

# Ai:Lab

## Artificial Intelligence for Low cArbon Building

### AI:LAB Summit 2025

Welcome to the Ai:Lab AI & Architecture Summit 2025. The Ai:Lab is asking how can processes of Artificial Intelligence (AI) target the reduction of carbon expenditure in the design and construction of buildings, and what role do architects, engineers, our students and the public have in the process of decarbonisation using new tools of AI?

## AI & ARCHITECTURE SUMMIT 2025: SUSTAINABILITY

Friday 31st January 2025 11:00am  
at Moorcroft Wintergardens, UK

11:00 Introduction: AI use in Architecture  
11:30 AI and Open Space: The State of AI Use in Architectural Practice  
11:40 AI & Sustainable Architecture: Sustainable Turkish Urban Architecture  
12:00 AI and BIM Integration  
12:30 Ai:Lab Artificial Intelligence for Low Carbon Building  
13:00 Public Opening: Exhibition Open Workshop

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### Mapping AI Design Processes

Over the course of a year, working within a team of engineers and computer scientists alongside Grimshaw Architects, we explored the impact that new tools of AI will have on the design process of sustainable buildings. This included mapping design processes for three different approaches to low carbon building design.

### Bio-Inspired Geometries

The creation of geometrically editable shell structures as meshes, generated from scanned images of seashells. ML tools classify and parse photo data, extracting key dimensions used as input parameters for a mathematical equation describing shell volume creation. Structures can then be evaluated in the context of structural and environmental performance, adapted and integrated within building design.

Next Steps

- Using this method, explore other natural forms that can generate editable geometries for performance analysis.
- Explore how the material and process of biological growth impact structure and material efficiency.

### Site Strategies For Low Carbon Buildings

ML was employed to accelerate the process of optimising solar potential of a site, exploring the potential of existing transportation networks, and generating conversation on policy for city planning. By analysing solar data located in conversation with a LLM, models integrated with Grasshopper identified optimal orientations.

Transportation patterns were modelled from traffic data and local bus information to explore entry and exit routes to site, influencing access points and defining transport strategy. A LLM Virtual Forum facilitated synthetic debate, exploring how historical stakeholders might explore scenarios of city planning based on published writing.

Next Steps

- Explore the potential of responsive urban design using LLM and ML tools for improved planning participation.
- Explore how user interface design for LLM based models can promote sustainable site strategies.

### LLM & The Zero Carbon Standard

A closed RAG-based LLM interface with the new zero-carbon standard, enabling users to query requirements and auto-populate the Excel proforma with relevant data for compliance and project reporting.

Next Steps

- Explore LLM use with 'Mindful' software and the design of user interfaces to comply with the ZCB standard.
- Explore interoperability of LLM and BIM software for compliance with general building standards.

### Low Carbon Surrogate Model Analysis

A surrogate model trained on the synthetic data of multiple shell structure variations, replacing traditional 'slow' computational analysis to provide rapid feedback on the environmental and structural performance of structures.

Next Steps

- Explore the accuracy of surrogate models for a wider range of structural typologies.
- How user interface design for surrogate models can prompt sustainable design decision at concept stages.

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Project Review: Outcome 3 - An ML-based method for the generation of 3D shapes (dataset of seashells)



Outcome 3 - 3D Shape Generation using Parsed Images

Model trained on shell datasets to identify and generate a geometrically idealized version of a shell, integrated within a generative model that takes image inputs information from that which is

SCENARIO 3.1 - EDITABLE 3D 2

AI-LAB Summit 2025

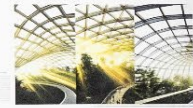
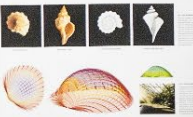
## AI & ARCHITECTURE SUMMIT 2025: SUSTAINABILITY

AI & ARCHITECTURE SUMMIT 2025: SUSTAINABILITY

Mapping AI Design Processes



Bio-Inspired Optimised Geometries






AI-Lab - Artificial Intelligence  
Canada Roof - Po. Lige - Centre  
Low Carbon Buildings

Site Strategies For Low Carbon Buildings



Experiments



Using AI assistants (GhatGPT) to conversationally build a house in Grasshopper and use OneClick to assess carbon use





**Forma Quick visual design exploration**

Continuum can leverage the power of generative AI to create design exploration options for their clients.

**Why is Forma? Concept**  
 This is a generative AI tool that helps architects to explore design options for their clients.

Third party integration (Forma)

Speaker at podium

**Architecture 2025: Sustainability**

**Bio-Inspired Optimised Geometries**

The creation of geometries often involves trial and error, which is time-consuming and costly. ML can be used to generate design options that are optimized for sustainability. This involves training a model on a dataset of existing buildings and their performance metrics. The model can then generate new design options that are optimized for sustainability.

**Site Strategies For Low Carbon Buildings**

ML was employed to accelerate the process of optimizing site potential at a site, reducing the potential of building transportation networks and generating conversations on site for city planning. The resulting site plan included a mix of building types, including residential, commercial, and public spaces.

**Experiments**

Generative AI has been used to create design options for a building. The resulting design options were evaluated using a set of criteria, including energy efficiency, sustainability, and cost. The results showed that generative AI can be used to create design options that are optimized for sustainability.

**LLM & The Zero Carbon Standard**

A recent study found that LLMs can be used to generate design options that are optimized for sustainability. This involves training a model on a dataset of existing buildings and their performance metrics. The model can then generate new design options that are optimized for sustainability.

# Process

Looking for a unique message and use to inspire you or has previous in your portfolio!



An exhibit of it. The image predicts a relative dimension of the grasshopper shell as an editable surface.



**Process**






**Shell Generation - Patterns and Structures using AI**

Users select from approximately 20 shell types - A camera is set up with ability to take photos. A photo is fed into the computer vision ML model, which generates a 3D model which is then able to generate a shell as an editable surface.

**Exhibit Process**

Users select from approximately 20 shell types - A camera is set up with ability to take photos. A photo is fed into the computer vision ML model, which generates a 3D model which is then able to generate a shell as an editable surface.

a) define type (cockle / sea snail / whelk)  
 b) define generative dimensions  
 - Characteristic radius / Coefficient of size section / Number of sections per turn / Ratio length/radius

machine learning model to begin to pass data from images to then input into the Grasshopper model which



Carbon, instructing principles of design based on an organism

biomimetics, biomimicry

## AI:LAB Summit 2025

Welcome to the AI:LAB & Architecture Summit 2025. The AI:LAB will host an afternoon of leading voices in AI, from the architecture and urban planning sectors, to the design and construction of buildings and infrastructure, to the future of the built environment in the process of the carbon transition and the role of AI.

### AI & ARCHITECTURE SUMMIT 2025: SUSTAINABILITY

Friday 31st January 2025 11:00am  
 @ Manchester, Manchester, UK

11:00 Registration  
 11:15 Welcome by the AI:LAB & Architecture Summit 2025  
 11:30 AI in Architecture: The Future of Design  
 11:45 AI in Architecture: The Future of Design  
 12:00 Lunch  
 12:15 AI in Architecture: The Future of Design  
 12:30 AI in Architecture: The Future of Design  
 12:45 AI in Architecture: The Future of Design  
 1:00 AI in Architecture: The Future of Design  
 1:15 AI in Architecture: The Future of Design  
 1:30 AI in Architecture: The Future of Design  
 1:45 AI in Architecture: The Future of Design  
 2:00 AI in Architecture: The Future of Design


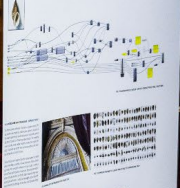

### Mapping AI Design Processes

Over the course of 1 year working with a team of engineers and computer scientists, we have mapped the design process of a building project. We have identified the key stages of the design process and how they are influenced by AI. This includes mapping design processes for the different disciplines in a building project.



## Bio-Inspired Optimised Geometries

The use of bio-inspired geometries in architecture has been a topic of interest for many years. This poster explores the potential of these geometries in the design of buildings and infrastructure. It discusses the benefits of bio-inspired geometries, such as improved energy efficiency and structural stability. It also provides examples of buildings and infrastructure that have been designed using bio-inspired geometries.

## Strategies for Low Carbon Buildings

This poster explores the strategies for low carbon buildings. It discusses the importance of reducing carbon emissions in the building sector and provides examples of buildings that have been designed using low carbon strategies. It also provides information on how to reduce carbon emissions in buildings.




## AI in Architecture: The Future of Design

This poster explores the future of design in architecture. It discusses the potential of AI in the design process and provides examples of buildings that have been designed using AI. It also provides information on how to use AI in the design process.





A woman in a leopard print jacket and green pants is looking at a poster.

A man in a dark jacket is standing near a poster.



**FIG.11 TRANSPORT AND WALKING ROUTES IDENTIFIED AND EVALUATED**

**FIG.12 AUTOMATED SOLAR POTENTIAL MAPPING USING GOOGLE EARTH AND GRASSHOPPER LAYERS**

**FIG.14 GOOGLE API CONVERSATIONAL DATA TRAIL OF CITY SITES**

A single prompt allowed leveraging a LLM to identify site location and conversationally explore key data to influence sustainable and efficient construction with the user. The LLM accessed APIs to identify nearby suppliers of construction materials, potentially reducing transportation distances and times, lowering carbon emissions. Solar potential of the site was analyzed by reviewing production-based data, identifying optimal building orientations and photovoltaic opportunities. The LLM allowed the user to explore live traffic and predictive analytics to assess traffic conditions for future dates, helping to optimize transportation logistics for material delivery. The method provides non-traditional and actionable insights into material sourcing, energy efficiency and transportation planning whilst strategizing about a site ultimately supporting a more sustainable and efficient construction process whilst fostering improved decision-making through the project's life cycle.

**FIG.15 SYNTHETIC EDITABLE PARIS BLOCK IN GRASSHOPPER**

**FIG.16 SYNTHETIC EDITABLE NEW YORK BLOCK IN GRASSHOPPER**

**FIG.17 URBAN THEORISTS RANDALL O'TOOLE AND JANE JACOBS**

**THE LLM TRANSFORMED THE BASE MODEL INTO A PARISIAN CITY BLOCK BY APPLYING LOWER DENSITY, REDUCED BLOCK HEIGHTS, SMALLER CENTRAL COURTYARDS, AND LARGER VEHICULAR INFRASTRUCTURE (ABOVE LEFT). IN CONTRAST, WHEN DESIGNING A NEW YORK BLOCK, THE LLM ADJUSTED PARAMETERS TO REFLECT TALLER BUILDING HEIGHTS, HIGHER DENSITY, REDUCED PEDESTRIAN ZONES, AND SMALLER CENTRAL COURTYARDS—TYPICAL OF THE CITY'S DIVERSE AND URBAN PLANNING STRATEGIES (BELOW LEFT). THE JSON FRAMEWORK PROVIDED THE METHOD OF COMMUNICATING BETWEEN GRASSHOPPER AND THE LLM, BASED ON A FULLY EDITABLE 3D MODEL THAT REFLECTS BOTH QUANTITATIVE DATA AND QUALITATIVE (SUBJECTIVE) / TECTONIC URBAN CHARACTERISTICS. THIS APPROACH DEMONSTRATES THE POTENTIAL OF ML-BASED TOOLS TO COMMUNICATE WITH ARCHITECTURE SOFTWARE TO EXPLORE AND REFINE CITY BLOCK DESIGNS ACROSS DIFFERENT CULTURAL AND URBAN PLANNING CONTEXTS.**

**SYNTHETIC CONVERSATIONS BETWEEN CONFLICTING URBAN EXPERTS**

Using a similar method, we tasked the LLM to critique the synthetic New York image (above left) by adopting two opposing personas: pro-sustainable urban planner Jane Jacobs and pro-industrialist Randall O'Toole. The LLM mediated their contrasting perspectives, balancing Jacobs' emphasis on pedestrian-friendly spaces with O'Toole's focus on economic growth and infrastructure efficiency. It proposed compromises that incorporated walkable streets and mixed-use spaces while accommodating vehicular access and economic hubs. This approach provides a method to expand planning public and expert policy participation, fostering positive urban outcomes by integrating diverse viewpoints into a cohesive city planning process.

... The main point of conflict between Jane Jacobs and Randall O'Toole on the New York image lies in the balance between accessibility and openness in the design of the urban block. While Jacobs emphasizes the need for better accessibility and mixed-use diversity, Randall O'Toole focuses on enhancing vehicular infrastructure and optimizing building layout to suit. To arrive at a compromise, the following steps can be taken:

- 1) Consider increased interior courtyard area within each block, as this is agreed upon by both personas.
- 2) Explore angling down the rear of the blocks facing the interior courtyard to reduce height and density, and increase street width.

**NEXT STEPS**

- Explore the potential of responsive urban design using LLM and ML tools for improved planning participation.
- Explore how user interface design for LLM based models can promote sustainable site strategies.

## Carbon Standard

zero-carbon standard, enabling users to query requirements and data for compliance and project reporting.

**FIG.20 LLM BASE FOR CARBON COMPLIANCE**

Advancement of a client's carbon footprint management on the building and structure of their organization. The model prompts LLM to interactively guide them through the process of identifying and quantifying their carbon footprint. The model also provides a dashboard for monitoring and reporting on their carbon footprint. The model is designed to be user-friendly and accessible to a wide range of users, from project managers to sustainability professionals. The model is also designed to be scalable and adaptable to different industries and organizations. The model is also designed to be secure and compliant with relevant regulations and standards.

## Low Carbon Surrogate Model Analysis

A surrogate model trained on the synthetic data of multiple shell structure variations, replacing traditional 'slow' computational analysis to provide rapid feedback on the environmental and structural performance of structures.

**FIG.21 SURROGATE MODEL PERFORMANCE EVALUATION**

We generated a synthetic dataset by measuring the relative weight of material required to support a shell structure which varied in material type, height, span, and location, and structurally calculated the gross material weight, providing a basis for calculating total embodied carbon use for the material of each variation. An ML model was then trained to predict carbon expenditure based on images of variations of shell form and material. This surrogate model bypassed the need for long computational calculations, allowing rapid feedback on structural performance whilst optimising carbon efficiency across multiple design scenarios, supporting rapid sustainable architectural ideation and optimising.

**FIG.22 SURROGATE MODEL DEFLECTION MAPPING**

**Solutions: 41 out of 100**

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e with ge...