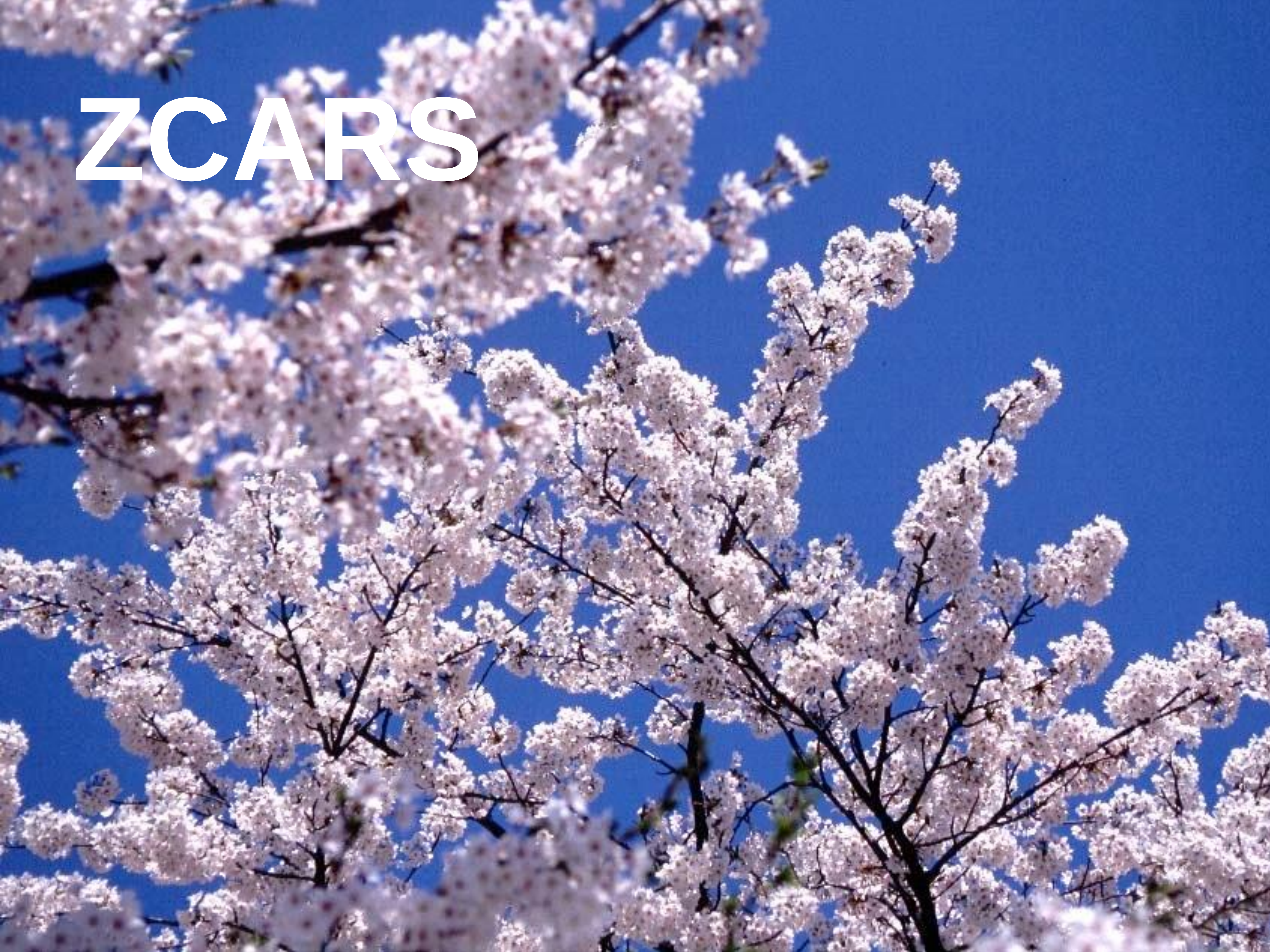
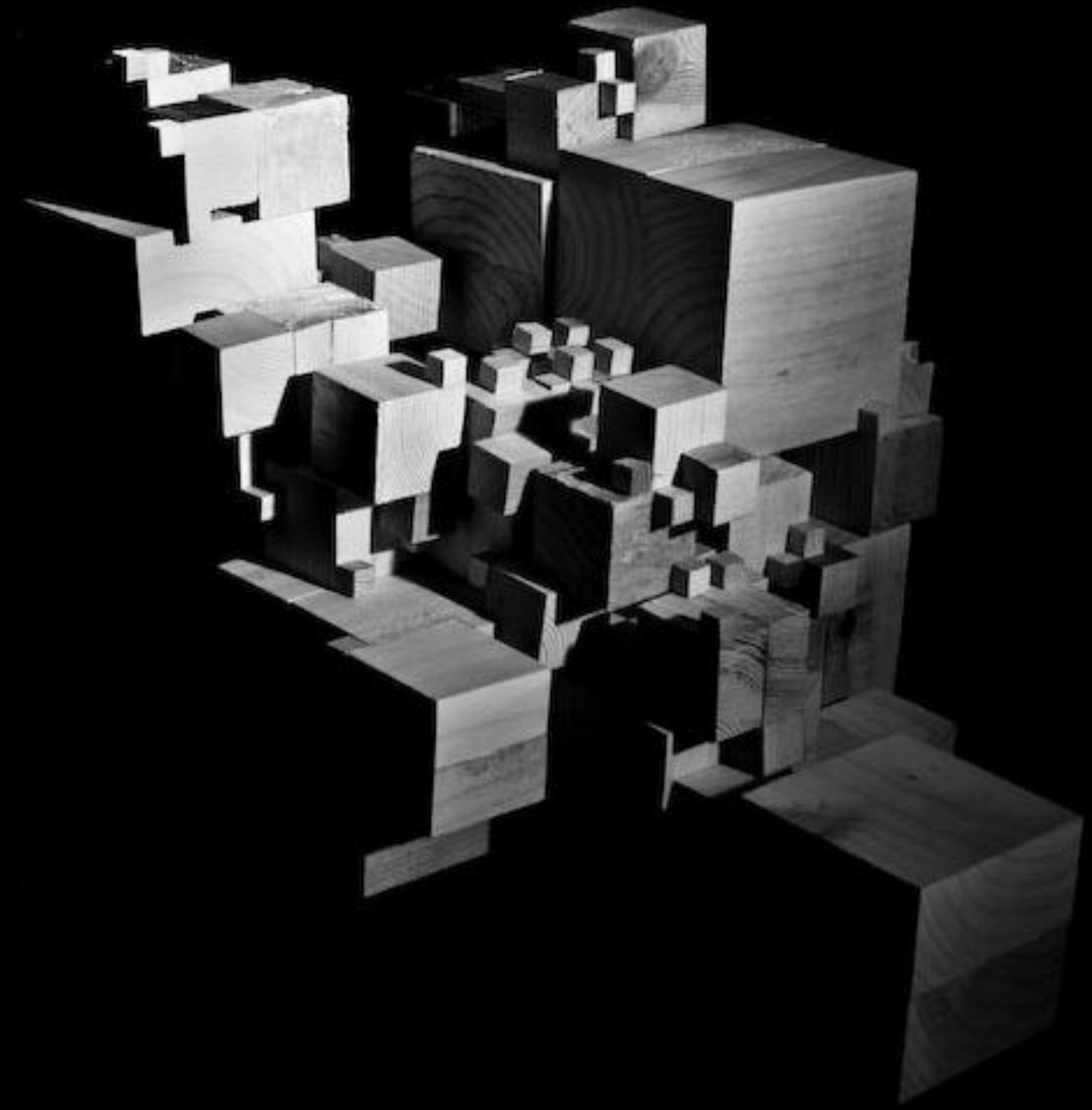

ZCARS

Zero Carbon Architecture Research Studio

A Design and Research Studio - Zero Carbon Architecture



Led by:

Professor Michael Stacey, Lucelia Rodrigues and Swinal Samant

Zero Carbon Architecture Research Studio

Professor Michael Stacey

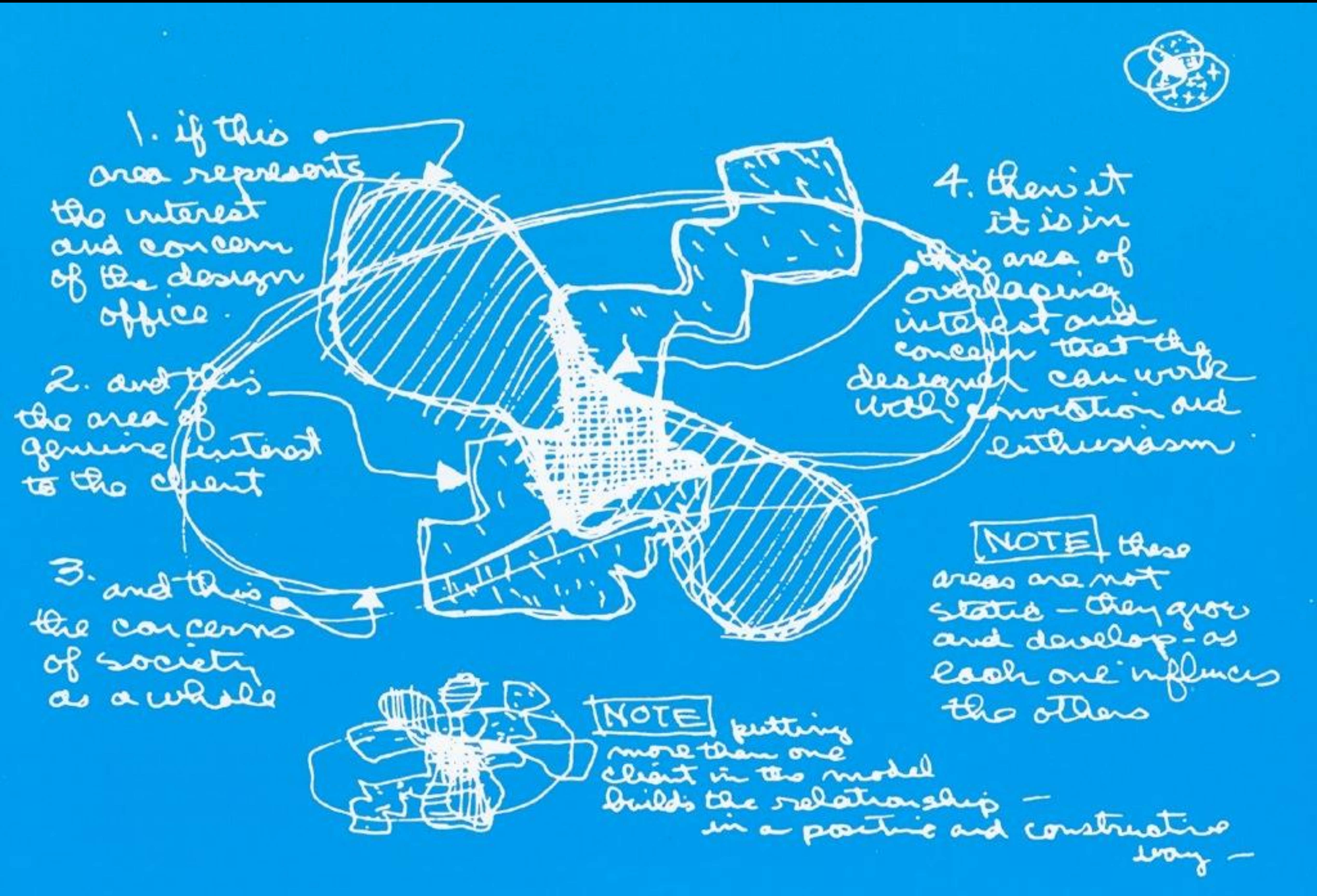
Zero Carbon Architecture Research Studio

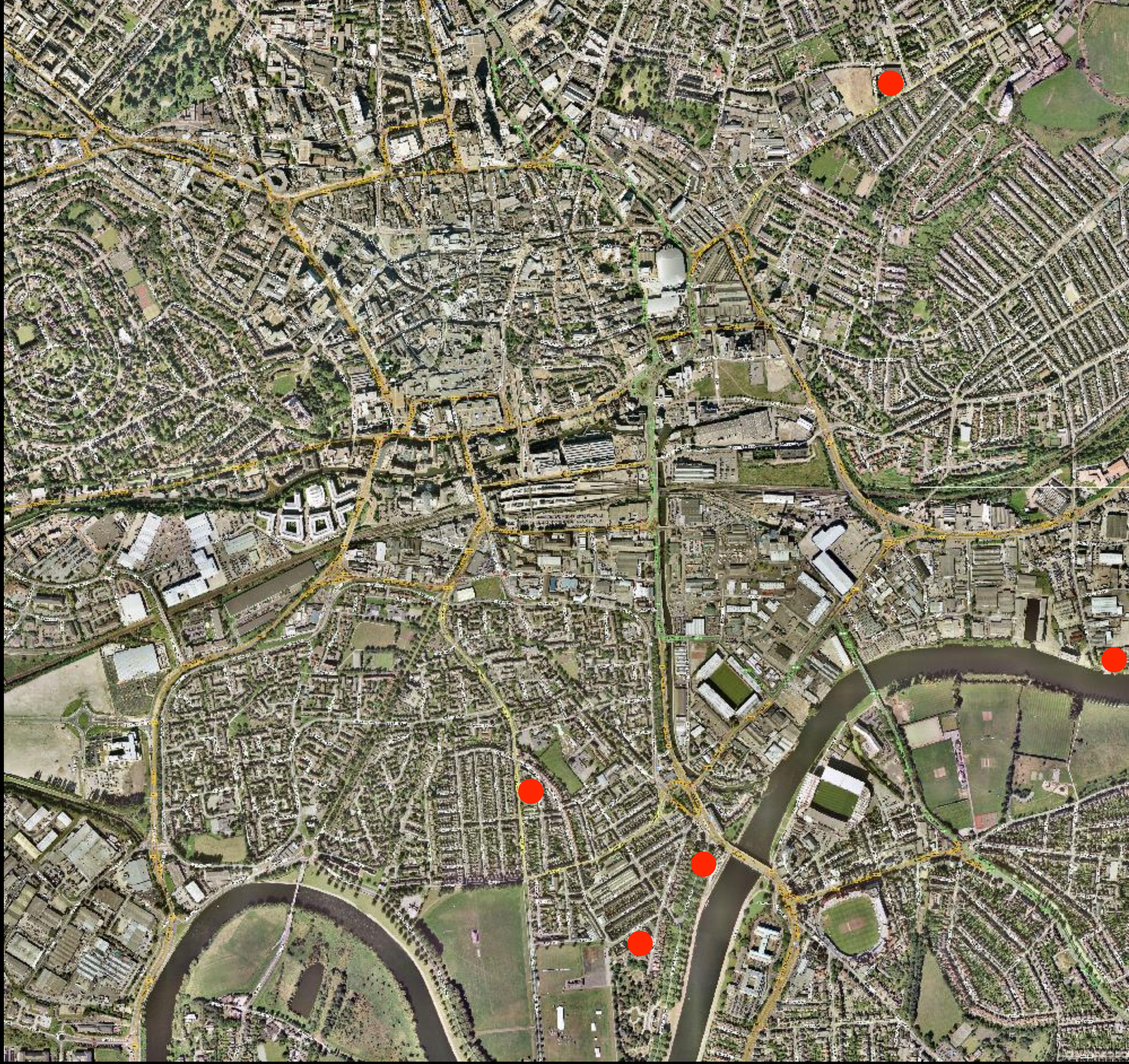
University of Nottingham **Michael Stacey Architects**

Zero Carbon Architecture Research Studio

‘We are still in charge of our own destiny. We have the technology to end our dangerous dependence on carbon fuels. We can take our pick of alternative energy sources: wind and solar; geothermal ….. And we have the technology to use dramatically less energy too.’

Fred Pearce writing in advance of the Copenhagen UN Climate Change Summit, December 2009.


1. if this area represents the interest and concern of the design office.
2. and this the area of genuine interest to the client
3. and this the concerns of society as a whole
4. then it it is in this area of overlaping interest and concern that the designer can work with conviction and enthusiasm.
NOTE these areas are not static – they grow and develop – as each one influences the others
NOTE putting more than one client in the model builds the relationship – in a positive and constructive way –



Prefabricated Homes on an urban site in Nottingham


Tyvek
Tyvek
Tyvek

Flexible standardisation


Alvar Aalto described flexible standardisation - think about ‘a group of houses as being like a branch of flowering cherry …. All the flowers are essentially the same, yet each is unique, looking this way or that, expanding or retreating, according to its relationship to its neighbours, to the sun and to the wind.’
Stockholm,1944, recorded by Jørn Uzton

Homes as a product

Peter Opsvik

Homes as a product

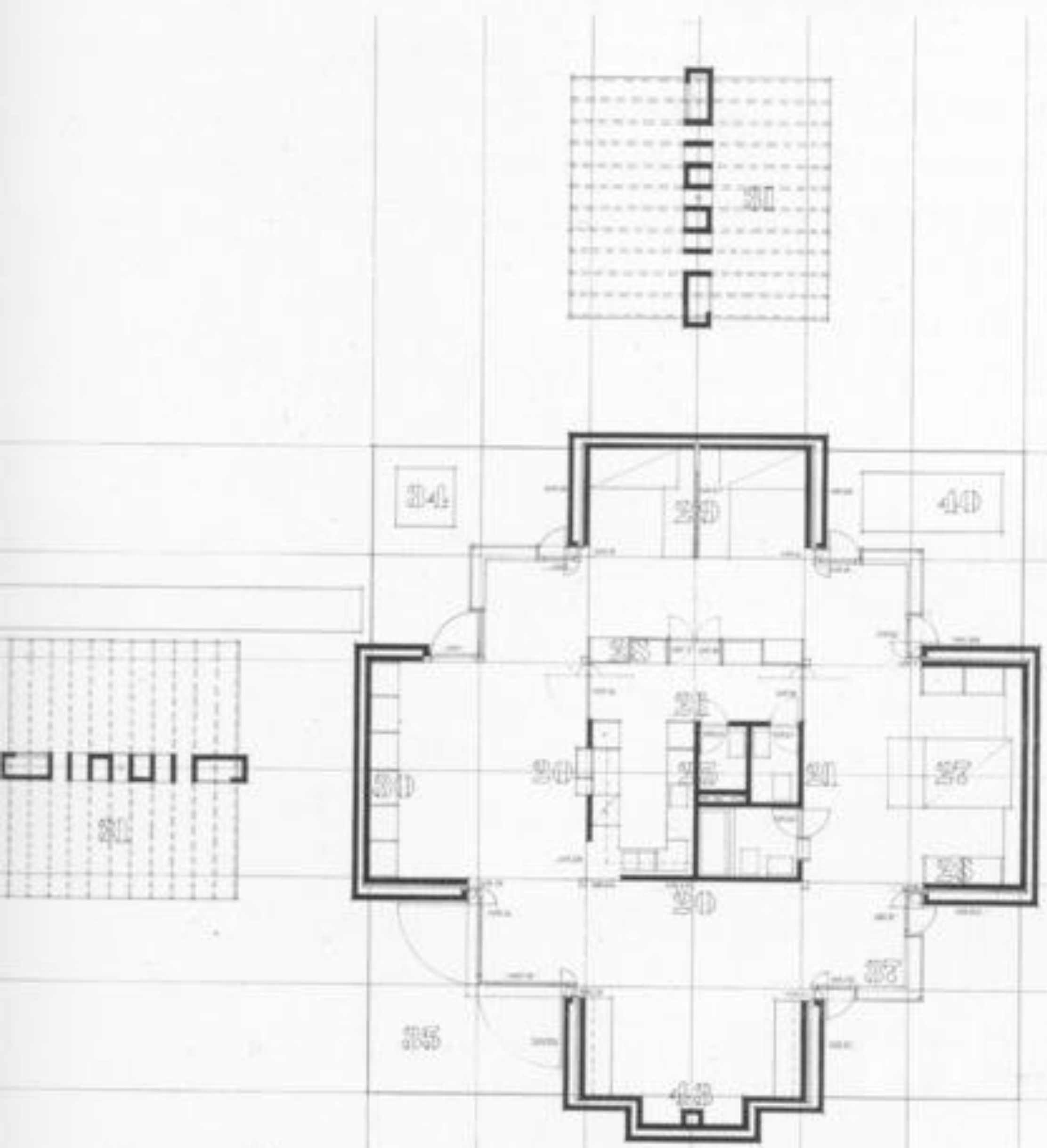
Peter Opsvik

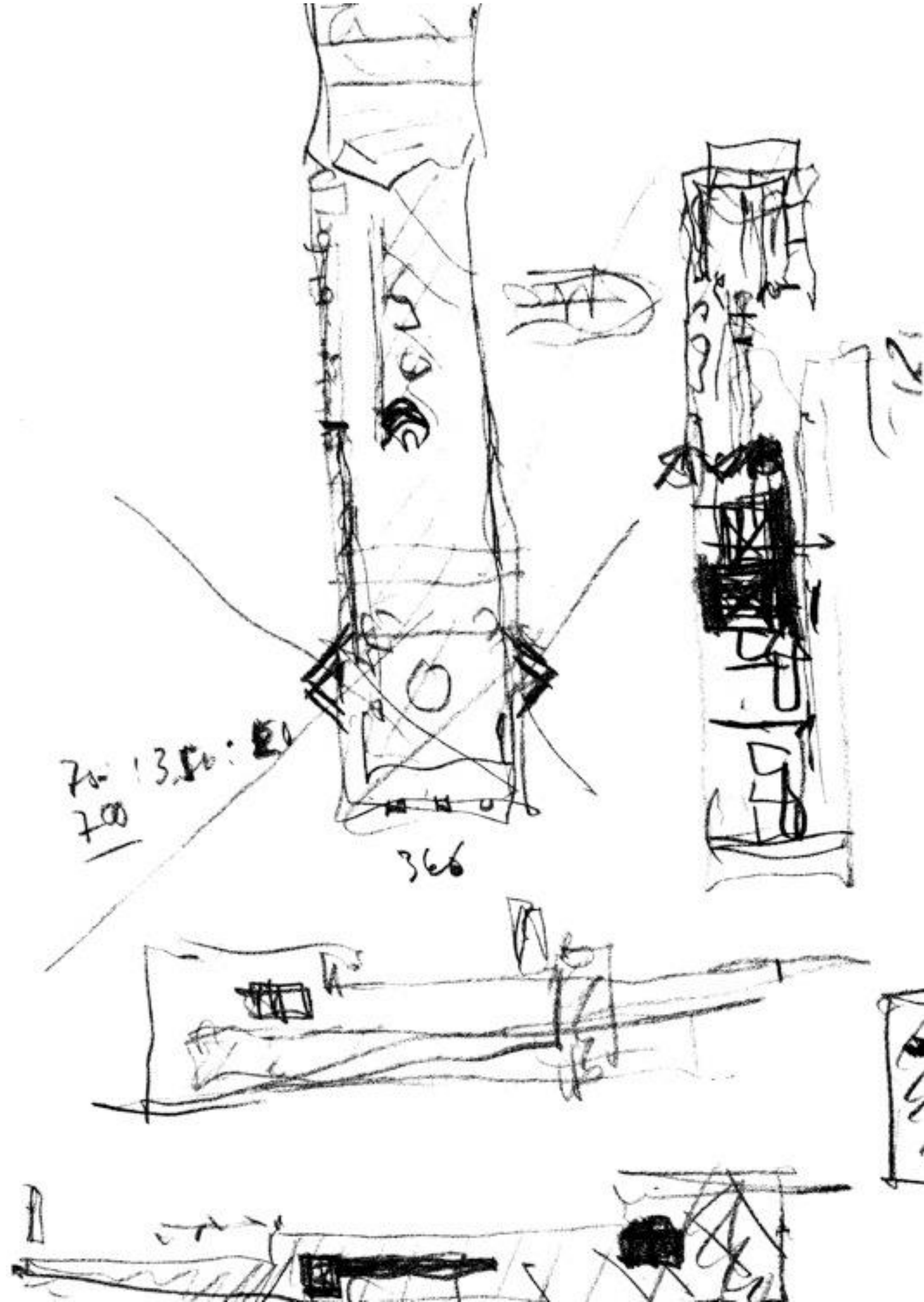
‘When a planet is overwhelmed by products and users for an endless number of articles, it can appear a paradox to develop new products. Nevertheless, I am convinced that products will enjoy a longer existence where devotion, farsightedness and thoughtfulness contribute too the development, than those governed by fashion and trends.’

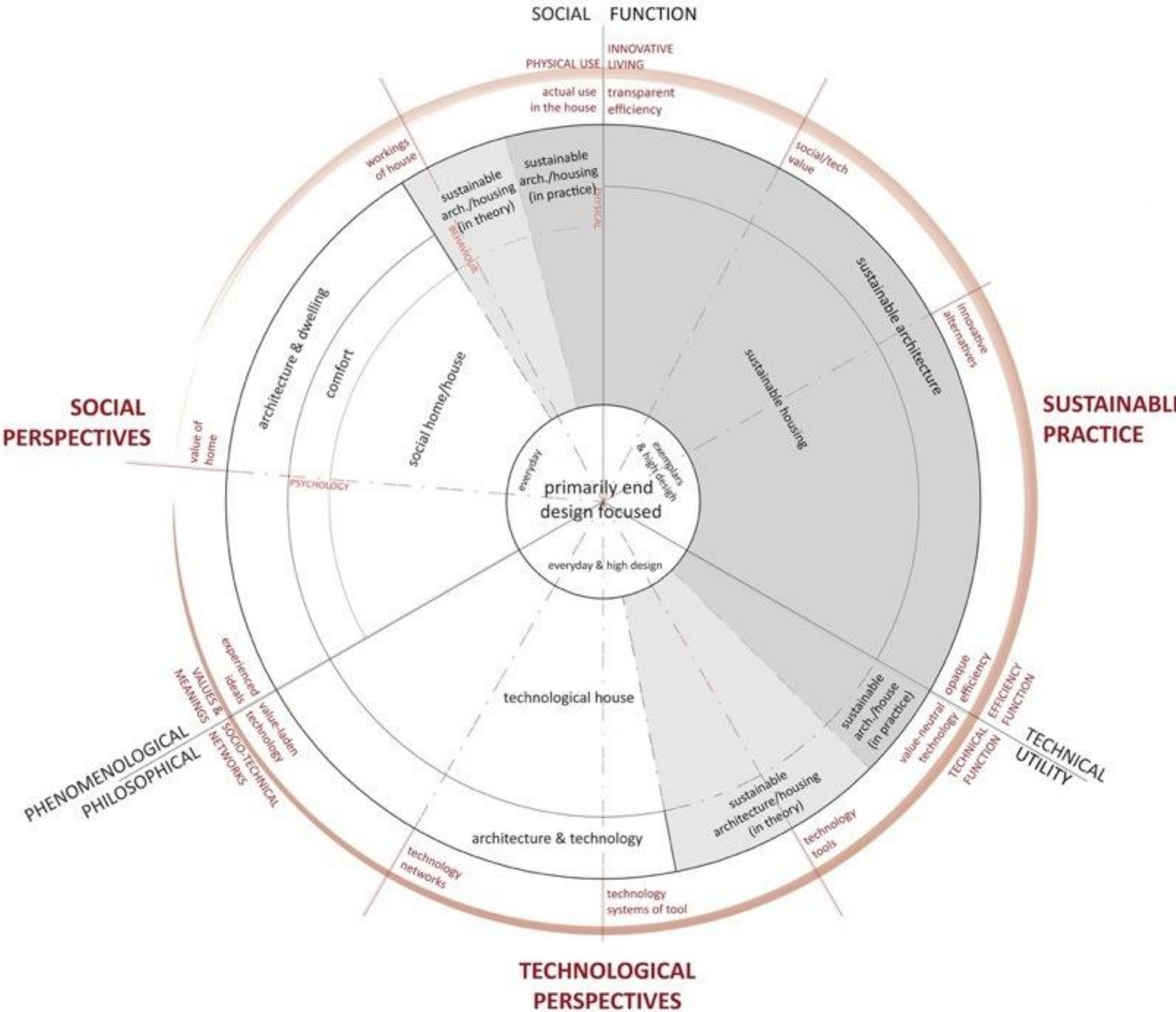
Phaidon Design classics: Volume 3 by Phaidon (2006): Product 809

Peter Opsvik

Samuel S. Kistler, 1931

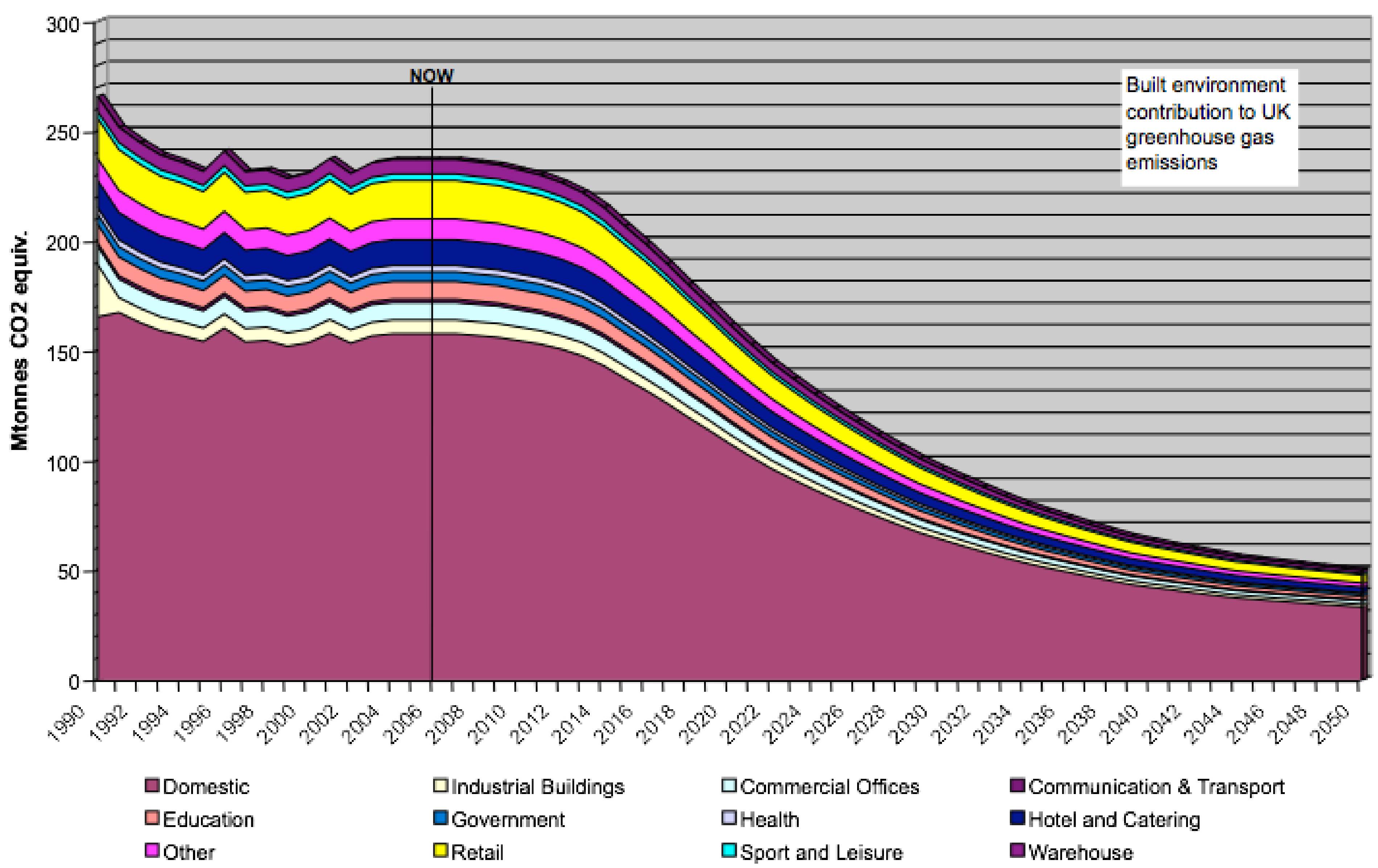



366



SOCIAL
FUNCTION
INNOVATIVE LIVING
PHYSICAL USE
actual use in the house
transparent efficiency
workings of house
social/tech value
sustainable arch./housing (in theory)
sustainable arch./housing (in practice)
sustainable architecture
sustainable housing
innovative alternatives
SUSTAINABLE PRACTICE
SOCIAL PERSPECTIVES
value of home
PSYCHOLOGY
architecture & dwelling
comfort
social home/house
everyday
exemplars & high design
primarily end design focused
everyday & high design
technological house
sustainable arch./house (in practice)
opaque efficiency
EFFICIENCY FUNCTION
TECHNICAL UTILITY
value-neutral technology
TECHNICAL FUNCTION
experienced ideals
VALUES & MEANINGS
value-laden technology
SOCIO-TECHNICAL NETWORKS
PHENOMENOLOGICAL
PHILOSOPHICAL
sustainable architecture/housing (in theory)
technology tools
architecture & technology
technology networks
technology systems of tool
TECHNOLOGICAL PERSPECTIVES

The Stern objective



Communities and Local Government

Code for Sustainable Homes

Technical guide
April 2008

www.communities.gov.uk
community, opportunity, prosperity

UK Government Target 3,000,000 New Homes by 2020

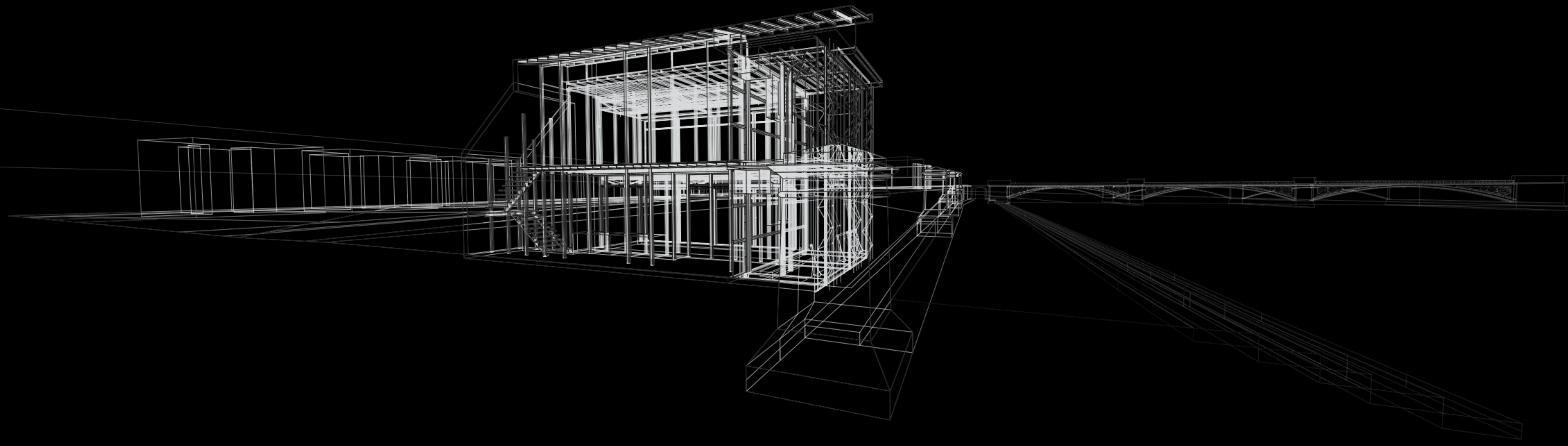
1969 4 Million houses had been built since WW2

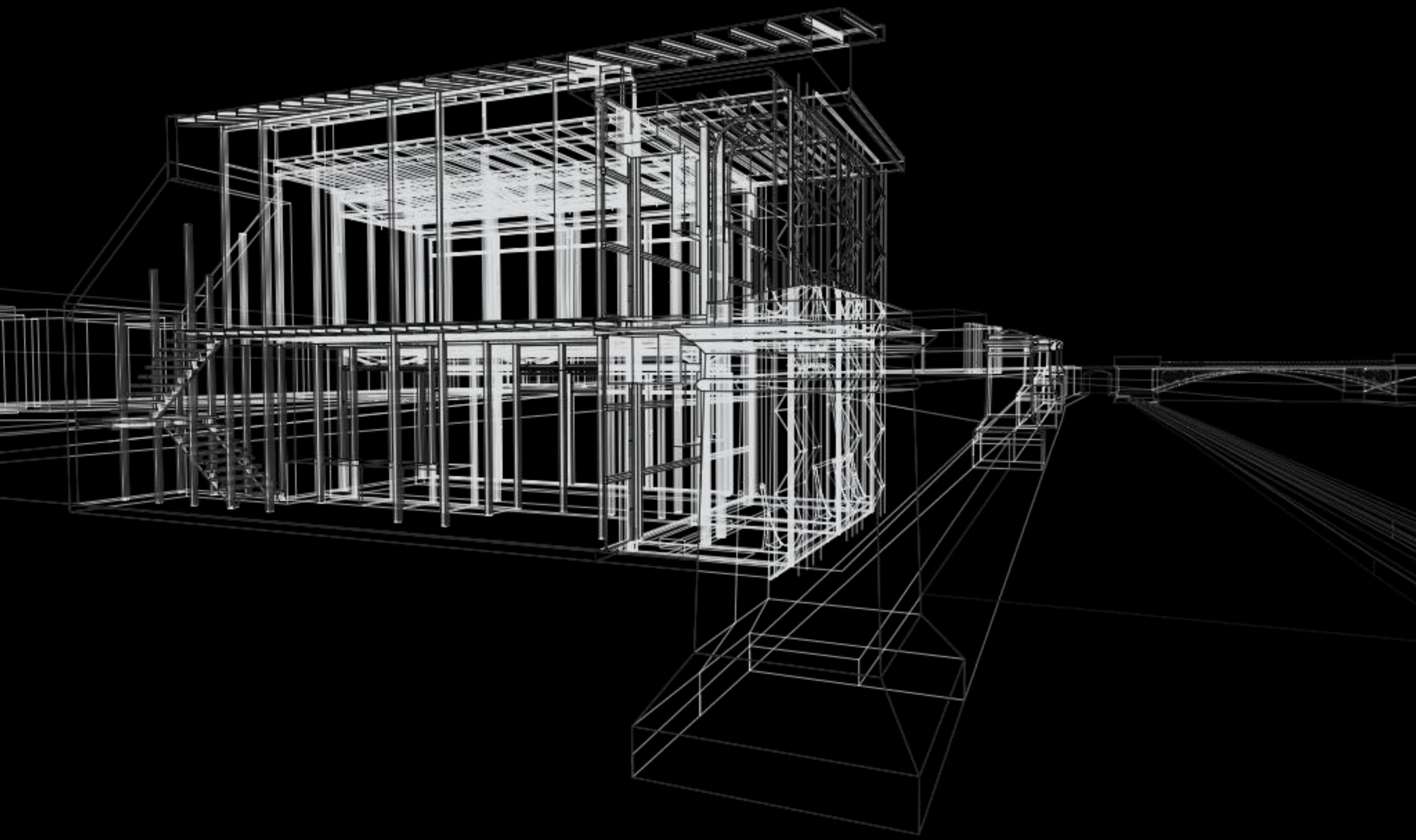

Woodward St
Green St
Green St
Green St
Fraser Rd
Fraser Rd

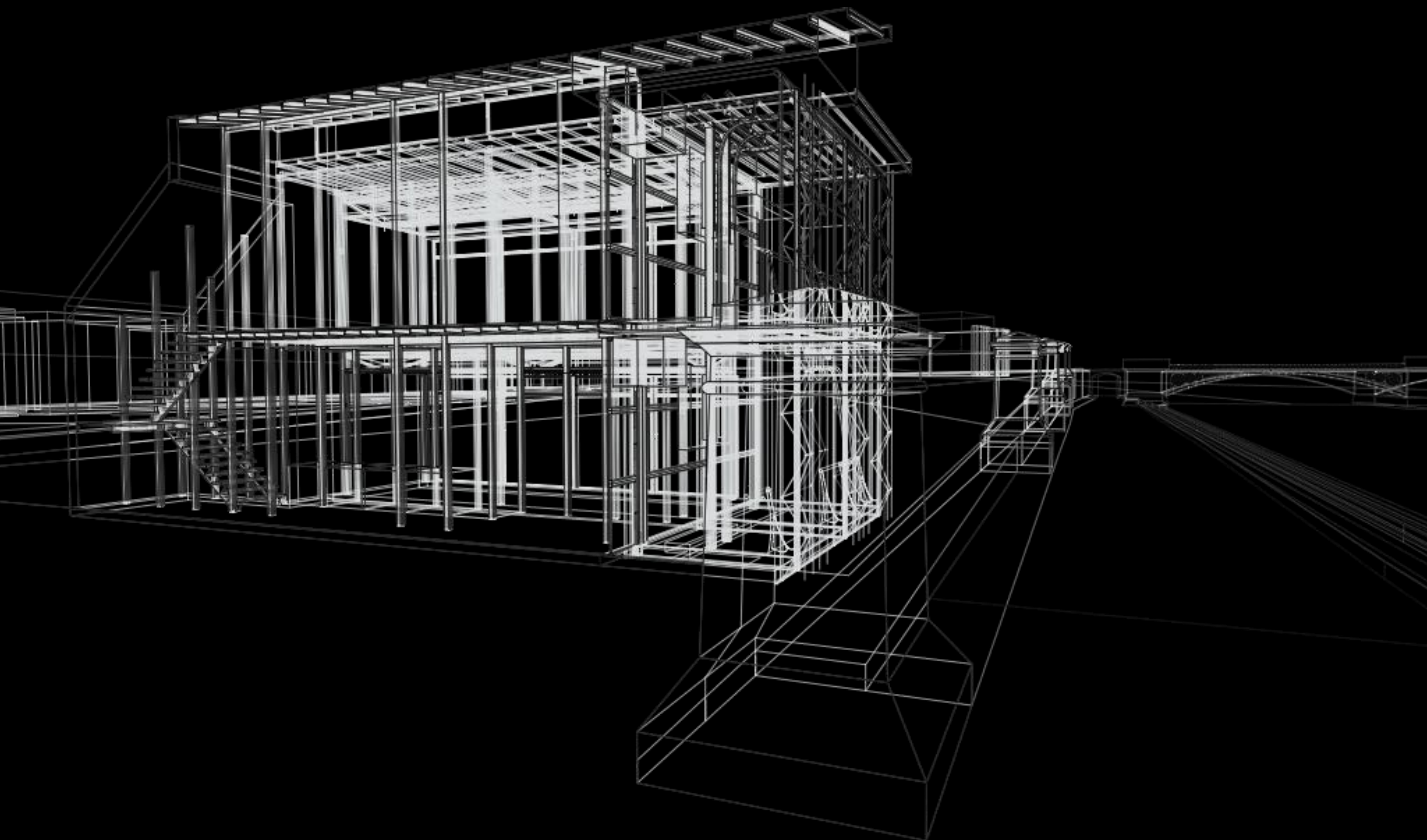
Inside: Show home opens at Green Street in The Meadows. Visit our Facebook page. Appeals for Meadows memories. New web site live.

THE GRASS IS GREENER IN THE MEADOWS

Selected ZCARS Student Projects



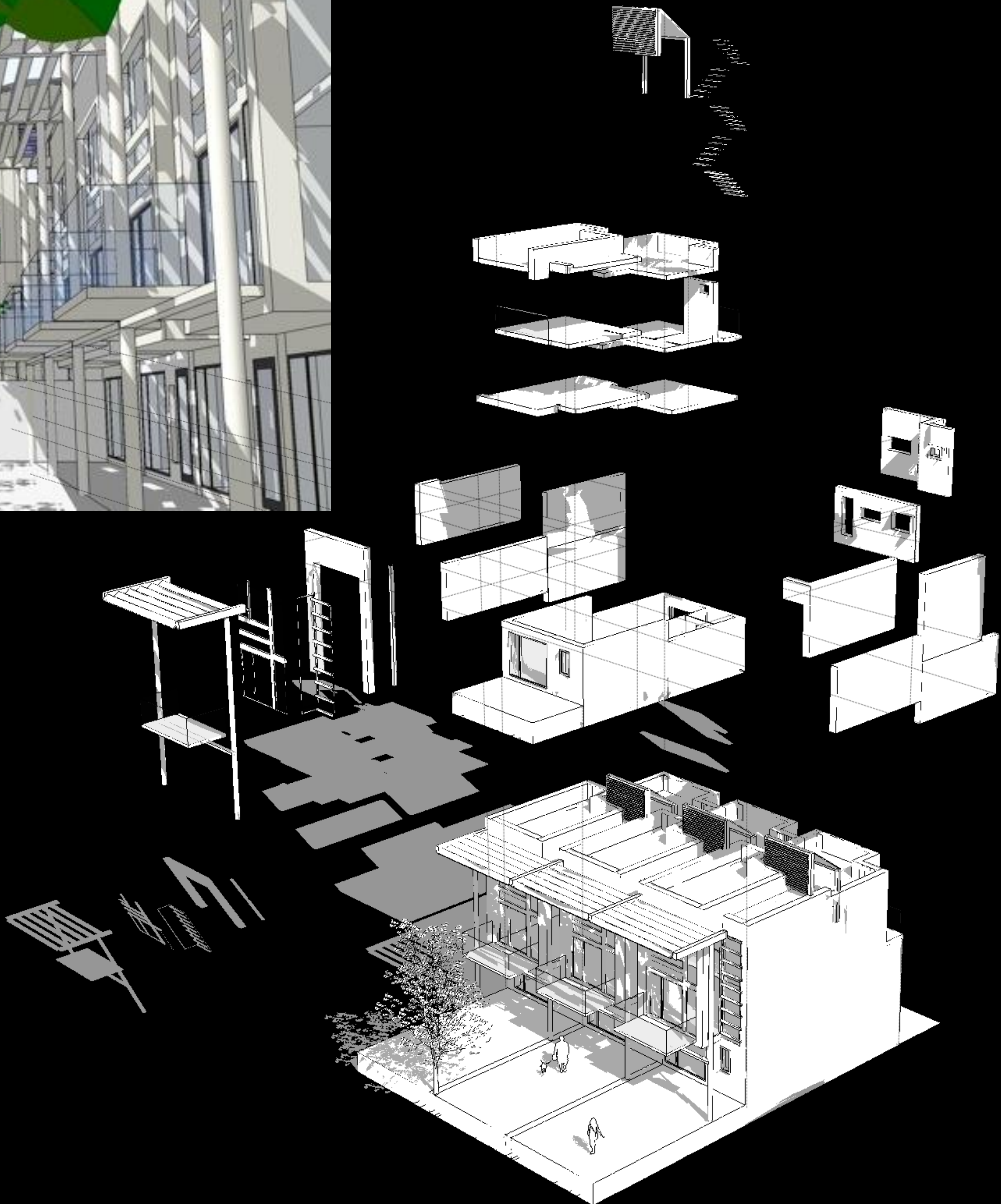


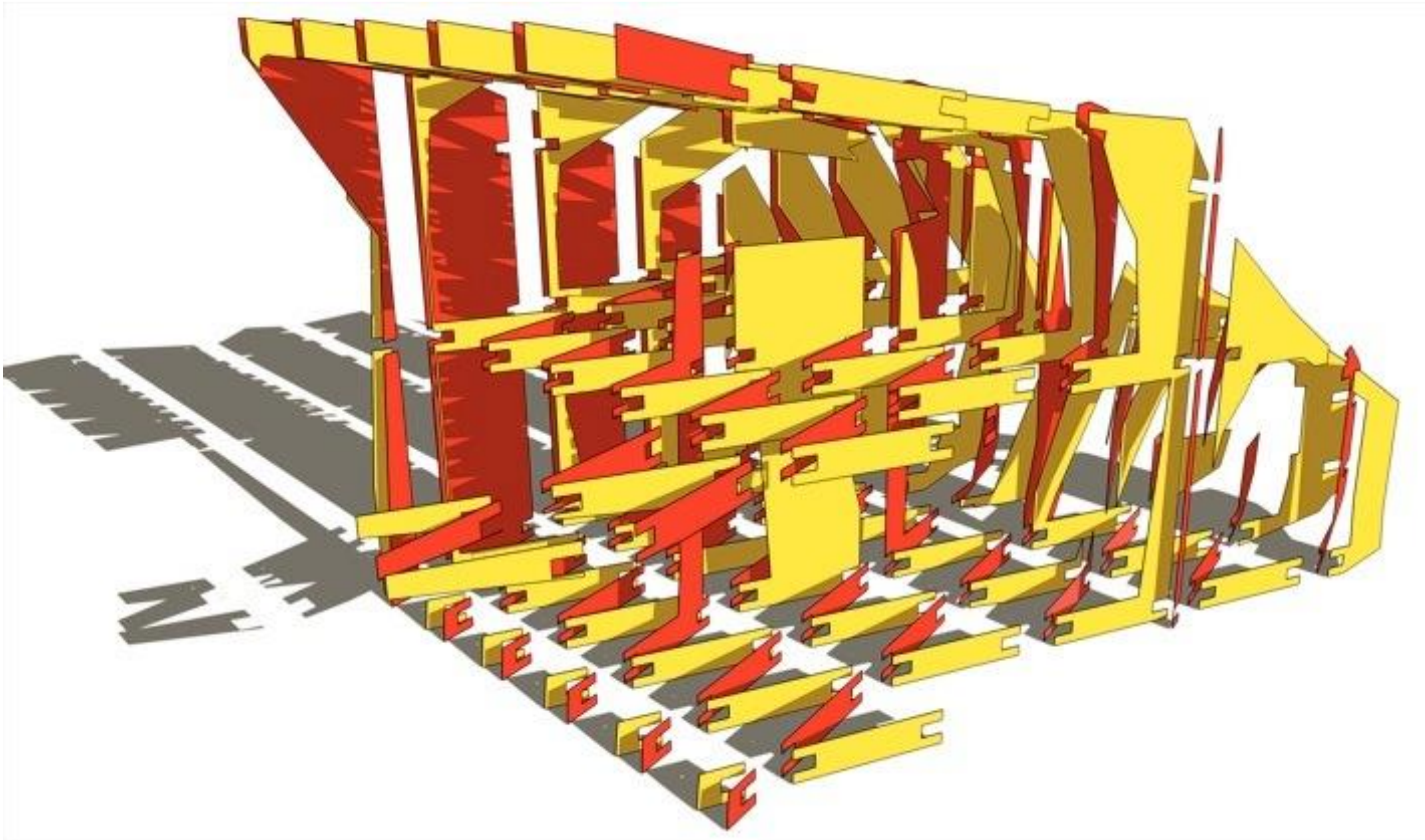


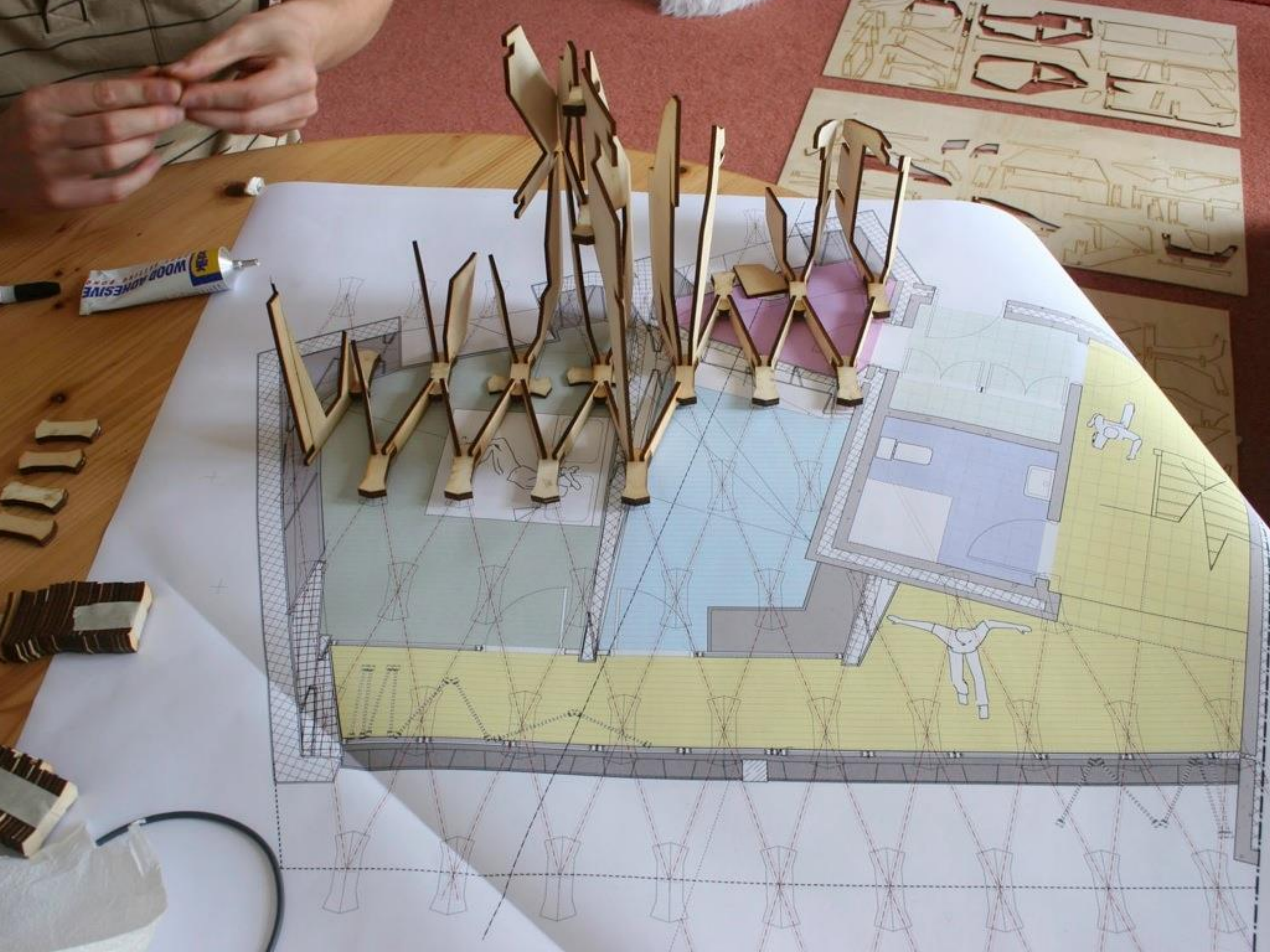
‘The Code for Sustainable Homes does not address the economical, political and, fundamentally, the social problems that we face with growing concerns over climate change’

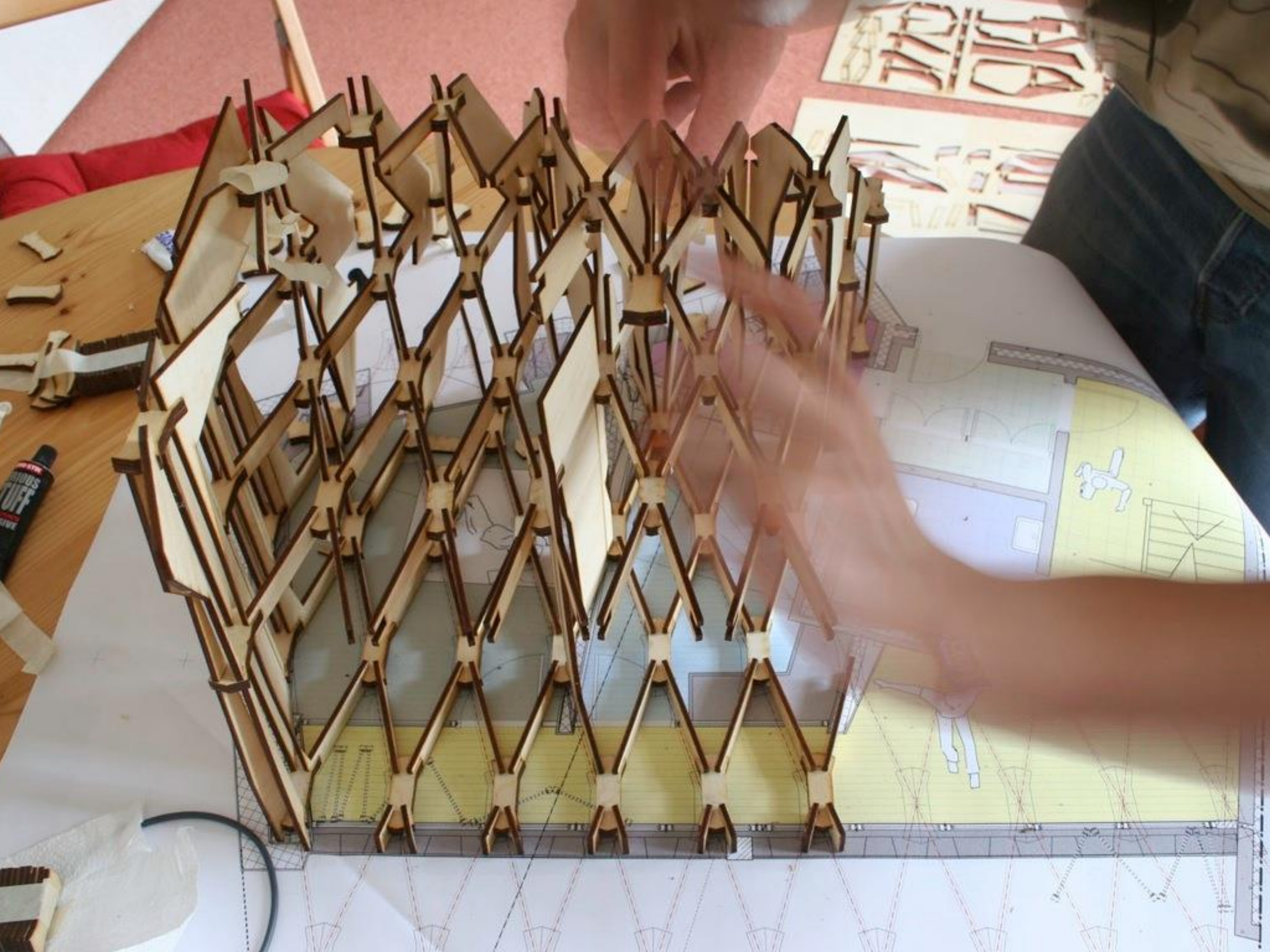
Paul Kensall, fifth year diploma student in ***The Operating System,*** ZCARS Project Report, 2008

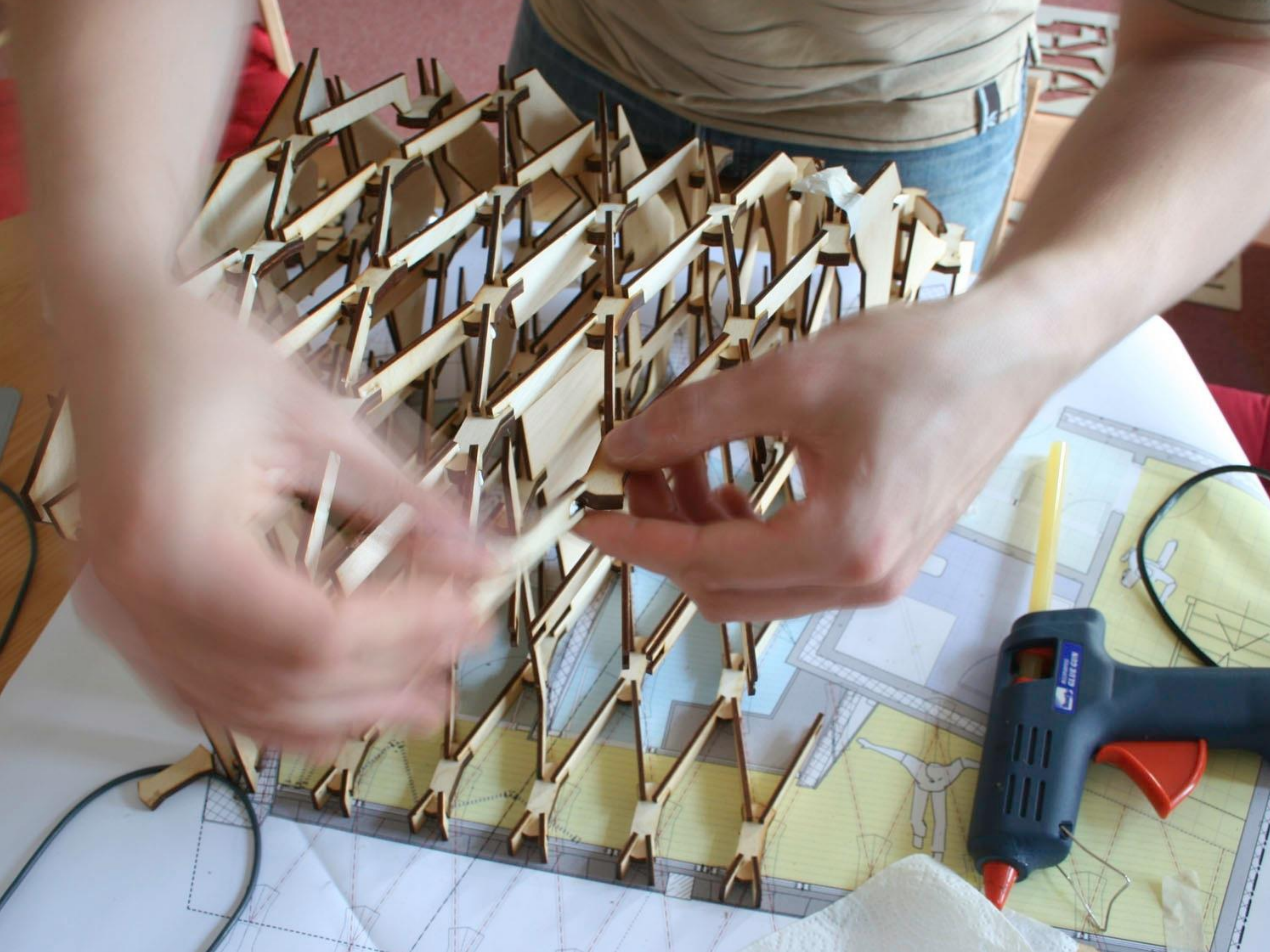
Porch Module






WOOD ADHESIVE





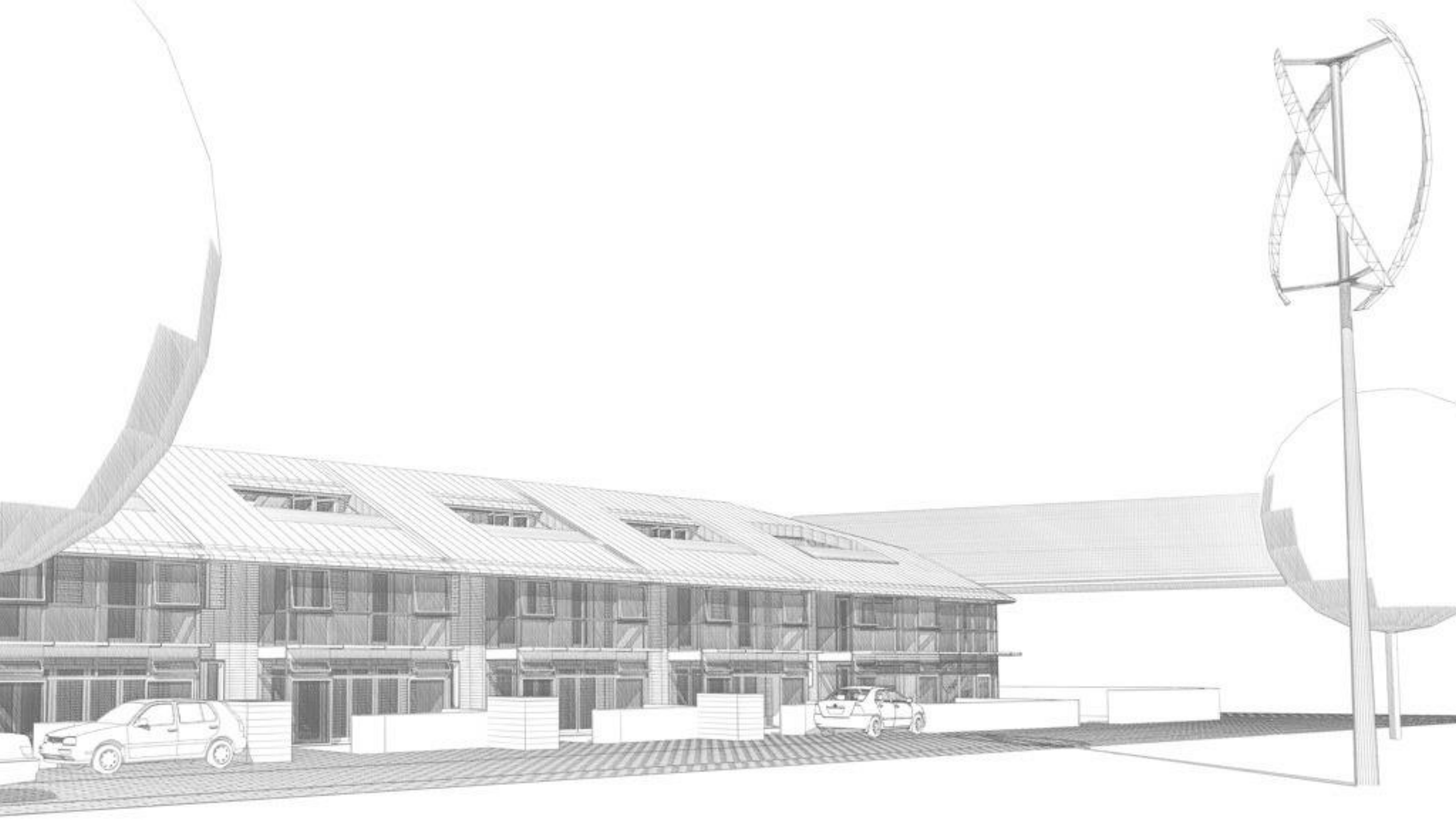
Jonathan Davey and Matthew Kidner

Winners: Nationwide Sustainable Housing Competition 2010

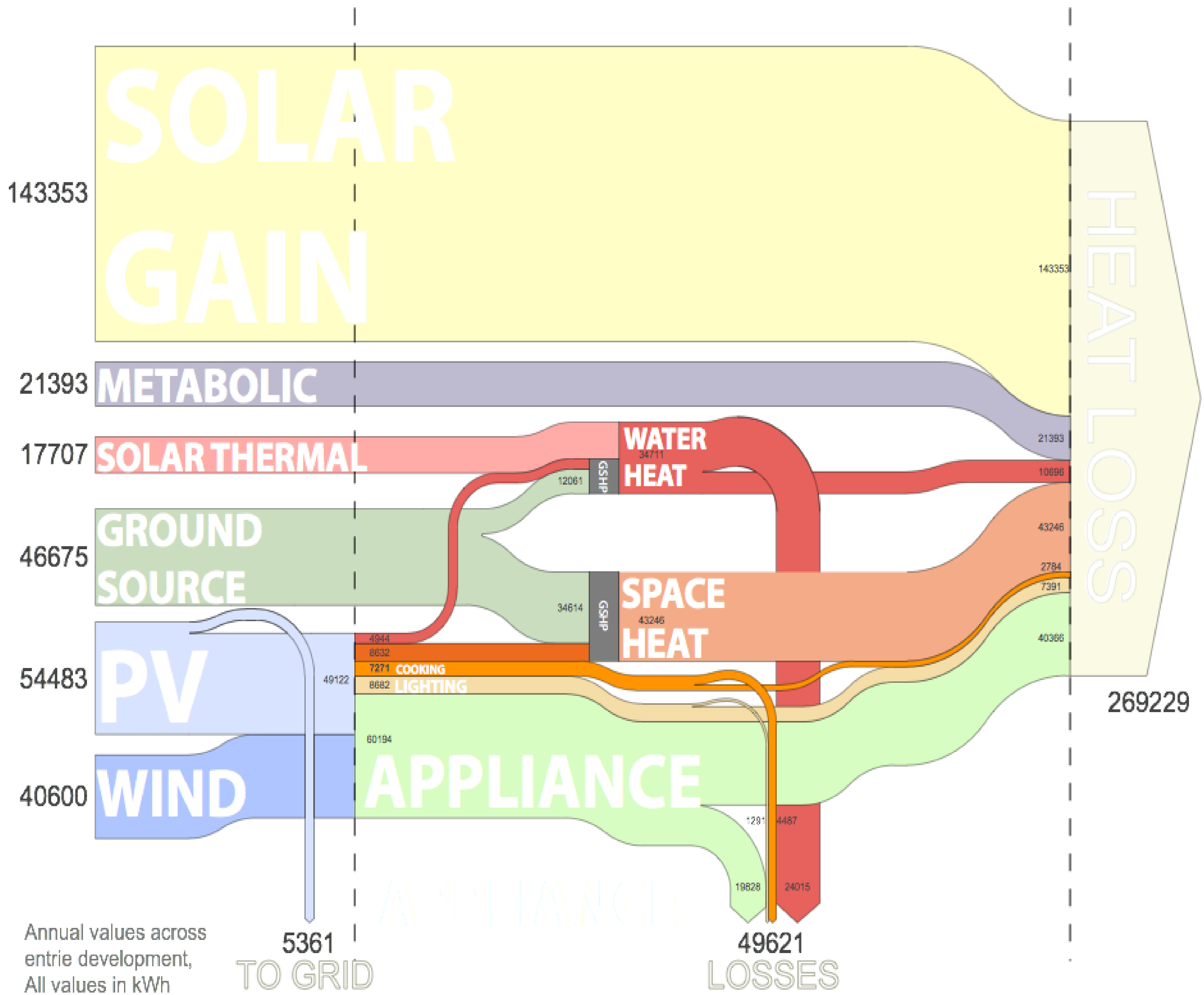
ZERO CARBON

HOUSING Green Street | The Meadows | Nottingham Level 1 Site Plan 1:200

ZERO CARBON
HOUSING Green Street | The Meadows | Nottingham Level 2 Site Plan 1:200



David Brook and Samatha Barclay


SOLAR GAIN
143353
21393 METABOLIC
17707 SOLAR THERMAL
46675 GROUND SOURCE
54483 PV
40600 WIND
WATER HEAT
34711
GSHP
12061
SPACE HEAT
43246
34614
4944
8632
7271 COOKING
8682 LIGHTING
49122
60194
APPLIANCE
143353
21393
10696
43246
2784
7391
40366
HEAT LOSS
269229
19828
24015
4487
5361
TO GRID
49621
LOSSES
Annual values across
entrie development,
All values in kWh

RIBA EM Awards 2009 Student Award for Low Carbon Environmental Design

Jun Aso and Jin Dong Wu

Benjamin Hopkins, Rachel Lee, and
Chris Dalton

Special Mention for:

Alex Lewis, Seema Mistry, and
Daniel Dunn.

RIBA EM Awards 2010 Student Award for Low Carbon Environmental Design

Oliver Peach, Alexander Loren-Gosling
and Peter Phillips

Special Mention for:

David Brook and Samatha Barclay

Best Use of Timber at Ecobuild 2010

Benjamin Hopkins, Rachel Lee, and
Chris Dalton

Nationwide Sustainable Housing 2010 First Prize

Jonathan Davey and
Matthew Kidner

Oliver Peach, Alexander Loren-Gosling and Peter Phillips

Winners: EM RIBA 2010 Low Carbon Awards

SOLUTIONS: TECTONICS/INSULATION

Dissecting the 1930s semi

Half a semi-detached house at the University of Nottingham is the site of an experiment in insulation that could benefit millions of homes

MICHAEL STACEY

Last year's House of Commons report on Existing Housing and Climate Change highlighted Britain's large existing housing stock – more than 26 million homes, many of which are highly valued culturally for their heritage and architectural significance.

More than 23 million of these homes are expected to still exist in 2050, and, in tackling climate change, it is essential that the thermal performance of this housing be addressed. Typically, these homes have single glazing and solid masonry construction or, if built after about 1930, uninsulated cavity walls.

To articulate this challenge and research the options to transform Britain's existing housing, a team led by Mark Gillott at the University of Nottingham's School of the Built Environment has built the Eon House, a semi-detached house to 1930s construction standards at Nottingham's University Park. The house is occupied by a family of four whose energy use is monitored in detail.

This research project, primarily sponsored by energy supply company Eon, forms part of the Creative Energy Homes programme at the University of Nottingham. Designed by Nottingham-based architect Marsh Grochowski, the house follows the pattern of the 1930s semis that are very common in the suburbs of north Nottingham and represent about 30% of homes in Britain.

In the 1930s, cavity walls had only just been introduced and the wall of the Eon House comprises a brick outer skin with a 50mm cavity and dense blockwork inner leaf, which has been plastered internally.

Next door to the Eon House is a research laboratory that mimics the environmental performance of its neighbour and helps to keep the party wall warm.

This laboratory and the house contain a significant amount of monitoring equipment, with nearly 200 sensors measuring environmental performance, occupancy, electrical power, gas and water consumption.

The project has been organised in three phases. The first was the construction of the Eon House. In a rare move, building control allowed the house to be built to 1930s building regulations.

The Eon house as constructed to 1930s standards is 340% below Part L standards

The Eon house has a laboratory attached.

Pre-war homes make up a large proportion of the existing stock.

The second phase involves upgrading the construction to make it 25% better than current building regulations, with the implementation of other measures to achieve the equivalent of Code for Sustainable Homes Level 3.

In phase three, Marsh Grochowski Architects will further improve the house to achieve CSH Level 6, including extensions necessary to achieve all aspects of this code. So the proposals in phase two need to take into account phase three, minimising the need to remove or rework the phase two enhancements.

The Eon house as constructed to 1930s standards is estimated to be more than 340% below the current thermal performance of Part L. To bring it up to the required standards, it is essential to insulate the ground floor, walls and roof.

The U-value of the uninsulated cavity wall is 1.4 Wm2/K. To achieve a thermal performance 25% better than Part L, filling the cavity with insulation is not enough. A high-performance graphite expanded-polystyrene bead insulation that fills the cavity would achieve a U-value of only 0.5 Wm2/K, making it necessary to further insulate the wall, inside or out.

The second phase of the project was organised as a student competition based on the Zero Carbon Architecture Studio for fifth-year and masters students, that I run with Swinal Samant and Lucelia Rodrigues.

The students worked to a budget of £25,000, and the proposals by the winning group — Dan Dunn, Alex Lewis and Seema Mistry — will be implemented this summer. The three students proposed a realistic and holistic strategy, which included insulating both the rear and side facades with external insulation finished with an acrylic render, such as Sto render.

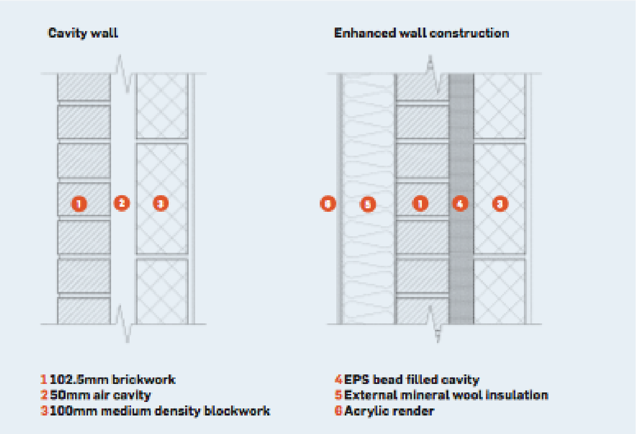
Based on Sto's 100mm mineral wool based system and filling the cavity with blown expanded-polystyrene bead — a U-value of 0.21 Wm2/K is achieved, which is more than 25% lower than the current building regulations.

They saw the front elevation as significant to the character of the street and here the cavity is filled and a similar thermal performance achieved by insulated dry lining. It is key that the two systems overlap to avoid cold bridges and a significant risk of condensation with a reduced overall performance.

It is worth considering reducing the U-value further, to 0.1Wm2/K, which would require a filled cavity and 280mm of external insulation.

This study shows that it should be possible to transform a 1930s semi to a code level 3 home with a budget of £25,000. This would both minimise the heating bills and provide comfortable living conditions for the occupants. This will be monitored in the next stage and the findings made available to the public.

Michael Stacey is professor of architecture at the University of Nottingham, and director of Michael Stacey Architects.



In the second phase rear and side facades are insulated.

KEEPING THE BALANCE RIGHT

Insulation slows the passage of heat through the fabric of a building when a temperature difference exists between the interior and the exterior.

It primarily provides thermal resistance by trapping still air, slowing convection and conduction of heat.

This is why silica-based Aerogel is such a good insulator as it is 99.8% gas and only 0.2% silica, trapping gases on a molecular level — it also has the advantage of being translucent.

The lower the U-value of insulated building fabric, the better it will resist this passage of energy — however it will not stop it. Adding a reflective layer will help to minimise heat transfer by radiation.

In a low-energy or carbon-neutral home, the aim is to reduce the flow of heat to a level that can be replaced by beneficial solar gain and "wild gains" from the occupants.

In the relatively mild winters of Britain the need for additional heating can be minimized or eliminated.

It is interesting to note that Sverre Fehn in the Villa Norrköping, like many Scandinavian architects, included 150mm of insulation in brick cavity wall construction way back in 1964.

CRACKING THE CODE

By Graham Farmer

Launched in December 2006, the Code for Sustainable Homes is the government's standard for assessing the environmental impact of new homes against a range of one to six stars.

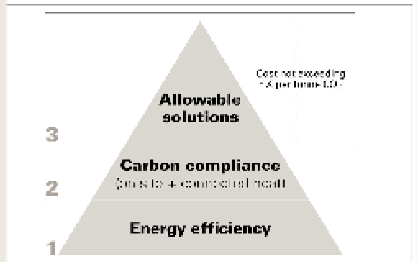
Although the code covers nine categories of environmental impact it is the ambition that all new homes should be "zero carbon" from 2016 that has perhaps attracted most attention. However, the code's definition of "zero carbon" has not been without controversy and in response the government has recently concluded a consultation exercise aimed at crafting a consensual and workable definition for zero carbon buildings.

The 111-page consultation document would appear to point to further revisions to the code and the SAP calculation on which it is based. Importantly, the document signals the government's intention to adopt a hierarchical approach to designing zero carbon buildings based on addressing energy efficiency, carbon compliance and allowable solutions.

Energy efficiency provides the foundation of the zero carbon strategy and suggests that existing standards for very energy-efficient homes such as the German PassivHaus standard will remain as the efficiency benchmarks for code level 6.

At present, a zero carbon home must have a minimum heat loss parameter of 0.8 W/m2K; a requirement that requires a careful balance between high levels of insulation, extremely airtight construction and typically the use of mechanical ventilation with heat recovery, which may not be relevant in the British climate.

The UK government is planning to introduce carbon compliance levels for regulated emissions (heating, lighting and hot water) compared to existing target emission rates of 25% (code level 3) in 2010 and 44% (code level 4) in 2013.



Currently, a "zero carbon" home has to achieve a minimum 100% reduction in regulated emissions and zero net carbon emissions including power for cooking and appliances. However, the consultation document considers less stringent requirements for regulated emissions in recognition of technical feasibility and cost implications.

The existing code also requires zero carbon homes to generate renewable energy to cover their own energy requirements via onsite installations or via an offsite "private wire" connection. The consultation suggests that energy harvesting could move off-site as a means of dealing with residual emissions beyond the carbon compliance level.

This offsetting approach could include exporting heat, or investments in off-site renewable energy and zero carbon technologies locally and nationally. Until the building regulations are updated, the Code for Sustainable Homes appears to be an acceptable if flawed guidance for the creation of zero carbon homes in Britain.

Graham Farmer is associate professor of architecture and diploma director at the University of Nottingham.


Sola

Table 9.2: Concrete-based wall details with thermal performance criteria

Full fill cavity wall: 100 mm block and 100 mm block (aircrete) with render	Solid masonry wall: 215 mm block (aggregate) mineral fibre insulation and reinforced render	Solid masonry wall: 215 mm block (aircrete), extruded polystyrene and reinforced external render	Precast concrete sandwich panel (70 mm/125 mm concrete)
			
Aircrete block ($\lambda = 0.15$) Mineral wool ($\lambda = 0.033$)	Aggregate block ($\lambda = 1.13$) Mineral fibre ($\lambda = 0.04$)	Aircrete block ($\lambda = 0.15$) Extruded polystyrene ($\lambda = 0.029$)	Dense concrete ($\lambda = 1.83$-2.0) PIR insulation ($\lambda = 0.023$)
300 mm wall (75 mm insulation) U = 0.28 W/m^2K	360 mm wall (120 mm insulation) U = 0.28 W/m^2K	300 mm wall (60 mm insulation) U = 0.28 W/m^2K	295 mm wall (75 mm insulation) U = 0.28 W/m^2K
325 mm wall (100 mm insulation) U = 0.22 W/m^2K	375 mm wall (135 mm insulation) U = 0.25 W/m^2K	325 mm wall (85 mm insulation) U = 0.22 W/m^2K	325 mm wall (105 mm insulation) U = 0.21 W/m^2K
350 mm wall (125 mm insulation) U = 0.20 W/m^2K	420 mm wall (180 mm insulation) U = 0.20 W/m^2K	340 mm wall (100 mm insulation) U = 0.20 W/m^2K	330 mm wall (110 mm insulation) U = 0.20 W/m2K
375 mm wall (150 mm insulation) U = 0.18 W/m^2K	440 mm wall (200 mm insulation) with aircrete block U = 0.20 W/m^2K	375 mm wall (135 mm insulation) U = 0.16 W/m^2K	370 mm wall (150 mm insulation) U = 0.15 W/m^2K
375 mm wall (150 mm insulation) with low conductivity wall ties U = 0.17 W/m^2K	480 mm wall (240 mm insulation) U = 0.15 W/m^2K	385 mm wall (145 mm insulation) U = 0.15 W/m^2K	375 mm wall (155 mm insulation) U = 0.14 W/m^2K
400 mm wall (175 mm insulation) with low conductivity wall ties U = 0.15 W/m^2K	615 mm wall (215 mm insulation) U = 0.1 W/m^2K	415 mm wall (175 mm insulation) with aggregate block U = 0.15 W/m^2K	440 mm wall (220 mm insulation) U = 0.1 W/m^2K
500 mm wall (275 mm insulation) with low conductivity wall ties U = 0.1 W/m^2K		515 mm wall (215 mm insulation) with aggregate block U = 0.1 W/m^2K	

Solar Decathlon: Madrid 2010 Design and Assembly of the Nottingham House

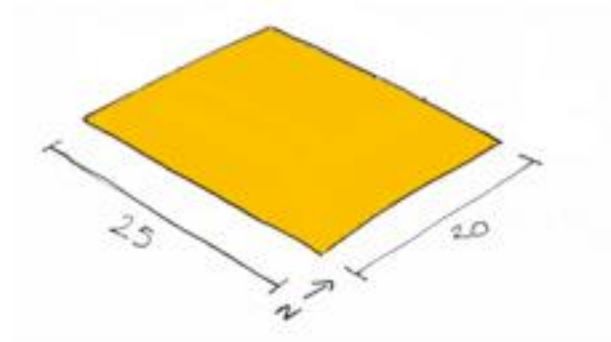
Nottingham House Winners:
Rachel Lee, Chris Dalton and Ben Hopkins

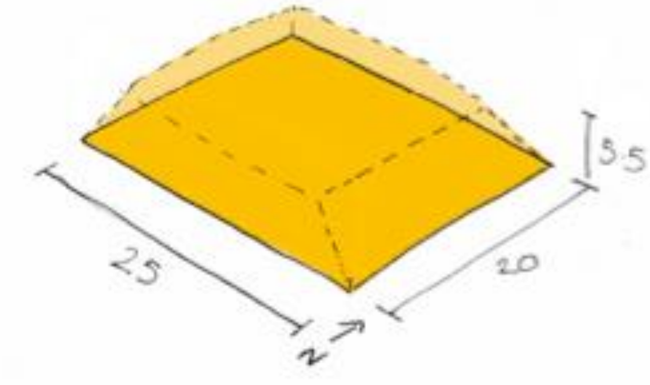

DANGER
sd europe

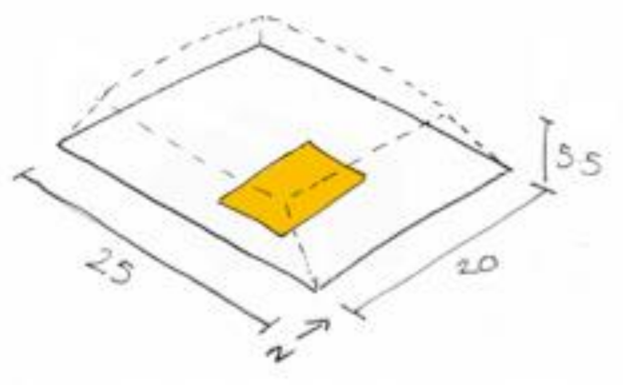
Mundella Works
HOLGATE ROAD

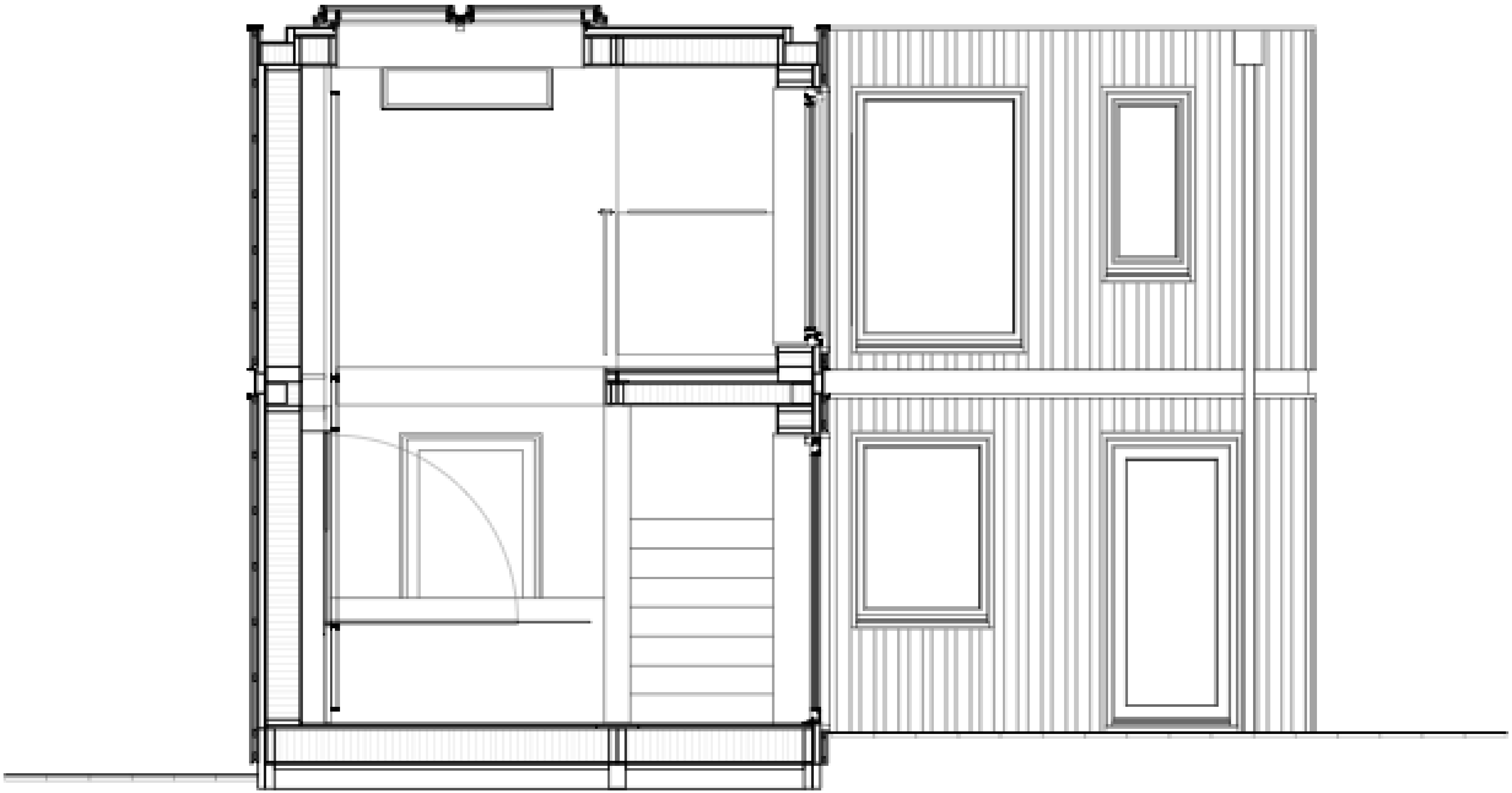
The Rules:

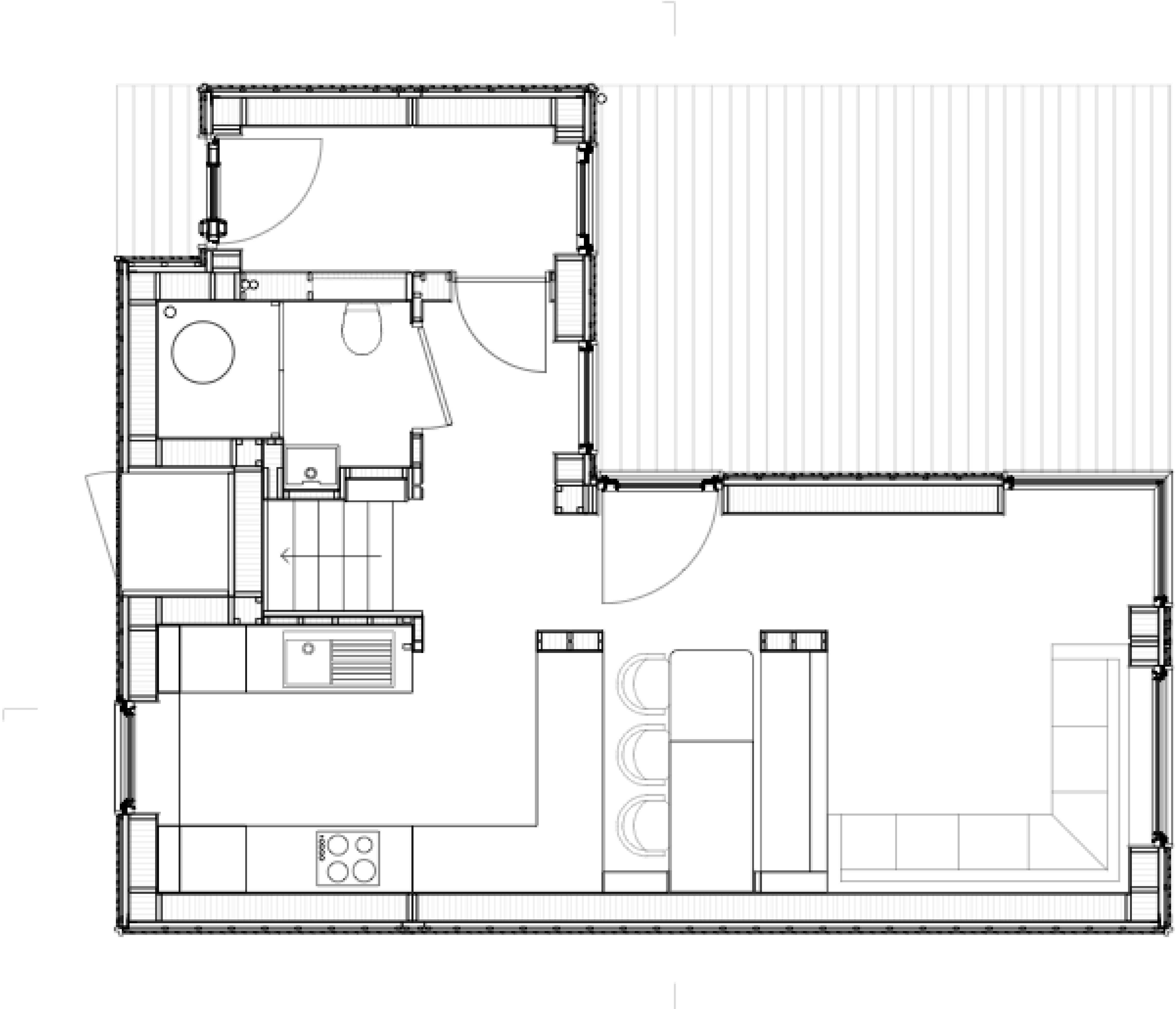
- Plot of 25m x 20m
- 5.5m high
- Site area of 74m²

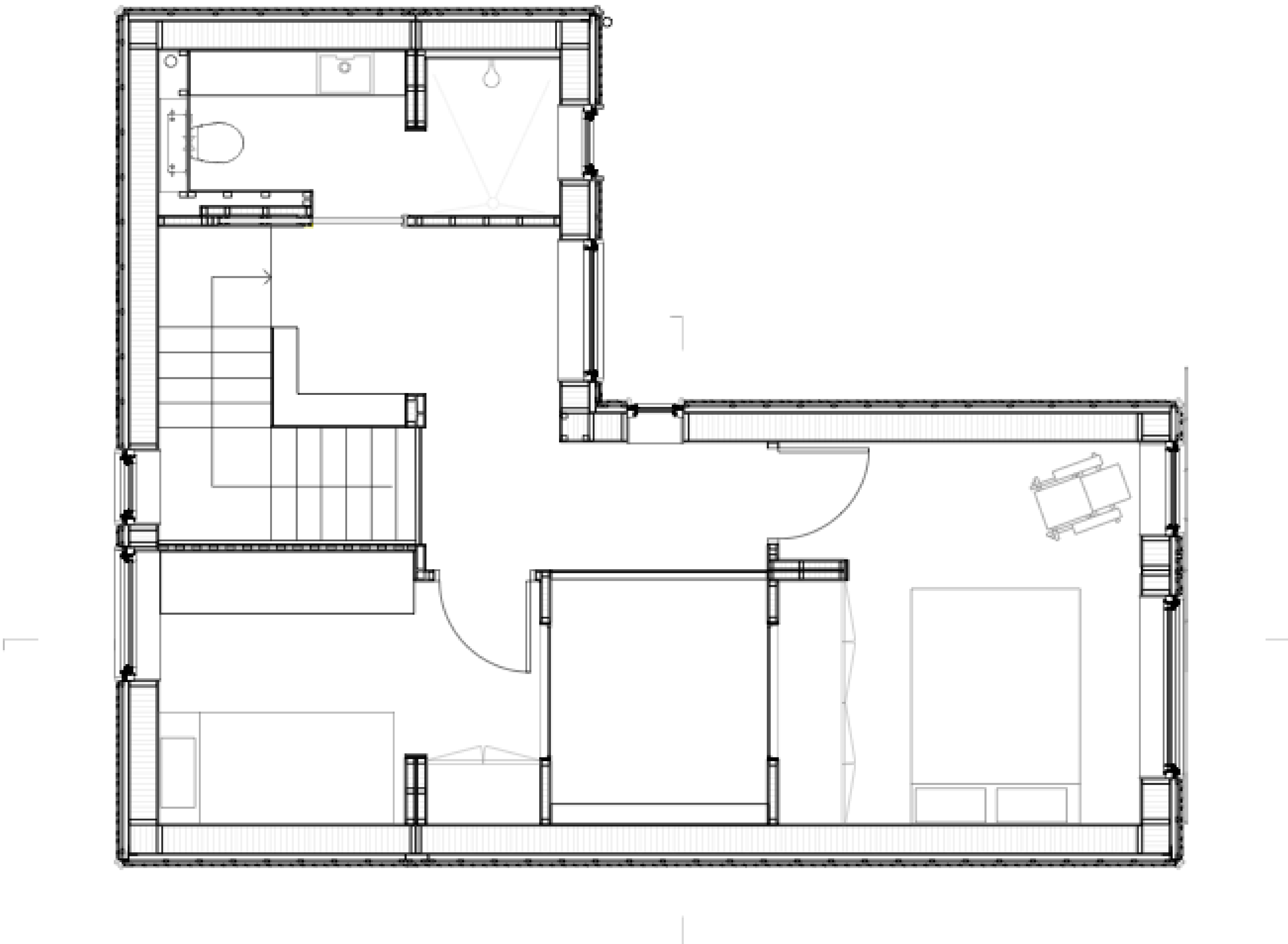








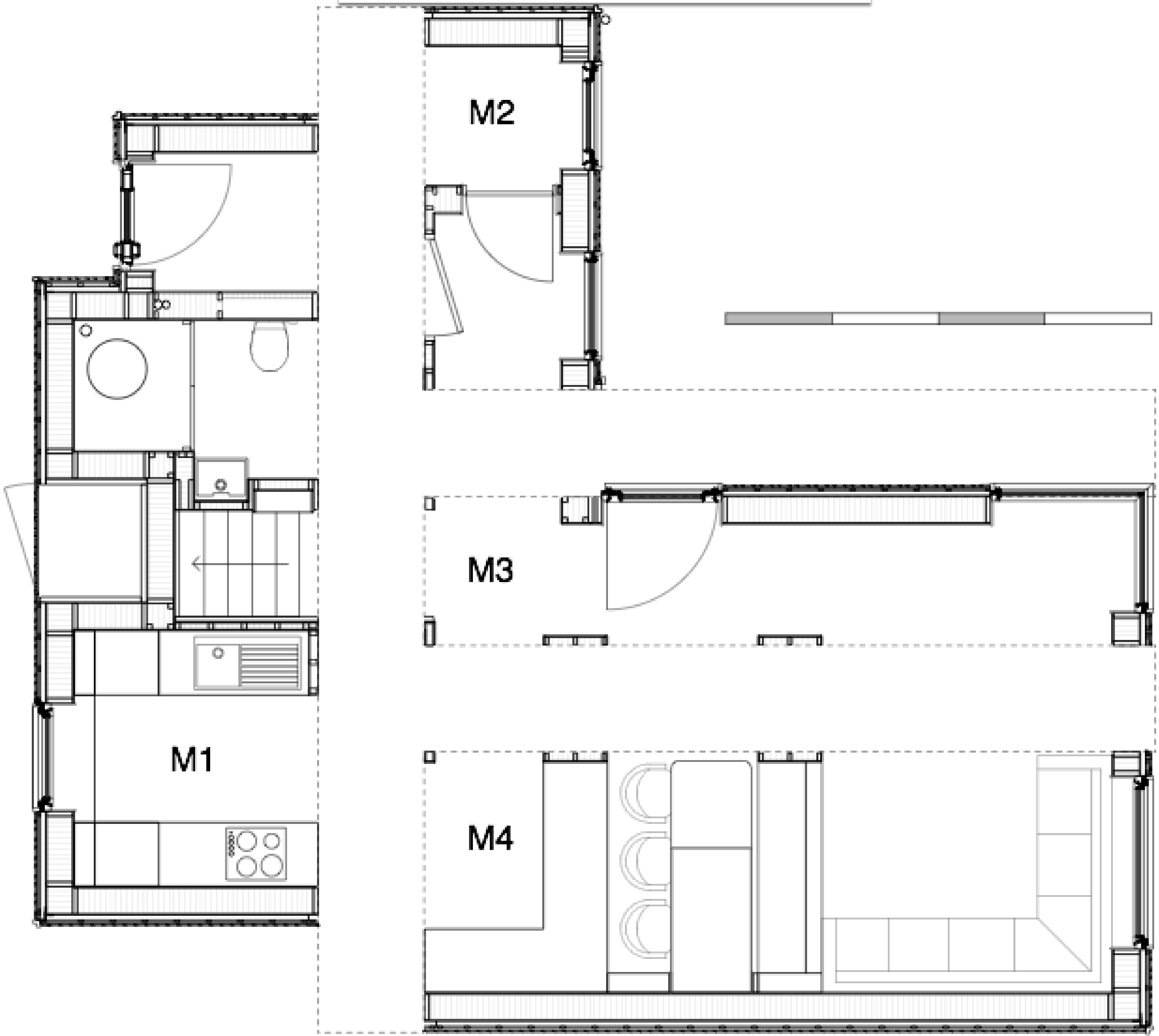


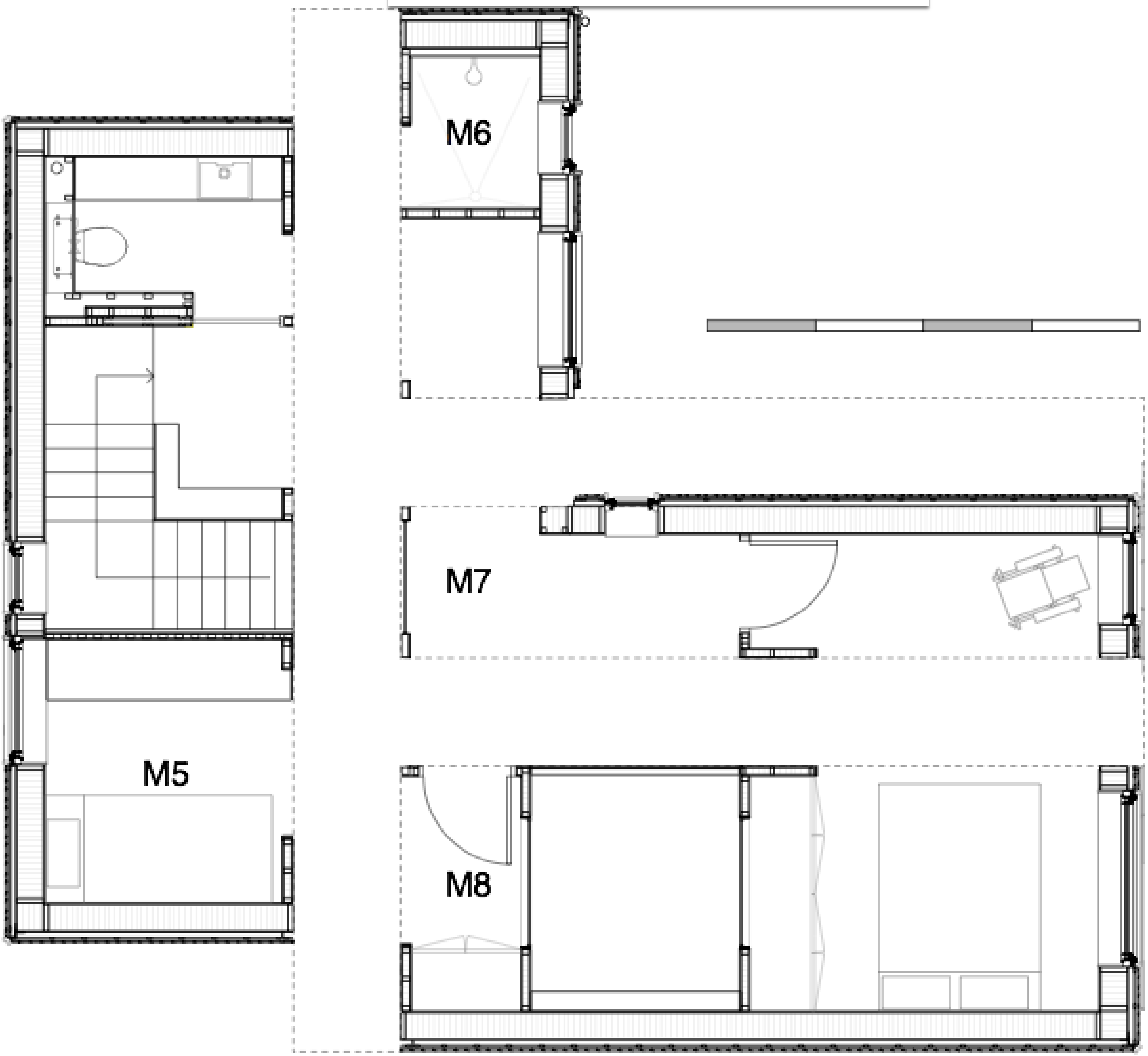



H.O.U.S.E

Wall U-Value 0.1 W/m2K


HIRE
411778
isover

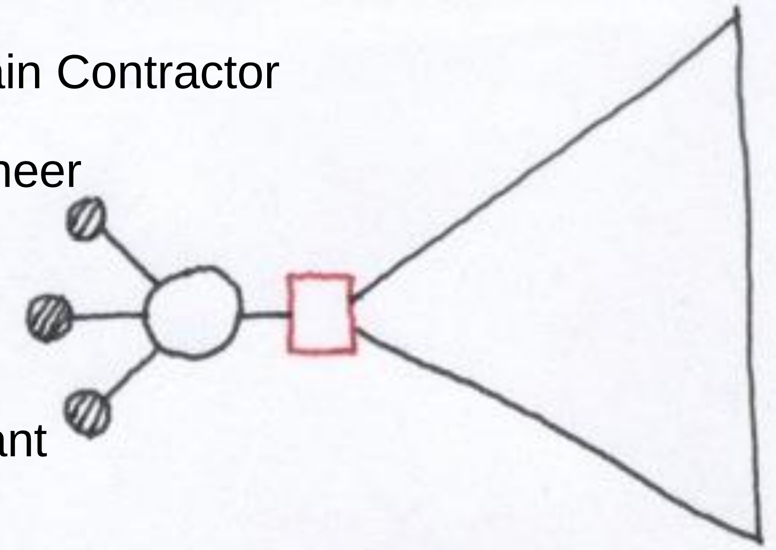

M2
M3
M1
M4


M6
M7
M5
M8

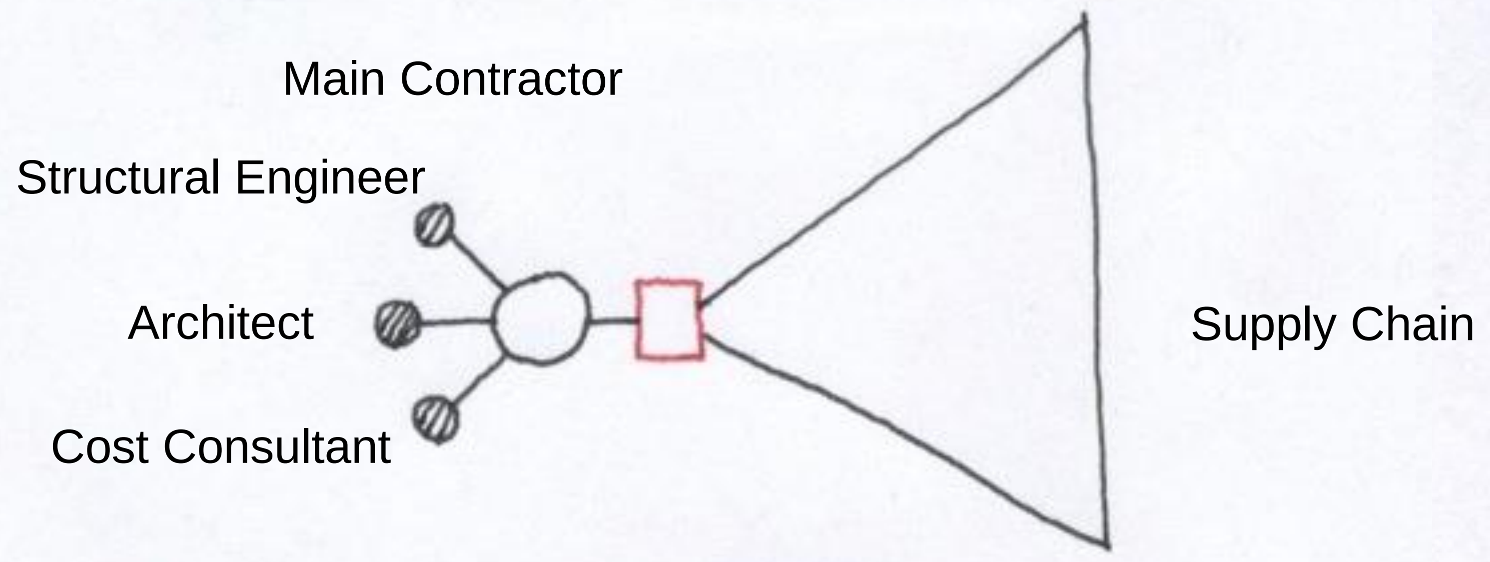
Fabrication 8 Weeks, Assembly 4 Days


ESPRESSO

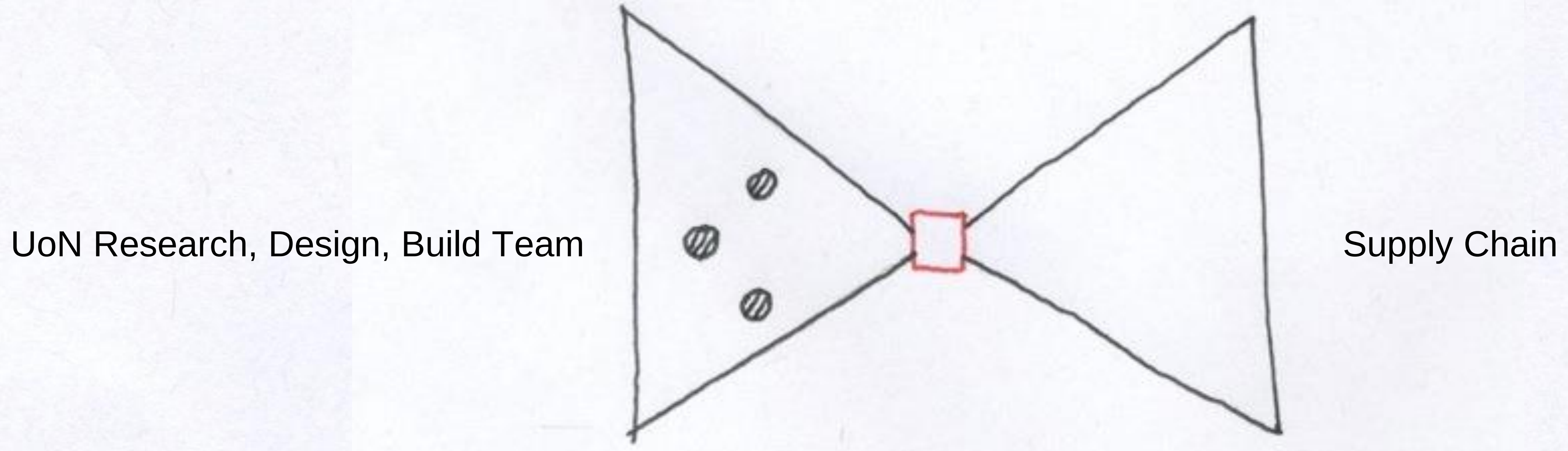

Toilets



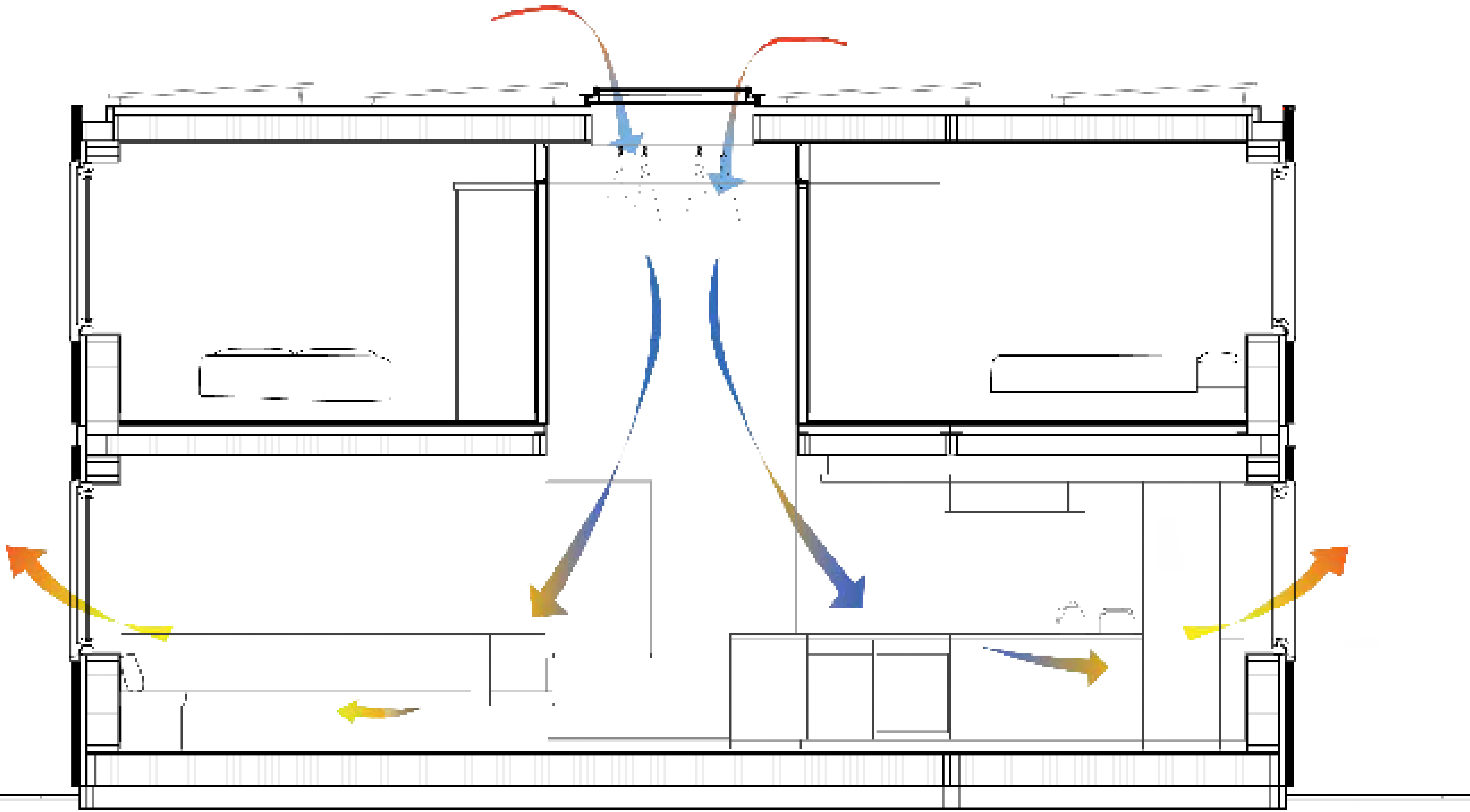
Conventional Construction Contract



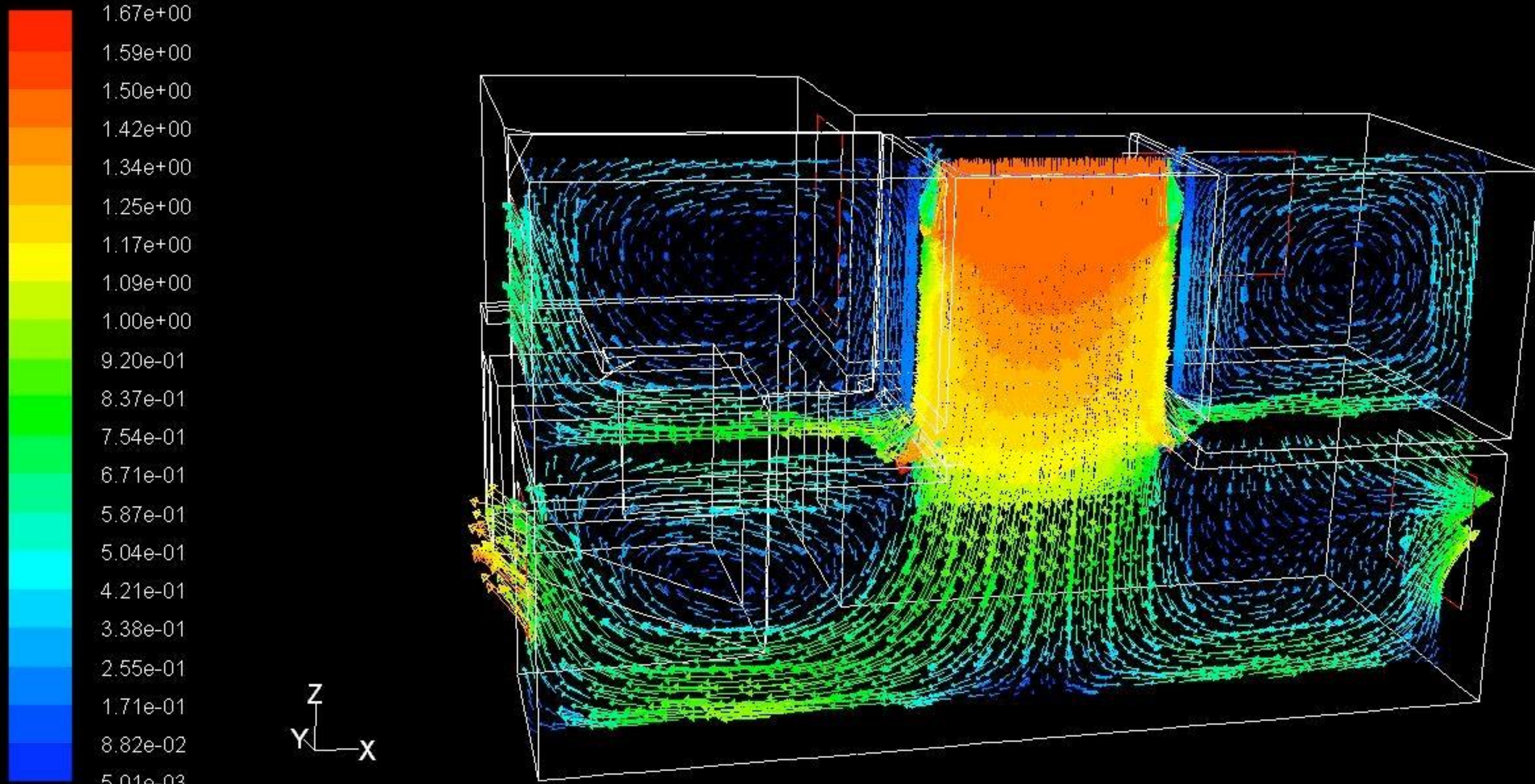
Conventional Construction Contract



Nottingham House ‘Partnering Contract’

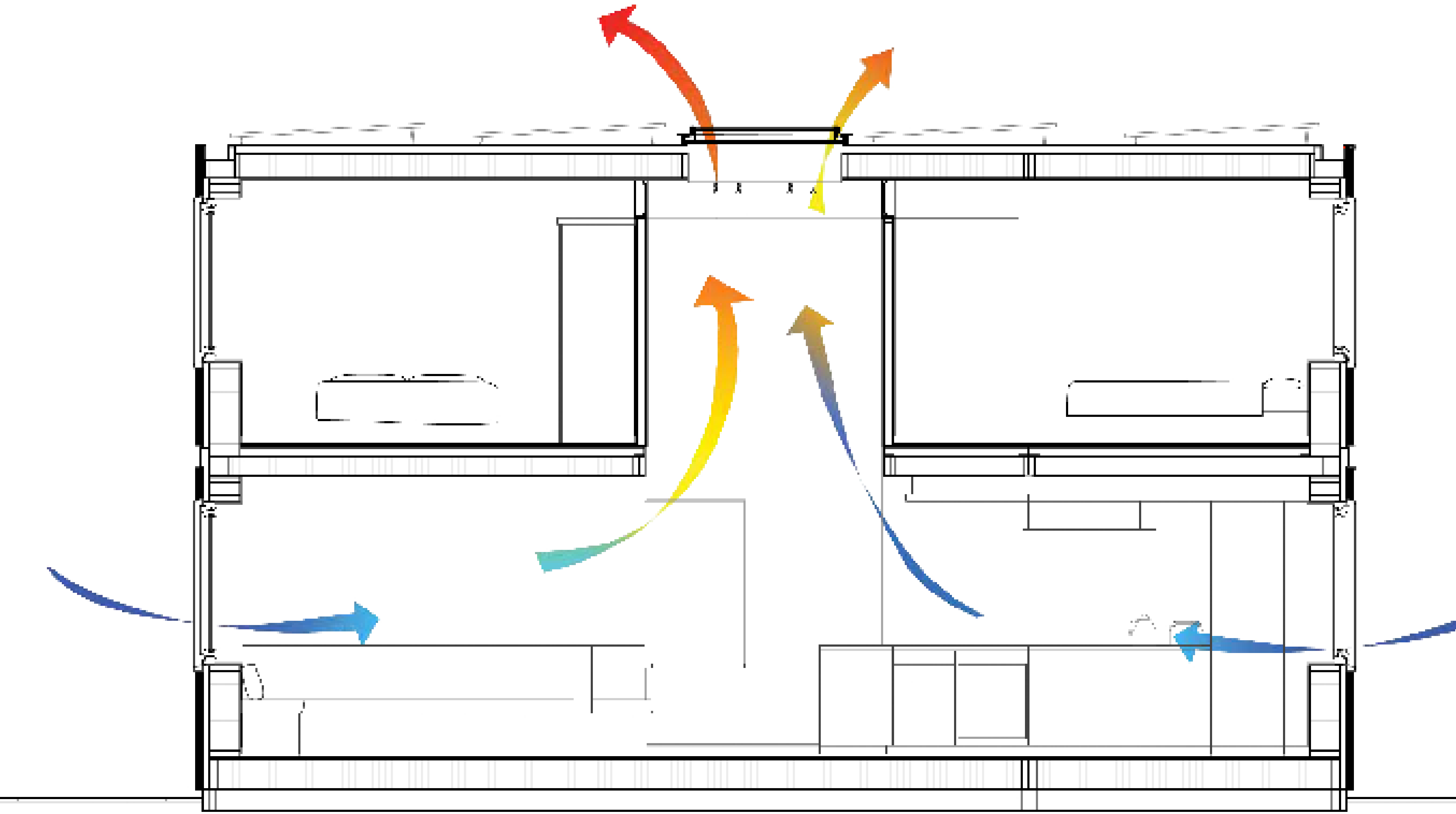



Nottingham House: Section showing night time air flow path in Madrid

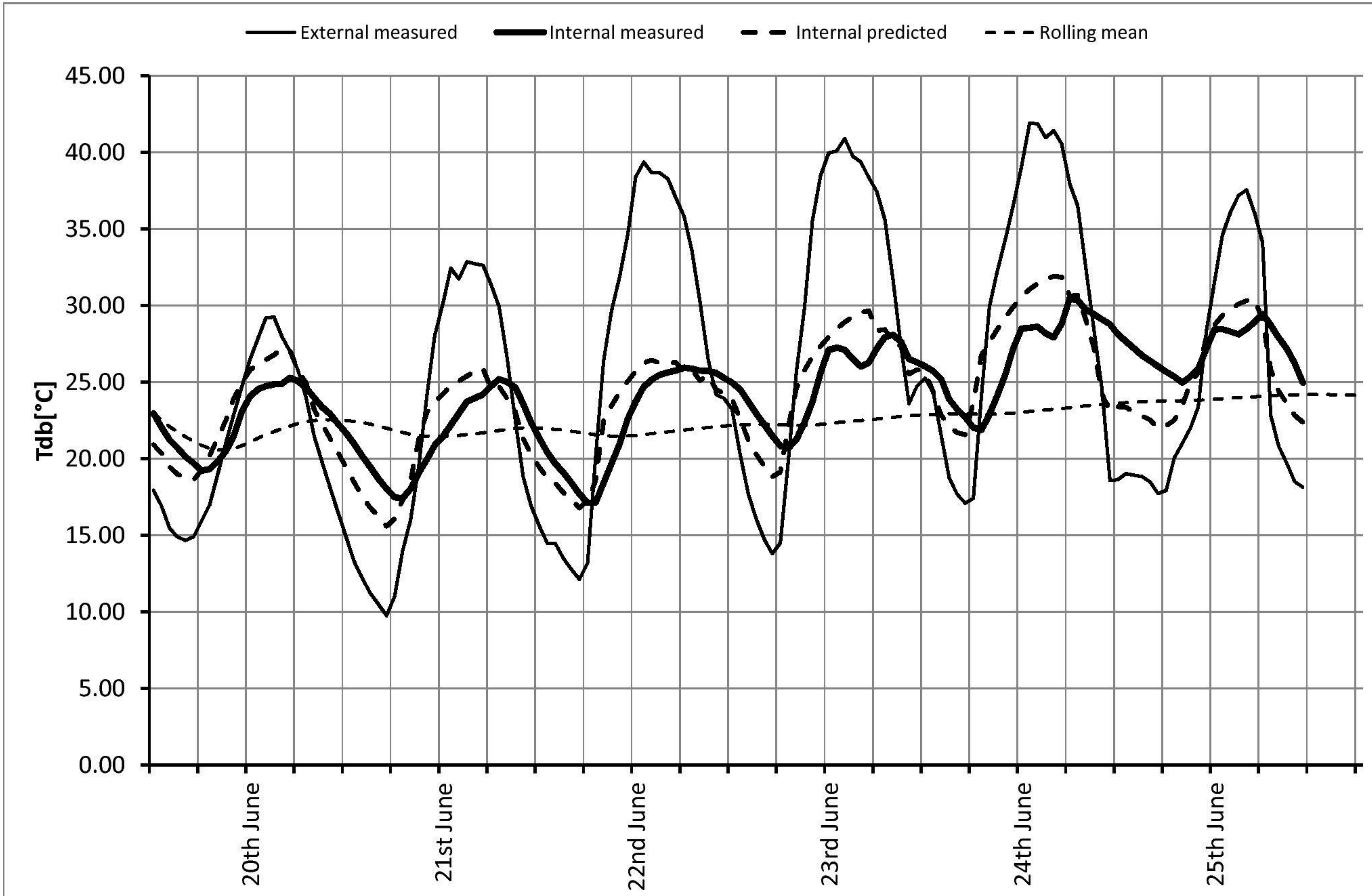


Velocity Vectors Colored By Velocity Magnitude (m/s)

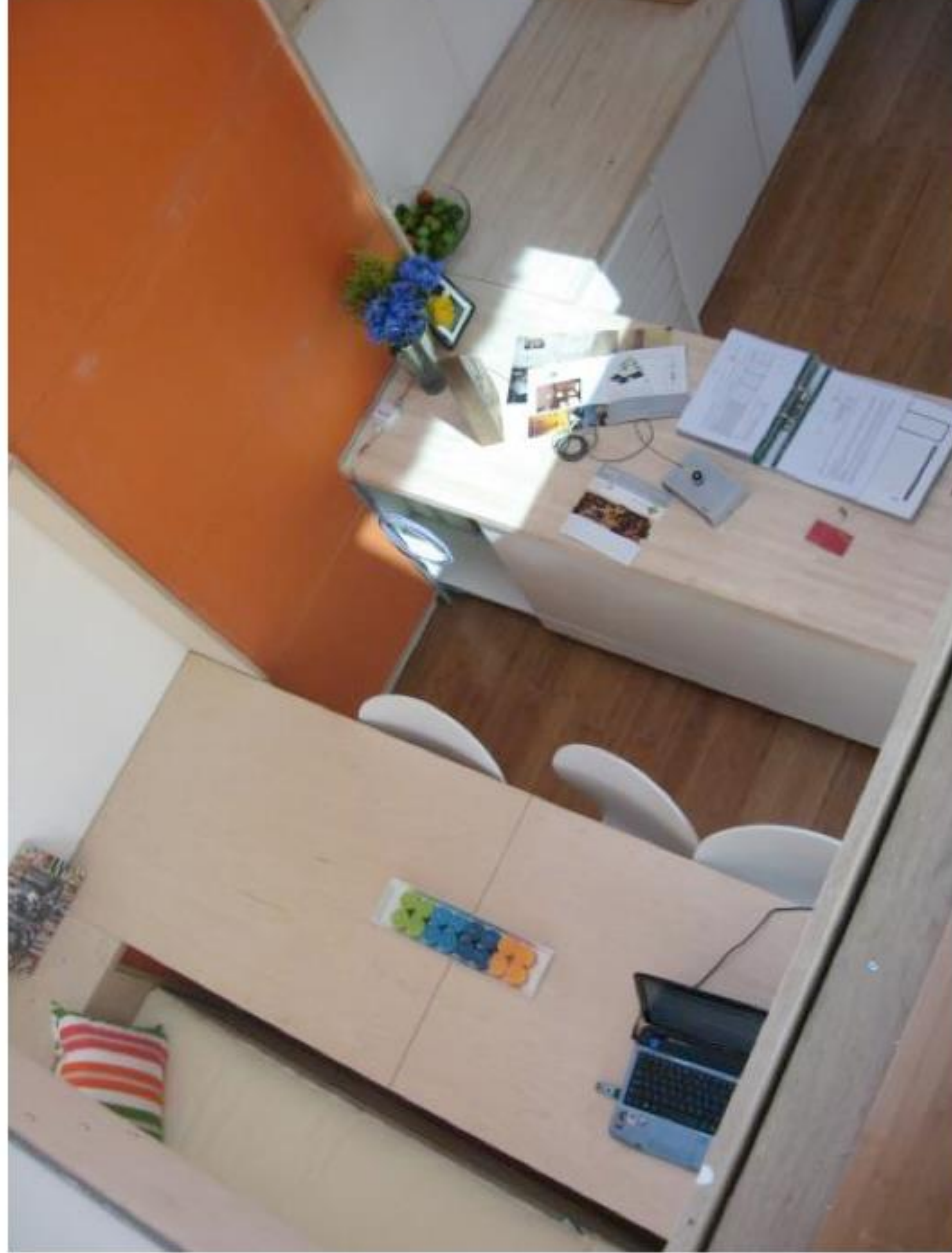
Oct 06, 2009
FLUENT 6.3 (3d, dp, pbns, spe, rke)

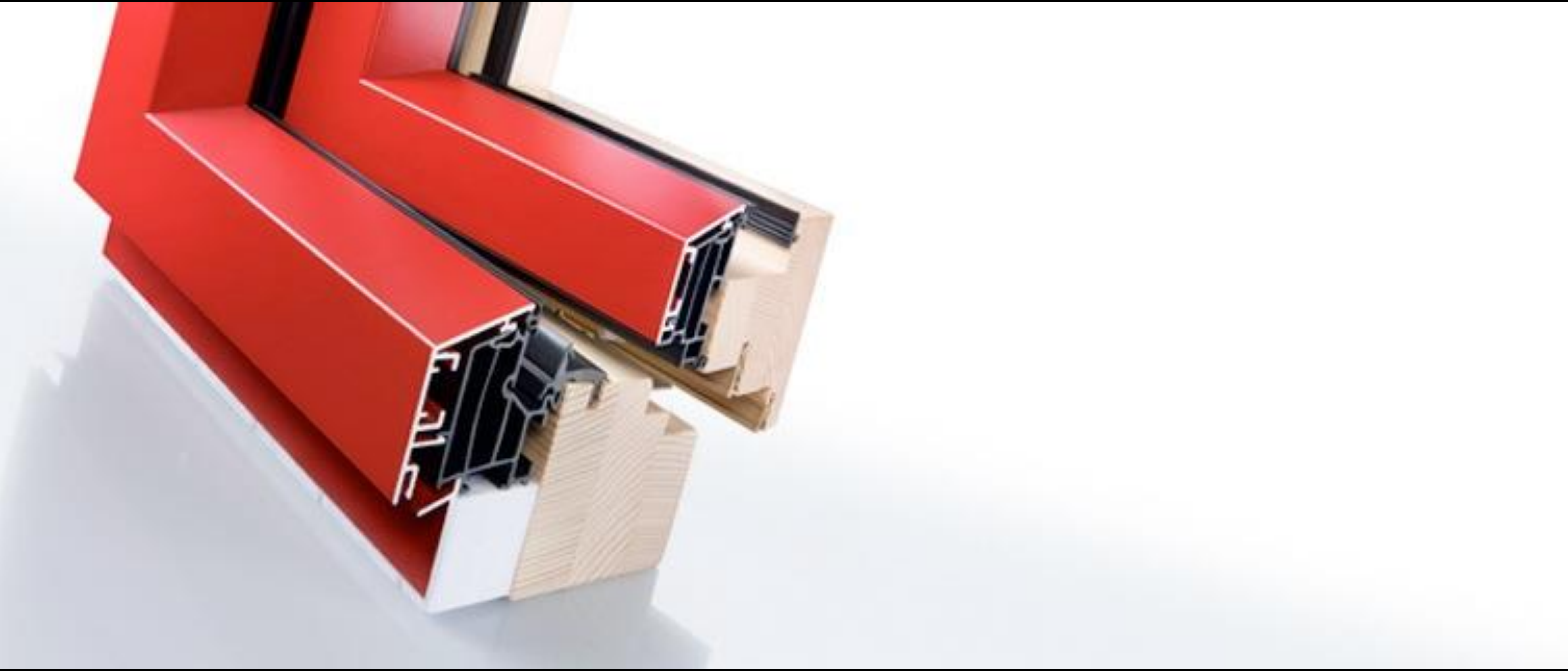


Nottingham House: Section showing night time air flow path, Madrid



External measured
Internal measured
Internal predicted
Rolling mean
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Tdb[°C]
20th June
21st June
22nd June
23rd June
24th June
25th June





Tripple Glazed Aluminium Timber Windows: U-Value 0.5 W/m2K

“I think the Nottingham House is priceless.   It is a demonstration of new ideas and how they can be put into practice...in the long term we need to build to this standard, across the board”

John Healey MP, Housing Minister at Ecobuild 2010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Attitudes to sustainable technology

Autonomy and presupposition

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