

# Creativity from Friction: Human-AI Interaction for Exploratory Structural Design

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## BACKGROUND & MOTIVATION

Structural design is a **constrained, creative** discipline for which AI systems focused only on providing a final answer are often not suitable.

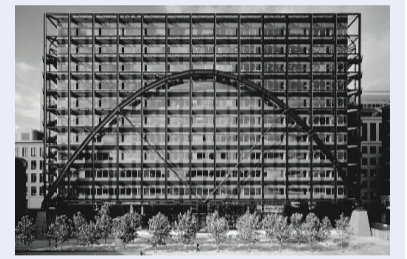
Designers develop ideas by modelling, inspecting and revising partial solutions under constraints including spatial configuration, mechanical behaviour and environmental performance. We distinguish between **productive** and **unproductive design friction** for structural engineering and investigate how experts interact with a **multimodal AI interface** in a constrained design task.

### UNPRODUCTIVE FRICTION

Repetitive modelling, low-level intent-to-geometry translation.

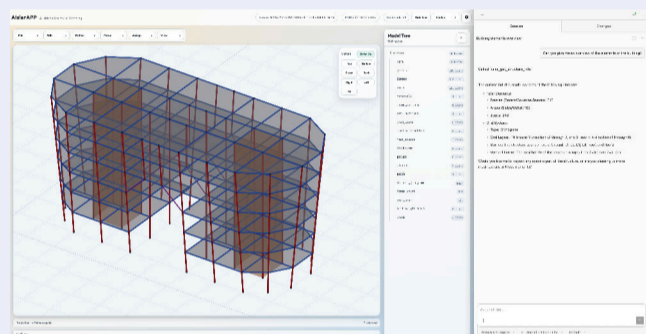
### PRODUCTIVE FRICTION

Negotiating constraints, judging design alternatives.

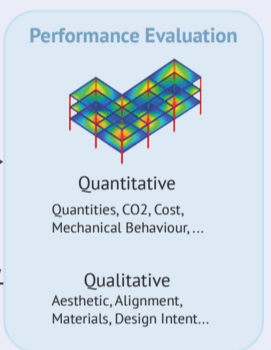
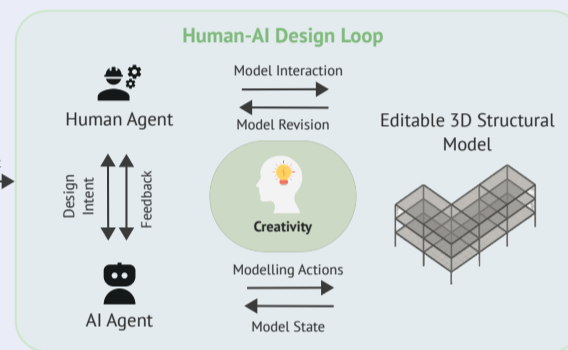


Broadgate Exchange (UK) by SOM: an example of creative, constrained structural design.

## HUMAN-AI EXPLORATION WORKFLOW



A prototype multimodal AI structural design interface



A Constrained Co-Creation Design Workflow: Creativity arises from iterations within the Human-AI Design Loop.

DESIGN DIMENSIONS

### MODEL GROUNDING

Grounded in discipline-specific knowledge for better outcomes.

### SHARED DATA STRUCTURES

Visual, editable data structures shared by humans and AI

### STATE AWARENESS

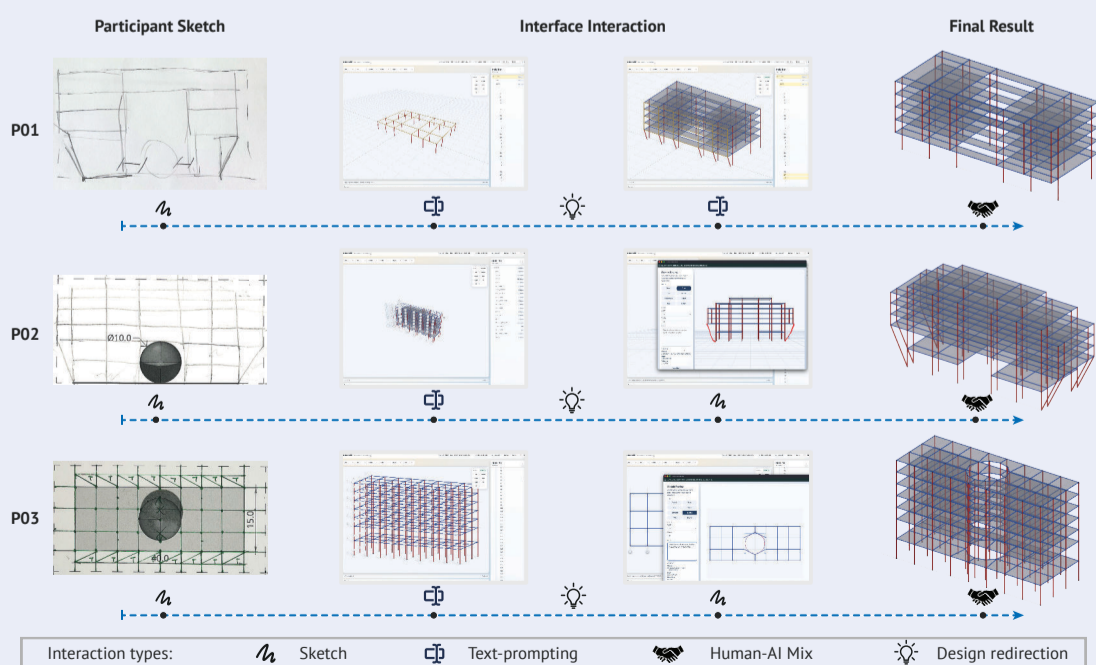
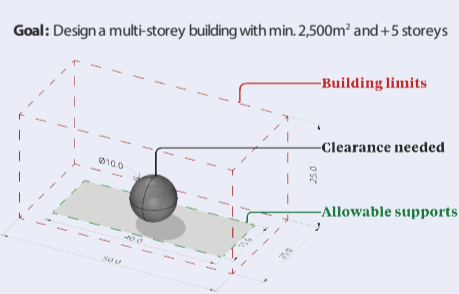
Tracks the evolving model, history and goals as design changes.

### MULTIMODAL INTERACTION

Interpret drawings, sketches and natural-language instructions.

## DESIGN STUDY

Invited experts ( $n=3$ ) received a constrained design task. They began with a hand sketch and then used the AI interface to develop their concepts in 3D. Participants interacted with the evolving model through different modalities and revised their designs during the process.



Initial sketch, interaction of the participants with the interface and final design model

## KEY FINDINGS

- AI reduced repetitive modelling friction:** Participants generated elements, storeys, and grids in seconds removing unproductive friction.
- Model feedback supported design redirection:** All participants revised designs during the process.
- Designers valued control and mixed initiative:** Participants preferred to retain control over the design while sharing modelling effort with the AI.

## CONTRIBUTIONS & OUTLOOK

The main contributions of this work are to:

- Distinguish (un)productive friction in structural design
- Identify four dimensions for co-creative interfaces
- Develop a multimodal structural design prototype
- Report a preliminary study with structural designers

**Limitations:** The study was conducted on a small sample and the interface provided limited CAD functionality.

**Future Work:** Increase the sample size, further develop the interface, investigate different levels of AI assistance, and strengthen constraint and structural performance feedback.

Support:



Paper:



Contact:

