

Automated Construction, Automated Design

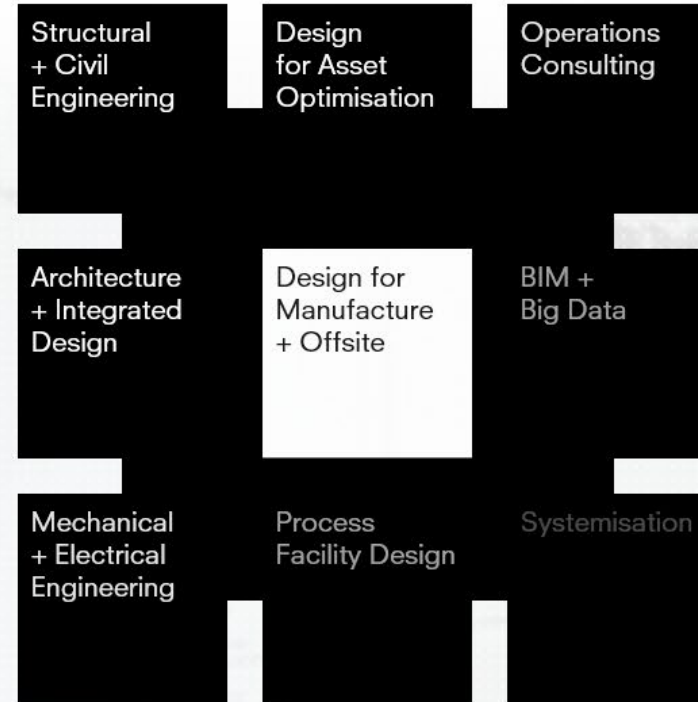
Jesus Perucho Alcalde, Bryden Wood

Automatización de Procesos en el sector AEC
Madrid, 2 de Diciembre



Introduction Bryden Wood

Structural + Civil Engineering
Design for Asset Optimization
Operations Consulting
Architecture + Integrated Design
Design for Manufacture + Offsite
BIM + Big Data
Mechanical + Electrical Engineering
Process Facility Design
Systemisation

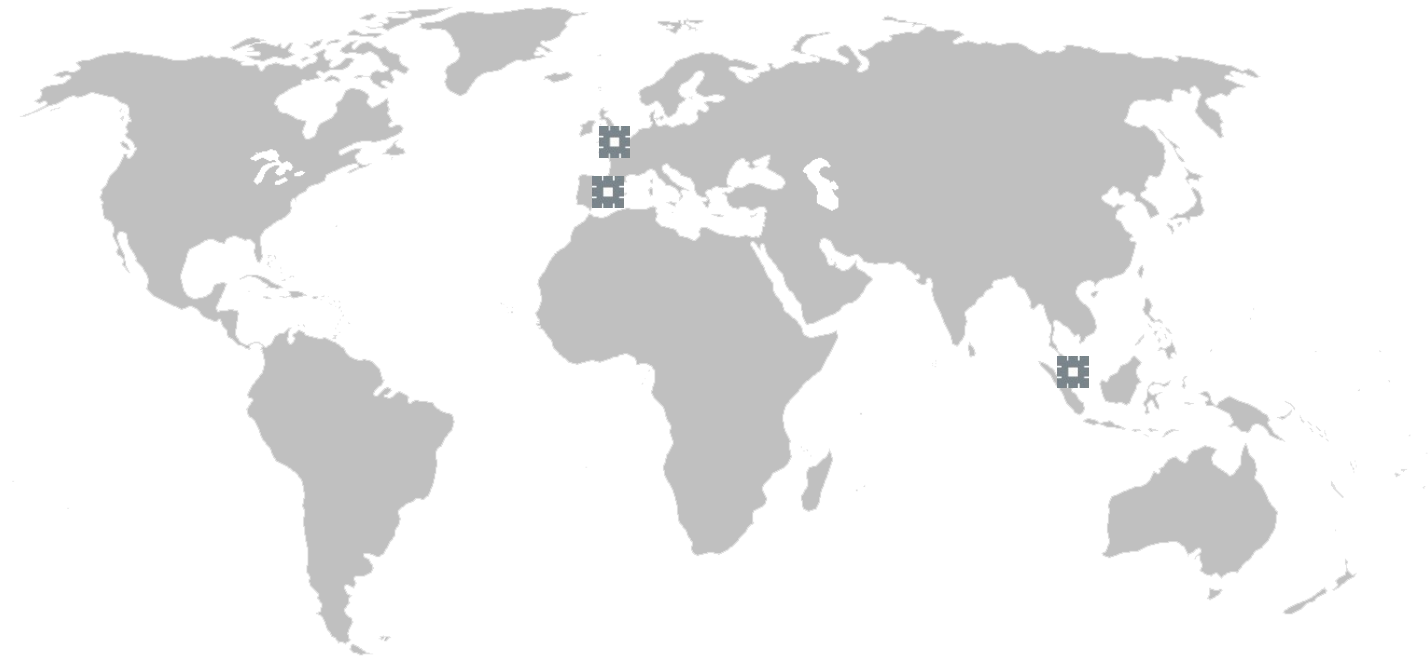


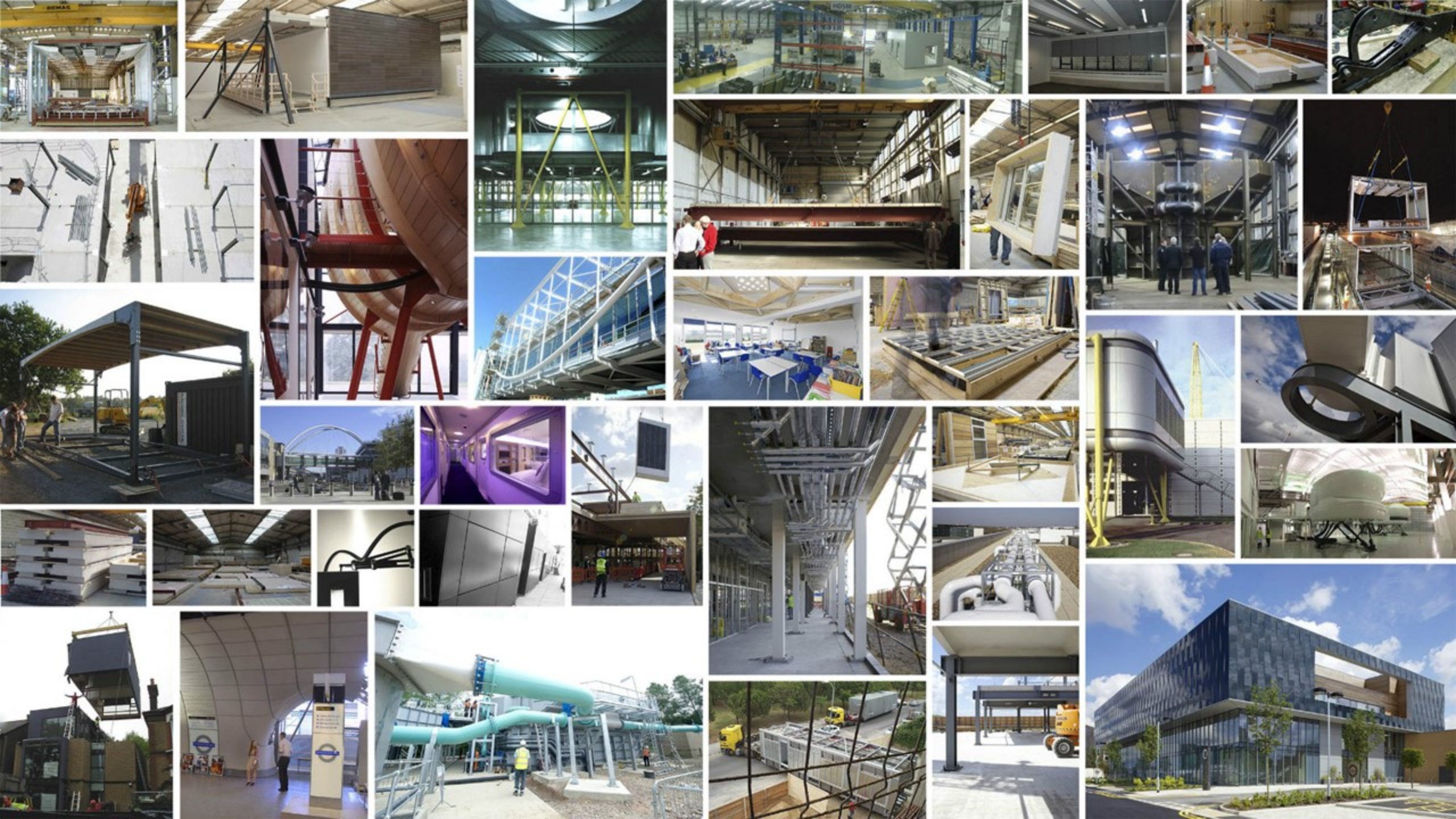
Learn the lessons of the future

Bryden Wood, is an integrated design and operations consultancy for the built environment, with offices in London, Singapore and Barcelona. Are leaders in the industry of technology for the construction. This paper is intended to show one of the latest works, the integrated design with computational tools of the façade and it's manufacture. This is to show a Building 4.0 process, where the construction industry is being digitalized as many other industries, in order to gain in more efficiency, speed, quality and of course, economical benefit.

Bryden Wood

A quick introduction





Bryden Wood is an integrated Design Consultancy for Architecture, Structures and MEP.

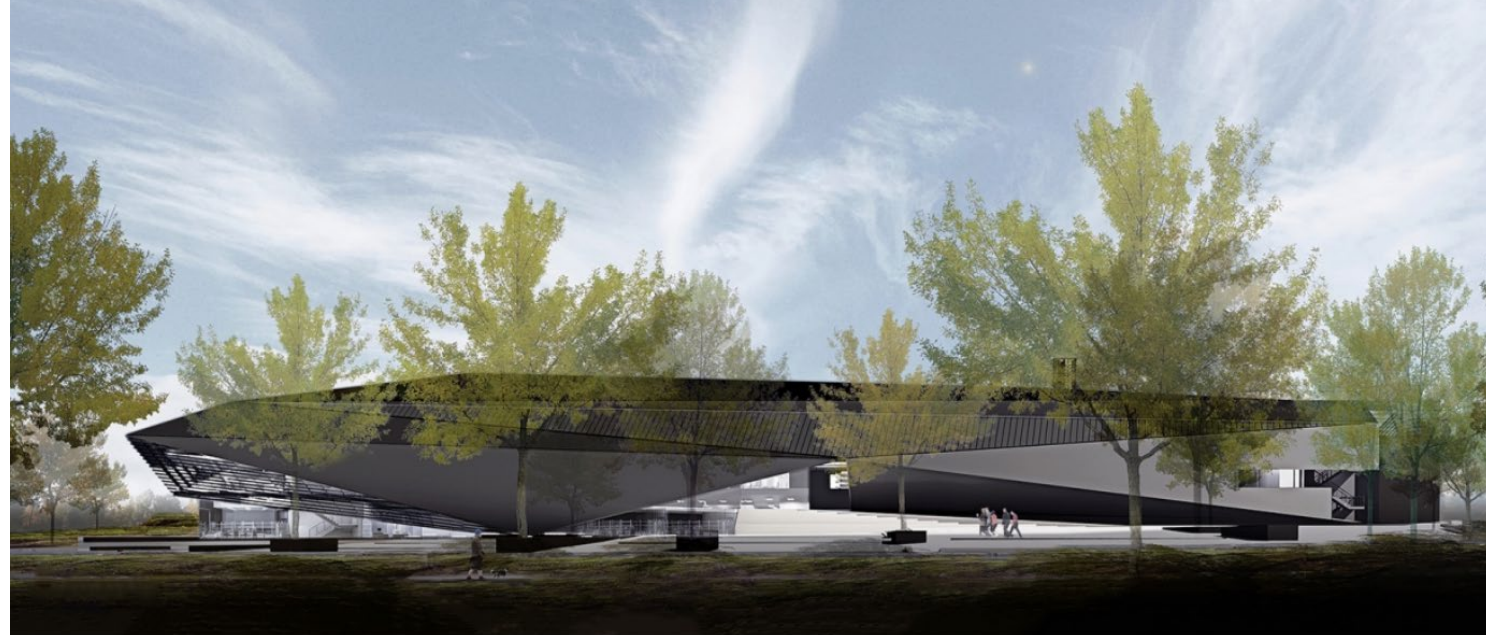
Since it was founded in 1995, the company has focussed not just on the final structure, but the process by which it was created.

That meant, and still means, using leading edge technology to untangle a complex web of information from stakeholders and user behaviour, to supply chain and delivery.

Integrated digital solutions now take the company to Construction 4.0.

A 23 strong in-house Creative Technologies Team uses data to inform design and digitise process from design, testing and even manufacture.

The company is a leading proponent of technology across the industry, and advises government on manufacturing style construction solutions such as platforms.



Services provided:

Structural + Civil Engineering

Design for Asset Optimisation

Operations Consultancy

Architecture + Integrated Design

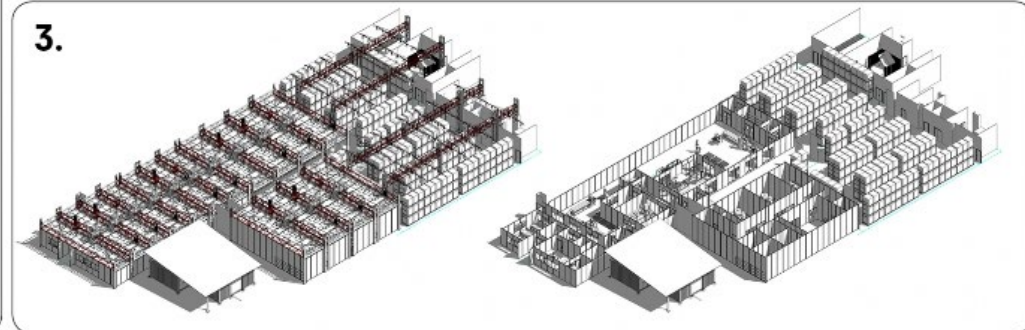
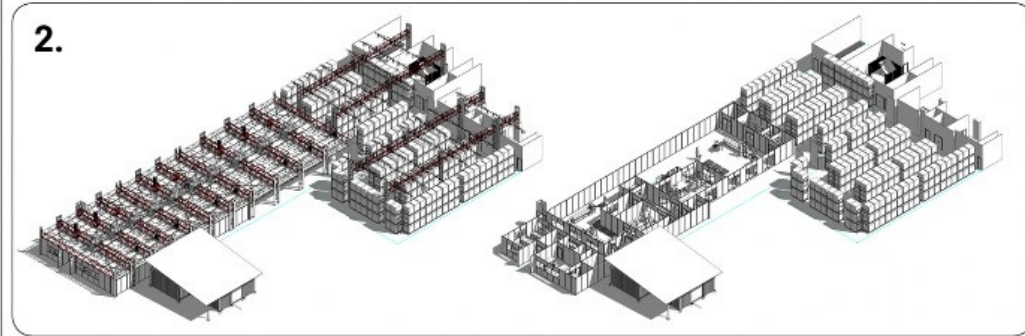
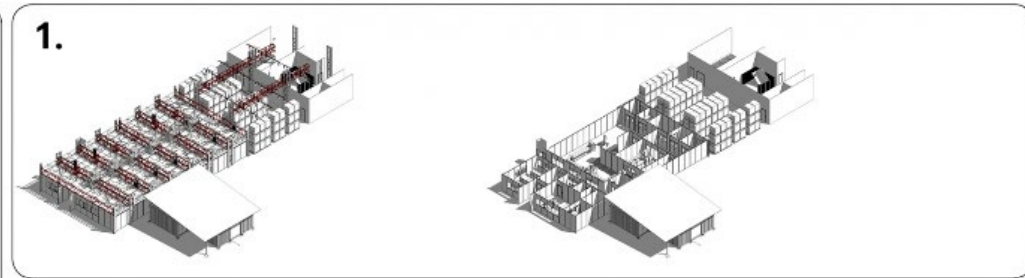
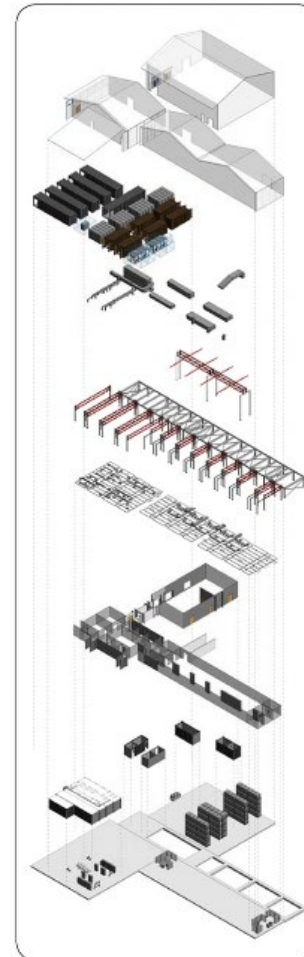
Design for Manufacture + Offsite

BIM + Big Data

Mechanical + Electrical Engineering

Process Facility Design

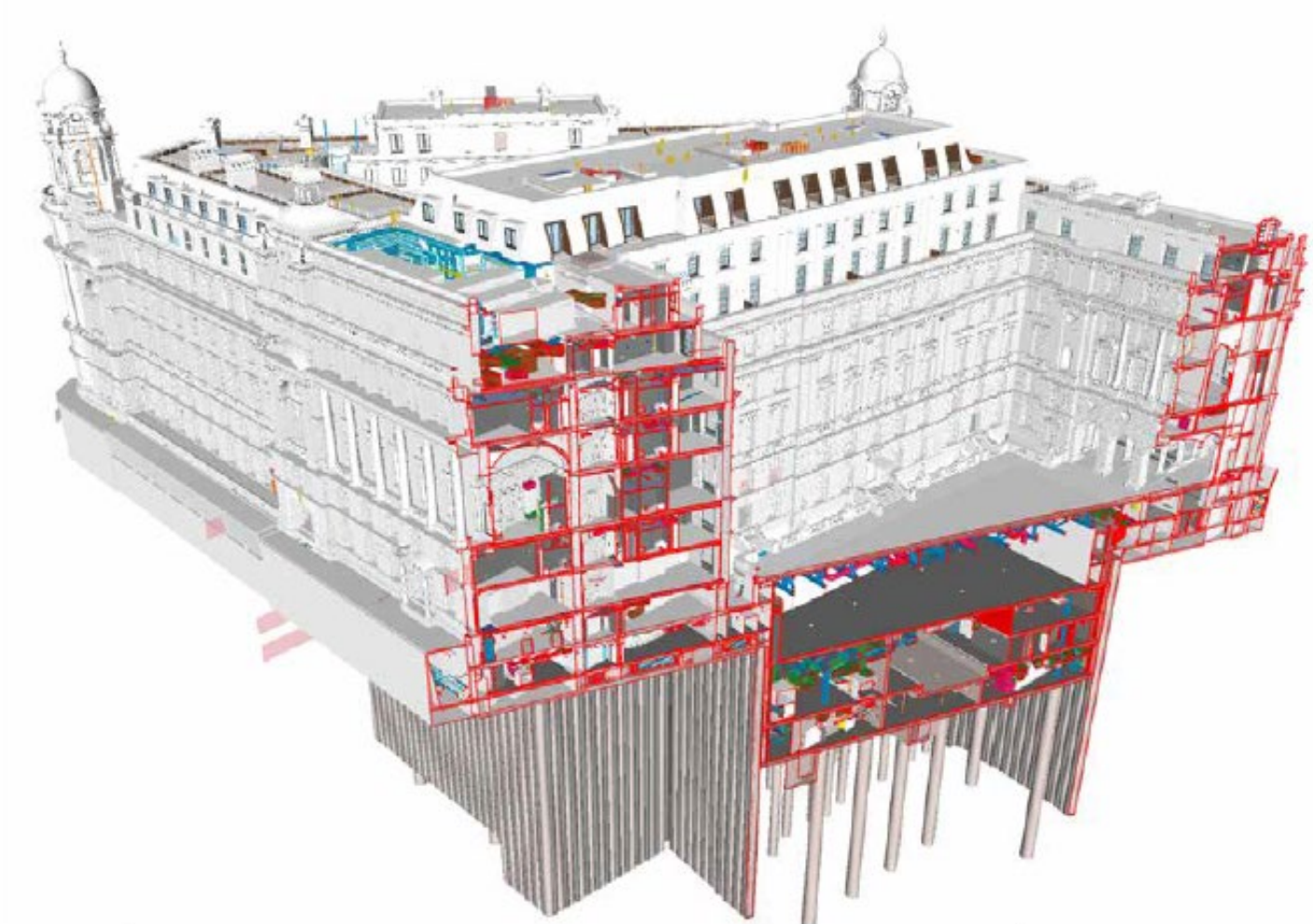
Systemisation



Old War Office

Client: OHL

Location: London, UK



St. James Centre

Client: Laing O'Rourke

Location: Edinburgh

1.7m sqft mixed use development

BW appointed as façade designers (including structural design of precast façade and connections, façade performance, GRC and handset stone)

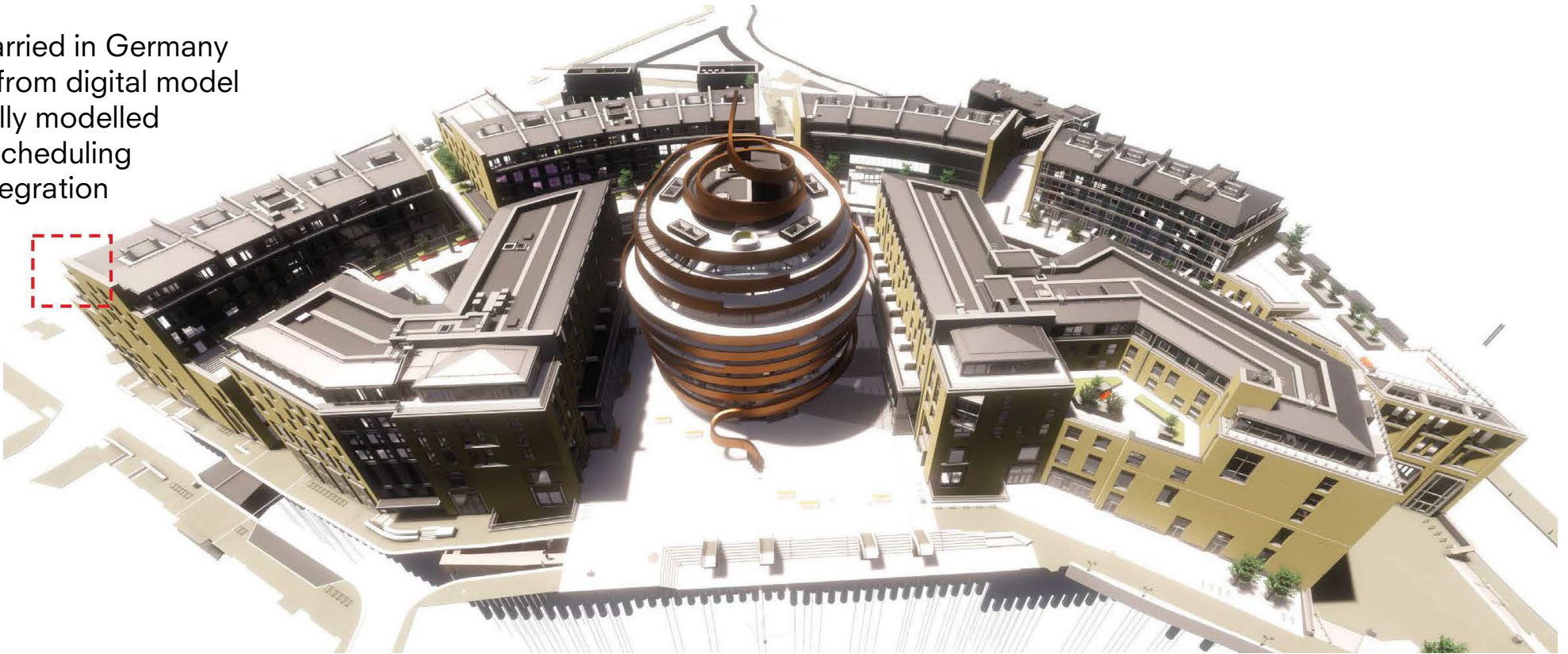
Stone cladding quarried in Germany

Cutting schedules from digital model

Connections digitally modelled

4D BIM for works scheduling

5D BIM for cost integration

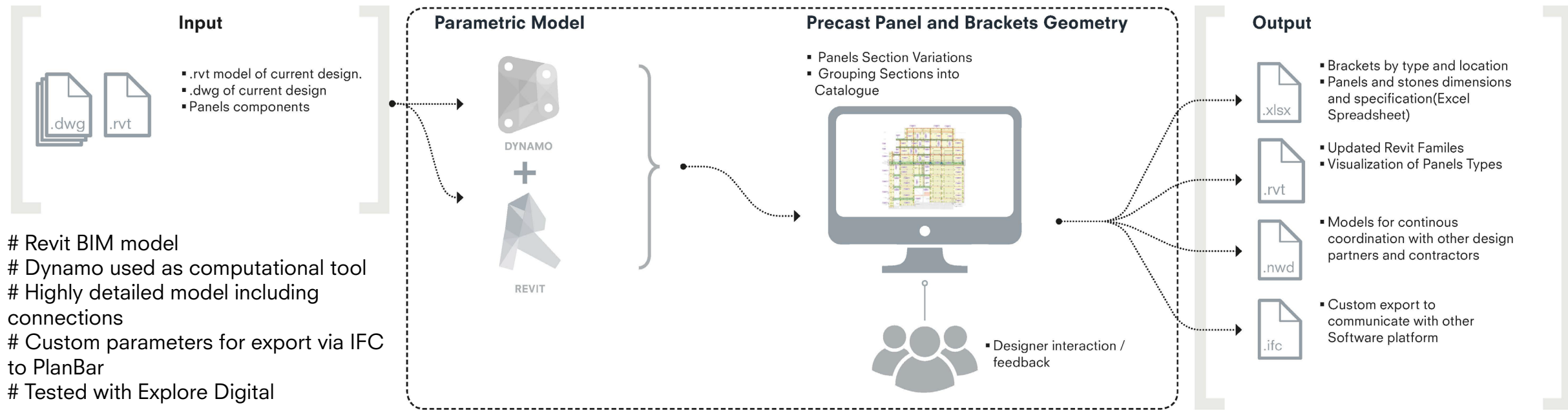


St. James Centre

Client: Laing O'Rourke

Location: Edinburgh

Digital Workflow



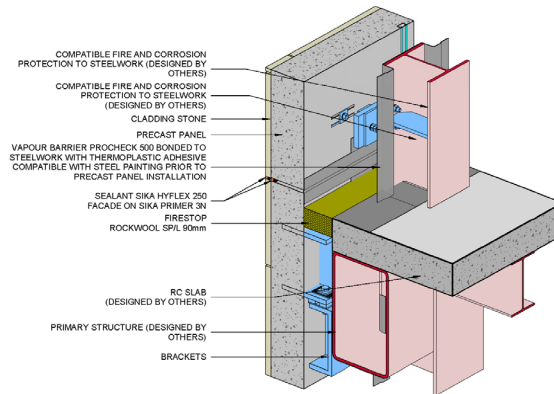
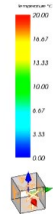
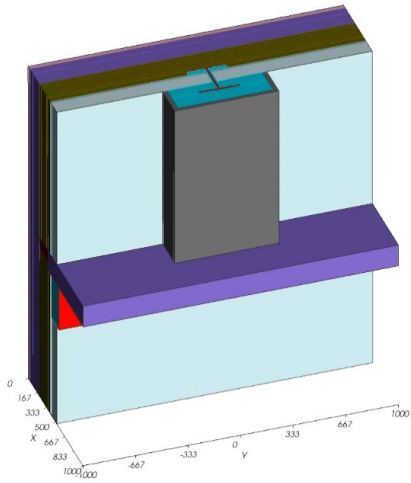
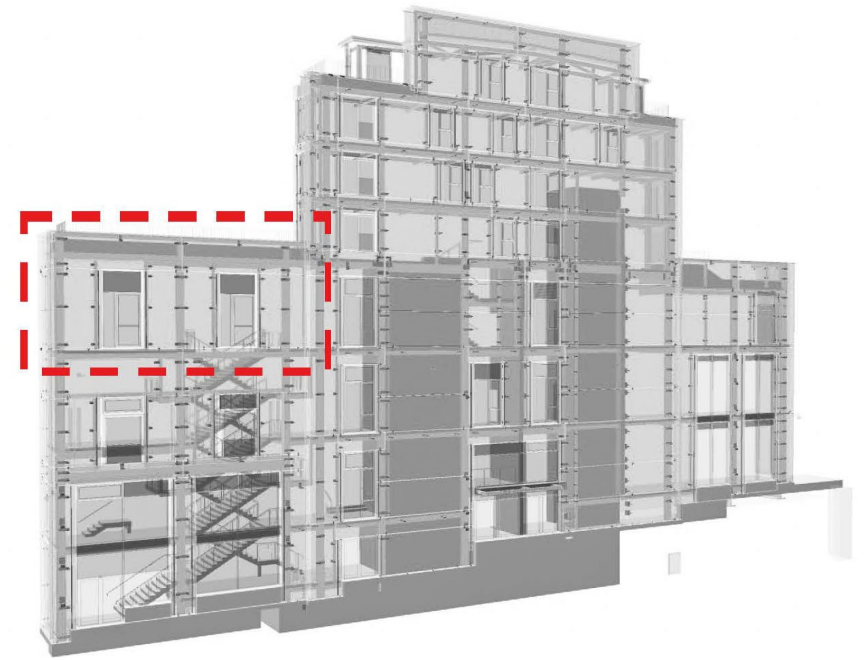
St. James Centre

Client: Laing O'Rourke

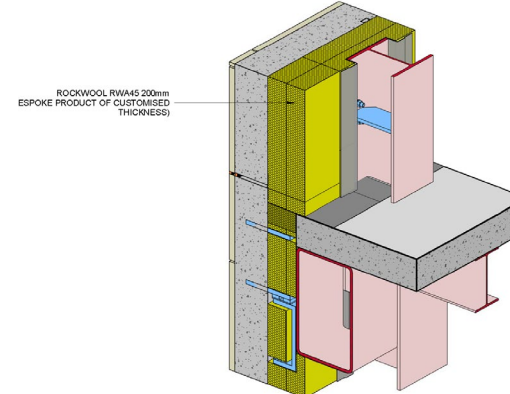
Location: Edinburgh

Constant collaboration

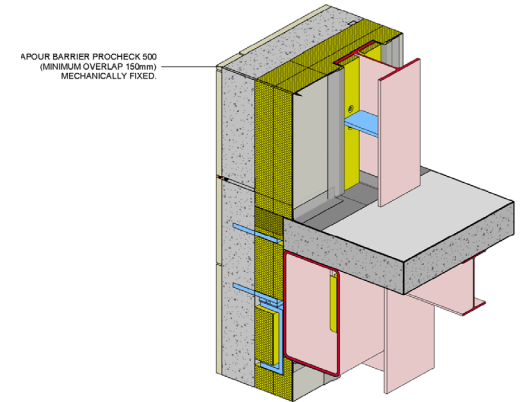
- # Digital workflows developed by BW
- # Each panel modelled to fabrication LOD 500
- # Fully coordinated with project partners
- # Bracket connections to structure modelled
- # Components scheduled from model for procurement
- # Cast in elements accurately positioned



PHASE 01 - JOINT DETAIL 3D VIEW 03



PHASE 02 - JOINT DETAIL 3D VIEW 03



PHASE 03 - JOINT DETAIL 3D VIEW 03

St. James Centre

Client: Laing O'Rourke

Location: Edinburgh

BIM model developed for panelisation

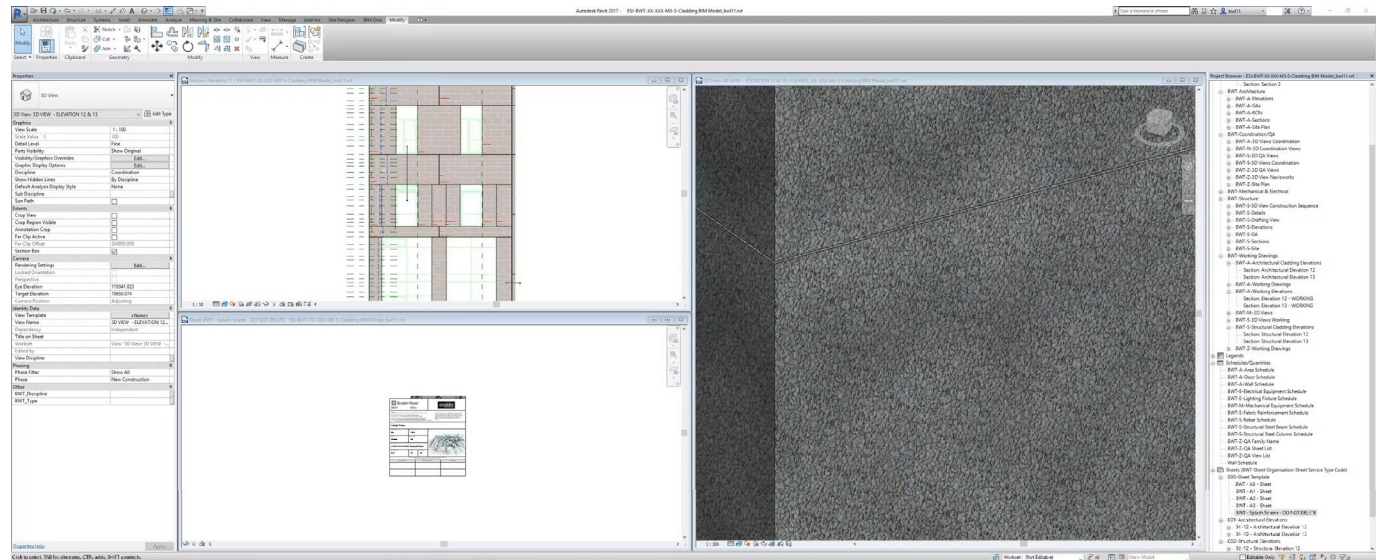
Scripts automate modelling process for stones

All stones placed using predefined rules

Rules based on architectural aspirations

ca. 19,000 individual stone pieces

10,000 square metres of stone



St. James Centre

Client: Laing O'Rourke

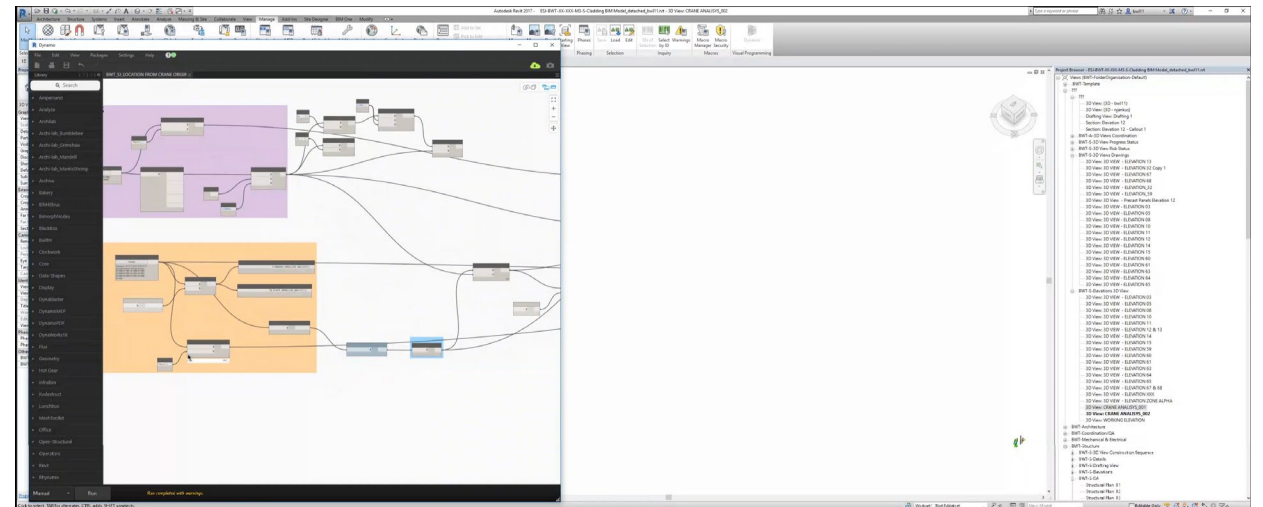
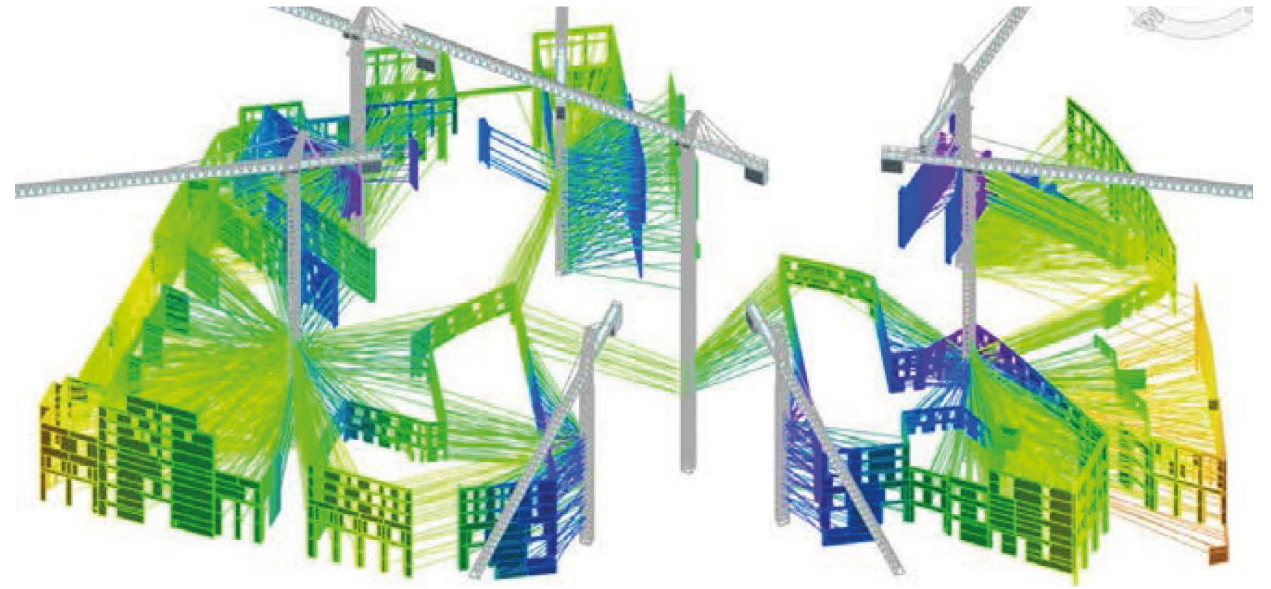
Location: Edinburgh

Crane utilisation strategy

Model used to develop lifting and installation approach

Dynamo script created for optimal positioning

Approach considers panel and crane variations



St. James Centre

Client: Laing O'Rourke

Location: Edinburgh

From Concept to Fabrication



Laing O'Rourke

Shell Centre

£1.3bn redevelopment

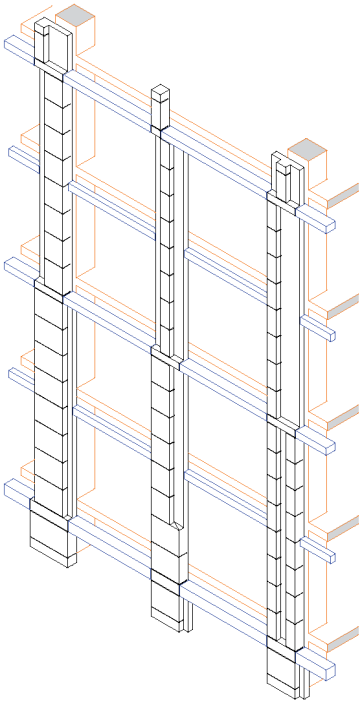
Systemisation of prefabricated
façade system

**800 new homes ,
offices
and restaurants**

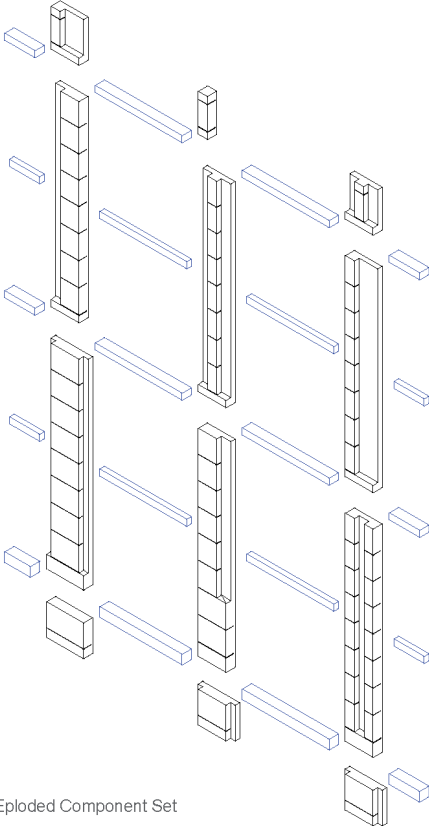


Laing O'Rourke

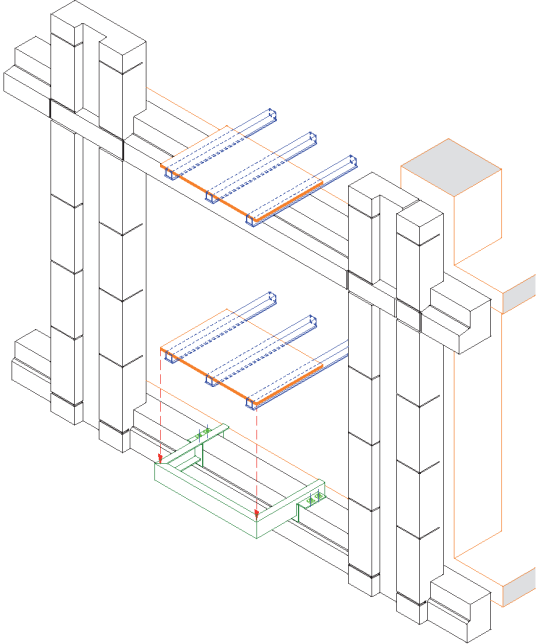
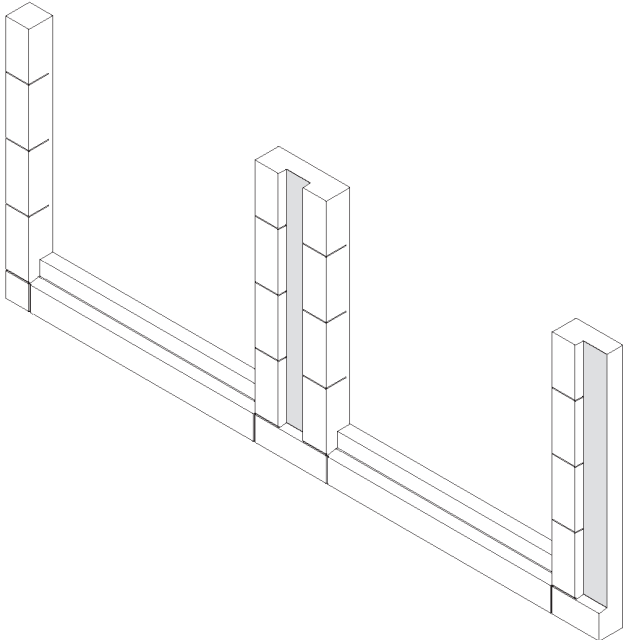
Shell Centre



External Isometric



Exploded Component Set



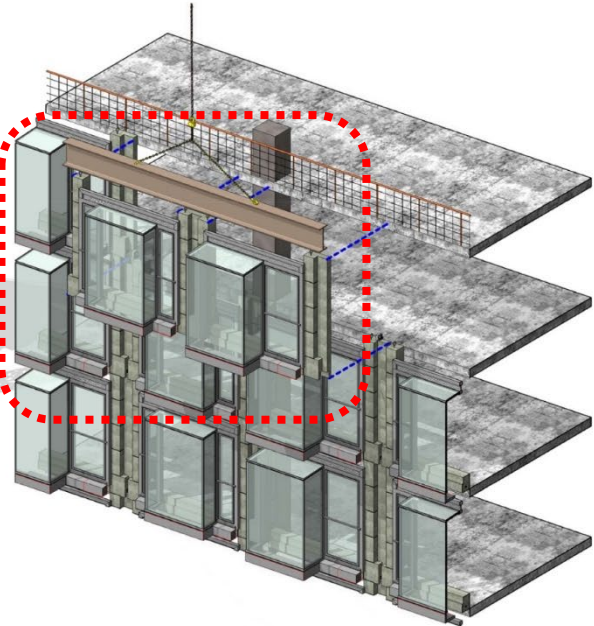
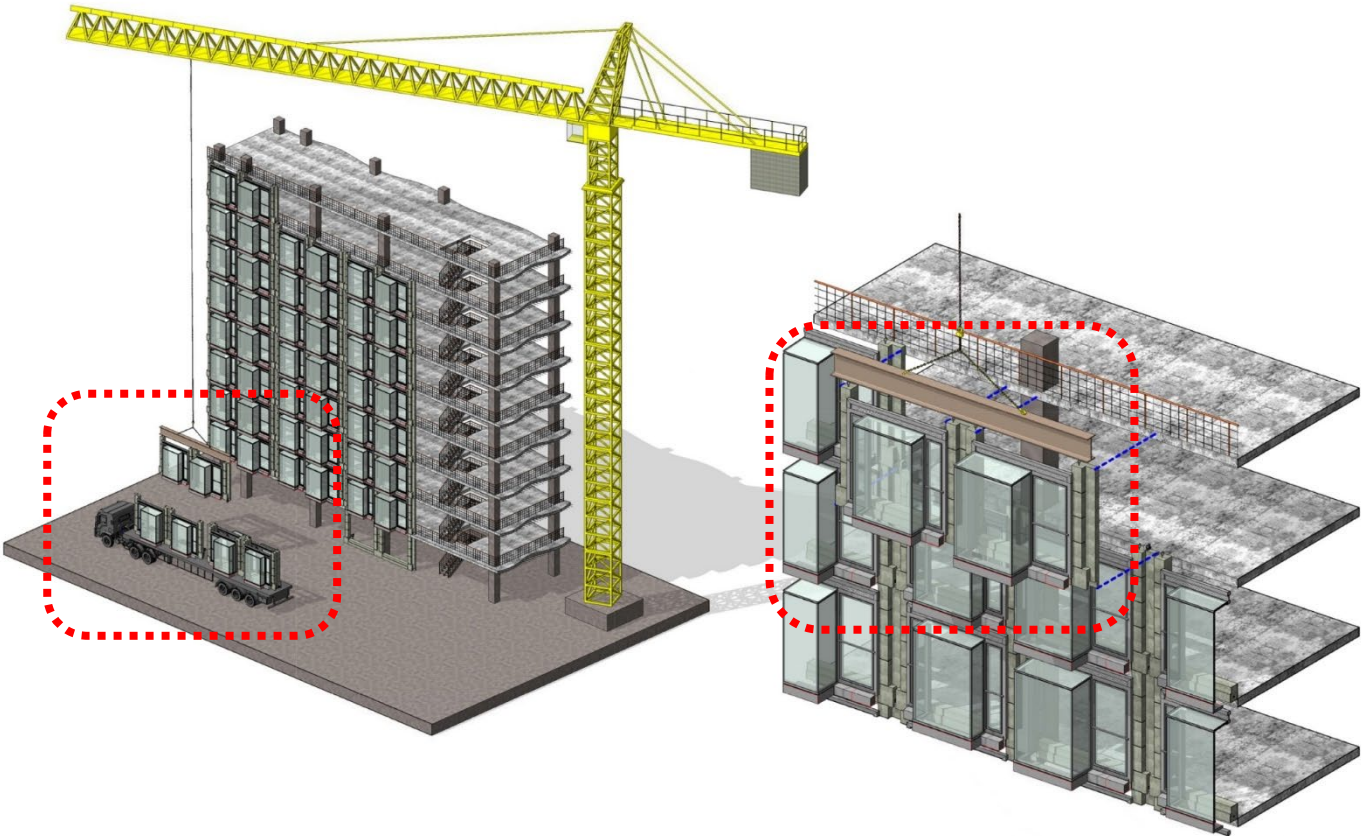
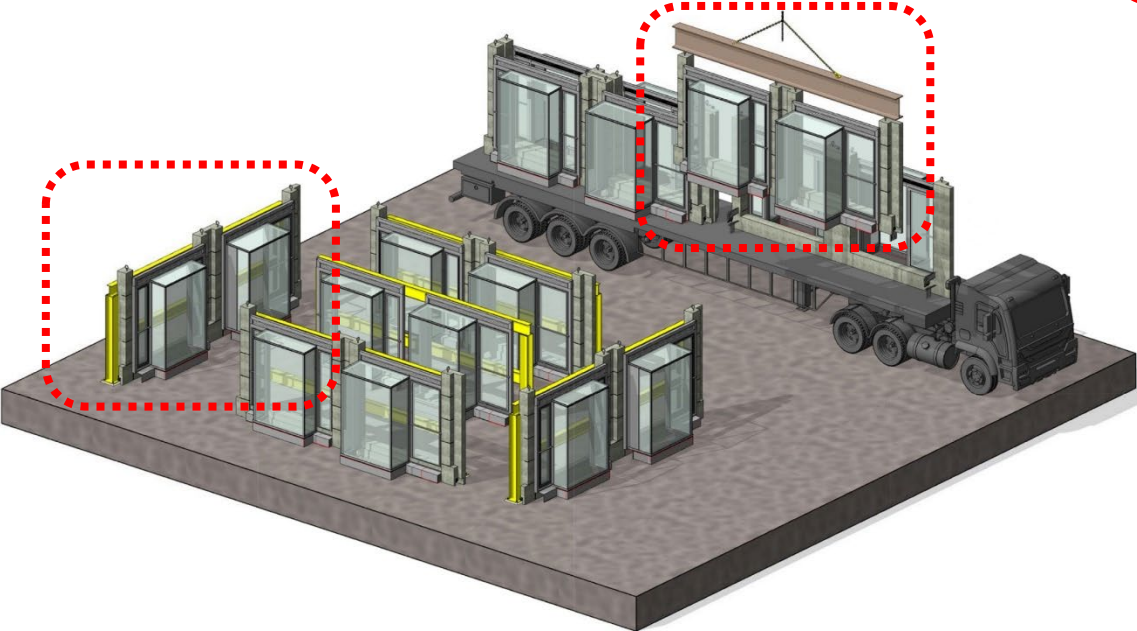
Laing O'Rourke

Shell Centre

London, UK

Systemisation of prefabricated façade system

From virtual prototype...



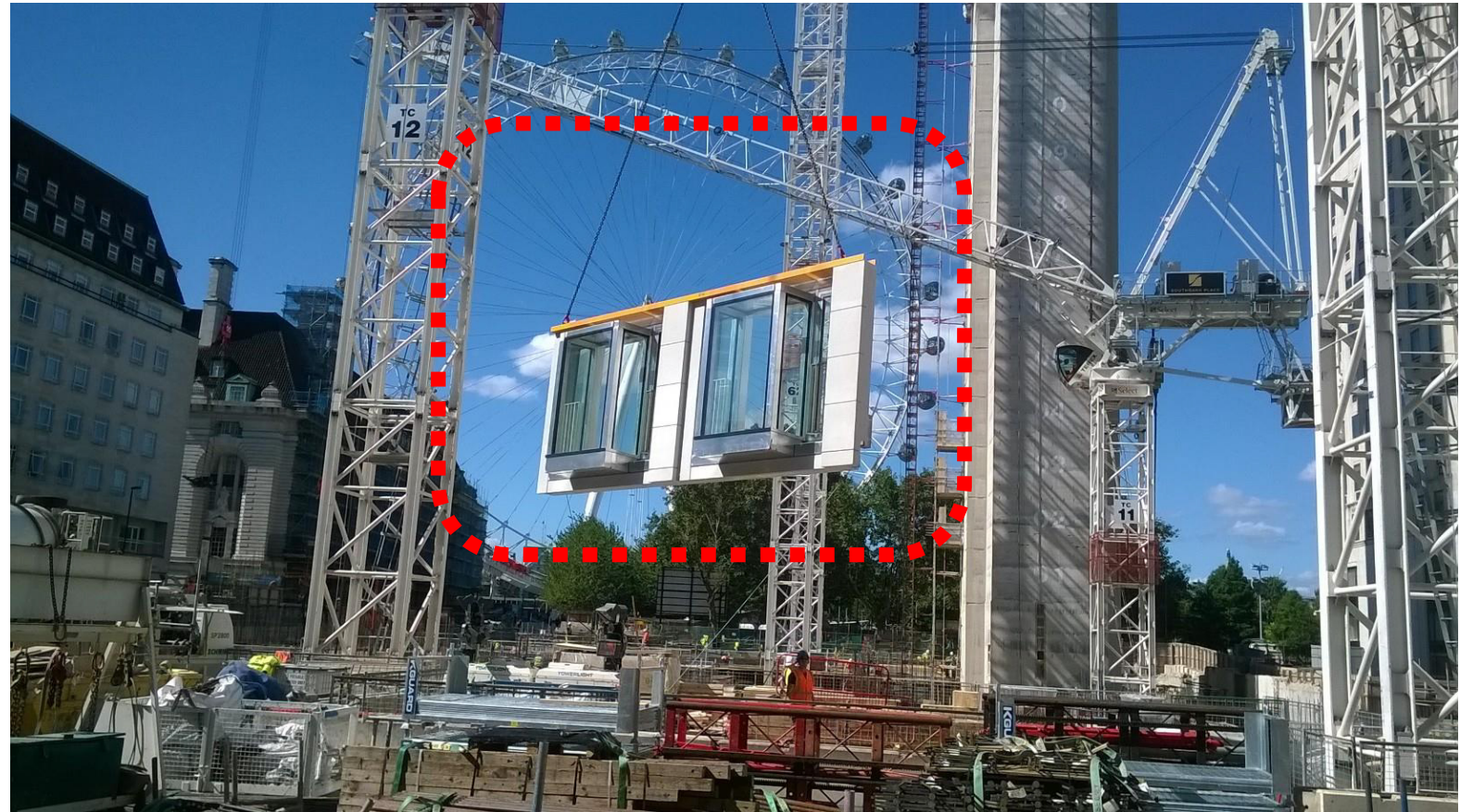
Laing O'Rourke

Shell Centre

London, UK

Systemisation of prefabricated façade system

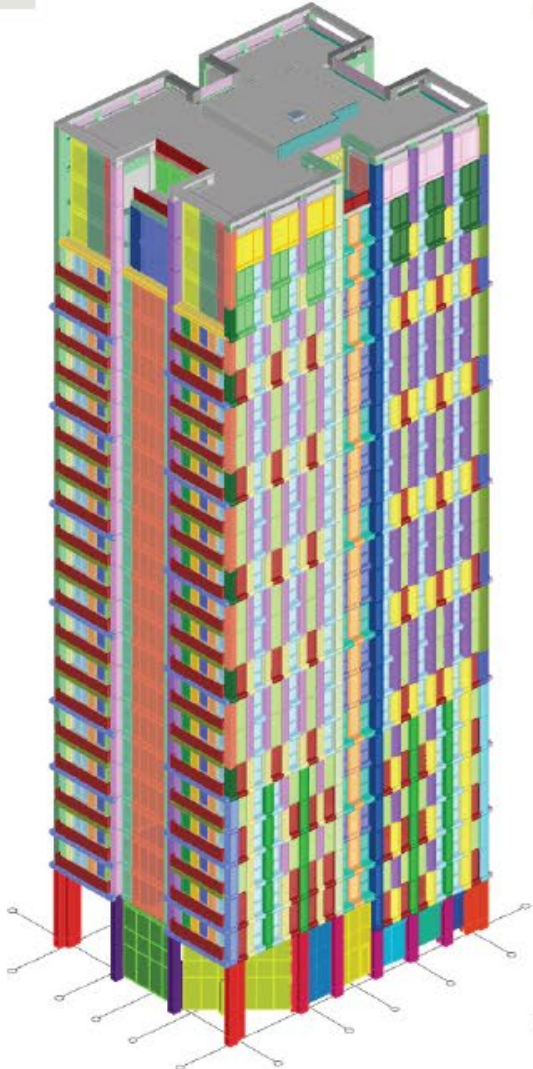
... to on-site installation



Input



- .rvt model of current design.
- .dwg of current design
- Panels components



Parametric Model



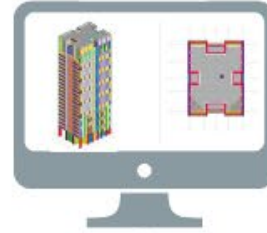
RHINOCEROS



GRASSHOPPER

Precast Panel Analysis

- Panels Variations
- Grouping Typologies into Catalogue



- Analysis feedback
- Dimensions (Excel Spreadsheet)

Output

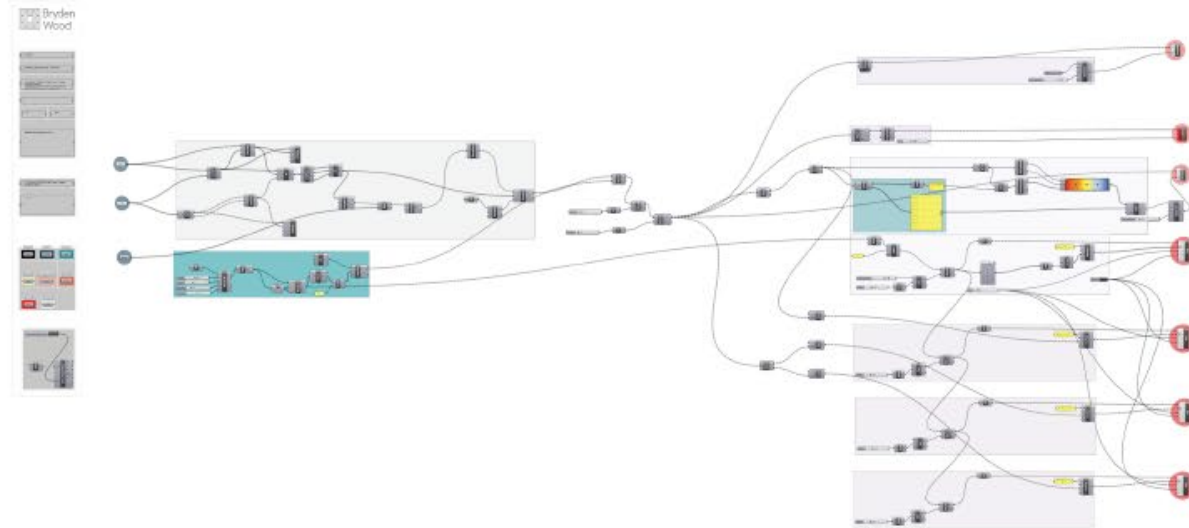


DYNAMO

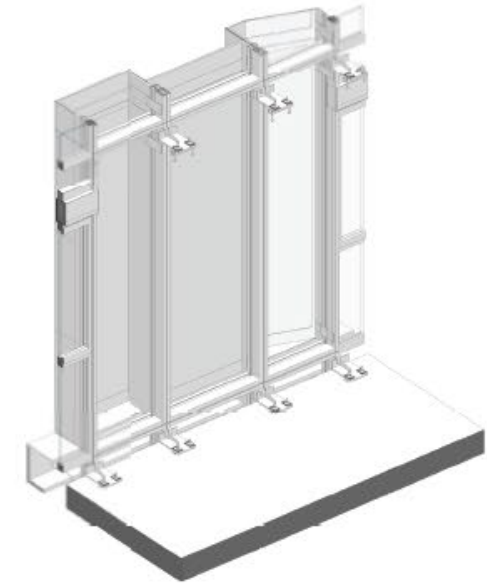


REVIT

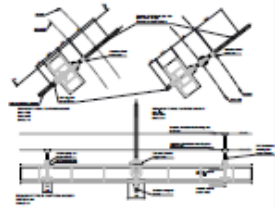
- Updated Revit Families
- Visualization of Panels Types



The parametric model of the Panels is used to:
— Assess the panel types and variations in the project

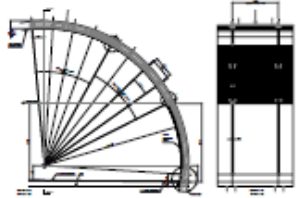


Unitised panel including of external cladding and internal wall finish.



Levelling brace and SCL fitting.
The ladder frame levelling brace incorporates a single anchor (localise bolt) which fits back into the SCL (sprayed concrete lining), and two adjustable ball jointed levelling feet which bear directly against SCL.

Acoustic base fit panel.
Incorporates 4 cast in place brackets which bolt directly onto brackets on the ladder.



Typical platform bay module.
Typical platform module section and elevation above. The platform module incorporates two base plates fixed to the slab and a single fixing back into the sprayed concrete lining.



Key Plan - Tottenham Court Road

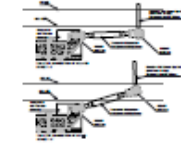
Soffit hinge panel.
To replace the typical soffit panel.

Typical platform in-fill bay.

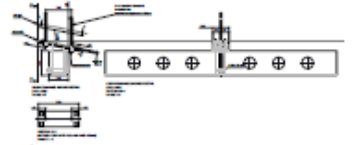
Solid soffit hook on panel.
Incorporates a backing frame which hooks directly onto the ladder and fits in place with two grub screws.

Task arch, 90mm thick GFRC (glass fibre reinforced concrete). The task arch is fixed to the lower task plinth and is restrained back to the SCL in the cross passage.

Task arch lifting points



Task arch restraint. Runs from the task back to the SCL in the apex of the cross passage. The restraint incorporates a turn buckle for precise tensioning to an localise anchor bolt.



Cross passage module restraint.
Allows for vertical tunnel movement.

The apex of the ladder frame incorporates a notched spline channel. The notch provides clear space for a cable tray/channel that has been sized to accommodate the general requirements for each station.



Cross passage base plate

A floor transition occurs directly after the junction module in the fill bay of the cross passage. The change in floor level is reflected in the skirting and fill bay panels.

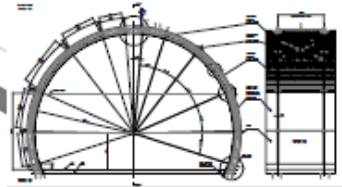
Platform skirting kerb

Platform base plate

Acoustic hook on panel.
Incorporates a backing frame which hooks directly onto the ladder and fits in place with two grub screws.

Task Plinth.
Incorporating two base brackets the task plinth forms a complete arch with the task arch.

Cross passage fill bay.
The bay deals with the complex bed and level difference between platform and cross passage.



Typical cross passage bay module.
Typical cross passage module section and elevation below. The cross passage module incorporates two base plates fixed to the slab and two fixings back into the sprayed concrete lining.

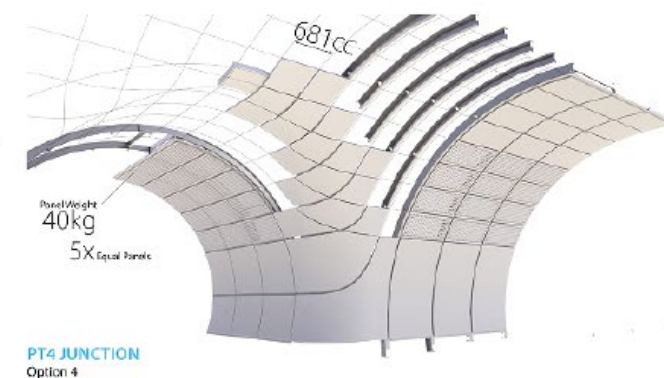
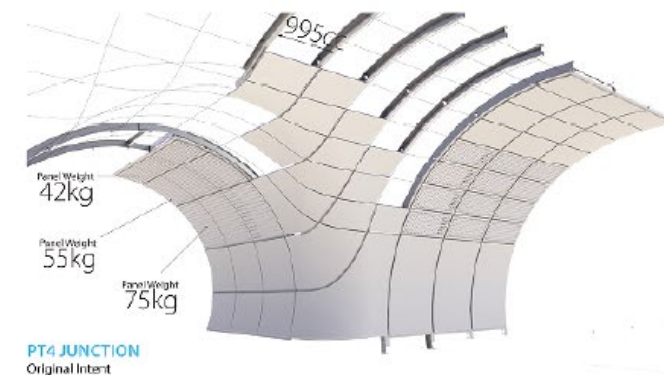
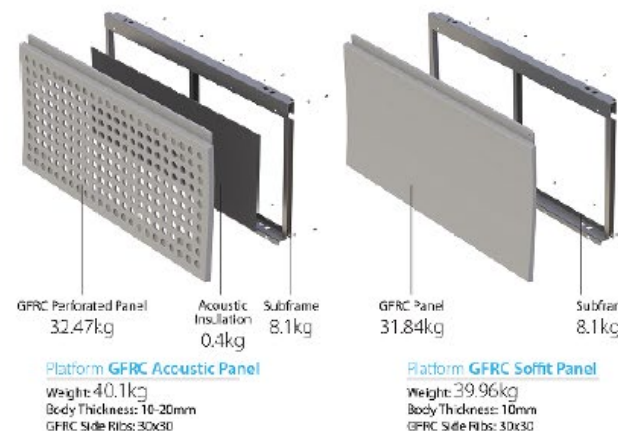
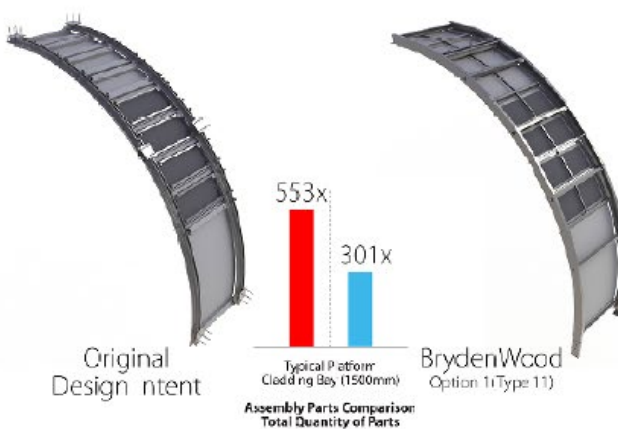
Crossrail

#Client: Laing O'Rourke

Location: London

The panel installation process resembles an assembly line where the tolerance has been predetermined at design stage and accuracy maintained through the use of Computer Numerical Control (CNC) cutting and forming machinery.

This solution was initially applied to Tottenham Court Road and Liverpool Street stations. It has since been adopted by Crossrail as their preferred solution and LOR have been approached by other Crossrail contractors' groups to provide the lining system throughout the Crossrail network.

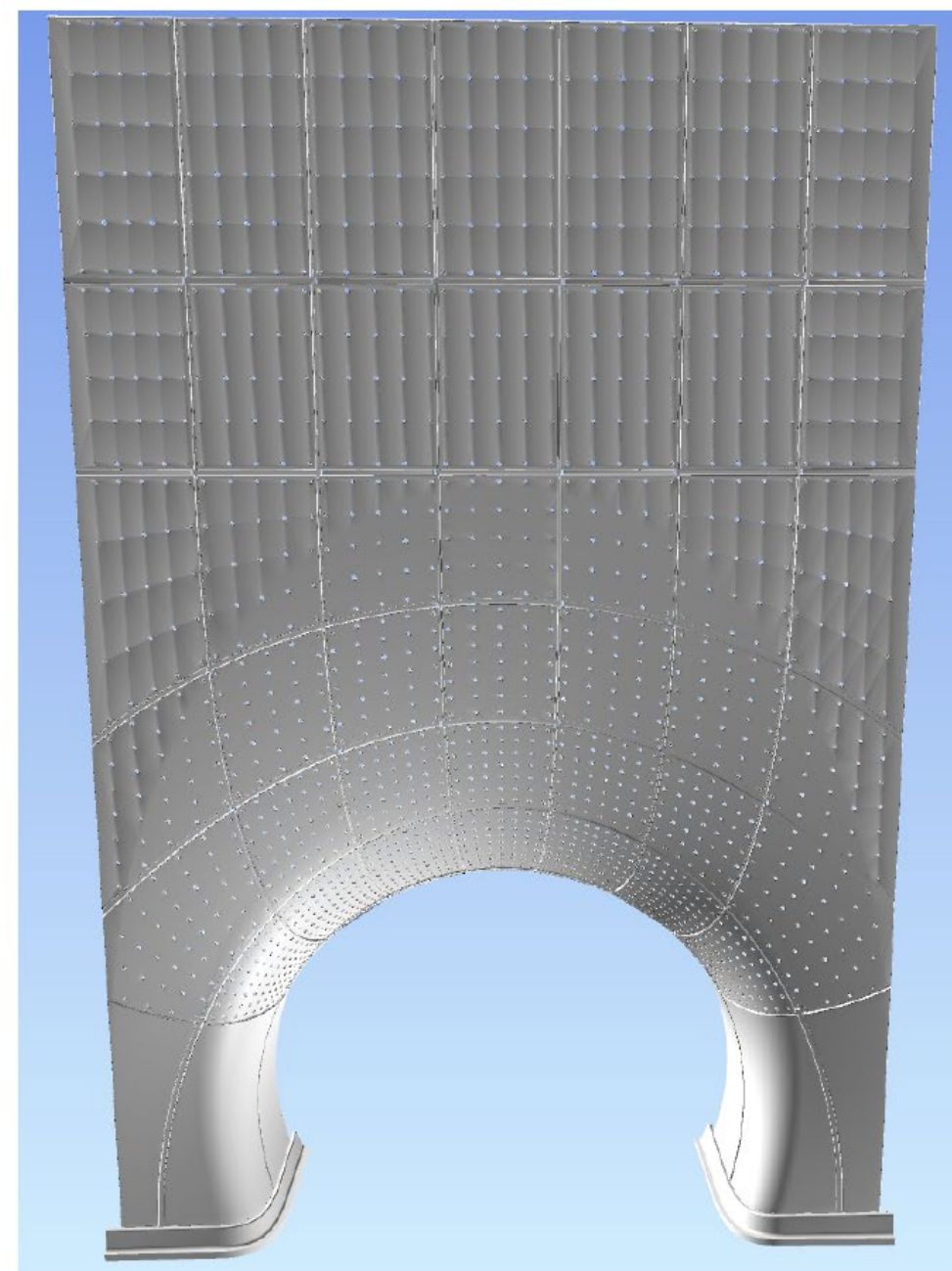
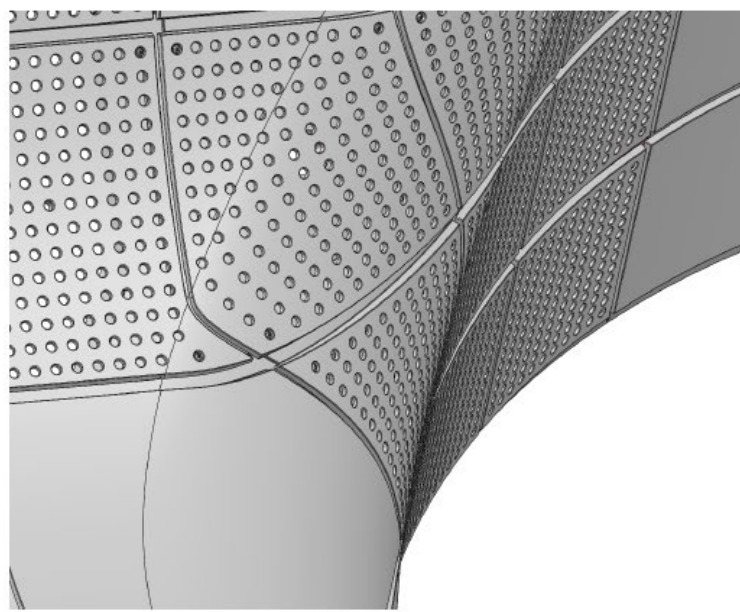


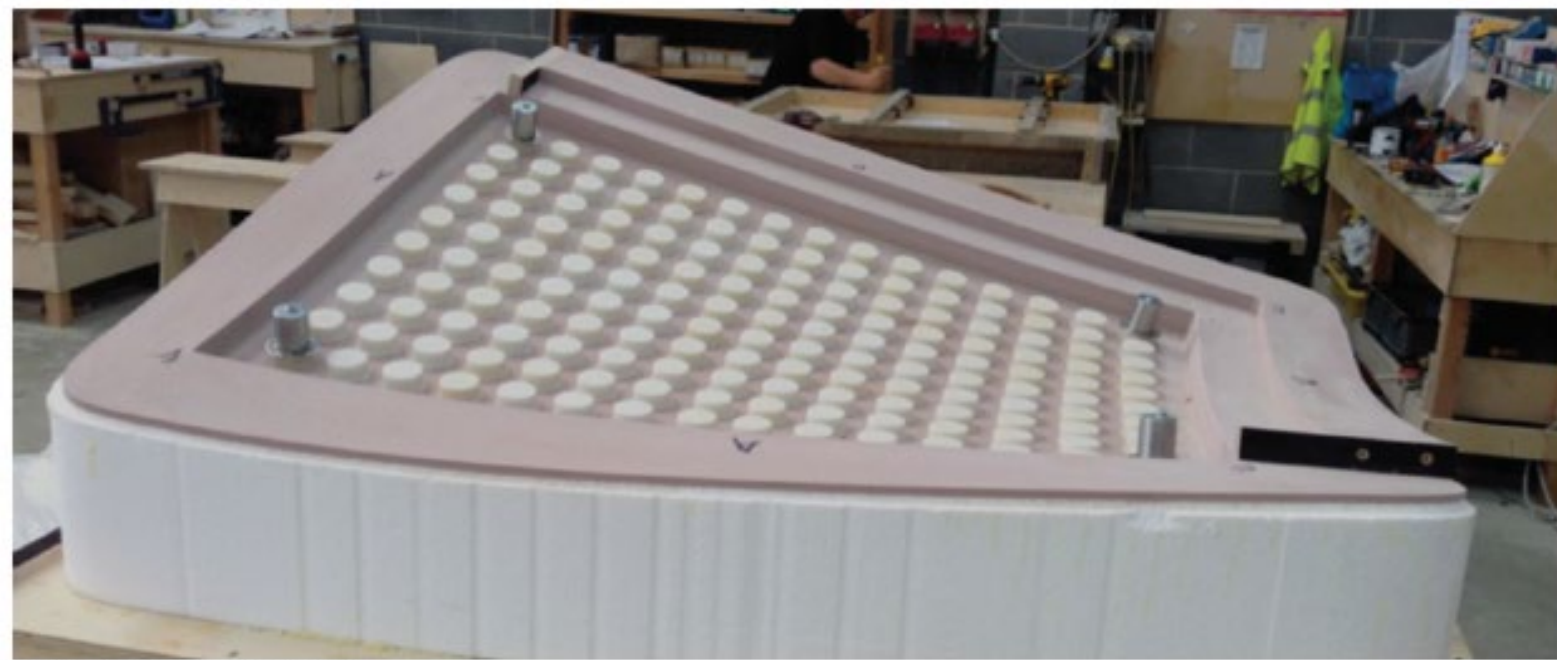
Crossrail

#Client: Laing O'Rourke

Location: London

Fully detailed Digital models of the panels.





Crossrail Double Curved Mould



Crossrail

#Client: Laing O'Rourke

Location: London

Test Offsite of the assembly of the different parts into a 1/1 model

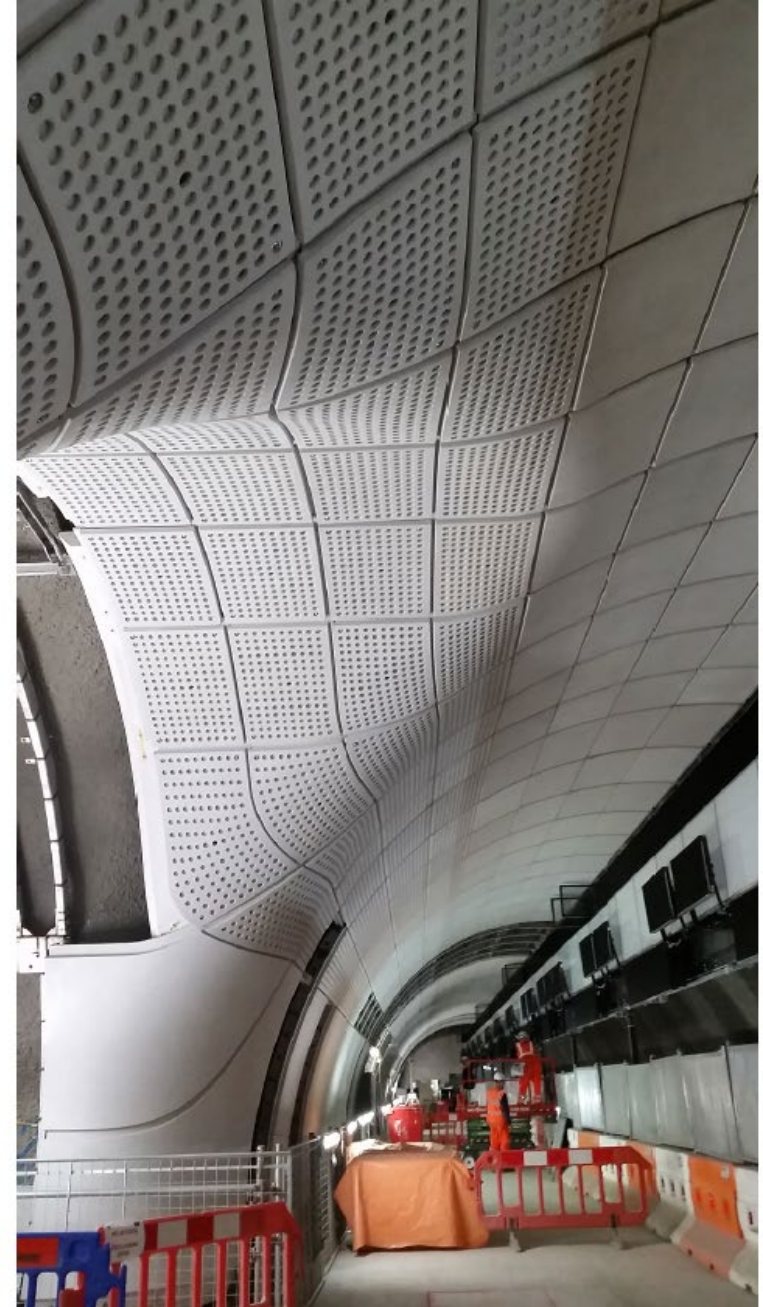


Crossrail

#Client: Laing O'Rourke

Location: London

Substructure and final panels mounted



Crossrail

#Client: Laing O'Rourke

Location: London

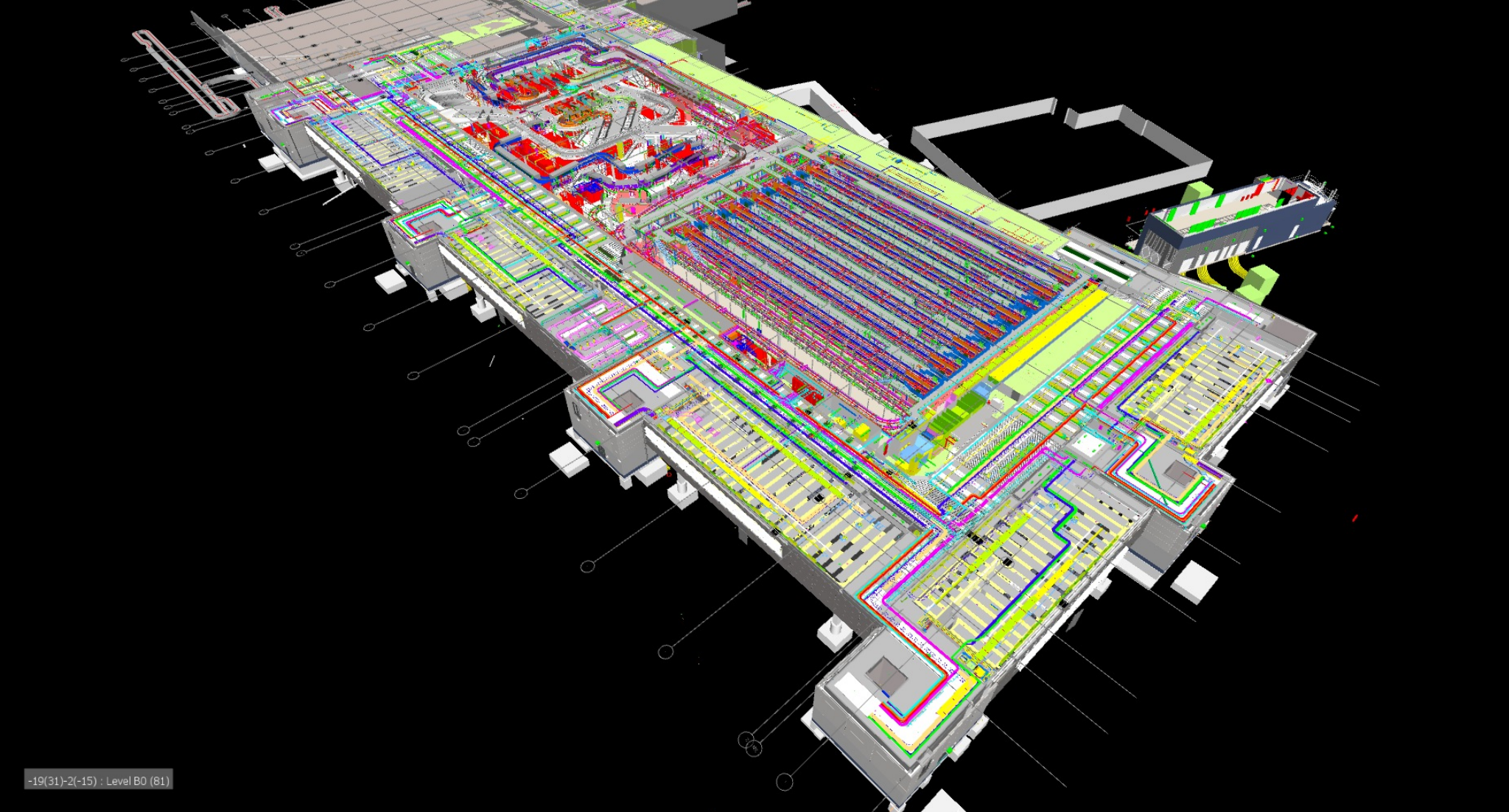
Substructure and final panels mounted





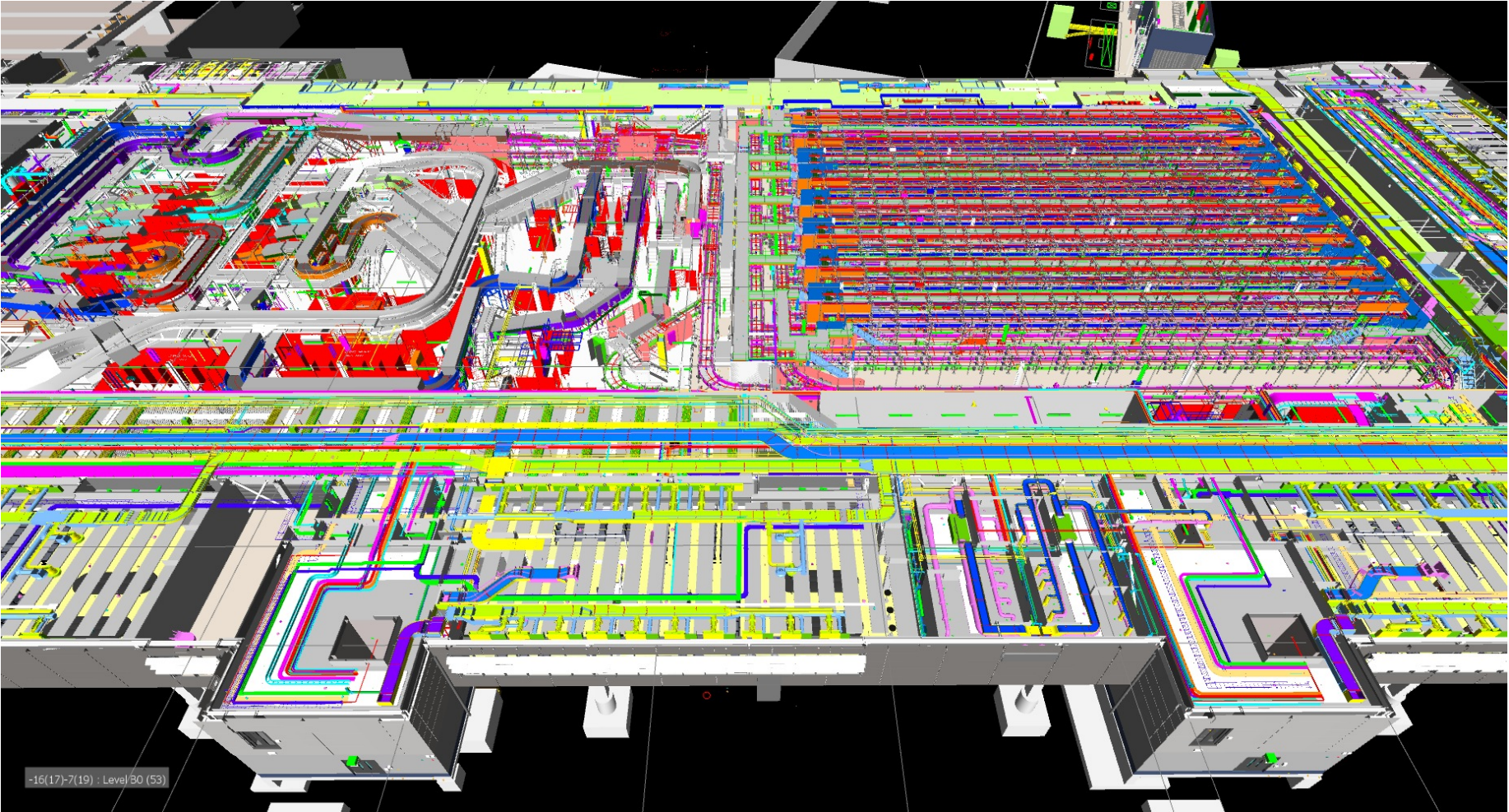
Gatwick Airport

South Terminal – Pier 1



Gatwick Airport

South Terminal – Pier 1

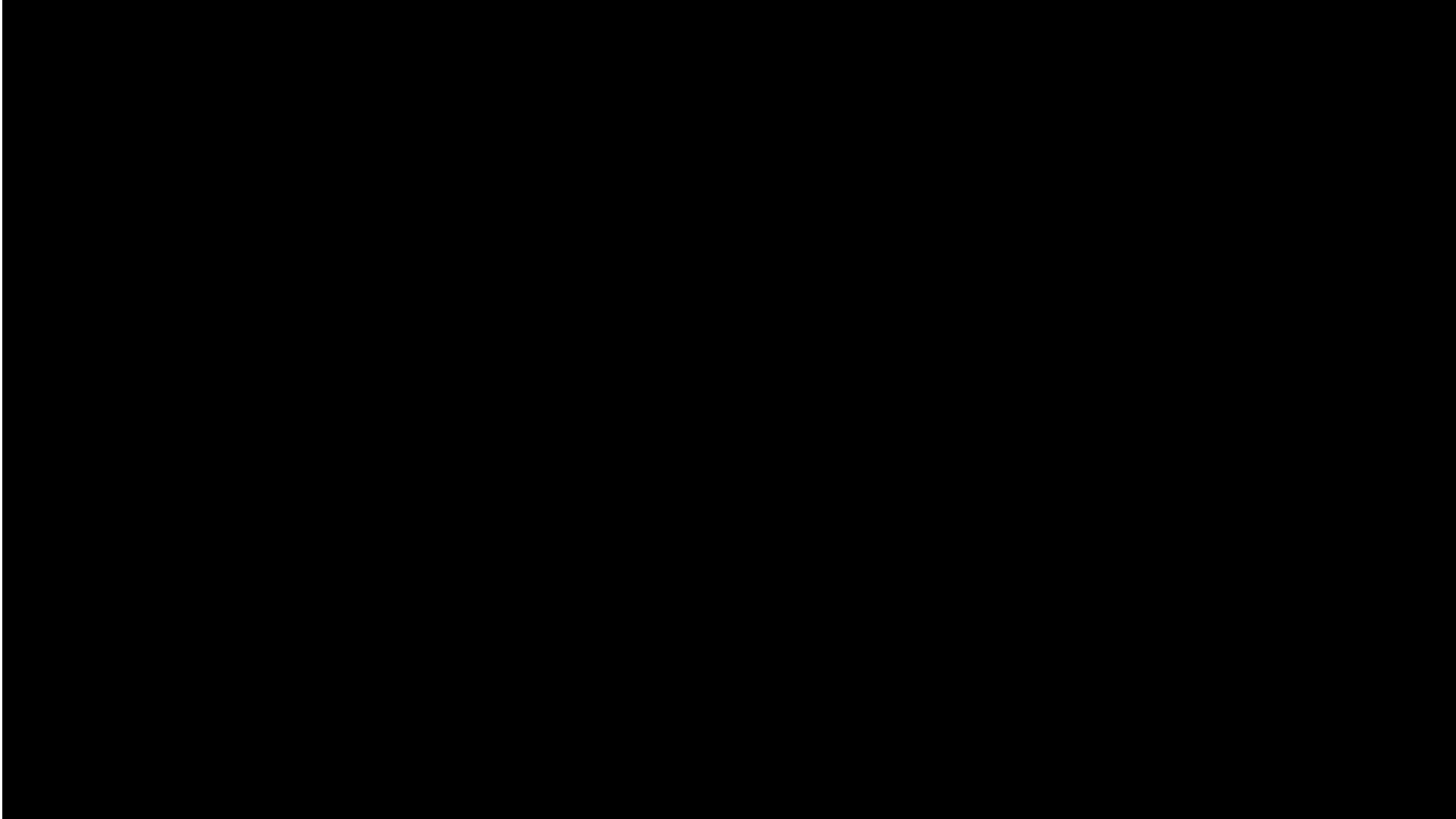


Gatwick Airport

South Terminal – Pier 1



Concepts Chip Thinking

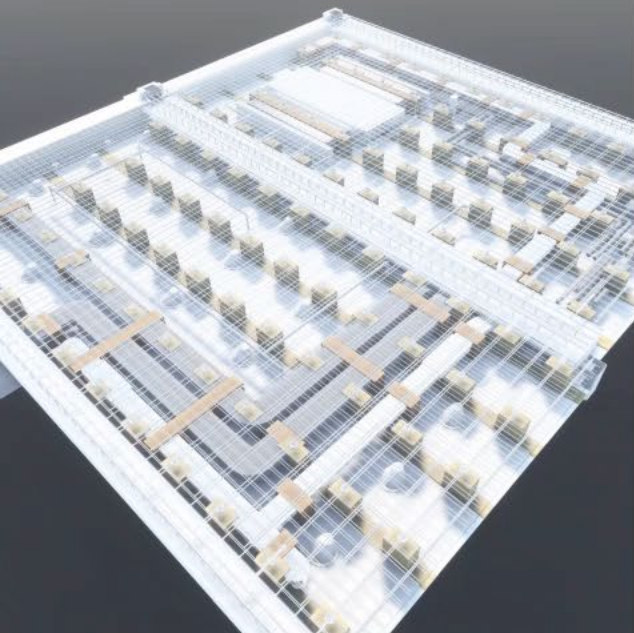


Automated construction

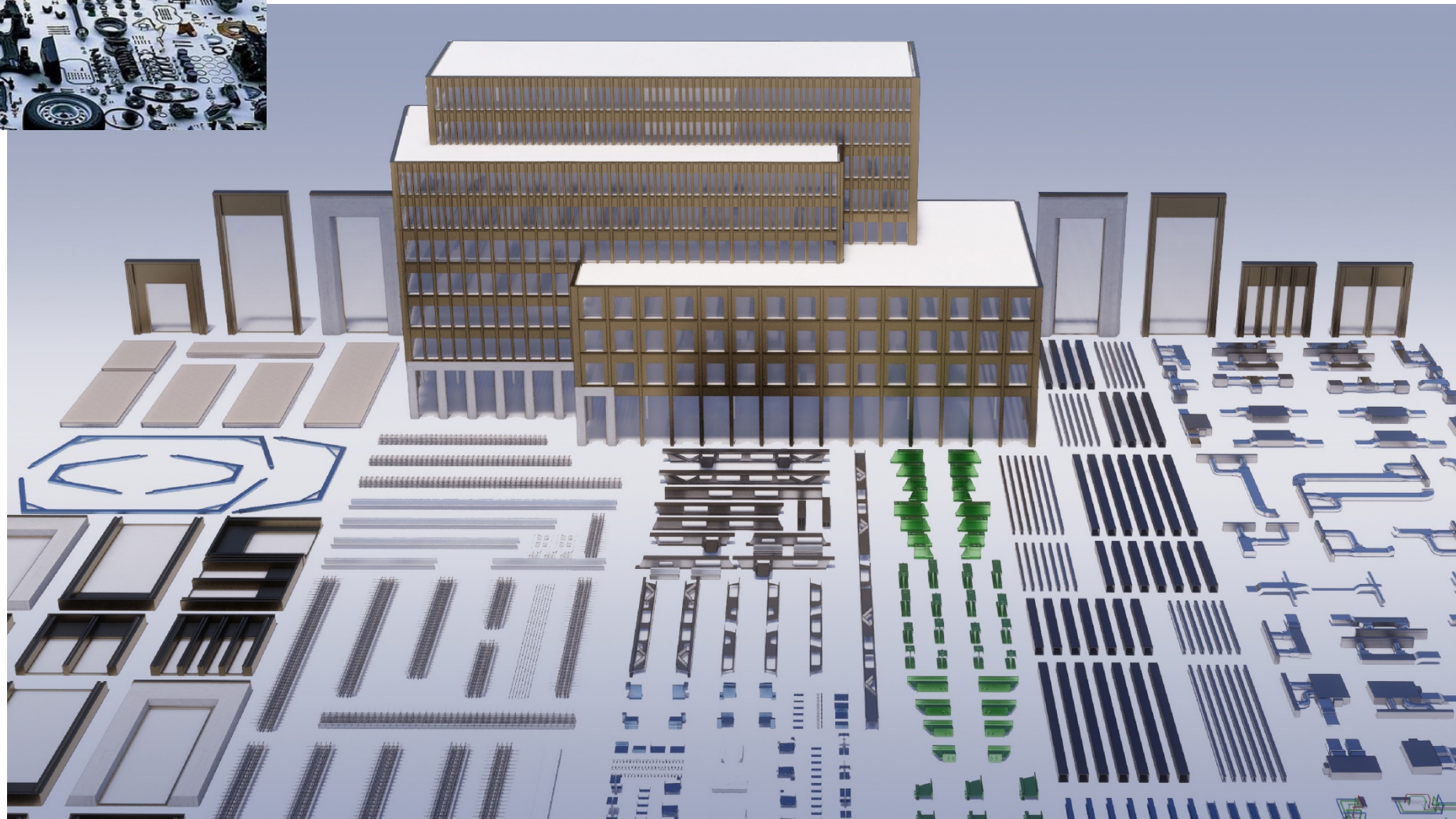
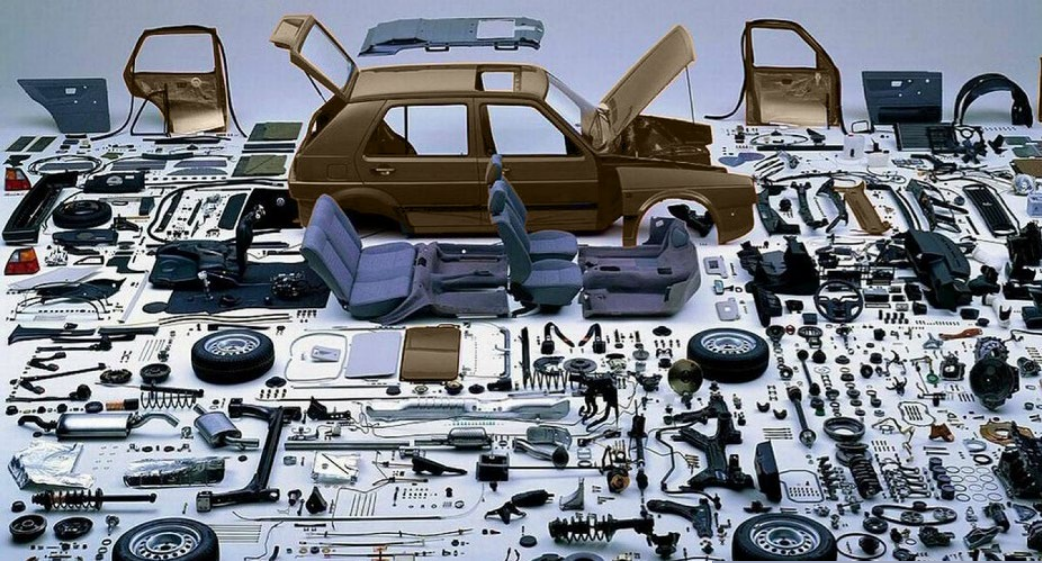
Concepts Platforms

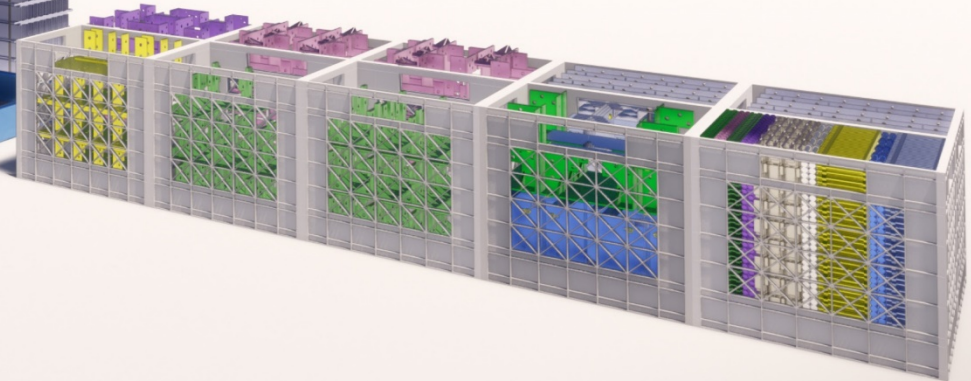
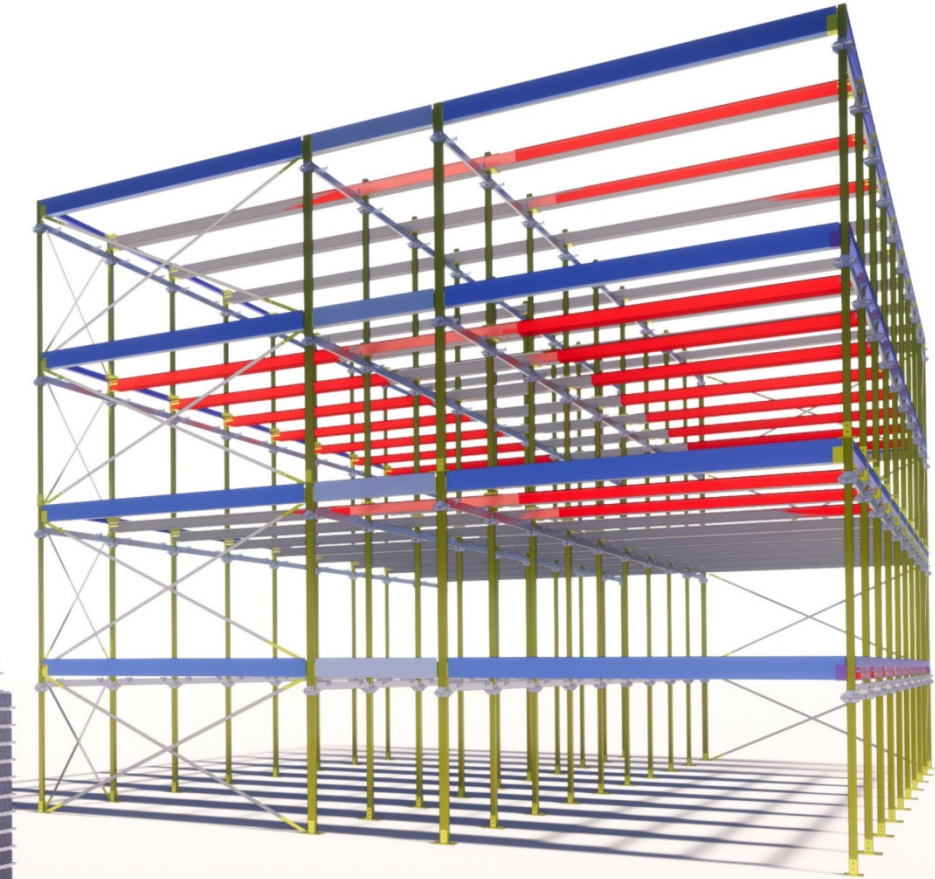
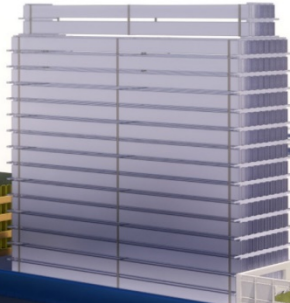
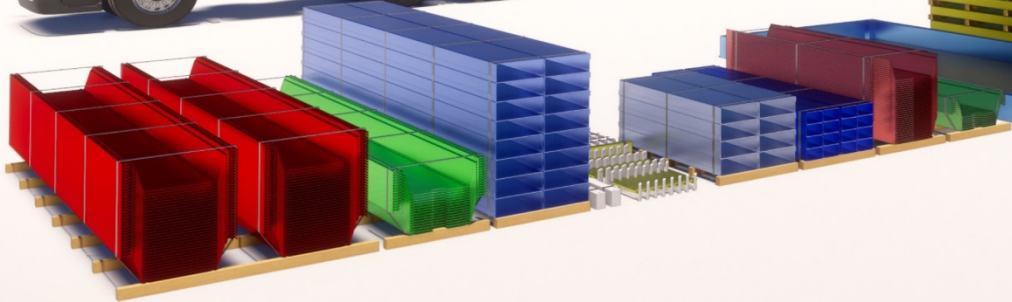
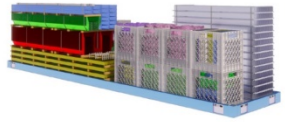


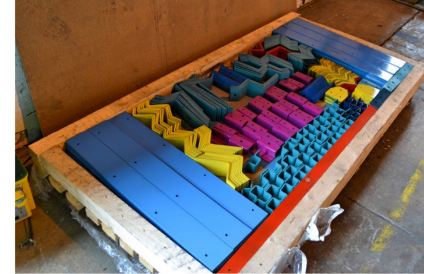
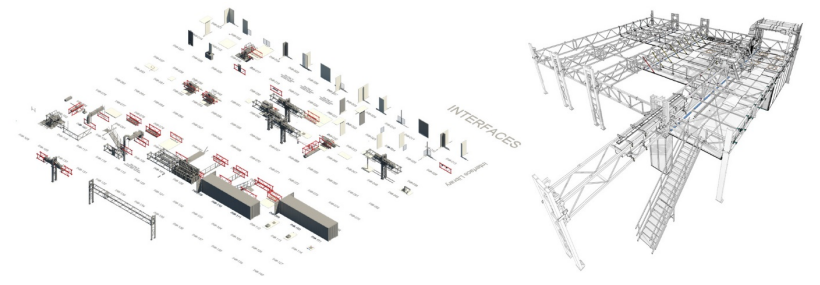
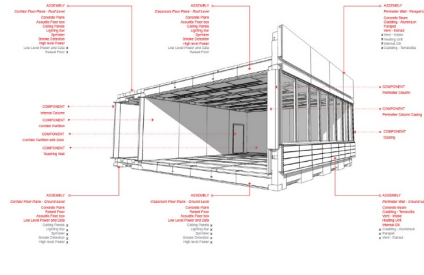
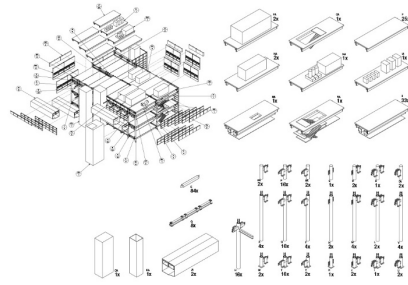
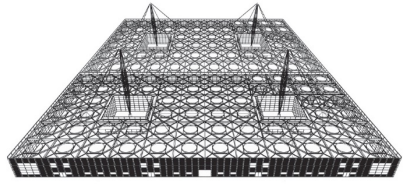
Site assembly



Sub-assembly work in progress







1995 - ongoing
Iigus GmbH

2007 - 2009
GSK 'New Ways'

2009
Herts BSF programme

2015 - ongoing
GSK 'Factory in a Box'

2004

2005

2006

2007

2008

2009

2010

2011

2012

2013

2014

2015

2004

2008 - 2014

2009 - ongoing

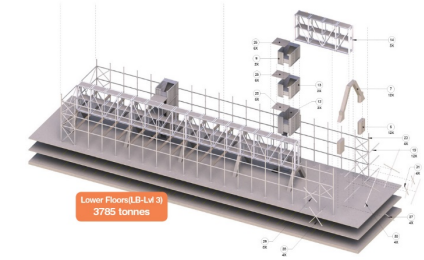
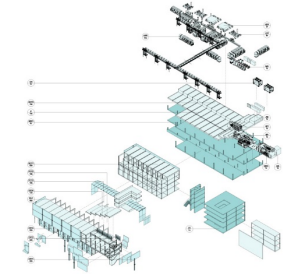
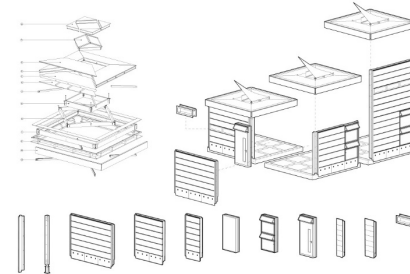
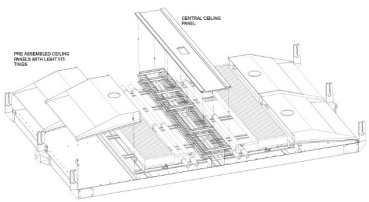
2012 - 2014

BAA Pier segregation product

EcoCanopy Schools

Circle Hospitals

Gutenberg, St. Petersburg



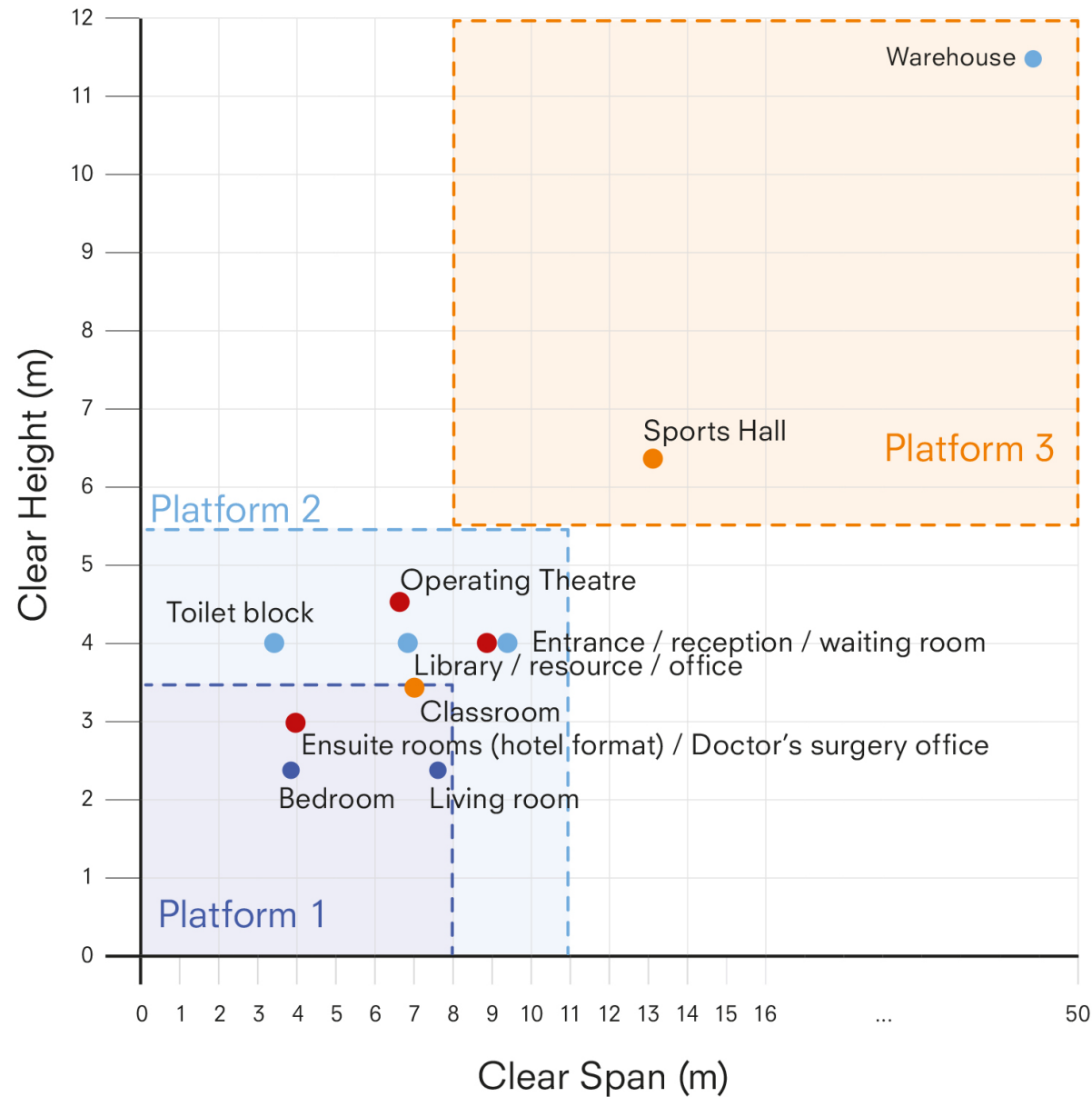
Lower Floor: 148
3785 tonnes





Platforms combine design, manufacture,
and procurement principles holistically to
ensure a **greater degree of
rationalisation and integration**

“Platforms could achieve a
33% reduction in capital
cost”



A Platform-based approach to construction



-  Residential
-  Offices
-  Health
-  School

 Infrastructure and Projects Authority

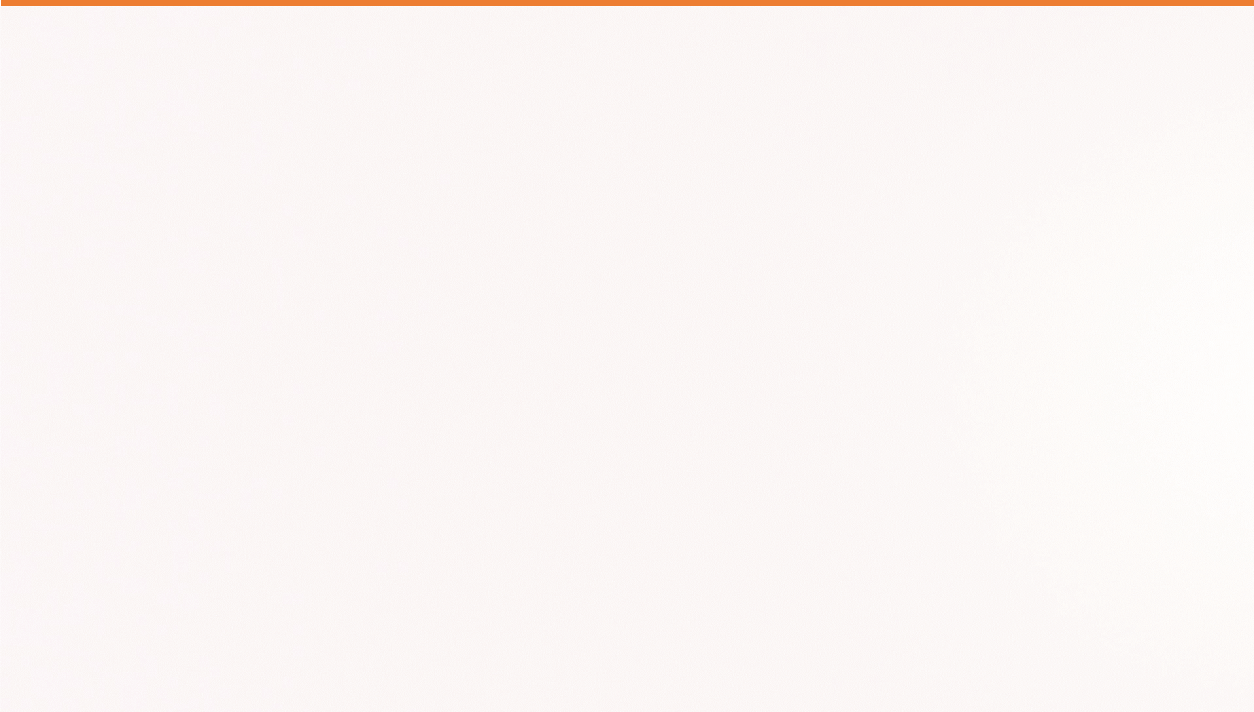
 Ministry of Justice

 Department for Education

 Department of Health

 Ministry of Defence

 Department for Transport

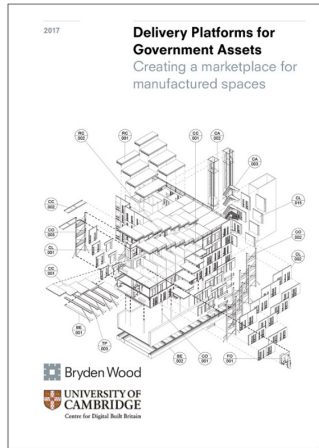


Scaling up – achieving
wider adoption in the
industry



Heathrow

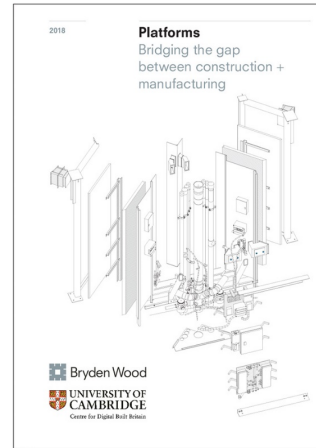
Delivery Platforms for Government Assets



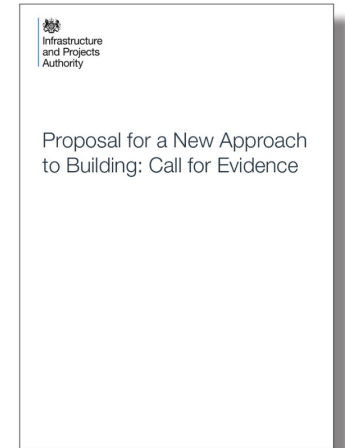
Autumn Statement
 'The government will use its purchasing power to drive adoption of modern methods of construction...'



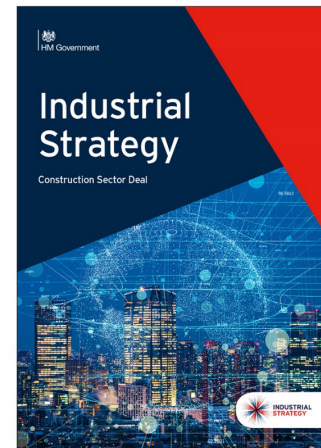
Platforms: Bridging the gap between construction + manufacturing



Proposal for a New Approach to Building



Transforming Infrastructure Performance



Construction Sector Deal



Construction Innovation Hub awarded £72 million to drive innovation + technological advances in the UK construction and infrastructure sectors.

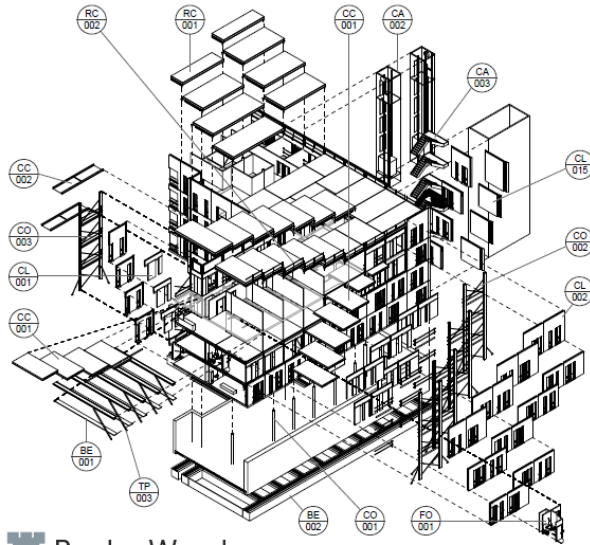


HM Government

2017

Delivery Platforms for Government Assets

Creating a marketplace for manufactured spaces



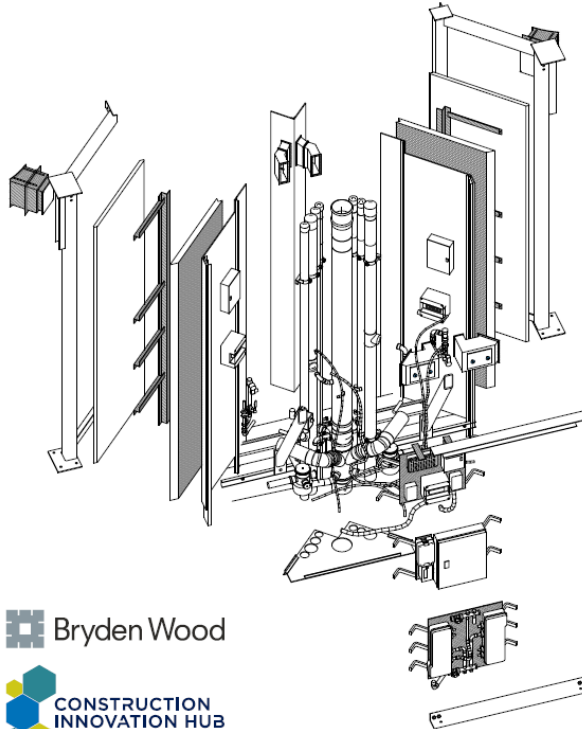
 Bryden Wood



2018

Platforms

Bridging the gap between construction + manufacturing



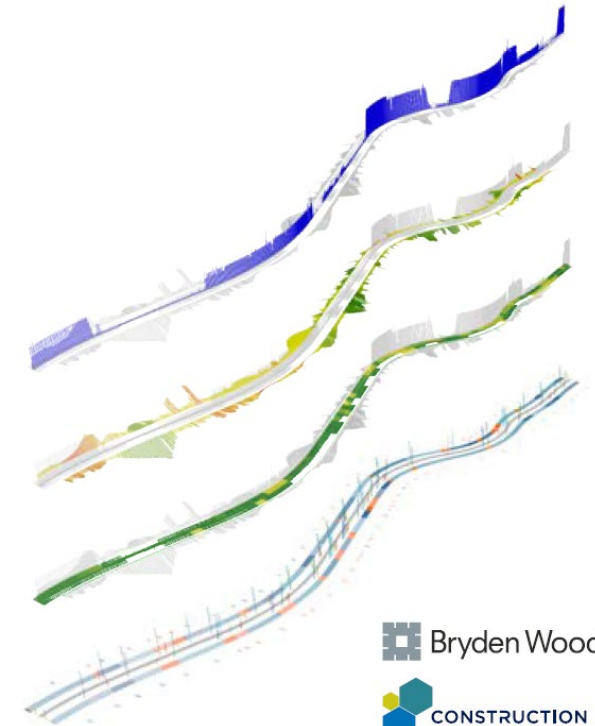
 Bryden Wood



2017

Data Driven Infrastructure

From digital tools to manufactured components



 Bryden Wood



brydenwood.co.uk/perspectives/178/

Bryden Wood

Structural
+ Civil
Engineering

Design for
Asset
Optimisation

Operations
Consulting

Architecture
+ Integrated
Design

Design for
Manufacture
+ Assembly

BIM +
Big Data

Mechanical
+ Electrical
Engineering

Process
Facility Design

Creative
Technologies

Jesus Perucho Alcalde
Associate,
Digital Delivery Information Manager

Creative Technologies @ Bryden Wood

Est. May 2018

We are a **computational design** team...

...**creating digital tech** for our clients...

Amin Hassanpour Divshali

Amir Awan

Anna Kampani

Charitini Skaltsari

Claudio Campanile

Diego Valdivia

Elite Sher

Eva Magnisali

Filippos Filippidis

Giulia Curletto

Giuseppe Miccoli

Hristo Dobrev

Ioannis Toumpalidis

Jami Cresser-Brown

Karim Anwar

Konstantina Spanou

Maria Mamoura

Marianna Chrapana

Maxime Downe

Parul Jain

Petroula Gkanidou

Vasileios Papalexopoulos

Algorithmic design + simulation

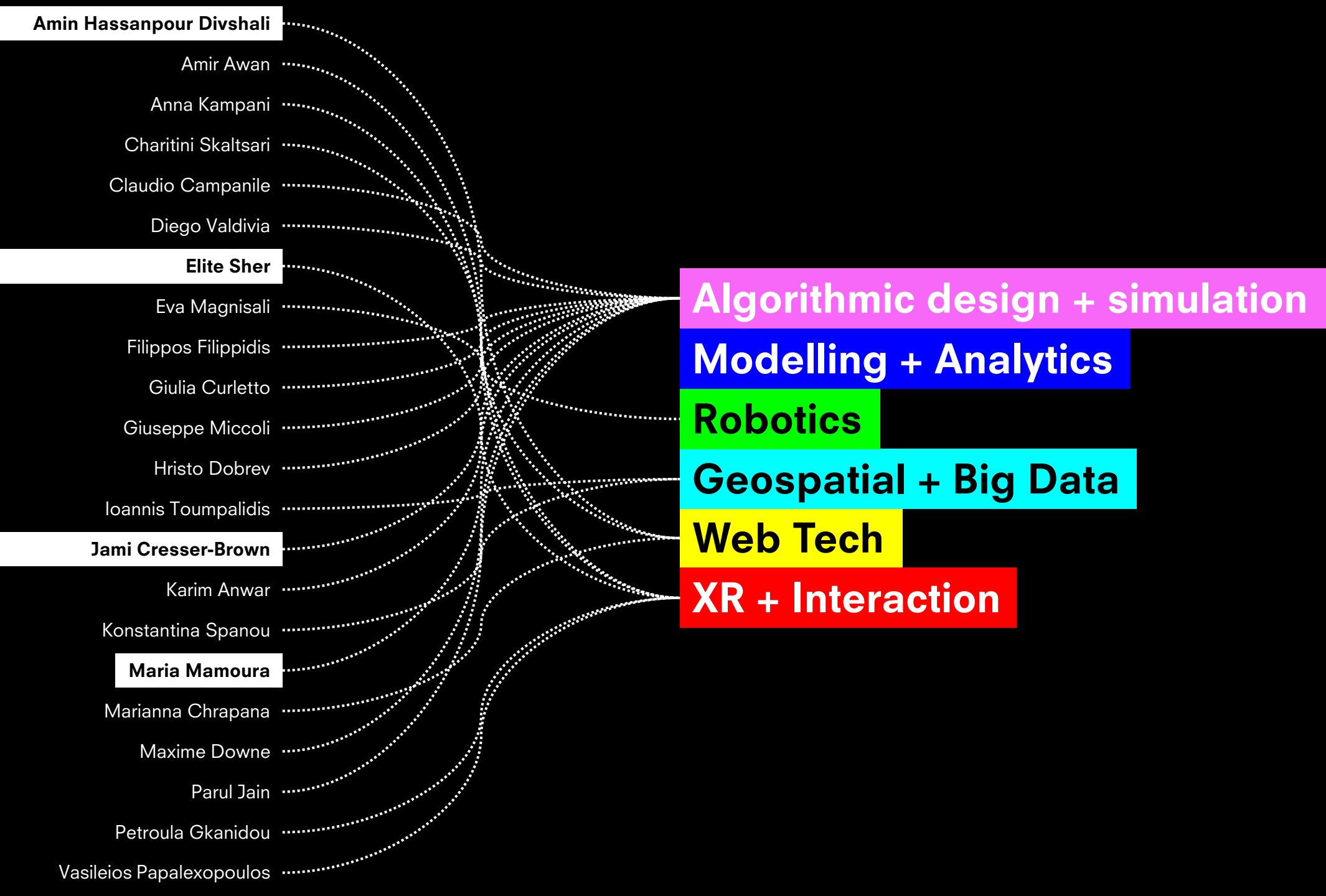
Modelling + Analytics

Robotics

Geospatial + Big Data

Web Tech

XR + Interaction



23

Creative Tech

177

Other Bryden Wood

23

Creative Tech

14

Sys

47

MEP

49

Structure

60

Architecture

96

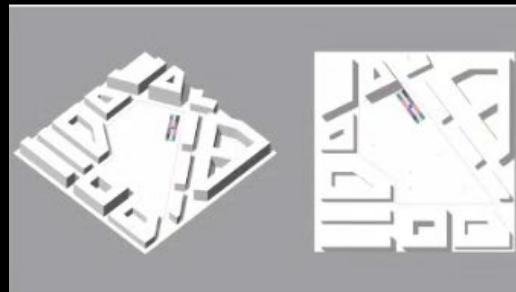
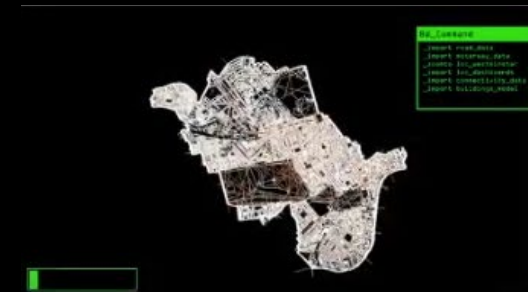
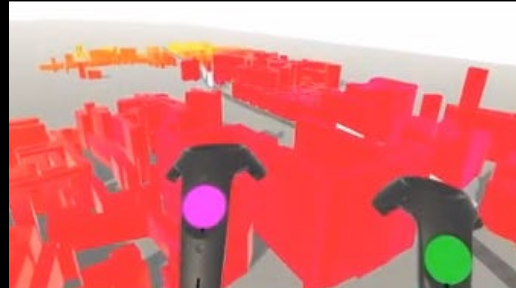
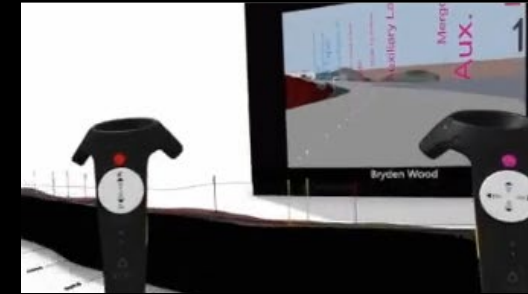
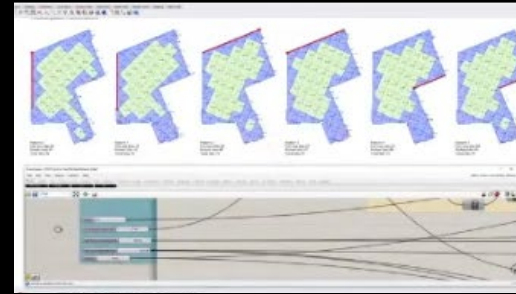
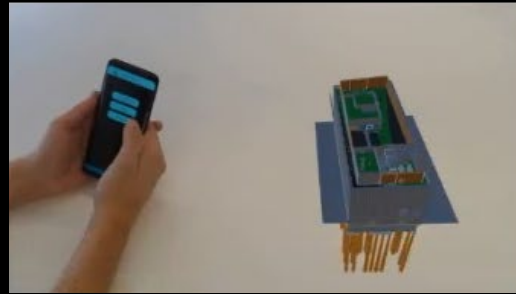
% of our team have an architectural or engineering background

48

% of our team are women

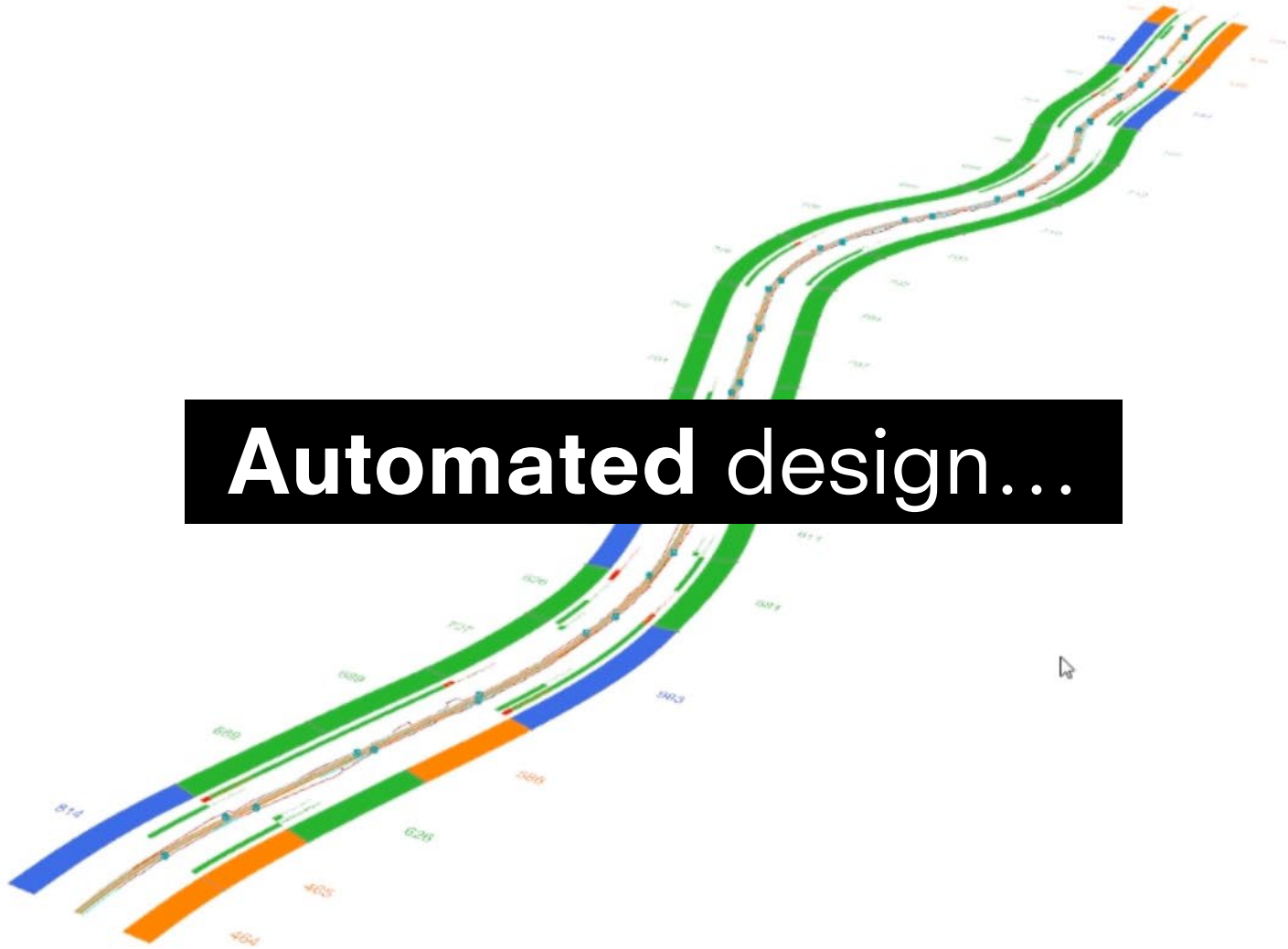
We are **not** a software development team, but...

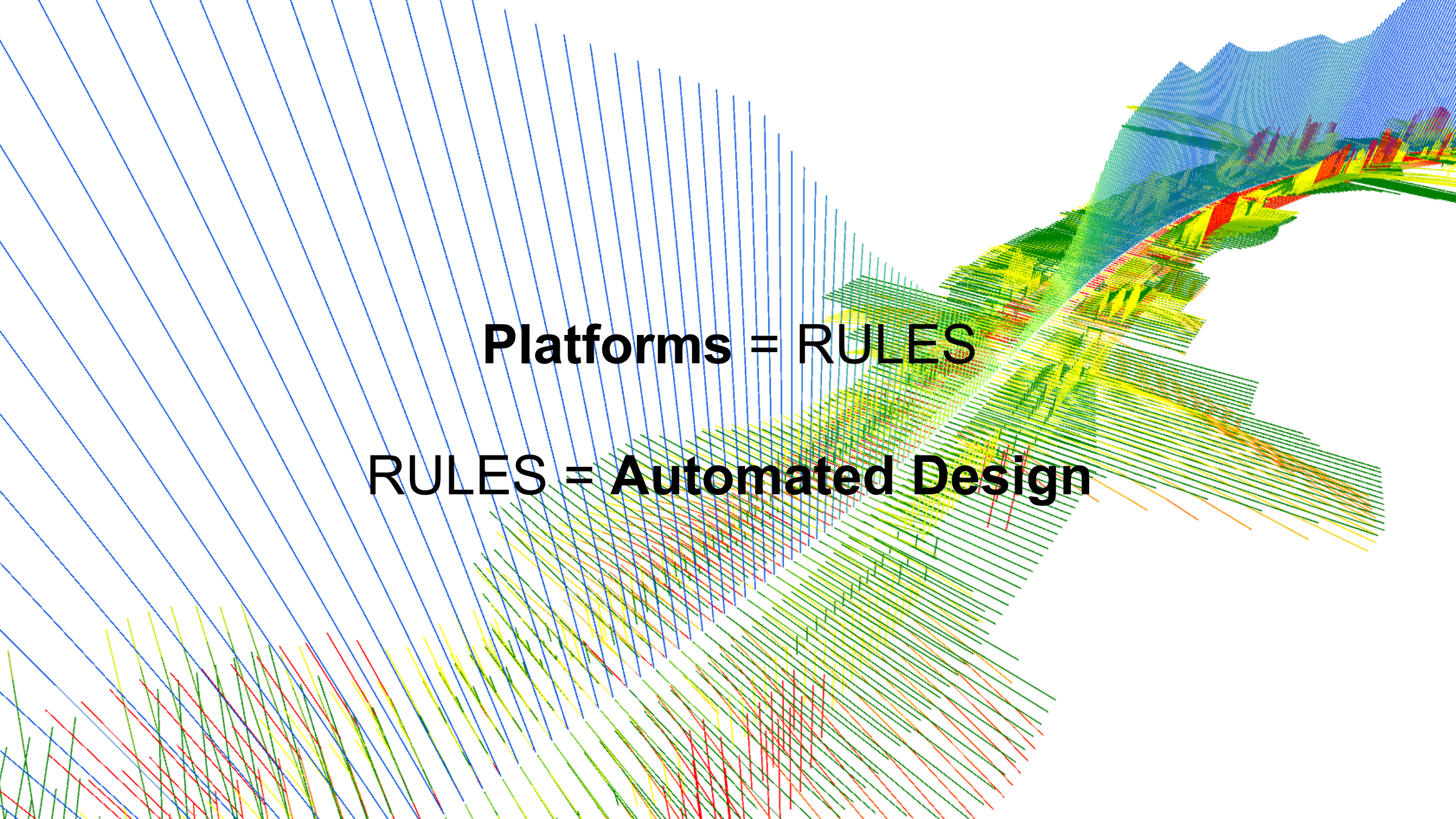
...we **do** make software



Concepts Automated Design

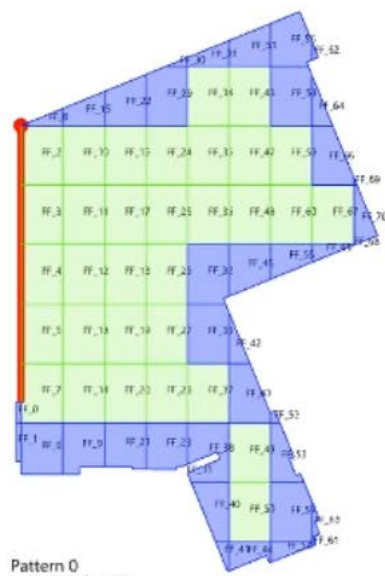
Automated design...



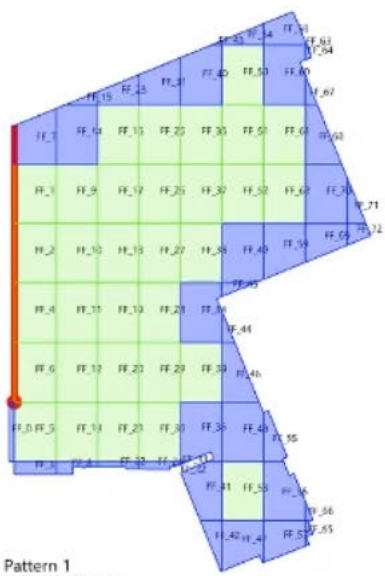
The background features a complex, abstract pattern of thin, parallel lines in various colors (blue, green, yellow, red) that create a sense of depth and movement. On the right side, there is a 3D wireframe structure that resembles a landscape or a series of overlapping planes, rendered in a color gradient from blue to red.

Platforms = RULES

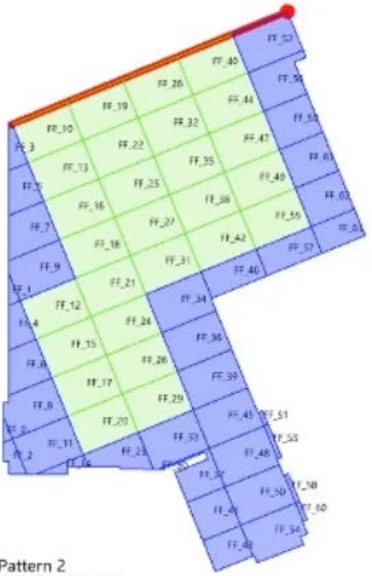
RULES = Automated Design



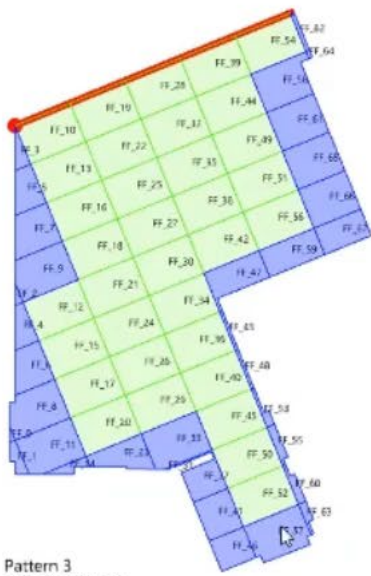
Pattern 0
Full-size tiles 32
Broken tiles 39
Total tiles 71



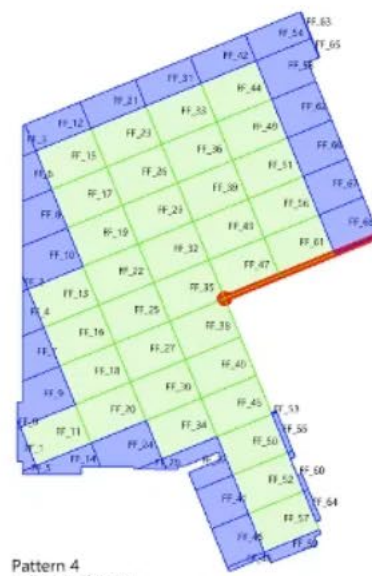
Pattern 1
Full-size tiles 32
Broken tiles 41
Total tiles 73



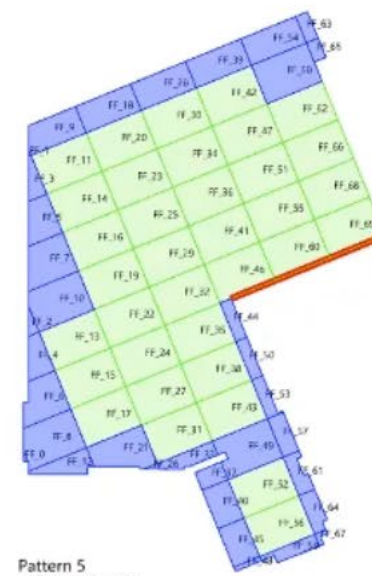
Pattern 2
Full-size tiles 27
Broken tiles 41
Total tiles 64



Pattern 3
Full-size tiles 34
Broken tiles 34
Total tiles 68

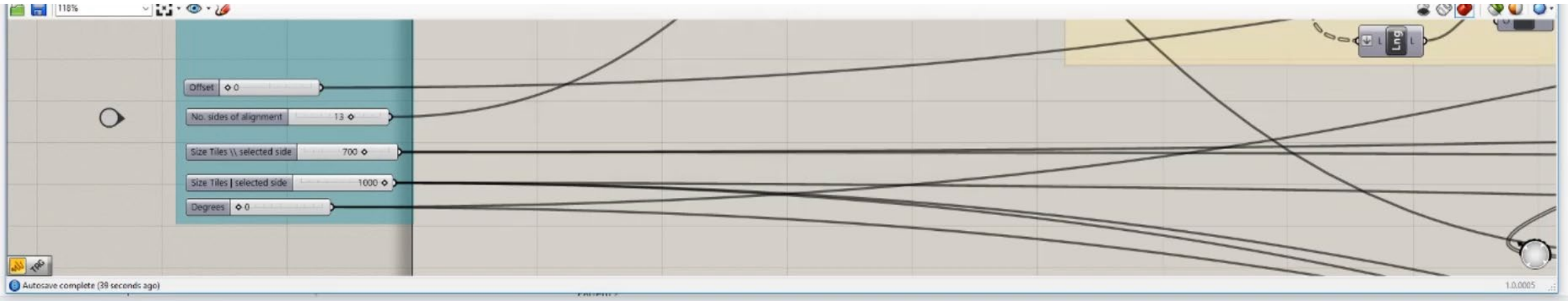


Pattern 4
Full-size tiles 34
Broken tiles 35
Total tiles 69

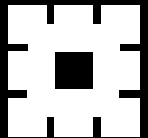
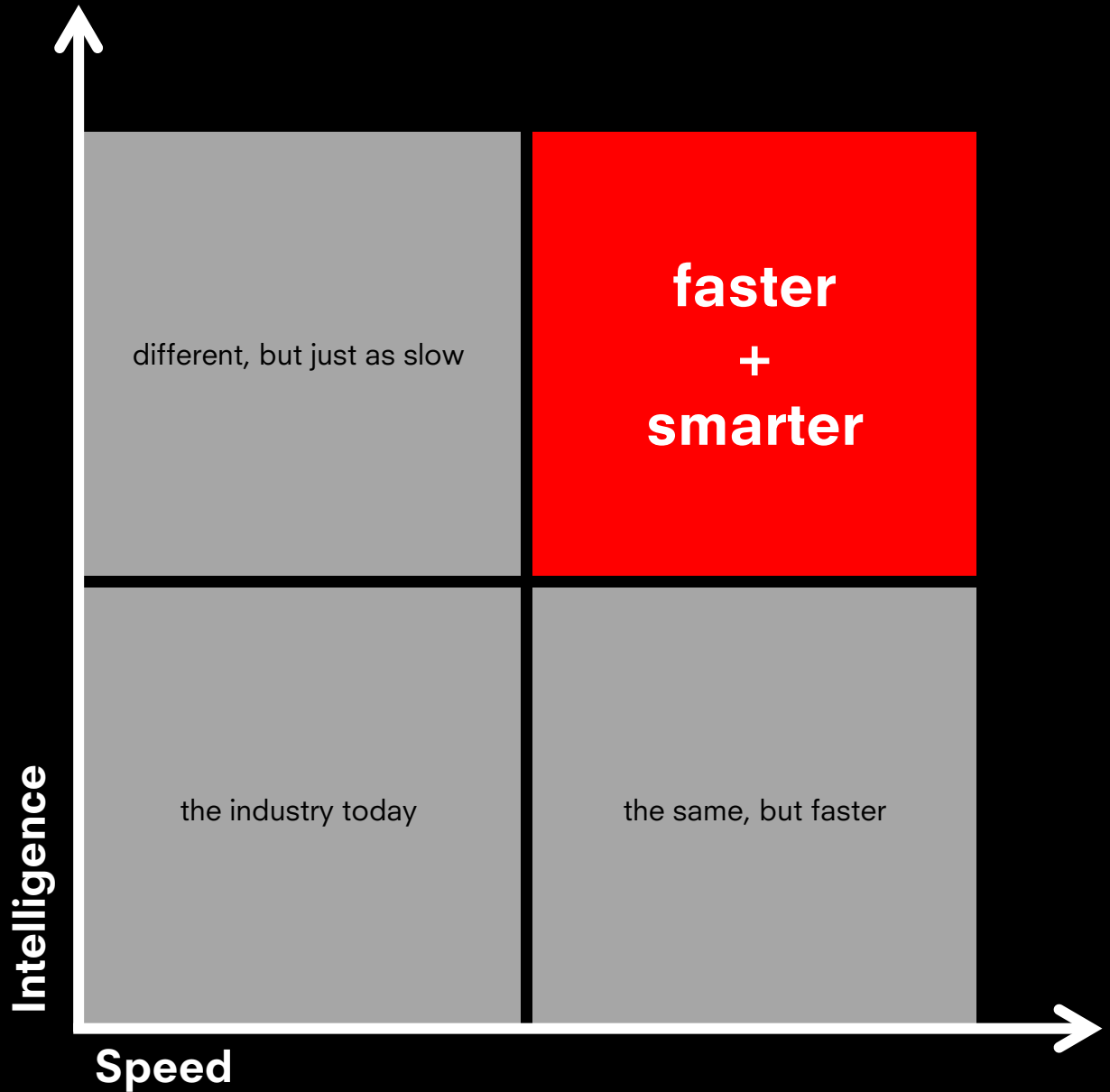


Pattern 5
Full-size tiles 35
Broken tiles 35
Total tiles 70

What do we mean by automated design?

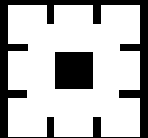
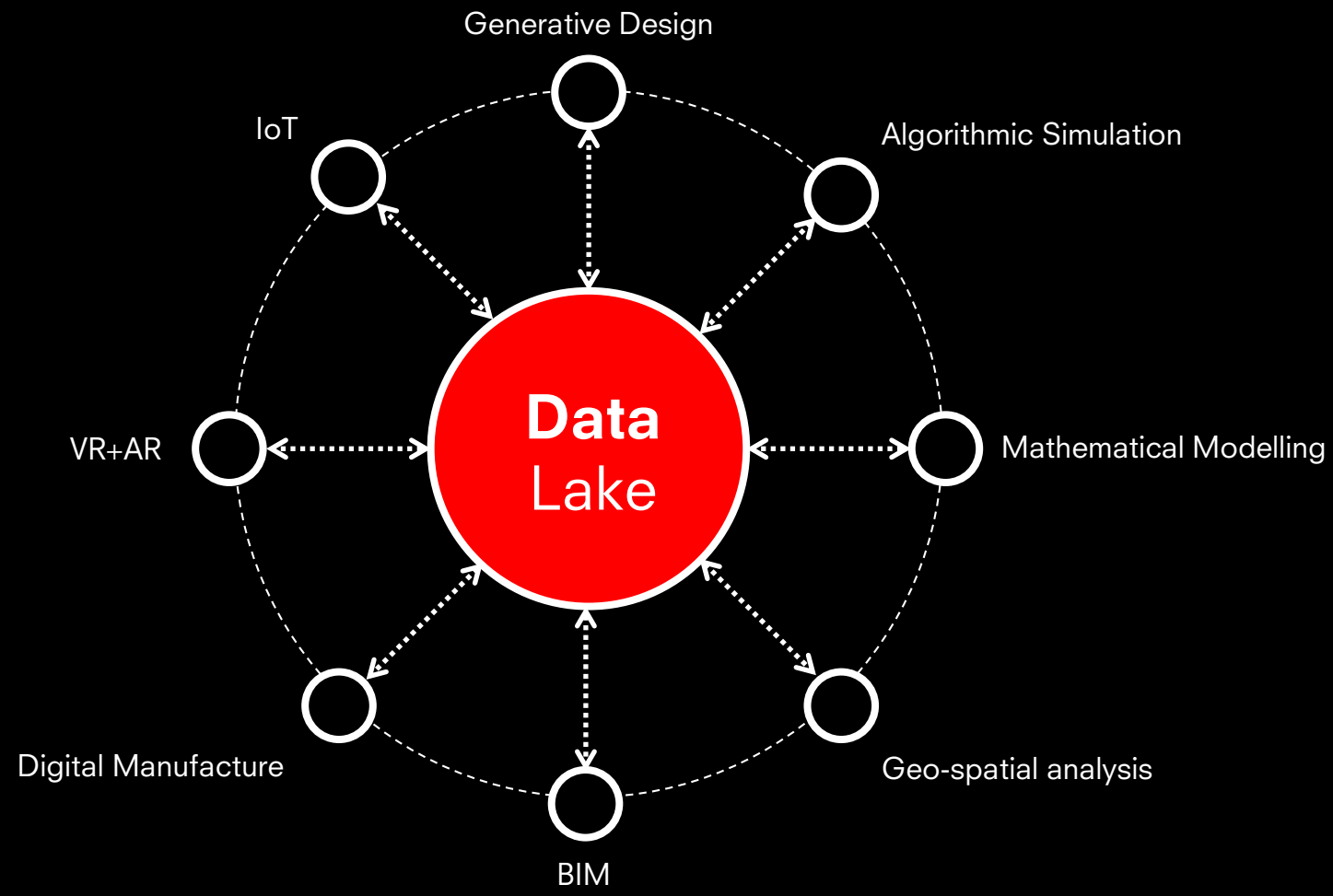


Automated Design =



Bryden Wood

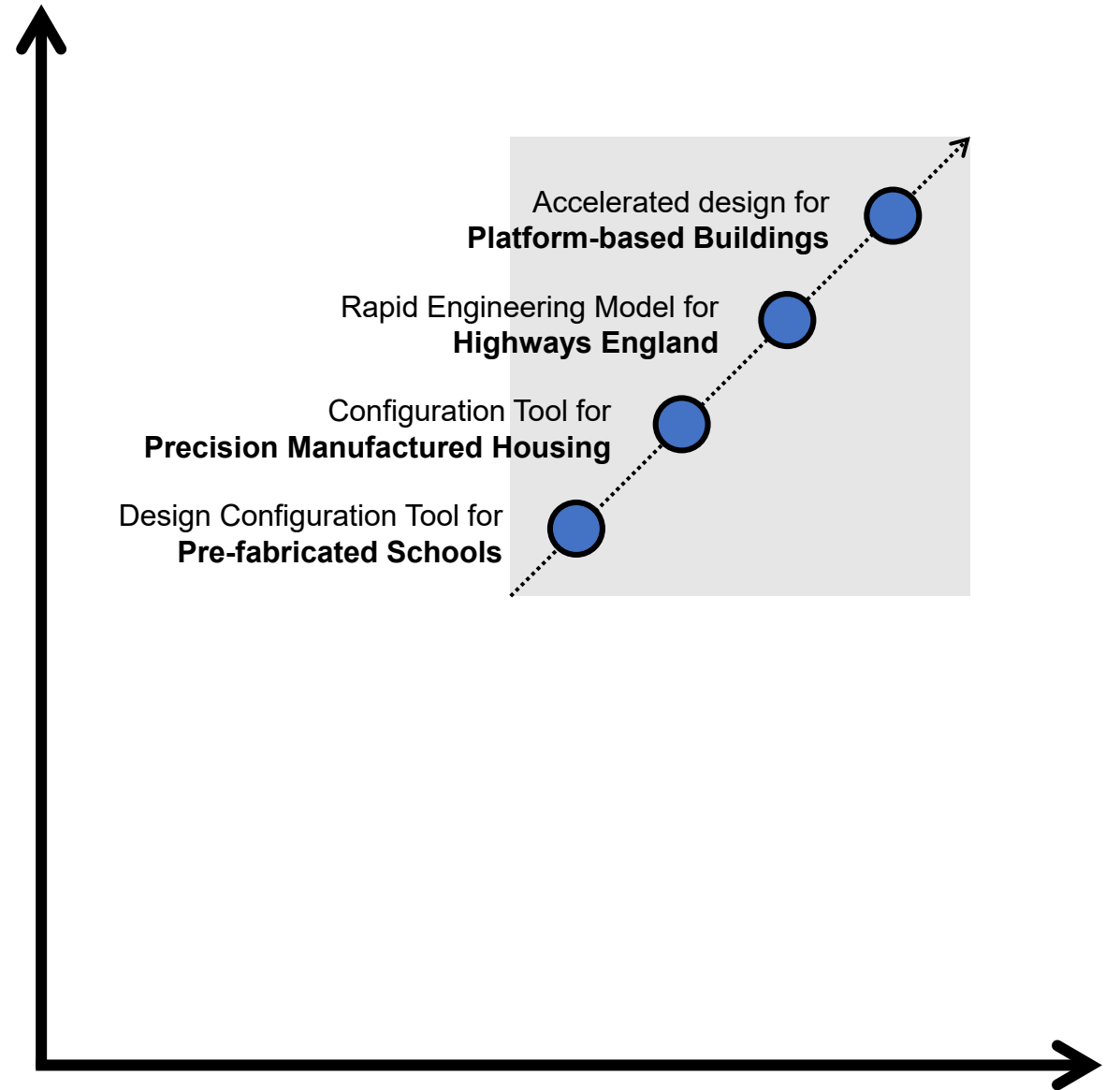
Automated Design =



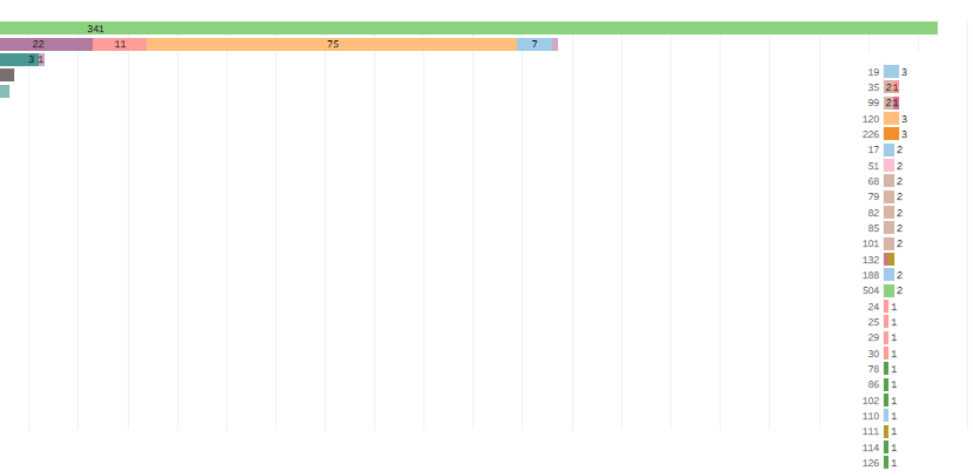
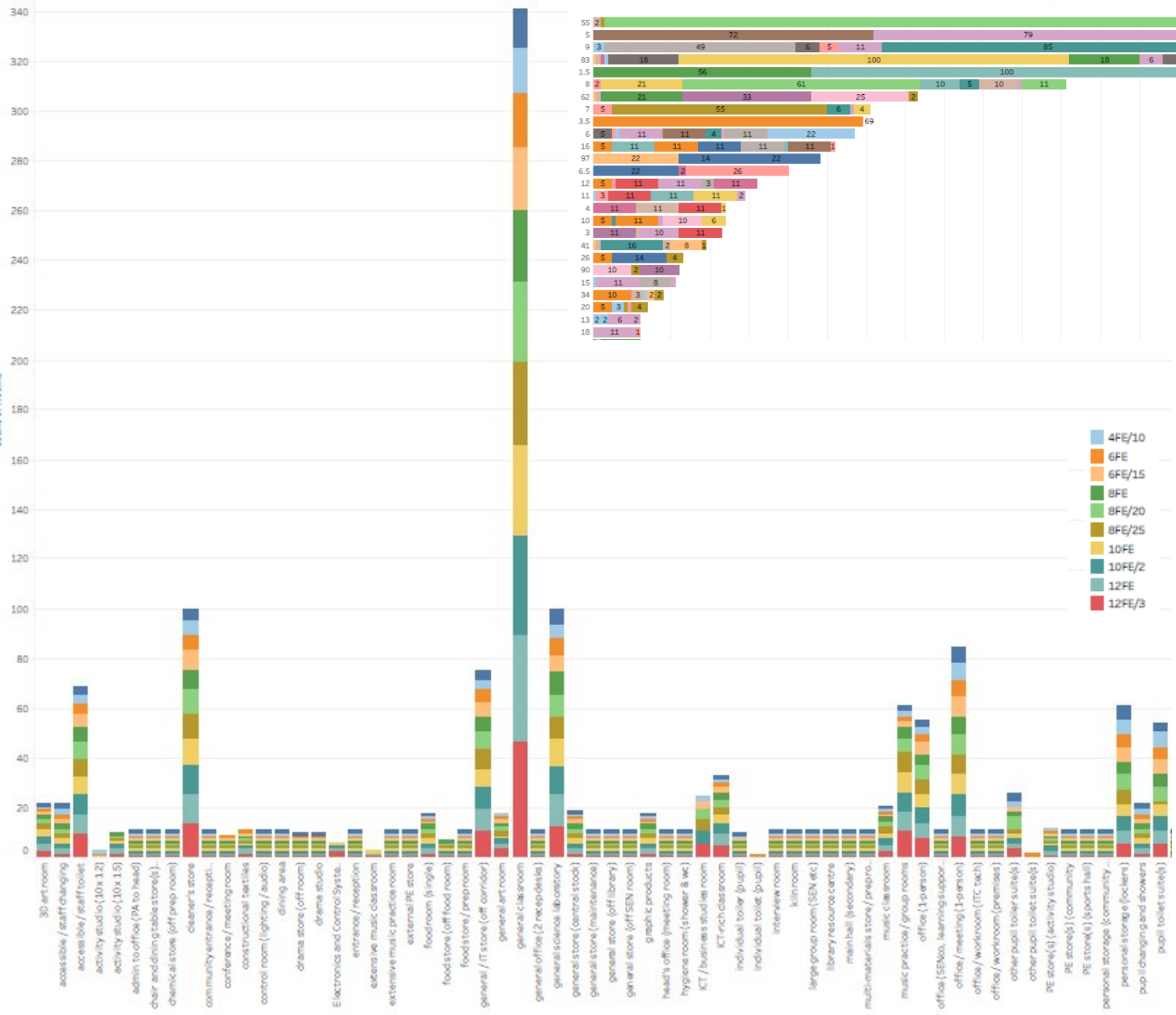
Bryden Wood

Automated Design

Open source apps + workflows



Design Configurator Systemised Schools
seismic-school-app.io



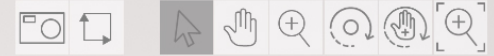
Frequency by area

Room frequency

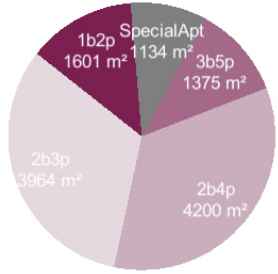
Design Configurator

Precision Manufactured Homes

prism-app.io

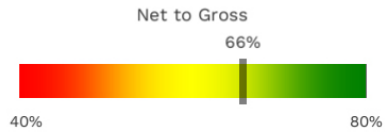


Areas by Type (m²) - Project

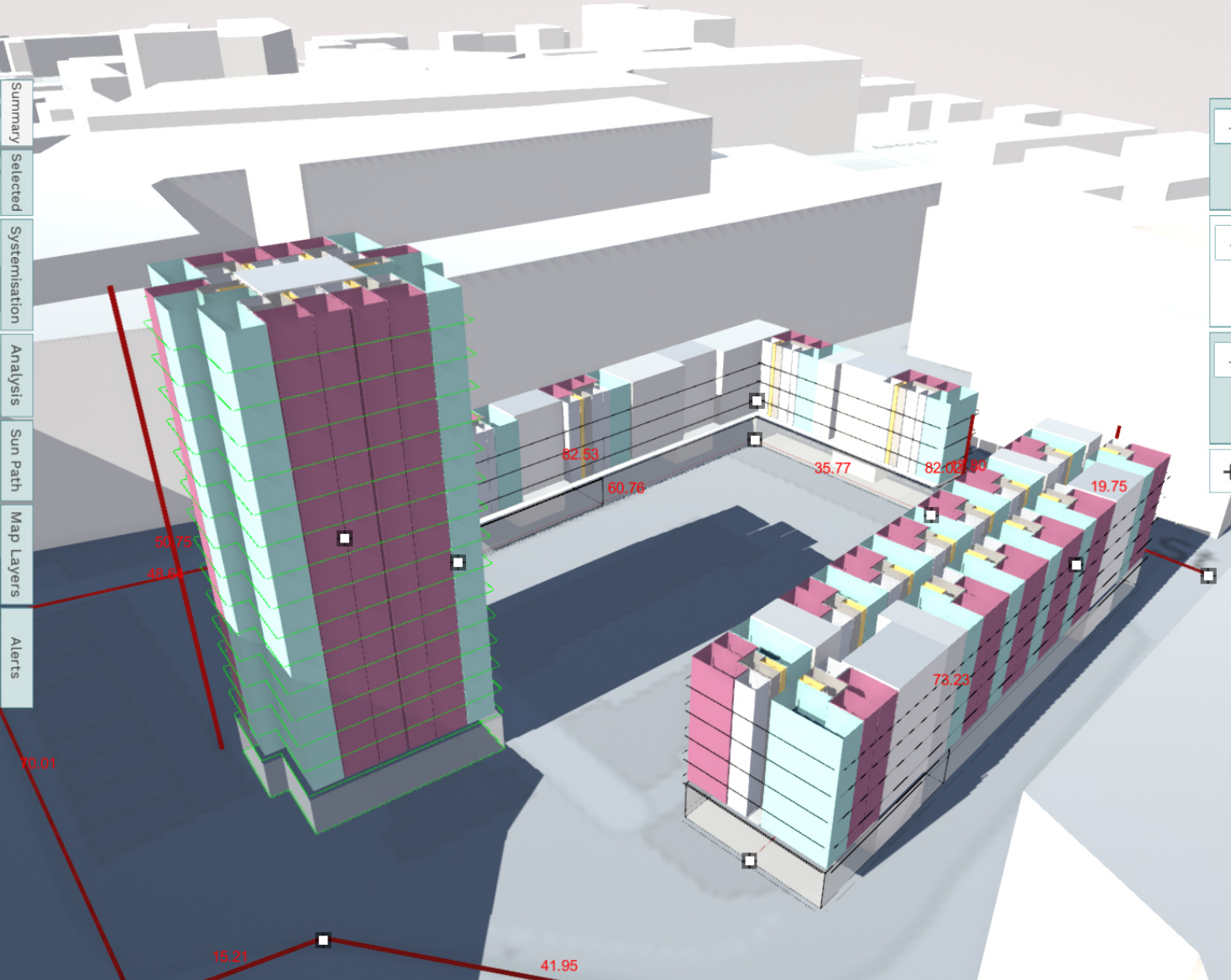


Summary - Project

Site area = 11,290m² / 1.129hectares
 Density = 186 (units per hectare)
 Density = 441 (habitable rooms per hectare)
 Site Coverage = 24.69%
 PTAL Zone = 6a
 GEA = 20,983m² / 225,862ft²
 GIA = 18,977m² / 204,266ft²
 NIA = 12,520m² / 134,764ft²
 Net to gross = 65.97%
 GIA to GEA = 90.44%



- Summary
- Selected
- Systemisation
- Analysis
- Sun Path
- Map Layers
- Alerts



Design a Building

West

Depth (m)

7.20

Move Rotate

Floors Panel

0 4.5 -

1-15 3.05 -

2b4p 2b4p

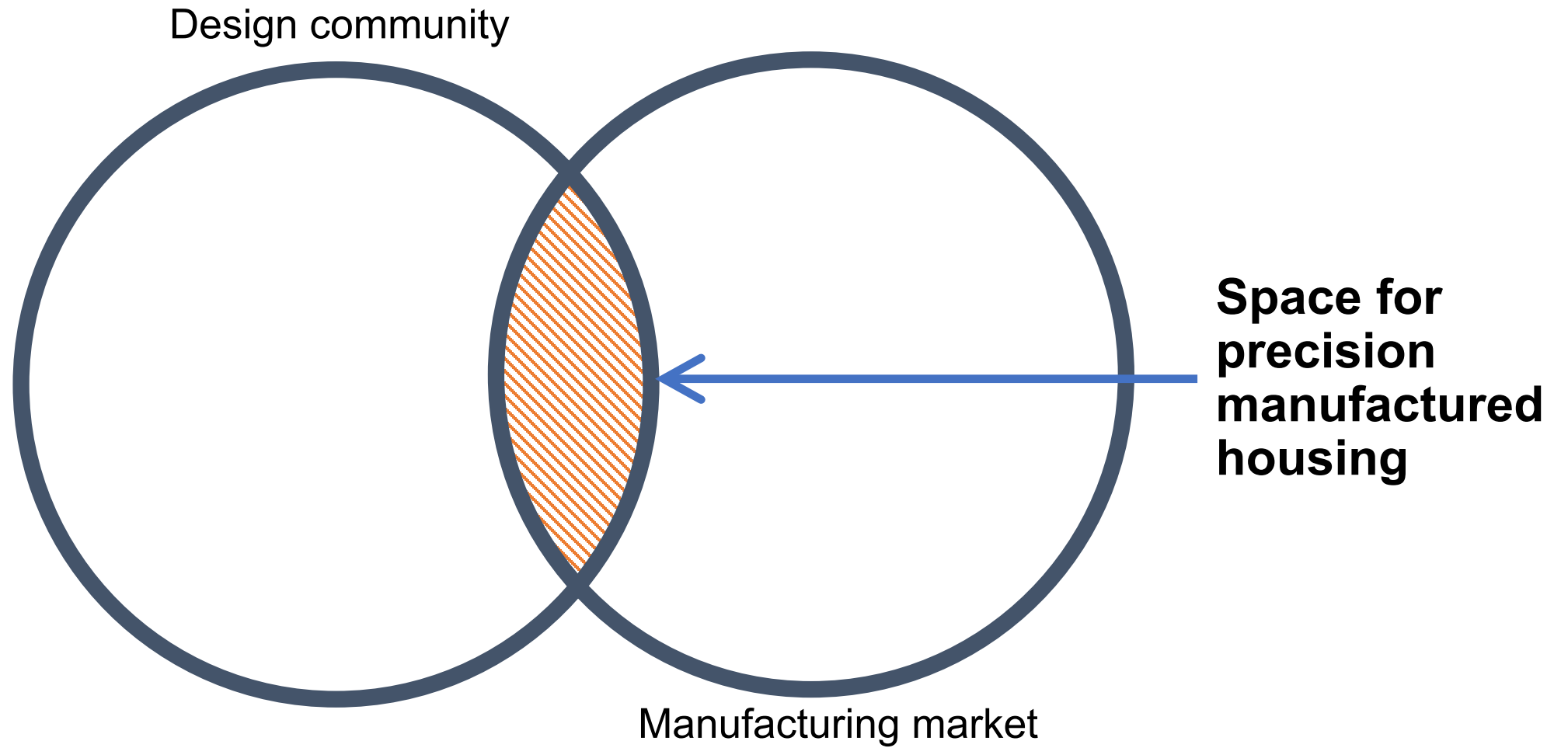
1b2p 1b2p

2b4p 2b4p

+

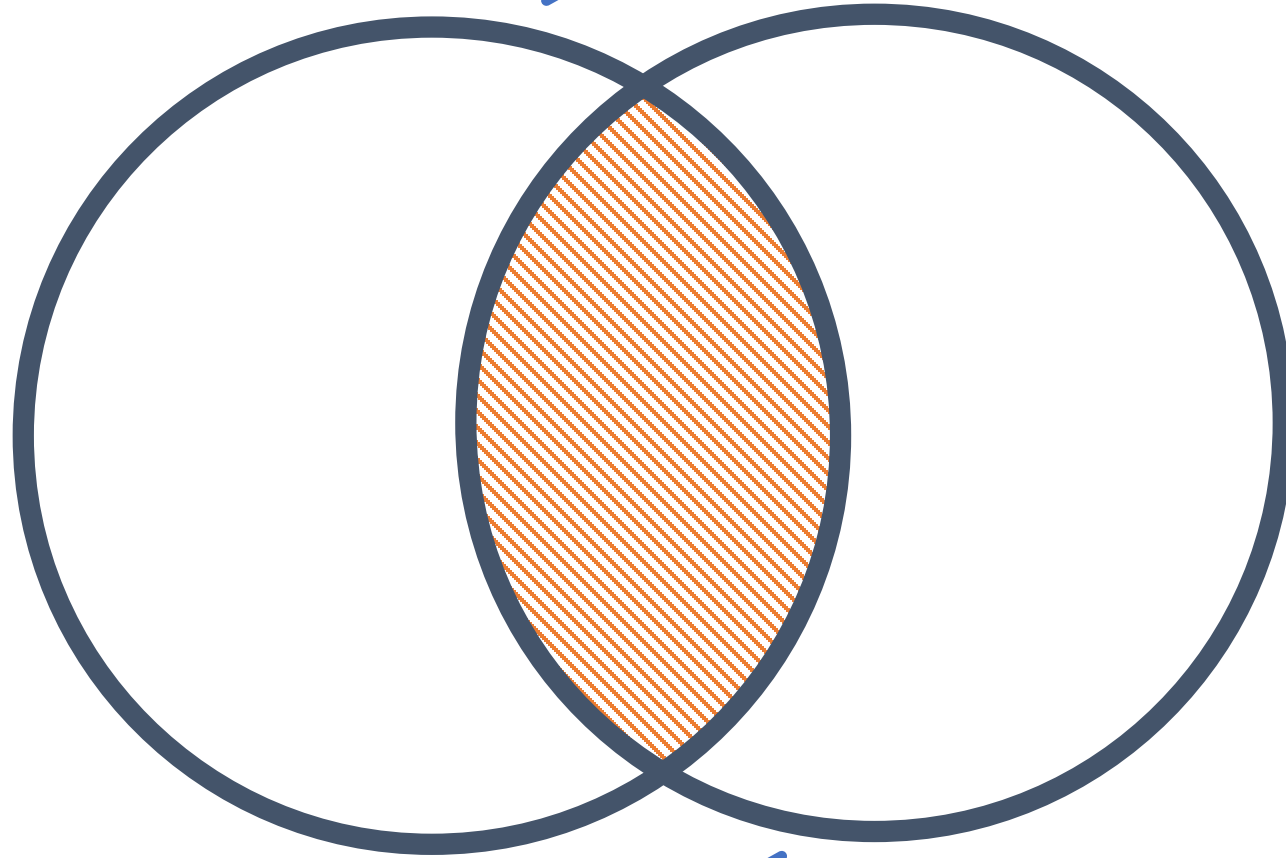
Refresh

Current state



Future state

Design community

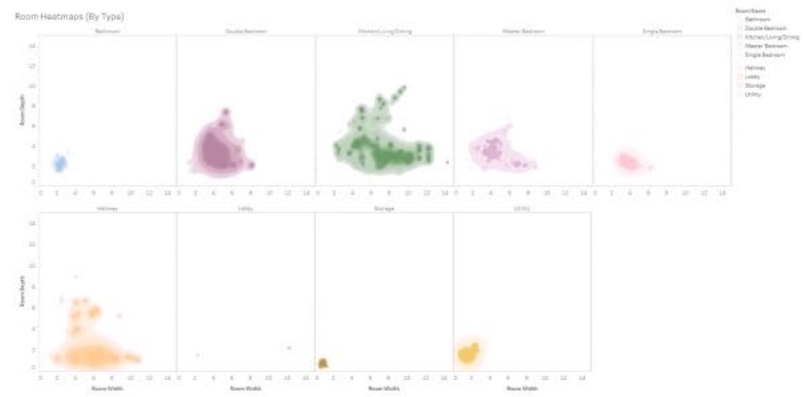
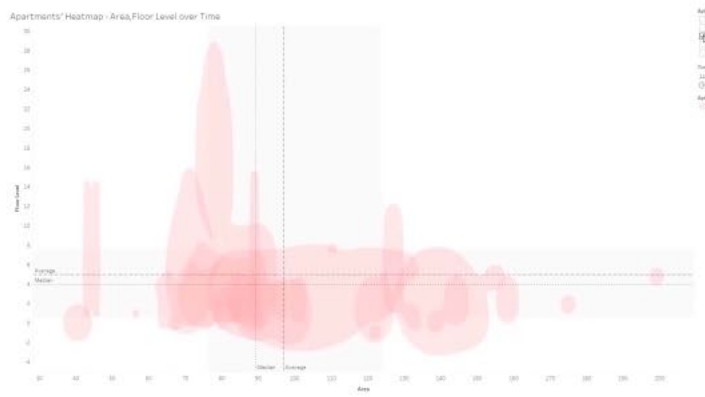
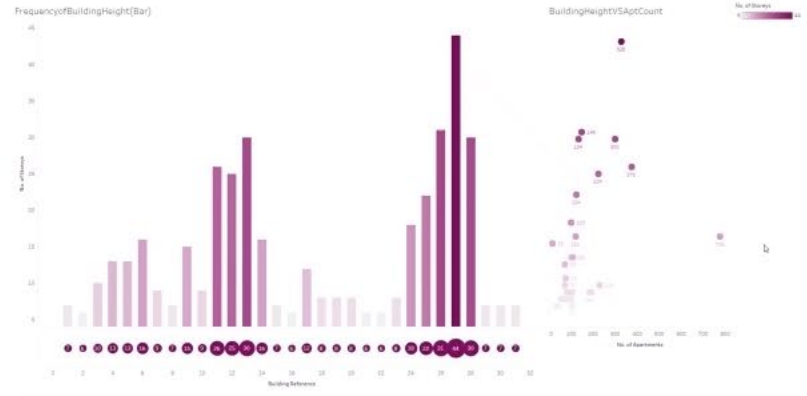
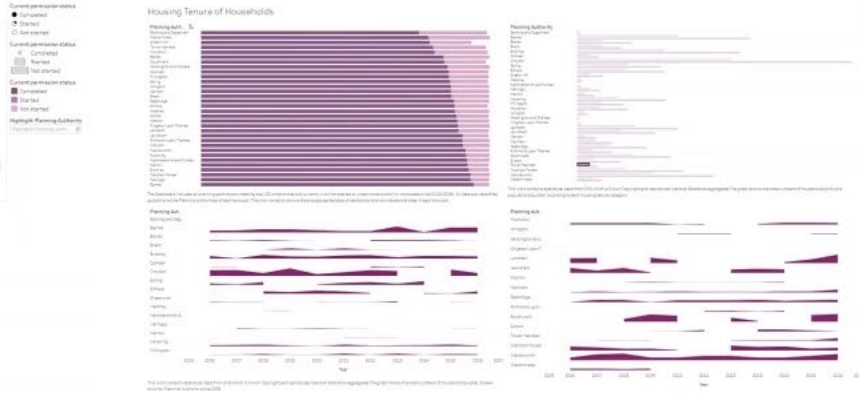
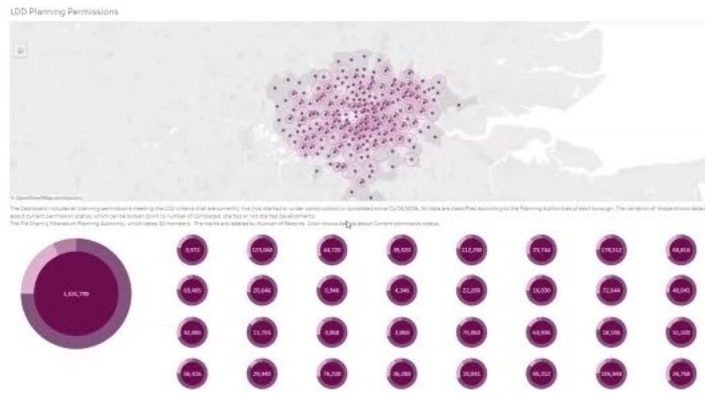


Manufacturing market



How did we go about it?

1. **Data analysis** of London housing
2. Capture **spatial design** rule sets
3. Capture **manufacturing systemisation** rule sets
4. Create a **digital toolkit**



Interactive Dashboards

Apartment Parameters, Building Tenure

Room Schedules

How did we go about it?

1. **Data analysis** of London housing
2. Capture **spatial design** rule sets
3. Capture **manufacturing systemisation** rule sets
4. Create a **digital toolkit**

Apartment central logic and parametric design



How did we go about it?

1. **Data analysis** of London housing
2. Capture **spatial design** rule sets
3. Capture **manufacturing systemisation** rule sets
4. Create a **digital toolkit**



PRISM

Areas by Type (m²) - Project

Special: 853 m²
 2bap: 3407 m²
 2bap: 2022 m²

Distribution by Type (m²) - Project

min max

Summary - Project

Site area = 22,022m² / 3.202hectares
 Density = 149 (habitable rooms per hectare)
 Density = 222 (habitable rooms per hectare)
 Site Coverage = 14.57%
 PTAL Zone = 67 / 275,230ft²
 GIA = 24,370m² / 259,408ft²
 NIA = 16,328m² / 173,679ft²
 Net to gross = 66.95%
 GIA to GIA = 94.29%

Net to Gross

40% 60% 80%

Design a Building

Building name

Corridor

Double load

Core alignment

Centre

Move

Draw

Depth (m)

7.20

Width (m)

1.20

Rotate

Add setback

Floors

0 3

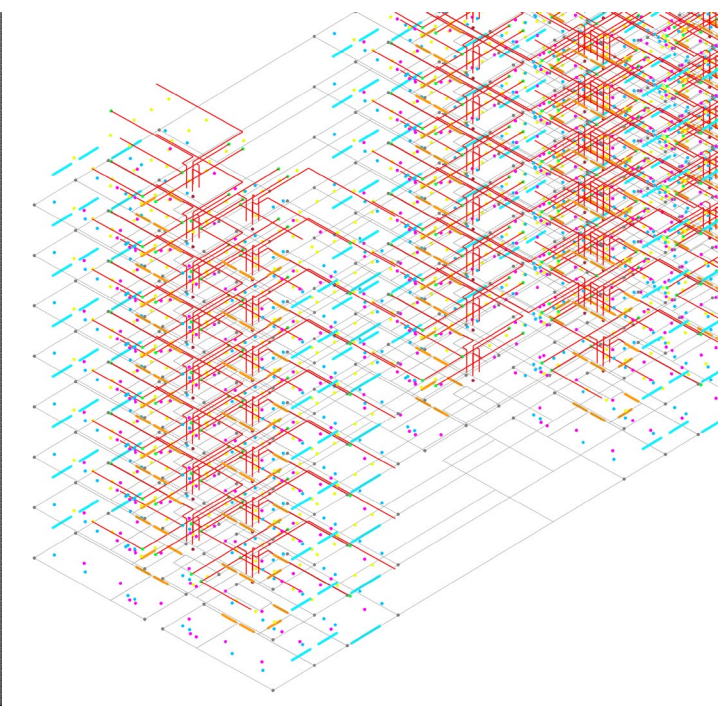
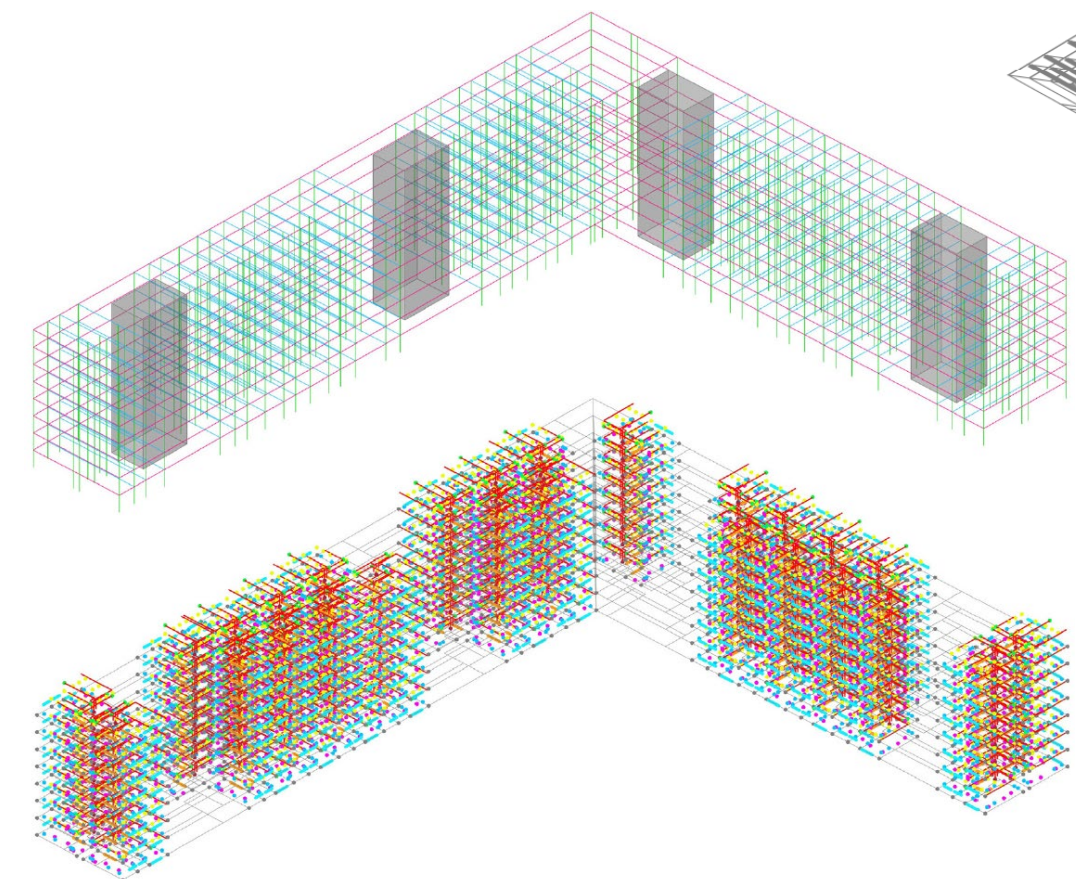
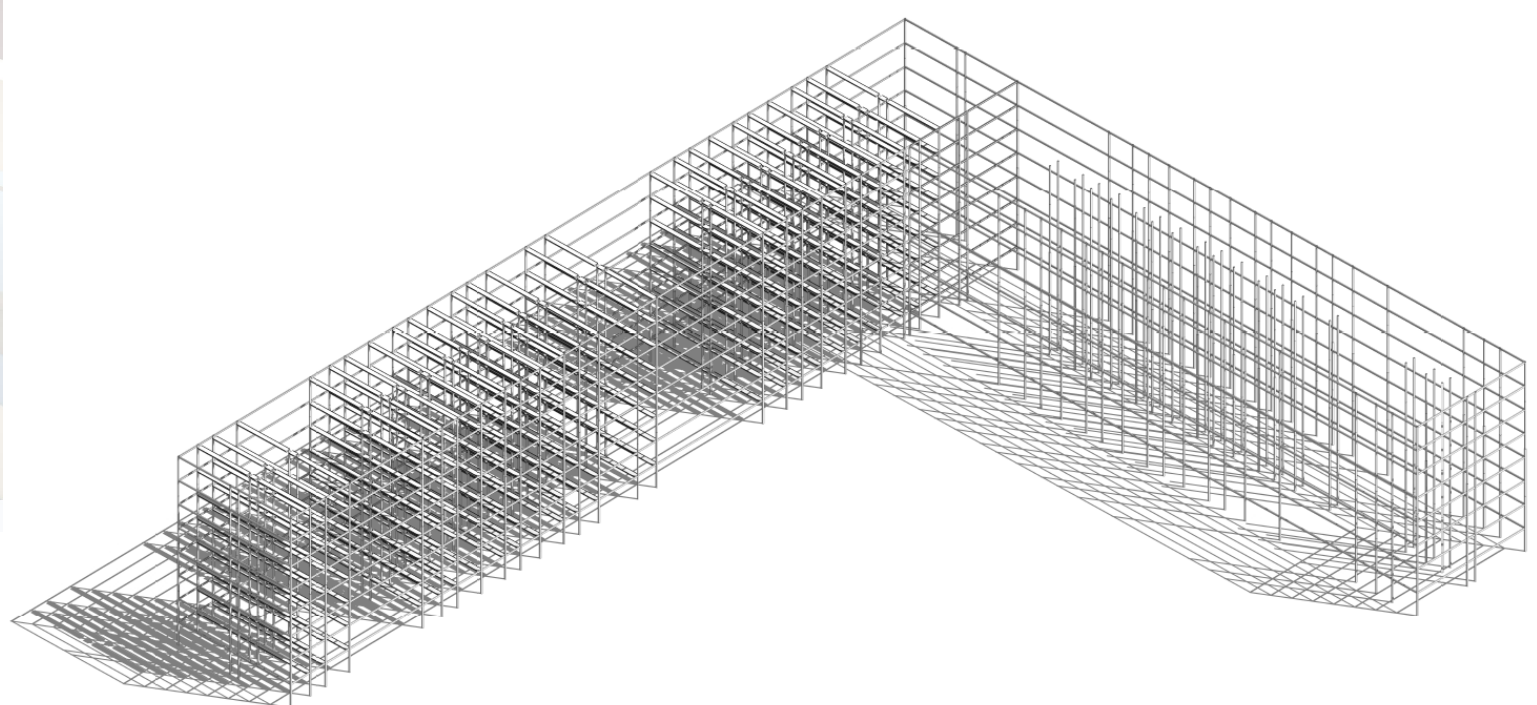
1.7 3

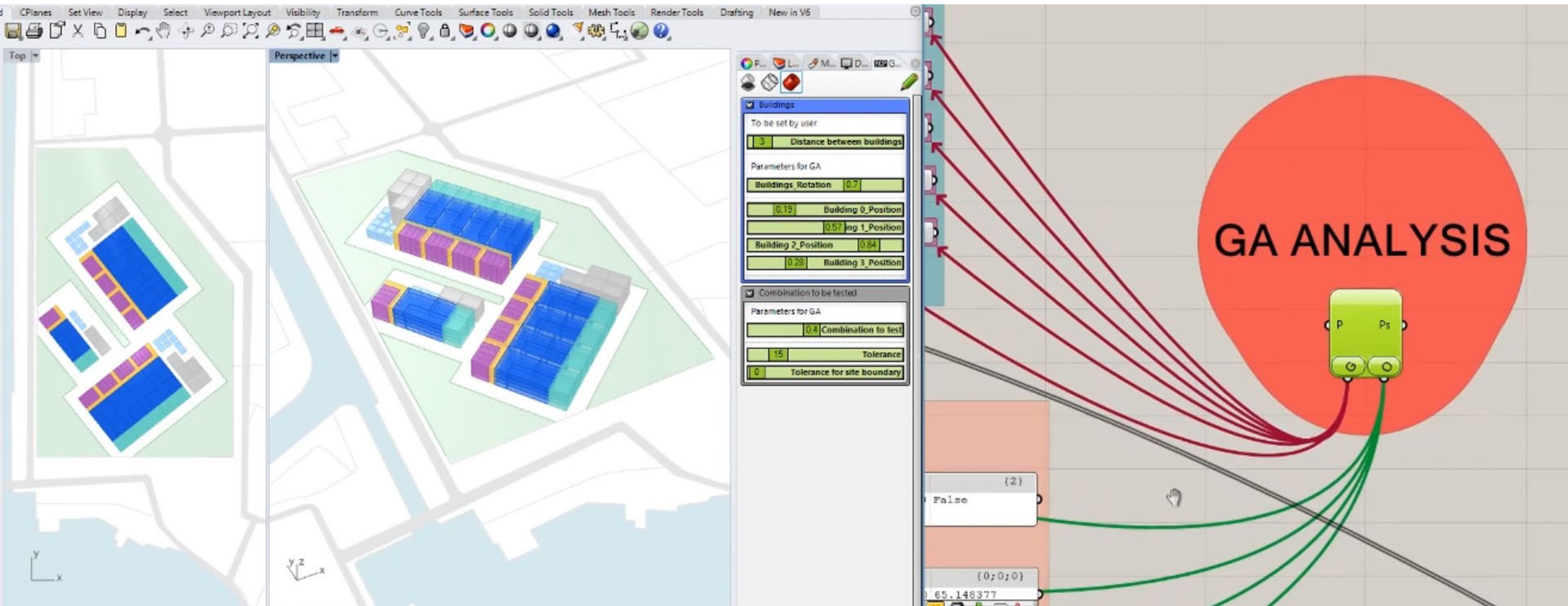
+

Apartment Mix (%)

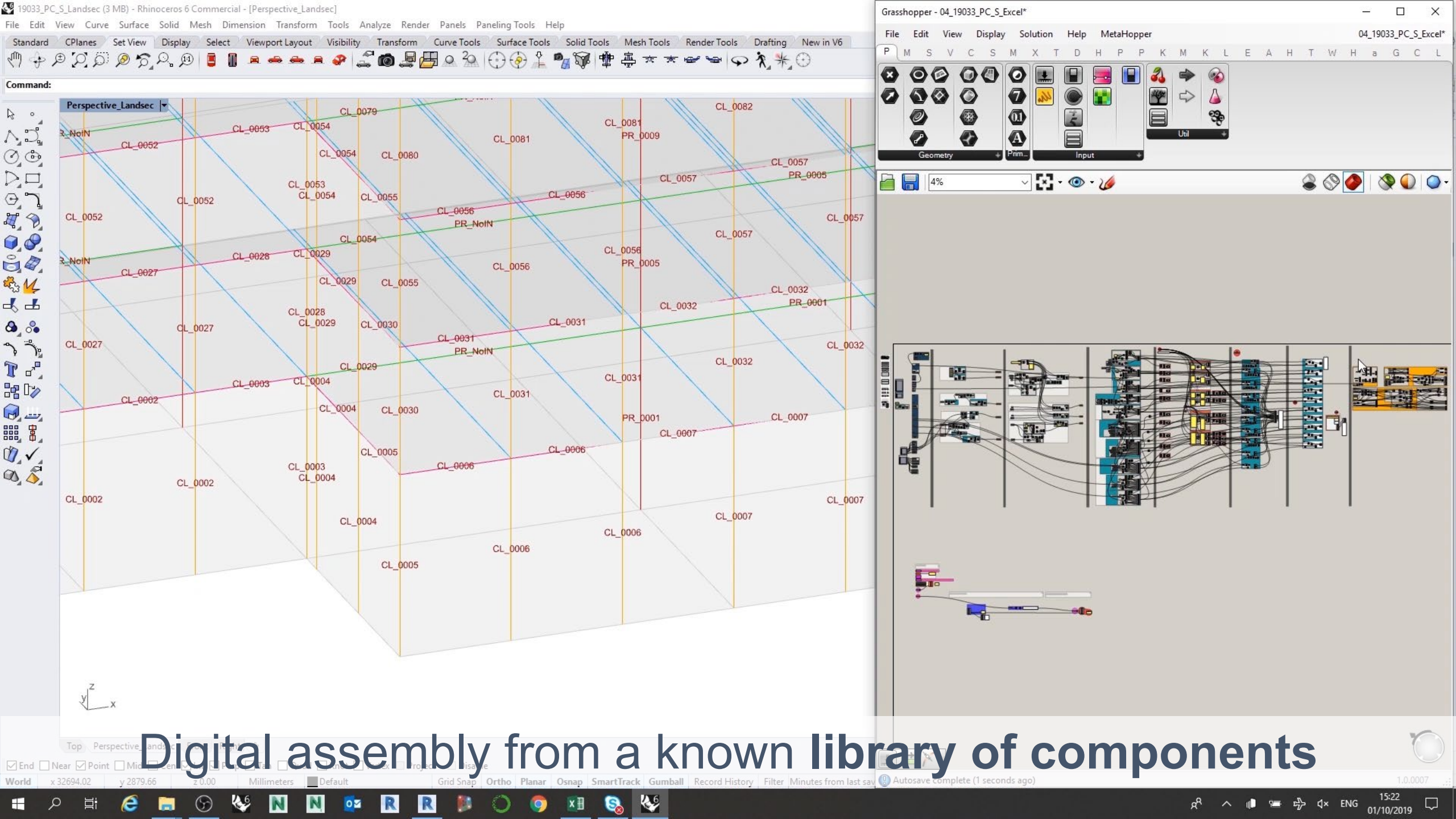
1bap	40
2bap	40
3bap	20

Generate Refresh





Optimise site layouts using a **genetic algorithm**

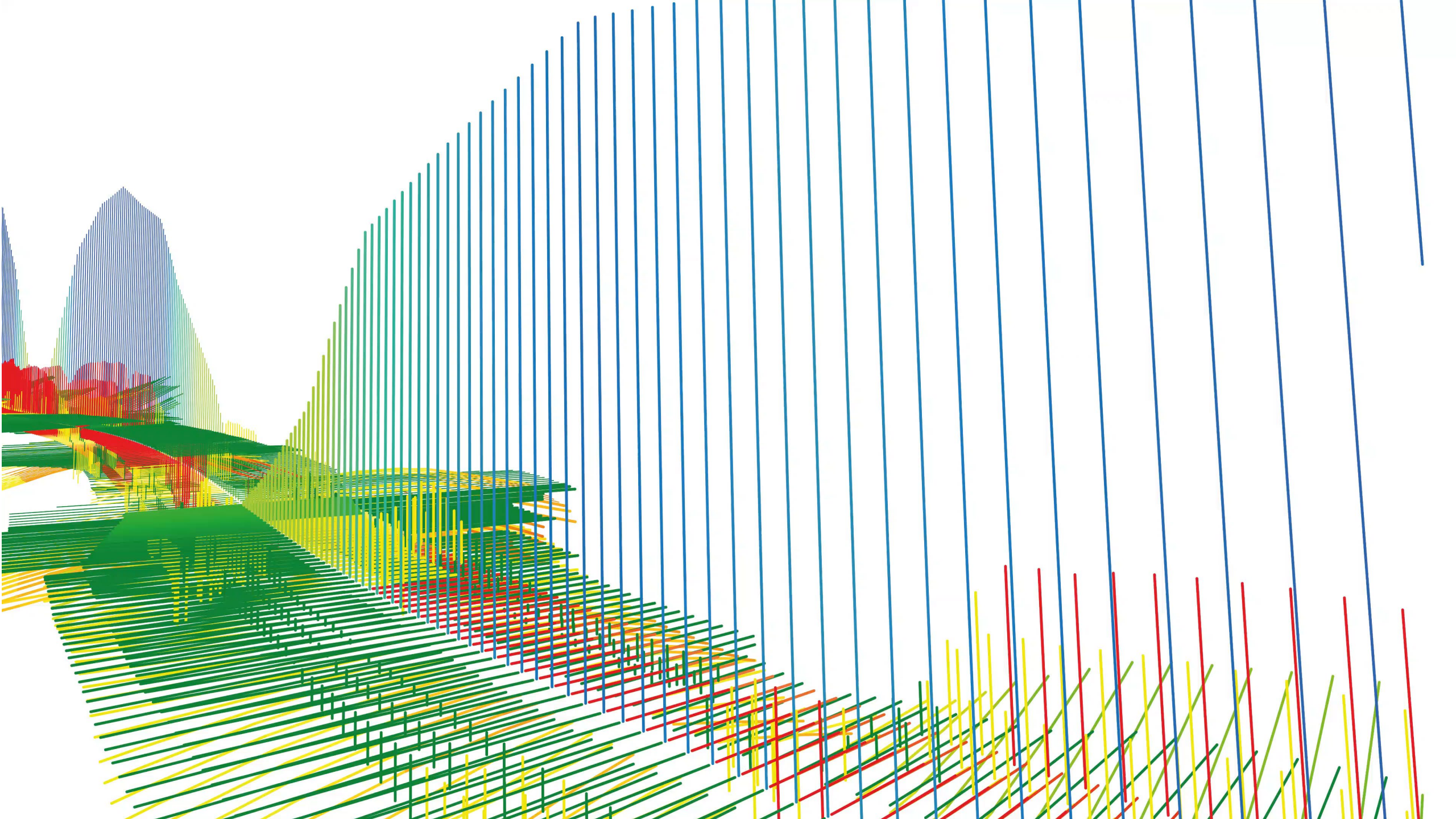


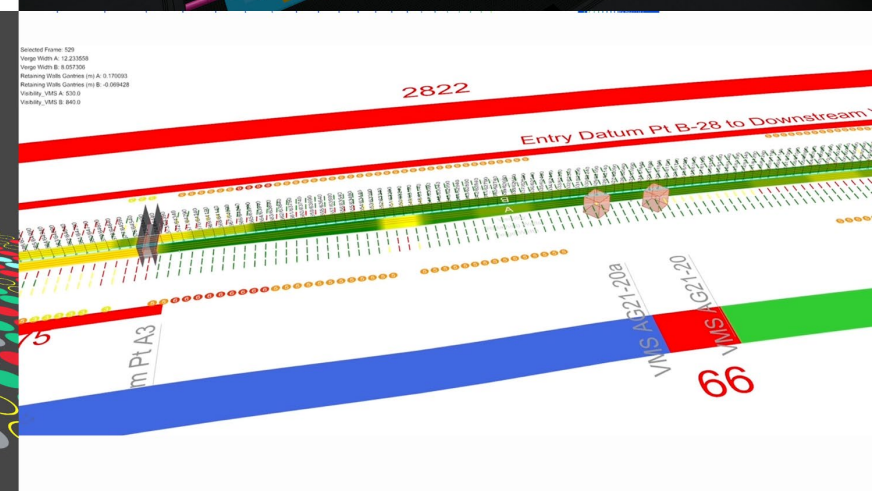
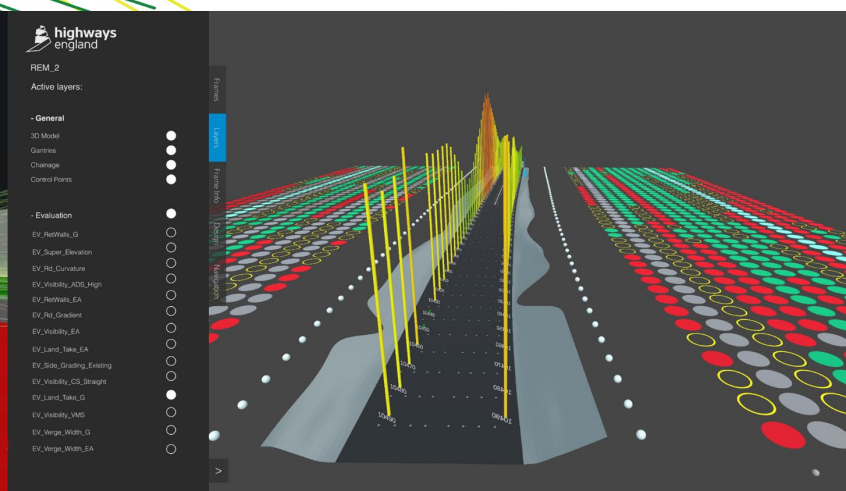
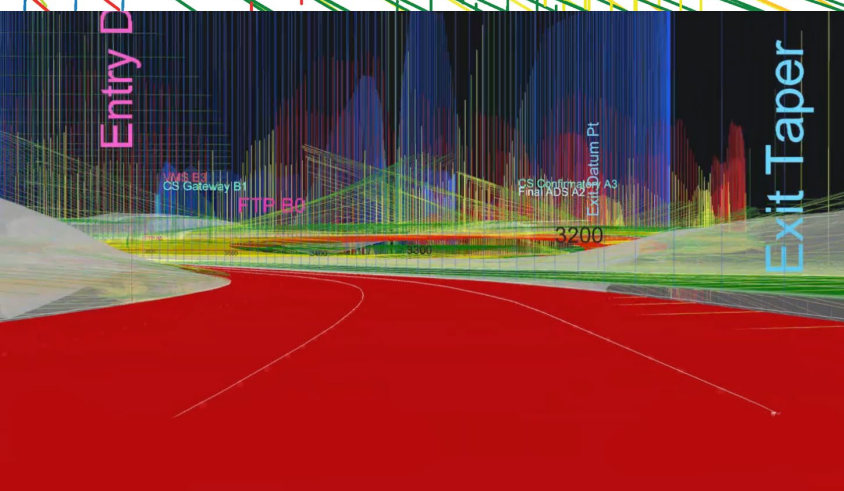
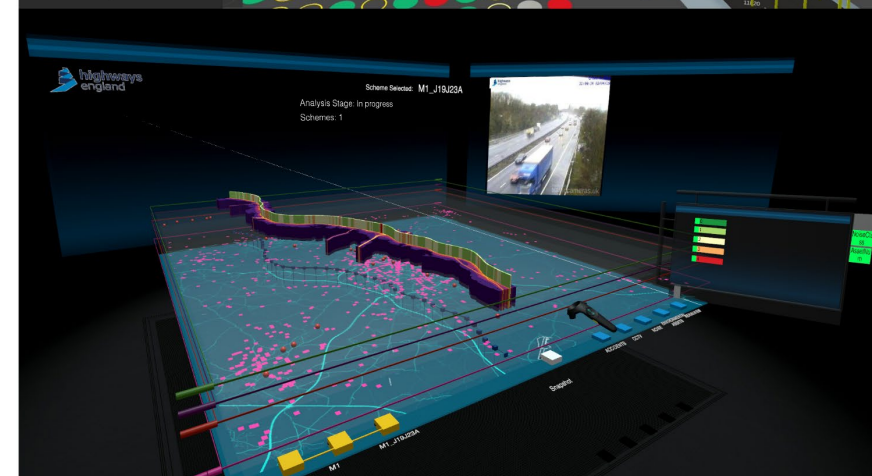
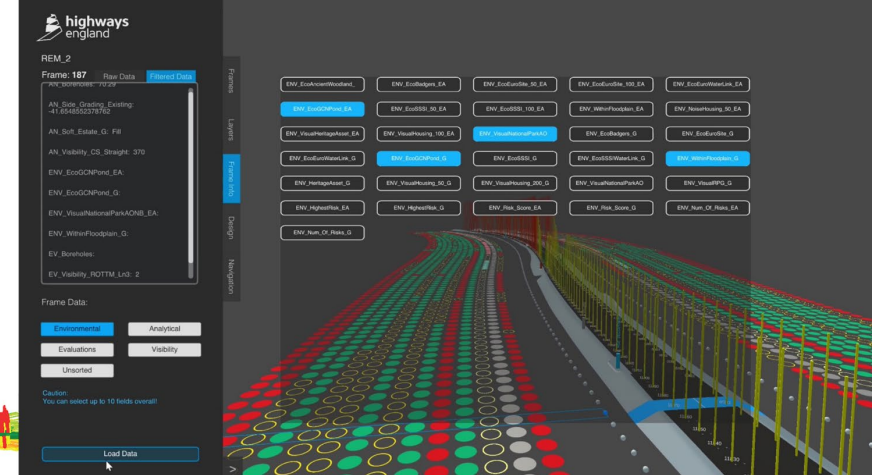
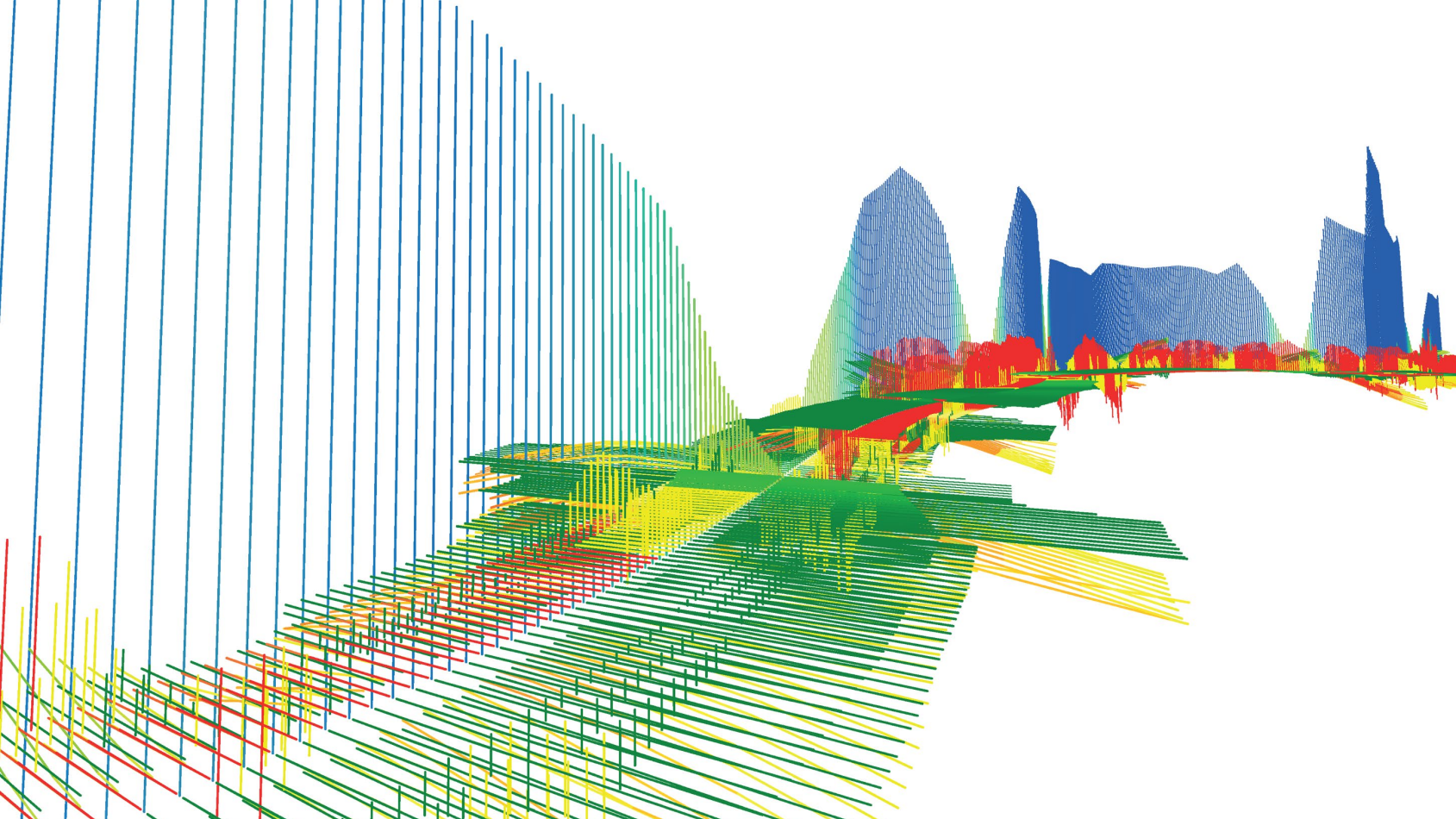
Digital assembly from a known library of components

Design Configurator

Rapid Engineering Model

Smart Motorways Programme, Highways England





REM_2

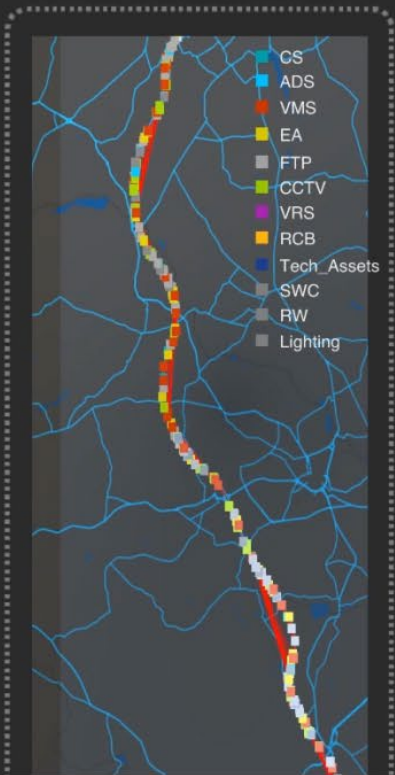
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From:

To:

Total:

Load Frames



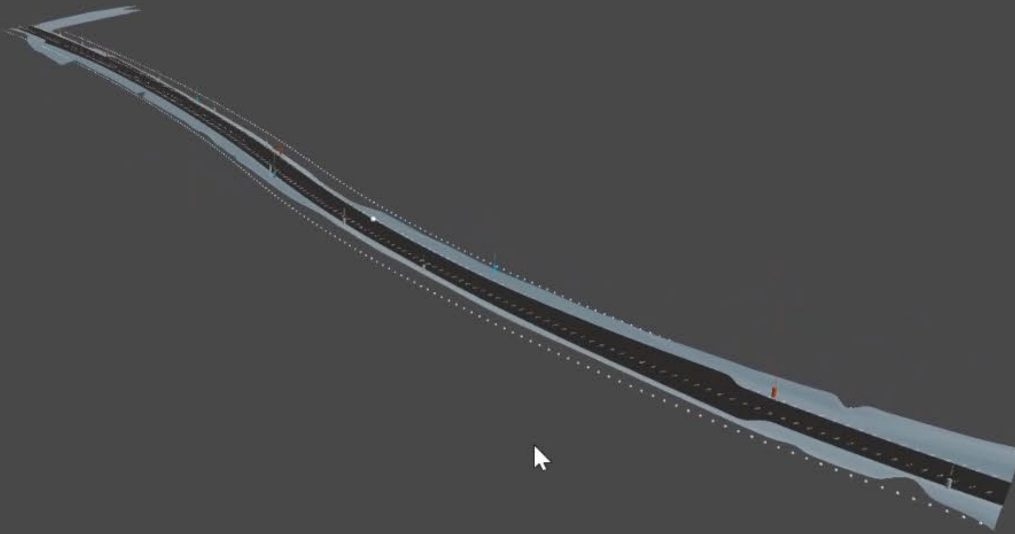
Frames

Layers

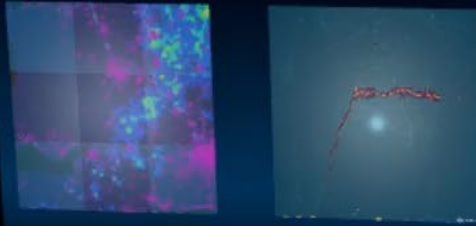
Frame Info

Design

Navigation



Analysis Stage: Completed
Schemes: 1



Creative Technologies @ Bryden Wood