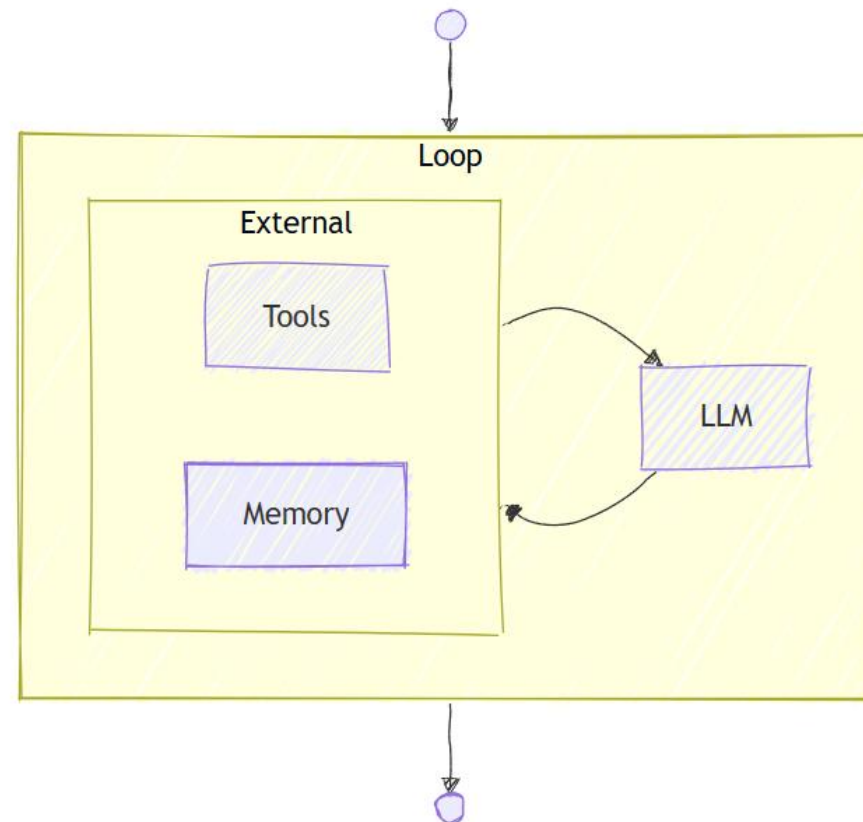
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What is an agent?

An agent is usually driven by a large language model (LLM) and it has access to various tools to help it accomplish tasks.

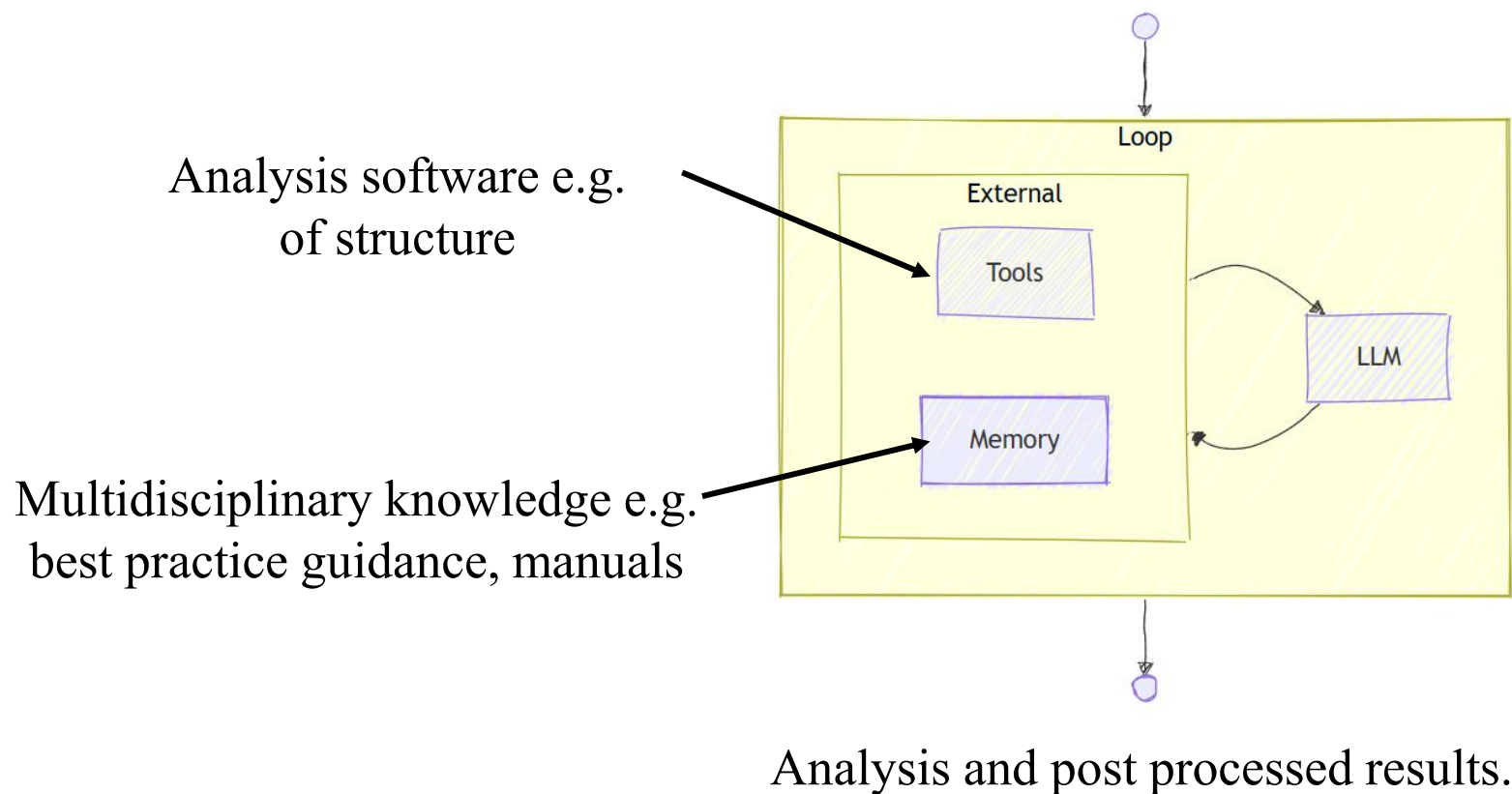
The steps an agent takes are dynamic and determined by the LLM based on the context of the conversation and the tools available.



What can agents do?

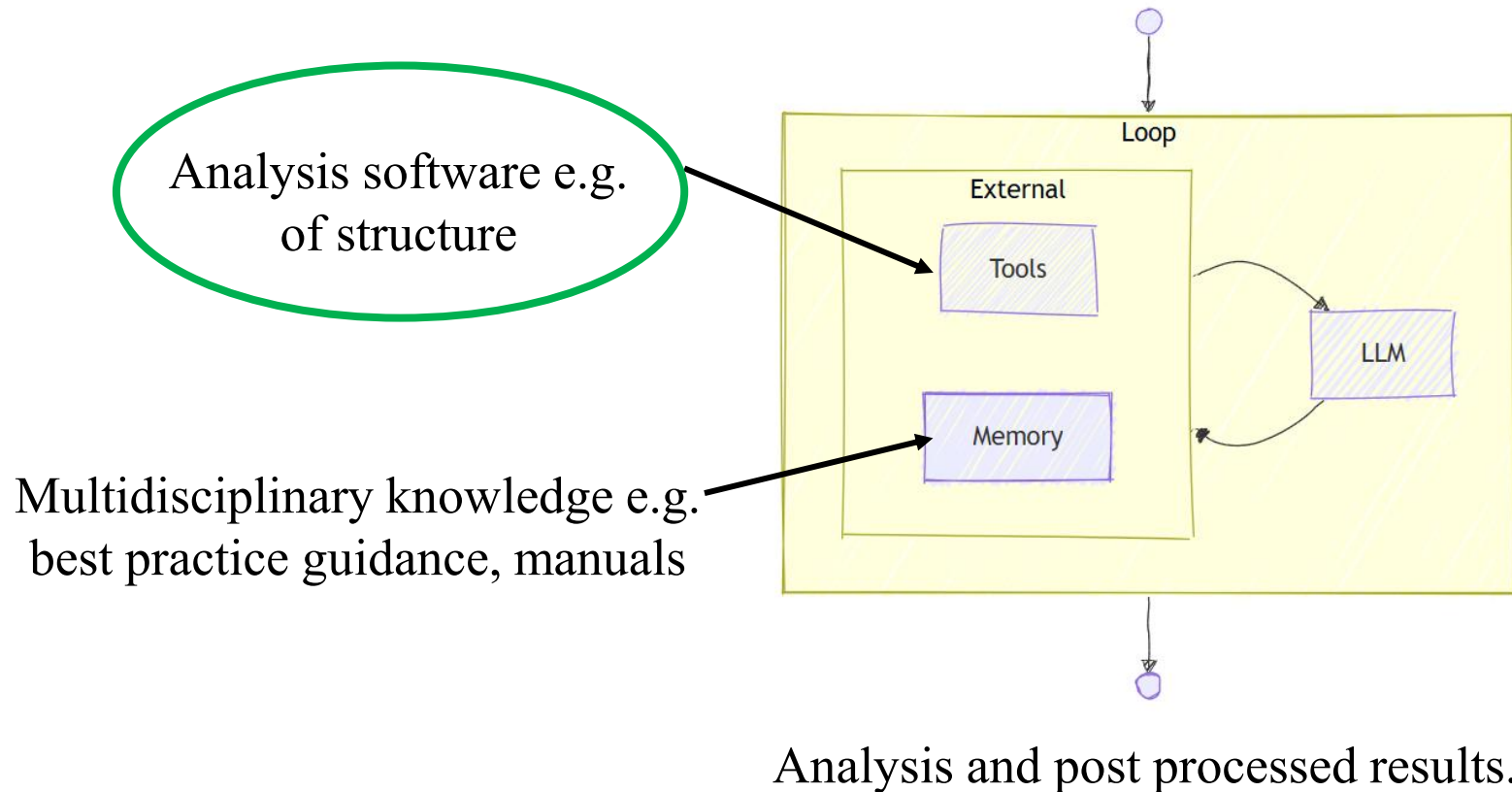
Your prompt:

“Update and run my analysis model”



What can agents do?

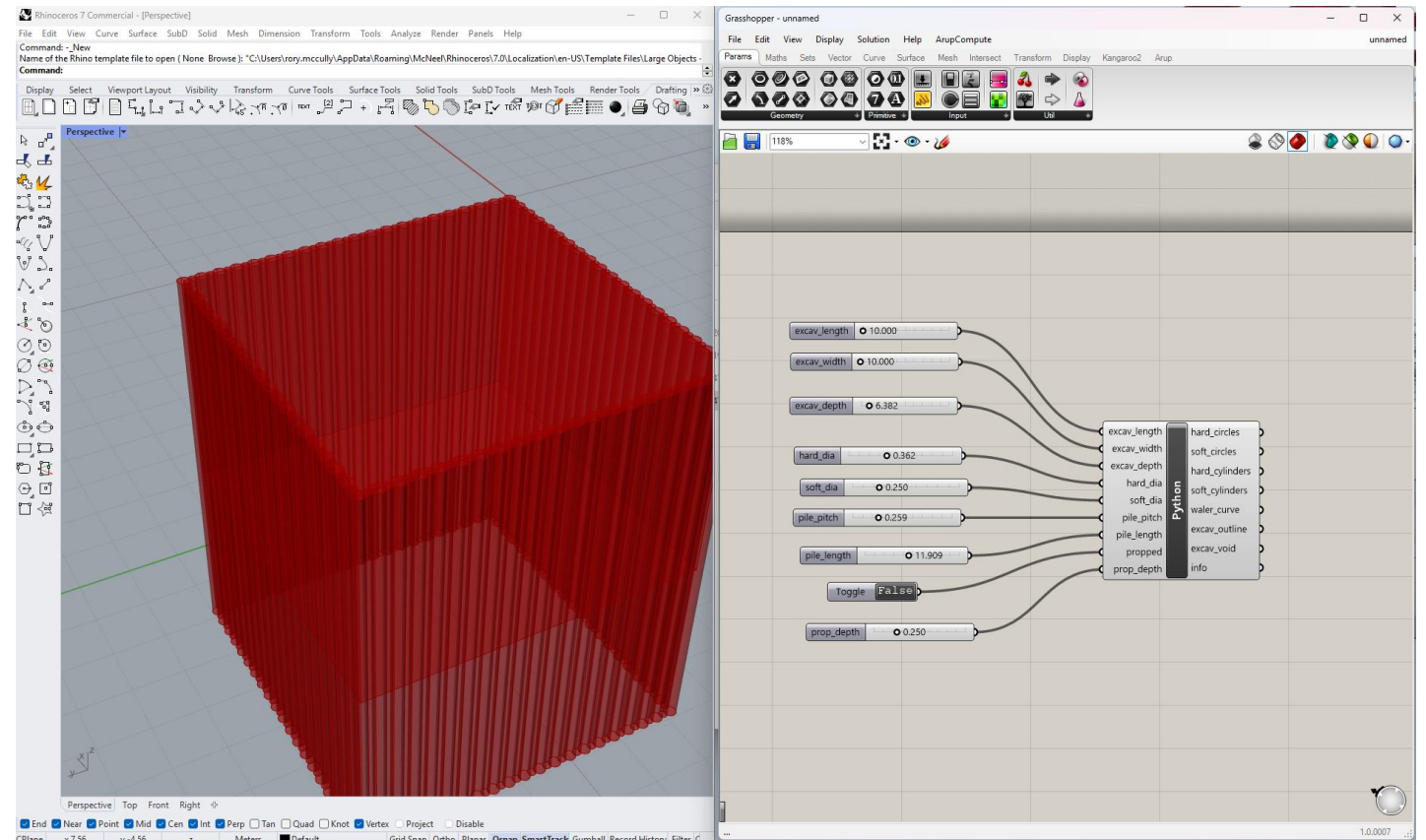
Your prompt:
“Update and run my analysis model”



Example 1

Agent wrote a rhino/grasshopper script to build a parametric model of a basement retaining wall.

Manual effort required to put the component into rhino/grasshopper

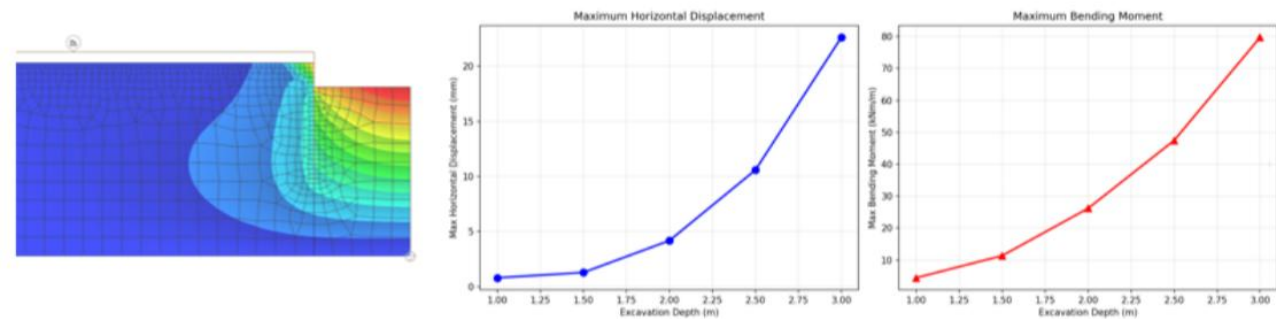


Example 2

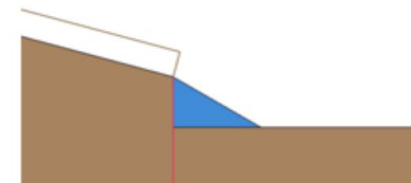
Agent can create, update and post process finite-element analysis.

It can run sensitivity and batch analyses.

Here's a base model of a retaining wall: 809c0831-d59e-4204-bb17-ee4fec8b0e53. Show the the effect of horizontal displacement, and bending moment with varying excavation depths, say between 1m and 3m. Plot the results as a graph so I can understand them quickly.



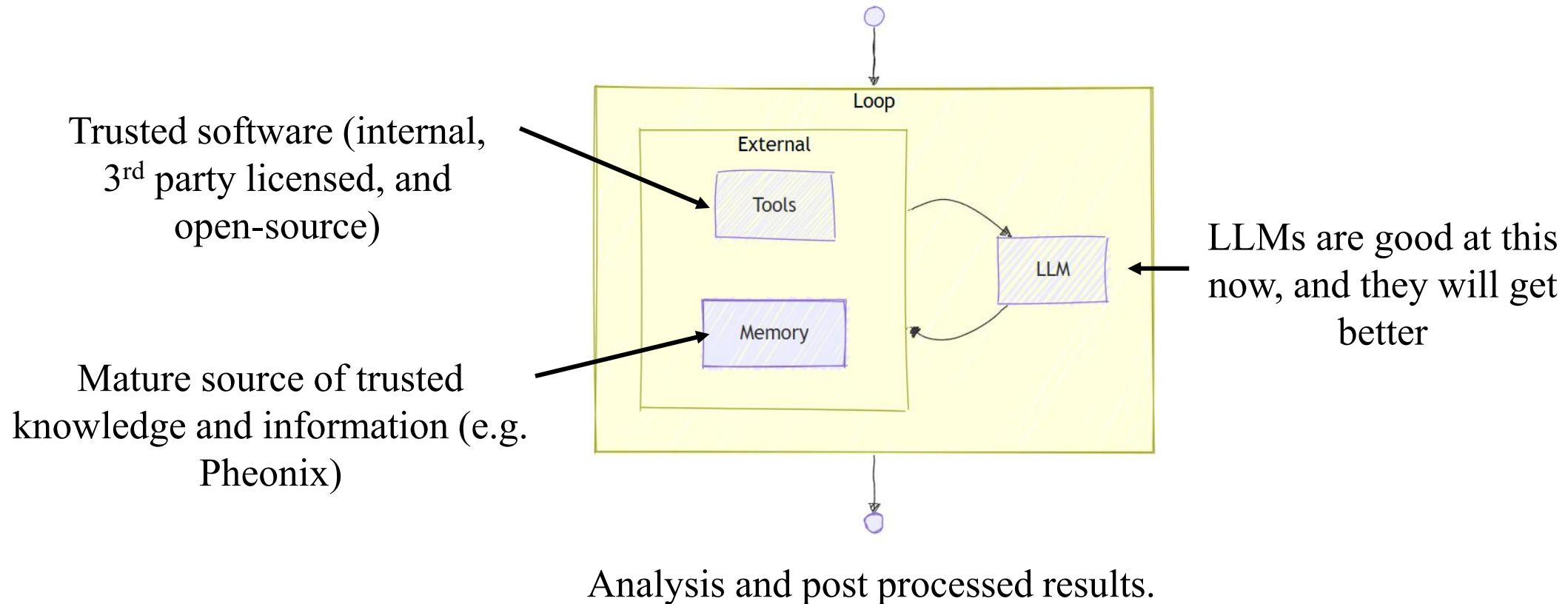
Sticking with the 2m model with ground sloping at 15°, add a 30° berm on the excavated side of the wall, down from the top of the wall to the base of the excavation. This should be activated in the final stage as part of the main excavation. The existing material won't be strong enough to stop a localised failure within the berm, so assign it a new material. You can copy the existing material, but increase the strength properties to $\phi=40^\circ$ and $c'=10\text{kPa}$. Make the little berm a blue colour.



Impact on project delivery

Your prompt:

“Update and run my analysis model”



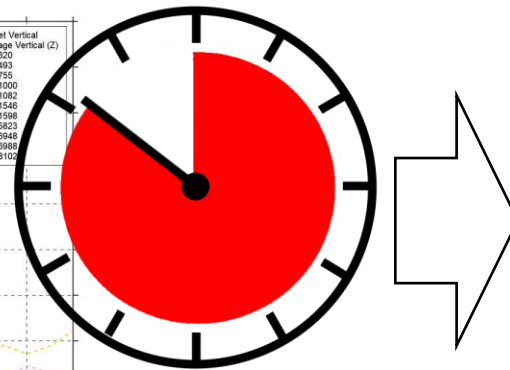
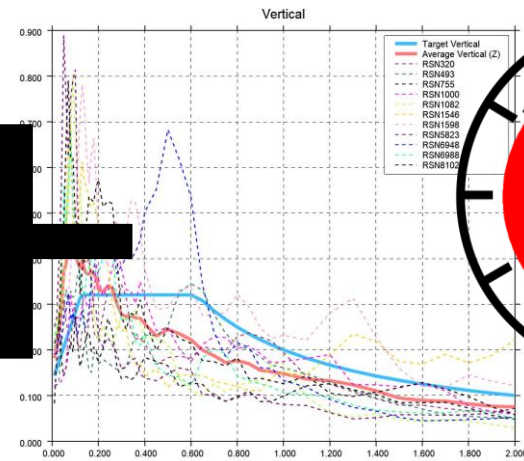
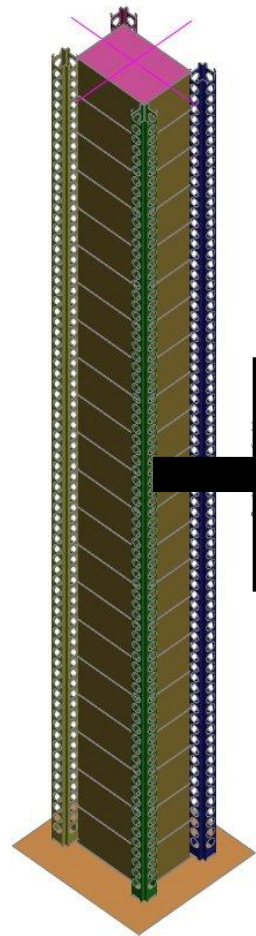
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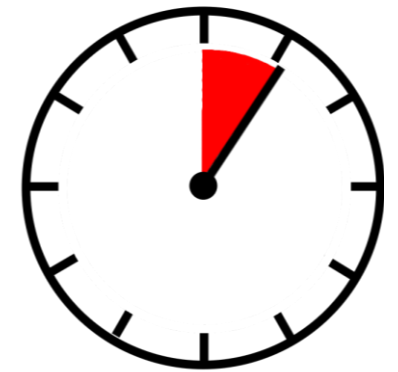
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Where we want to be



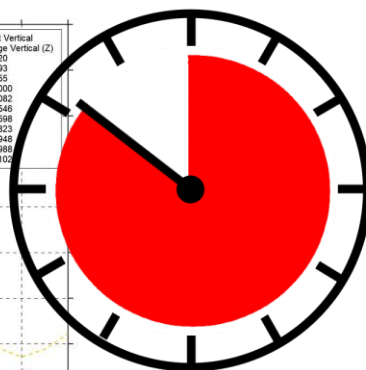
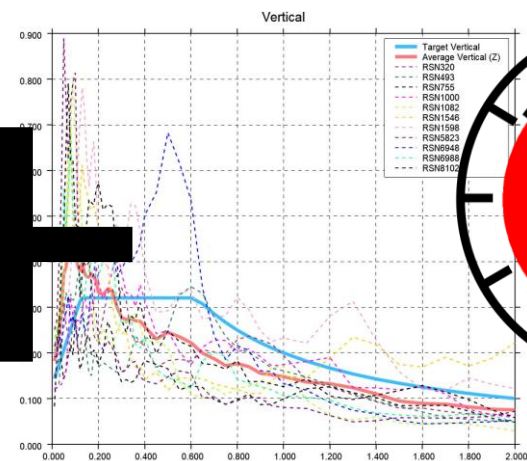
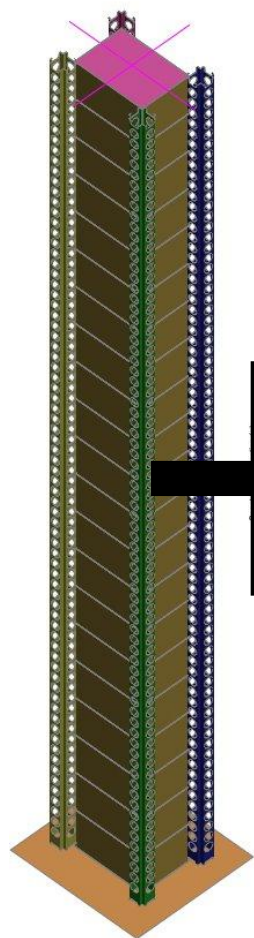
2 hours each
2 months total



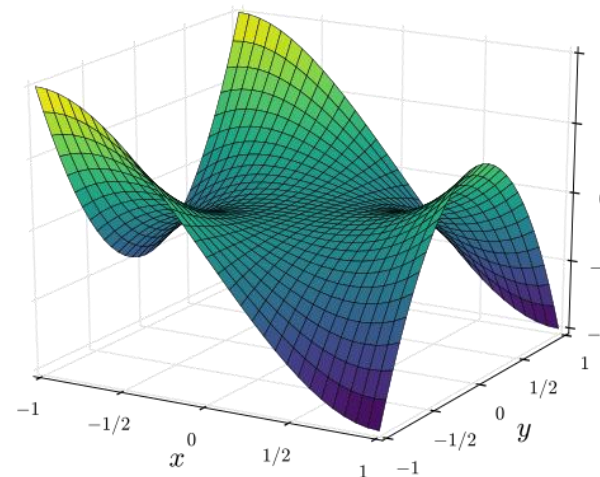
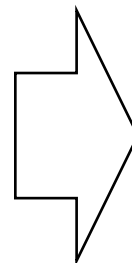
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Full Fidelity Models

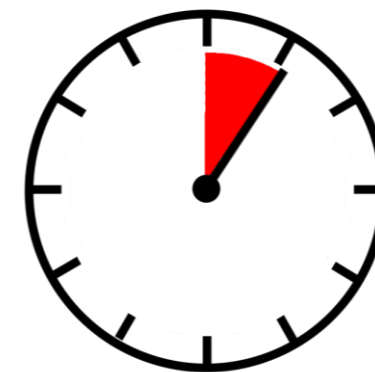
Where we want to be



2 hours each
2 months total



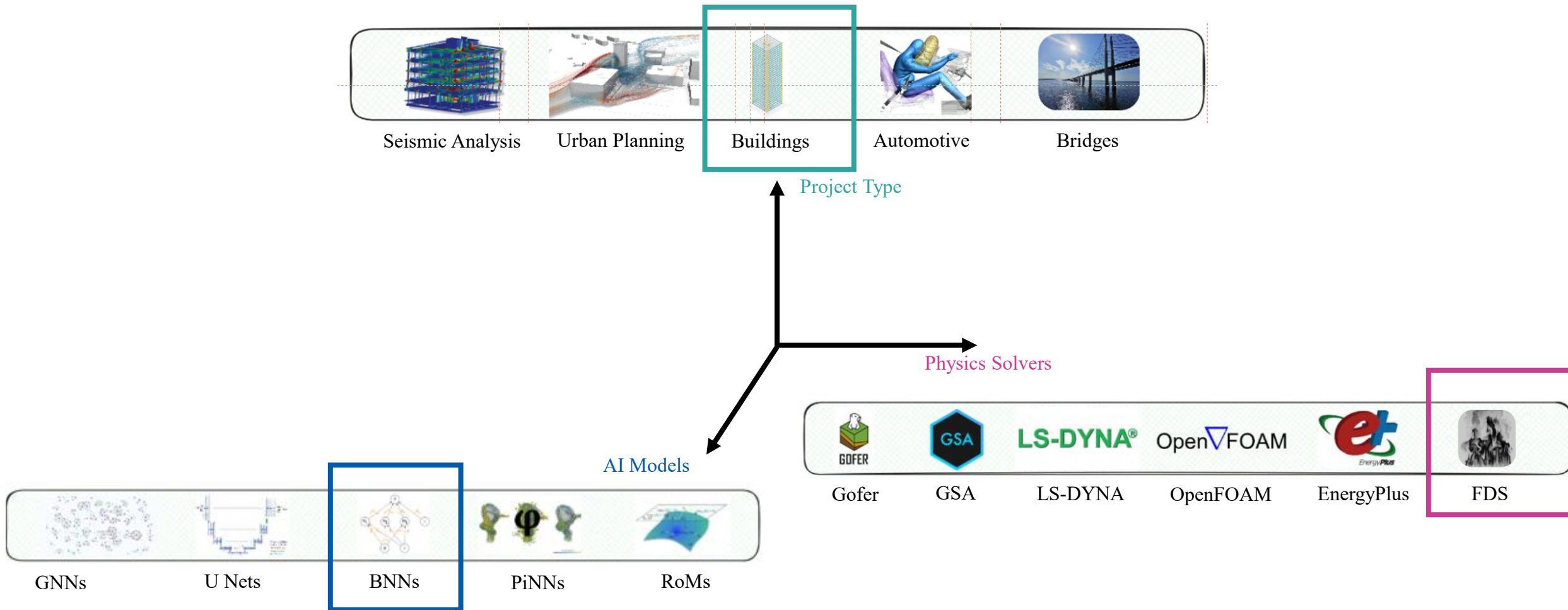
AI Surrogate Models



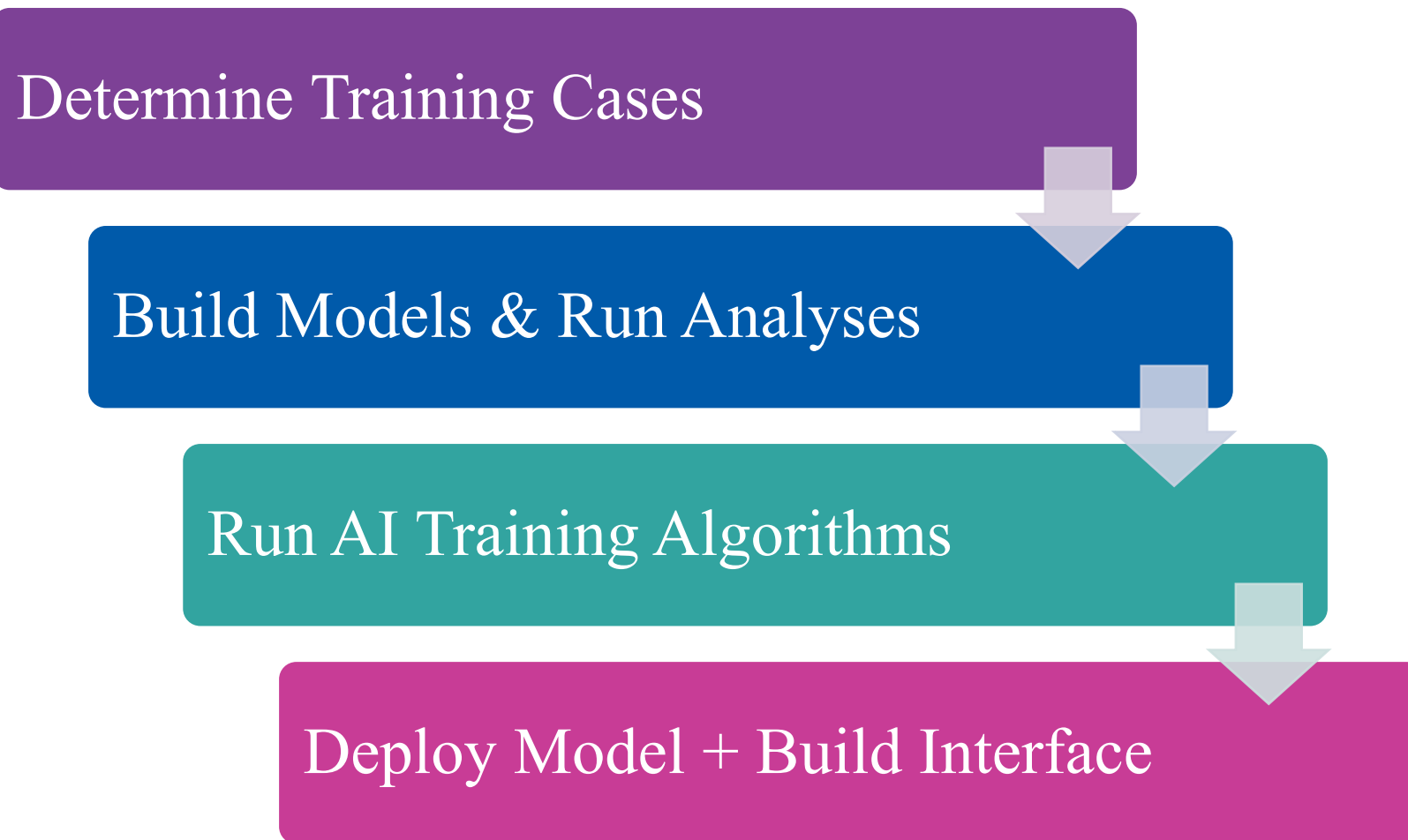
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Full Fidelity Models

A framework to create AI surrogates

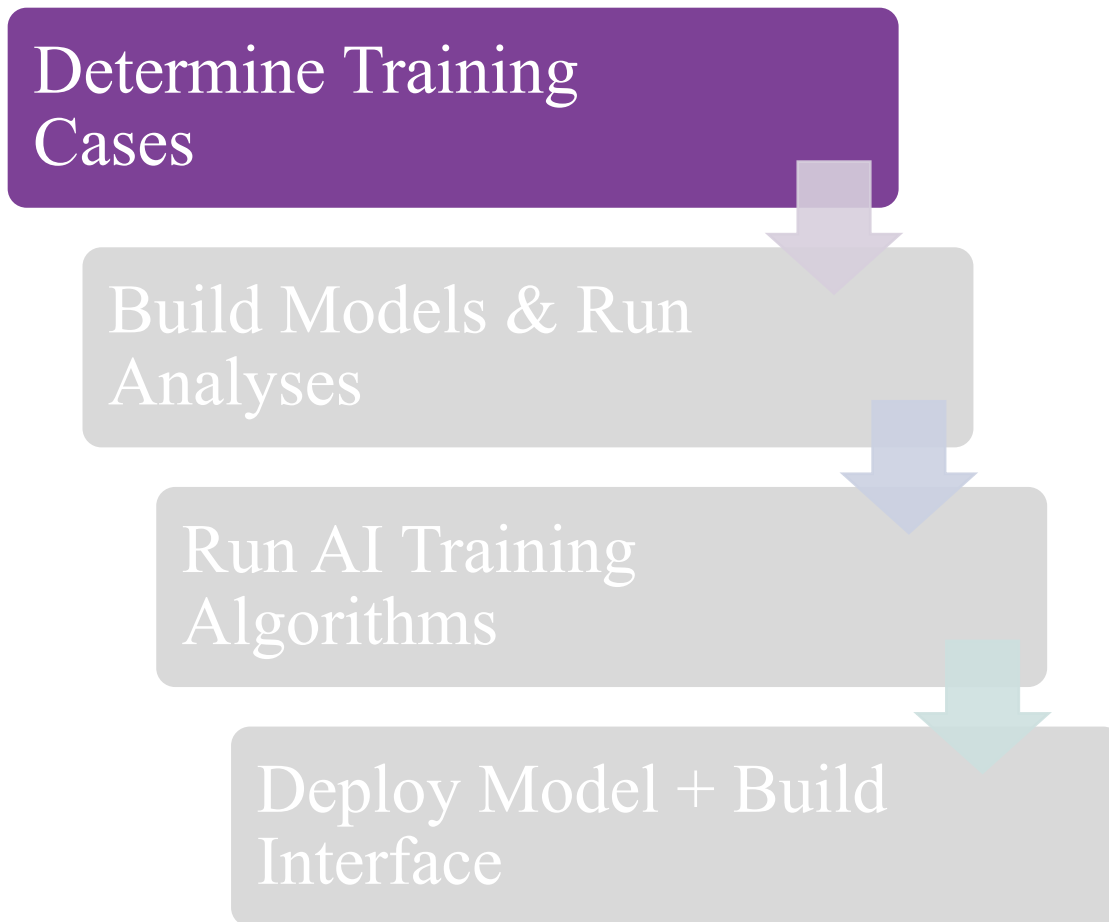


Development Process



Determining the Dataset

End-to-end Development Process

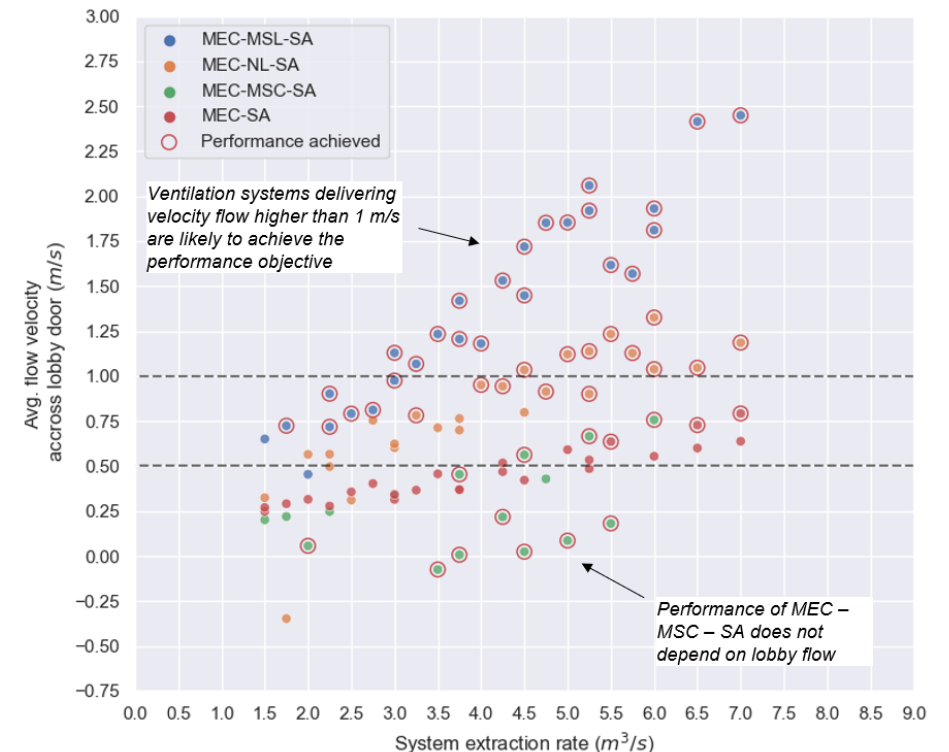
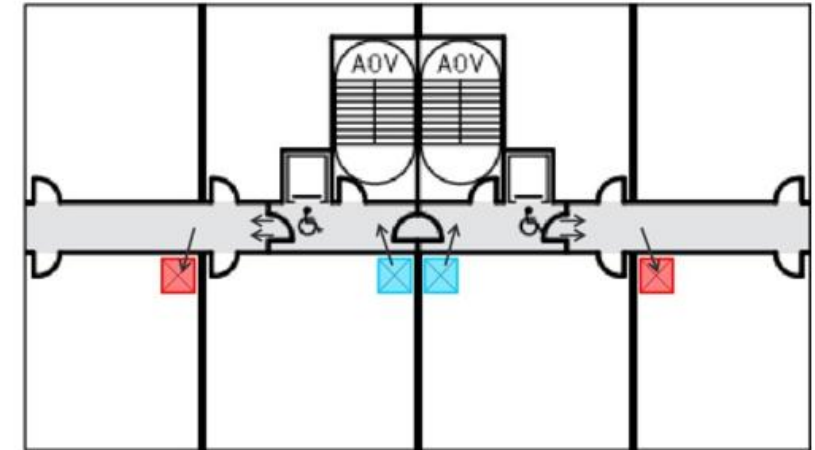
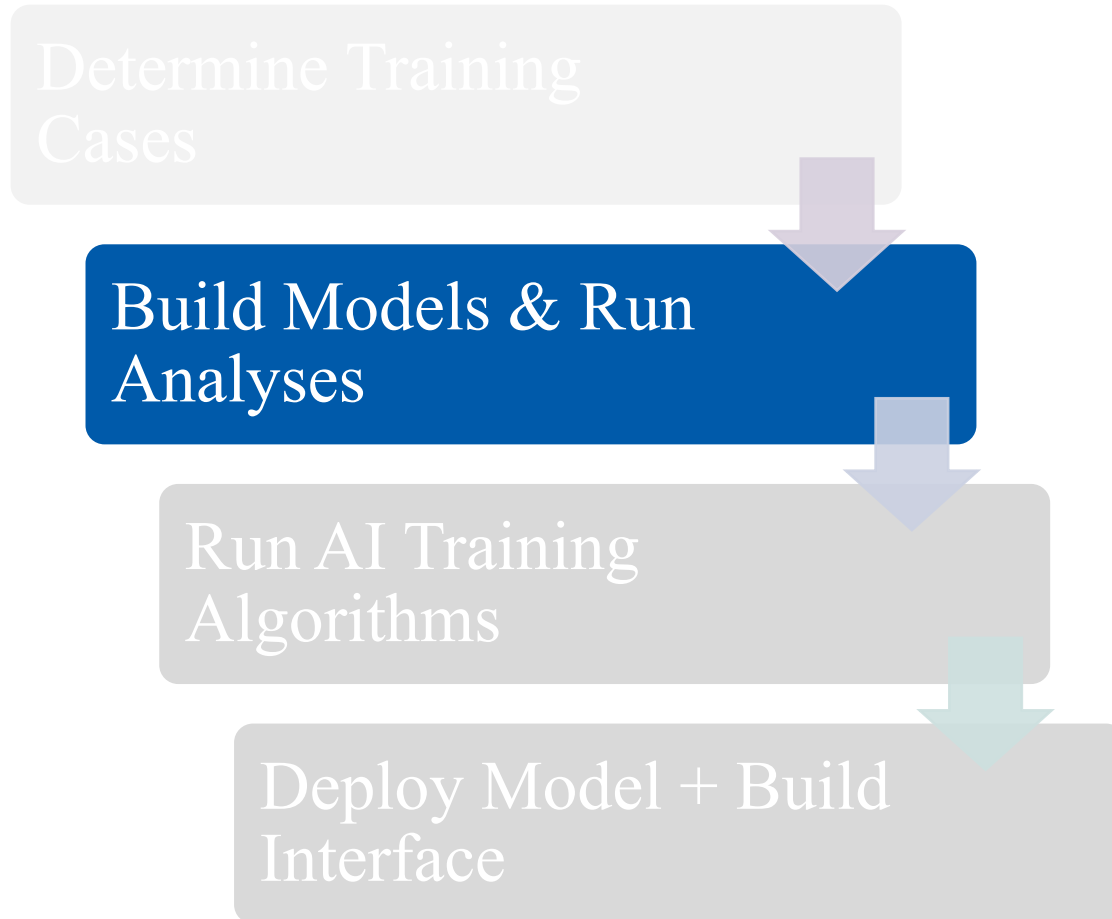


Permutation	Time	Tote Guide Stiffn	Friction Coefficient	Frame Stiffness - 561 (x)	Frame Stiffness - 761 (y)	Grid Mass (kg)	Tote Mass Distribution Samples
P1	RSN1000	With holes	0	500	750	5415	H-S1
P2	RSN1000	With holes	0	500	750	5415	H-S2
P3	RSN1000	With holes	0	500	750	5415	H-S3
P4	RSN1000	With holes	0	500	750	5415	H-S4
P5	RSN1000	With holes	0	500	750	5415	H-S5
P6	RSN1000	With holes	0	500	750	5415	M-S1
P7	RSN1000	With holes	0	500	750	5415	M-S2
P8	RSN1000	With holes	0	500	750	5415	M-S3
P9	RSN1000	With holes	0	500	750	5415	M-S4
P10	RSN1000	With holes	0	500	750	5415	M-S5
P11	RSN1000	With holes	0	500	750	5415	L-S1
P12	RSN1000	With holes	0	500	750	5415	L-S2
P13	RSN1000	With holes	0	500	750	5415	L-S3
P14	RSN1000	With holes	0	500	750	5415	L-S4
P15	RSN1000	With holes	0	500	750	5415	L-S5
P16	RSN1000	With holes	0	500	750	6600	H-S1
P17	RSN1000	With holes	0	500	750	6600	H-S2
P18	RSN1000	With holes	0	500	750	6600	H-S3
P19	RSN1000	With holes	0	500	750	6600	H-S4
P20	RSN1000	With holes	0	500	750	6600	H-S5
P21	RSN1000	With holes	0	500	750	6600	M-S1
P22	RSN1000	With holes	0	500	750	6600	M-S2
P23	RSN1000	With holes	0	500	750	6600	M-S3
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P25	RSN1000	With holes	0	500	750	6600	M-S5
P26	RSN1000	With holes	0	500	750	6600	L-S1
P27	RSN1000	With holes	0	500	750	6600	L-S2
P28	RSN1000	With holes	0	500	750	6600	L-S3
P29	RSN1000	With holes	0	500	750	6600	L-S4
P30	RSN1000	With holes	0	500	750	6600	L-S5
P31	RSN1000	With holes	0	500	750	7785	H-S1
P32	RSN1000	With holes	0	500	750	7785	H-S2
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P35	RSN1000	With holes	0	500	750	7785	H-S5
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P37	RSN1000	With holes	0	500	750	7785	M-S2
P38	RSN1000	With holes	0	500	750	7785	M-S3
P39	RSN1000	With holes	0	500	750	7785	M-S4
P40	RSN1000	With holes	0	500	750	7785	M-S5
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P42	RSN1000	With holes	0	500	750	7785	L-S2

Example of Required Data

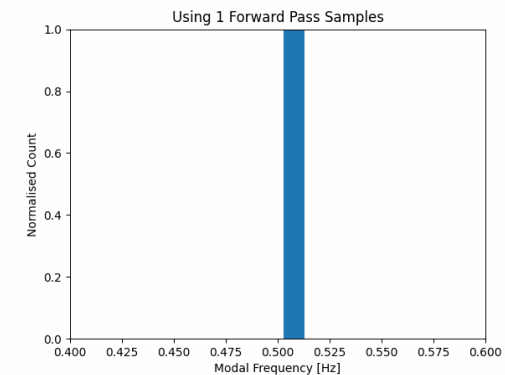
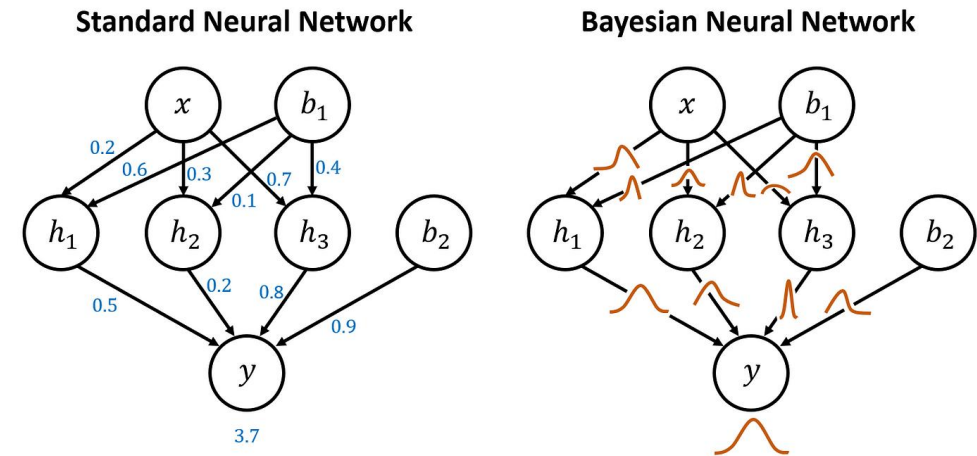
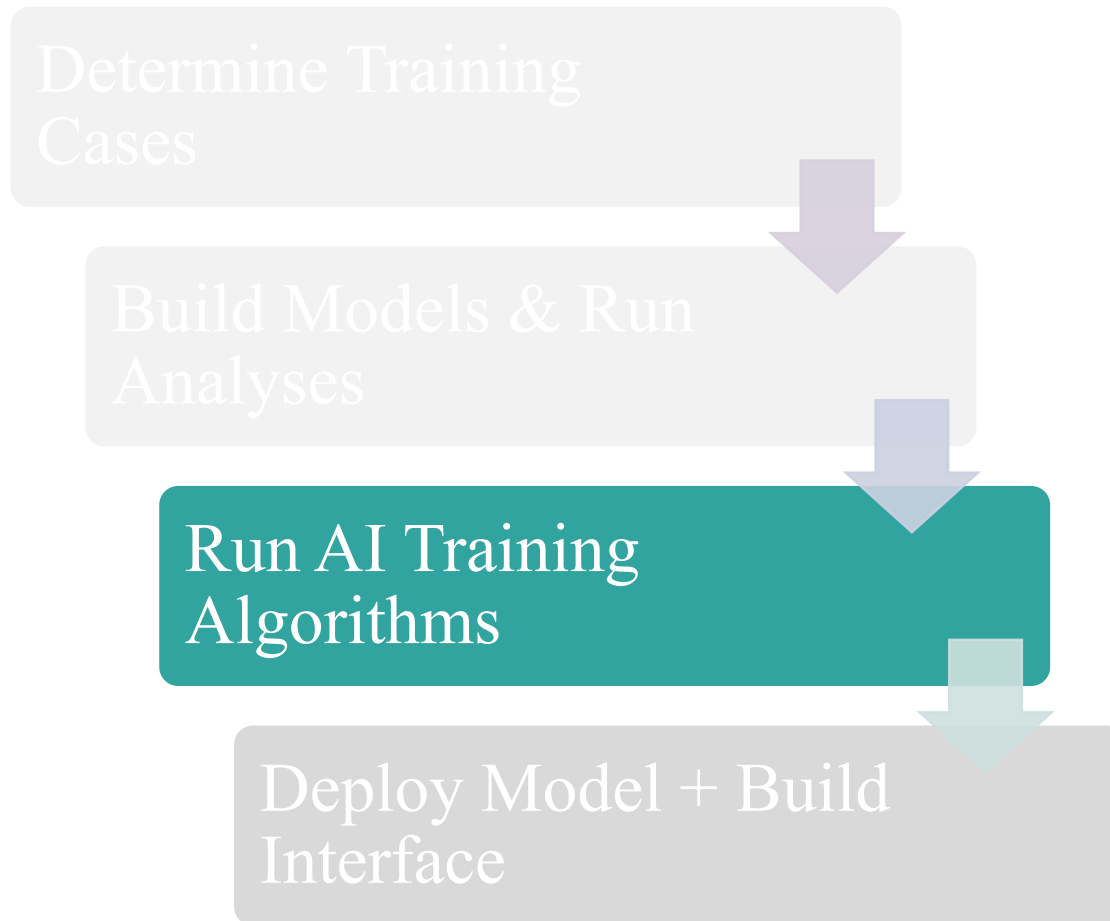
Generating the Dataset

End-to-end Development Process



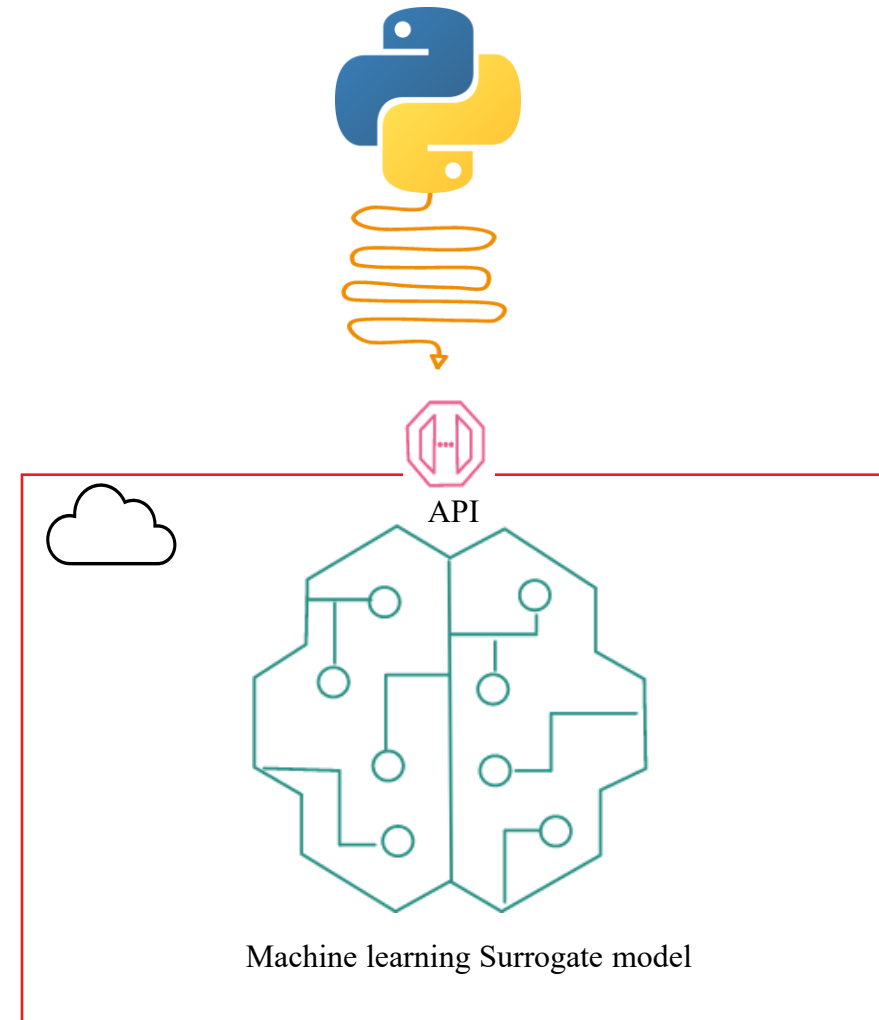
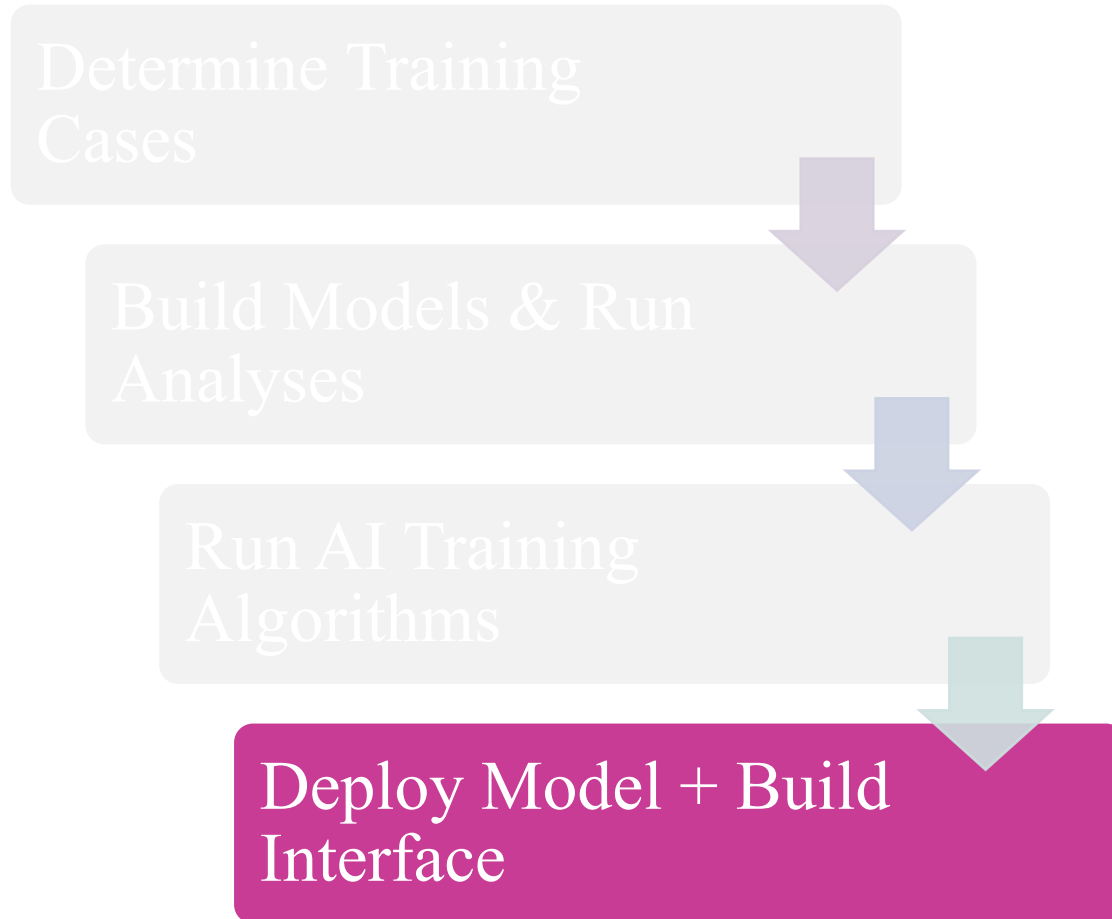
Model Training

End-to-end Development Process



Deploy Model

End-to-end Development Process



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*the risks involved with using agents,
including **quality and security** need to be
carefully managed*

*rate of adoption in the construction
sector is slow*

But accelerated use of AI and digital technology could enable much faster delivery, reduced costs...and improved quality...

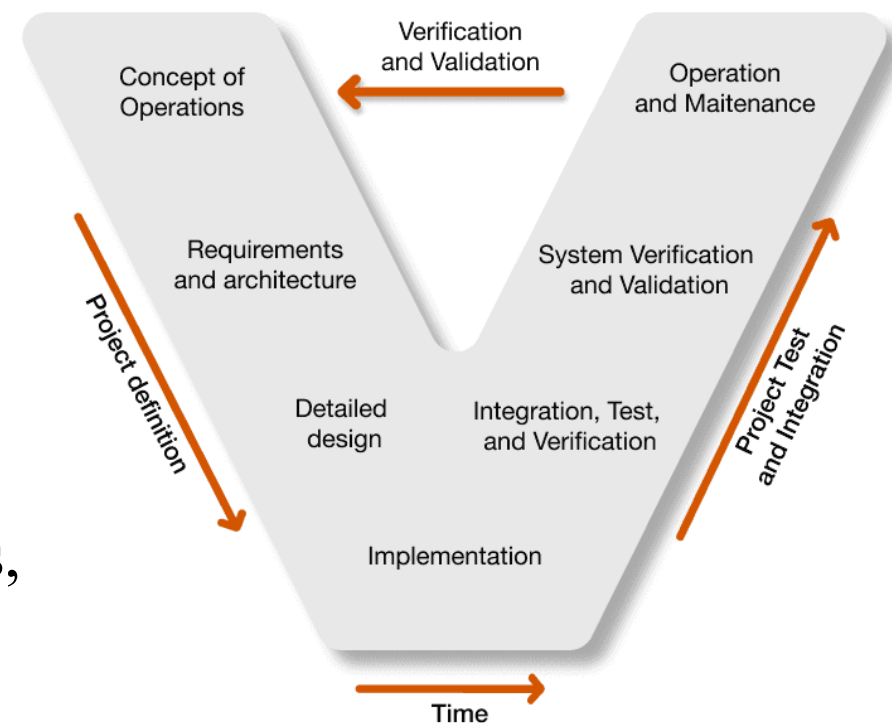
How could this make a real difference to fire safety equity?

e.g. systems engineering

Current challenges for adoption

- High overhead due to specialist teams
- Designers, contractors, operators, and regulators work under different incentives
- System interactions are often tested late

Although AI does not change the organisational challenges, it can lower the cost of doing systems engineering well.



*Human involvement is essential for ethical judgement,
accountability for safety assurance, stakeholder trust building,
and creative conceptual thinking*

All are central to delivering equitable fire safety solutions.

ARUP