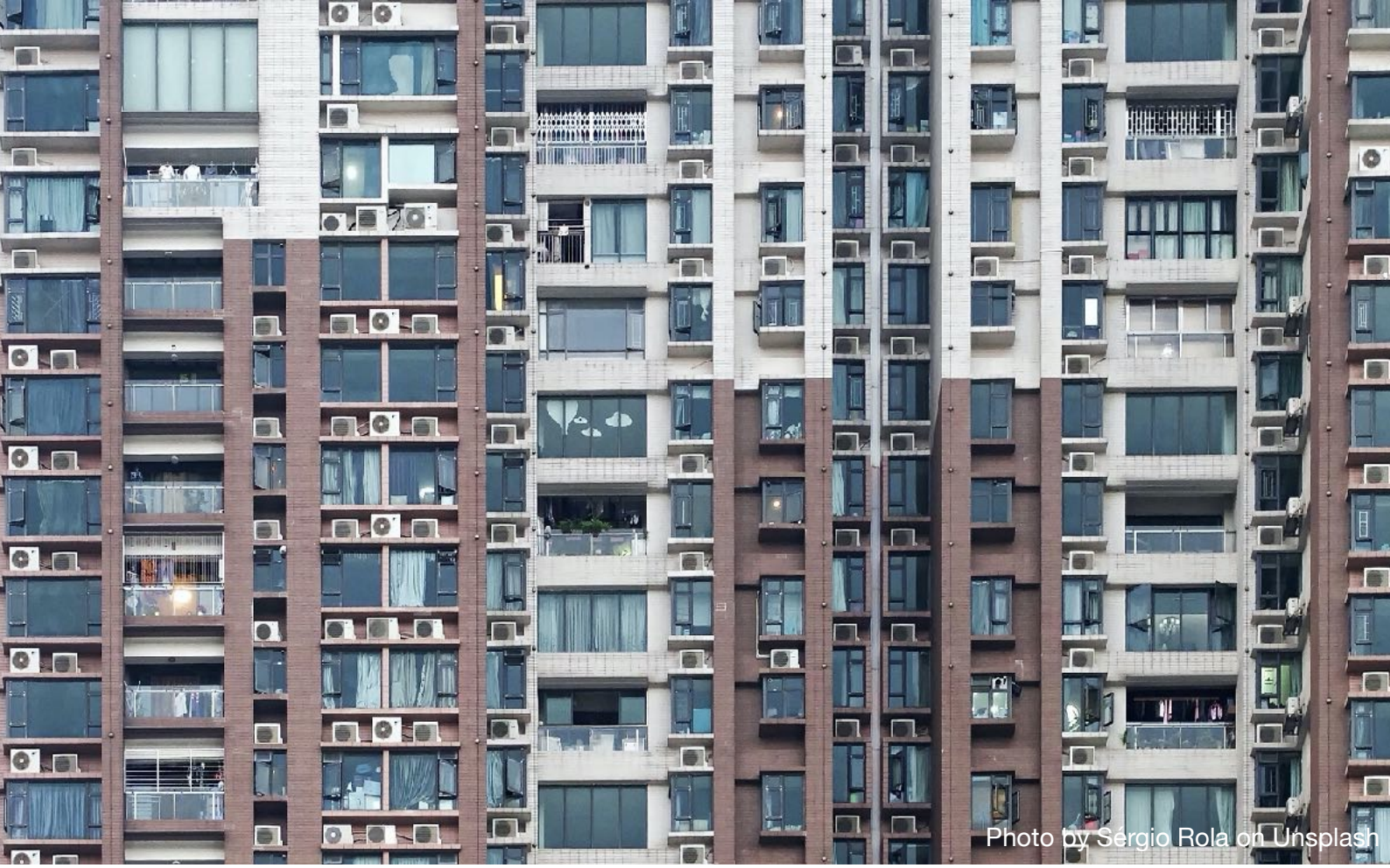


Housing.

The Next Generation.

Centre Name	East Kent College Folkestone
Centre Number	
Candidate Name	Samuel Hutchings
Candidate Number	
Pathway	Design and Problem Solving

Table of Contents

Initial Research
The Size of UK Houses 4
The Cost of UK Houses 4
Typical Occupancy 5
Satisfaction with UK Houses 5
Parker Morris Committee 6
Typical Plot Size 6
Bringing It All Together
Product Parameters 7
Initial Designs and Sketches
The Z-House 8
Isometric Buildings 10
Developing Ideas
Z-House 11
Z-House 420 - Average Plot Size 11
Z-House 125 - 125 square metres house 12
Z-House 80 - 80 square metres. 13
Scaling the Z-House 15
Building the Z-House 15
Furnishing the Z-House 15
Z-House Technology 16
Environmental Impact 16
Modelling the Z-House
Research Activity: Material Finishes 19
Results 19
Choice of Ground Floor Finish 19
Choice of First Floor Finish 19
Combination Choices 20
Workshop 21
Building A Bigger Z-House 21
Construction Process 22
Construction Plan 22
Required Materials 22

Acquiring Materials 24
The Building Process 24
Accompanying Material 27
Evaluation
Similar Solutions 31
The Mountain, Bjarke Ingles 31
LEGO 31
Areas of Improvement 32
Looking to the Future 33
Appendix 1: Bibliography 34
Appendix 2: Z-House Configurator Results 36
Appendix 3: Problem Log 37
Appendix 4: Budget 38

The goal of this project is to better understand the UK's housing situation and develop a range of ideas and solutions to the current problems in the market. My aim is for the main outcome of the project to be a new design of house, with supporting ideas and services to help those who are in areas where new houses are not being built or where a new build may be prohibitively expensive.

Initial Research

Before I can propose ideas and solutions around the UK's housing crisis, I need to better understand the current situation and proposed solutions in the market. This will be done through primary and secondary research online, from books, and from conversations with people in the community.

This research will focus on the current size, price and availability of housing in the UK, as well as the expectations people have when looking to buy a new house around size, cost, rooms, etc.

The Size of UK Houses

Research undertaken by Find Me A Floor (n.d.) found the average UK house size was 71.2 square metres, which appears small compared to 92.7 square metres in Germany and 150 square metres in Canada. Interestingly, the average floor space in Hong Kong is just 31.9 square metres, making UK houses look huge in comparison.

This is also smaller than the 91.2 square metres average total useable floor area found in the 2008 English Housing Survey conducted by Department for Communities and Local Government and the Office for National Statistics (2010).

This potentially shows that the average house size in the UK is decreasing over time as new housing stock is built and made available to the market.

According to the Royal Institute of British Architects (Roberts-Hughes, 2011, pp. 4-5), "A lack of space has been shown to impact on the basic lifestyle needs that many people take for granted, such as having enough space to store possessions or even to entertain friends. In more extreme cases, lack of adequate space for a household has also been shown to have significant impacts on health, educational attainment and family relationships."

Their research found that the typical one bedroom home in the UK was 4 square metres short of the recommended minimum size for a single storey, one bedroom home for two residents. And that the average three bedroom house is 8 square metres short of the recommended minimum. This is the equivalent to the floor area of a single bedroom.

The Cost of UK Houses

In 1995, the average worker would expect to pay 3.6 times their yearly earnings to buy their first house. In 2016, this rose to 7.6 times (Office for National Statistics, 2017a). This is because, between 1995 and 2016, the average house price increased by 259%, whilst average individual earnings rose by 68%.

According to the UK Land Registry, the average price of a property in the United Kingdom in January 1995 was £55,437. By December 2016, this average had increased to £215,500. This is an increase of 288%.

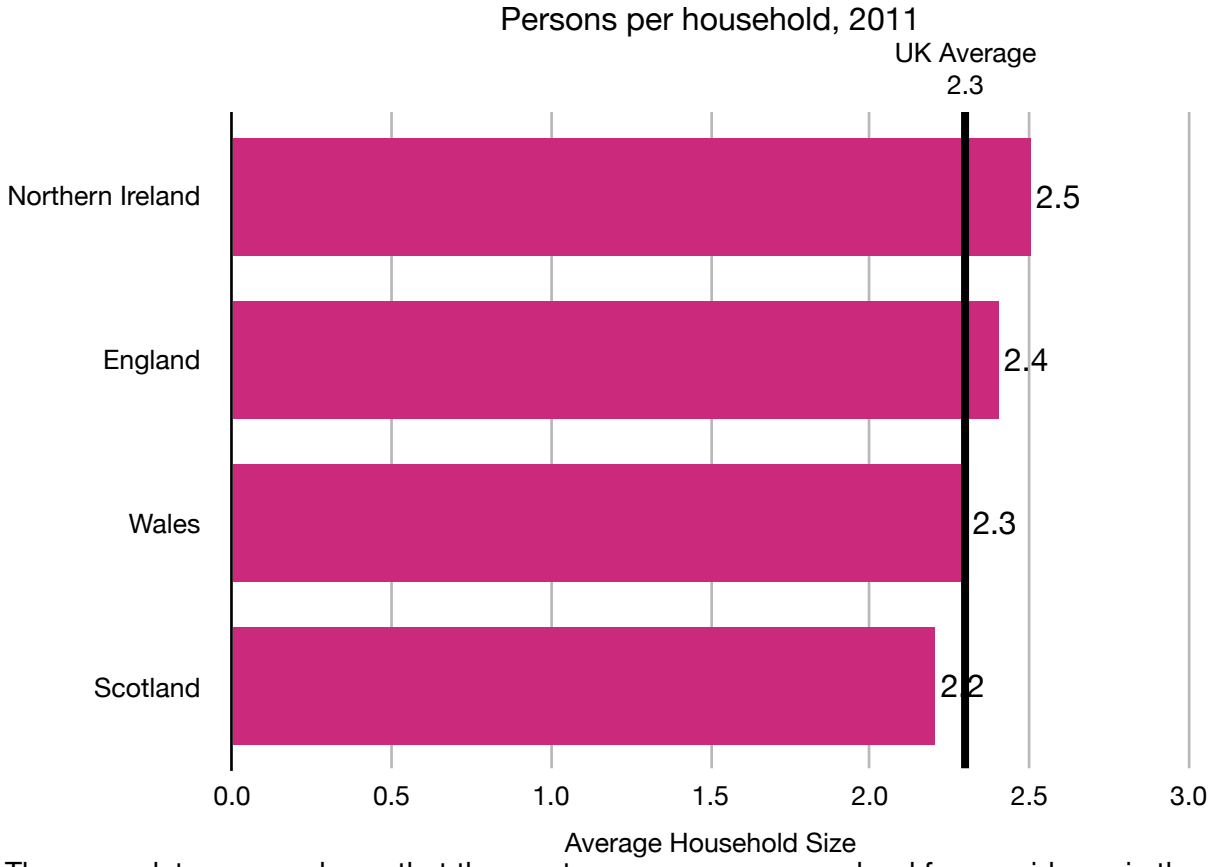
In the same time, the average UK salary has increased from £387.50 per week in 1996 (Office for National Statistics, 2017b) to £497 in 2016 (Office for National Statistics, 2018). This is an increase of 28%, a tenth of the increase in the average price of a house in the UK.

At the time of writing, the newest data available is for February 2018, when the average UK property price was £225,047. A further 4% increase on the 2016 average.

Using information from the Office for National Statistics and the Official Data Compendium (2018), it's possible to calculate the inflation-adjusted price for a house in 2016 if it had kept the same value it had in 1995. Using this information, a house valued at £55,437 in 1995 would have an interest-adjusted price of £87,767.80 in 2026, an increase of £42,330.80. Compare this to the actual value increase of just over £160,000, and you can see that house prices have increased well about the UK's inflation rate for the last 20+ years.

Typical Occupancy

According to the 2011 Census (Office for National Statistics, 2013), the average number of people per house in the UK is 2.3, with Wales and Scotland falling on or below the average, and England and Northern Ireland falling just above the average.



The same data source shows that the most common occupancy level for a residency in the United Kingdom is two occupants, with 9.0 million households (or 34% of the sample size of 26.4 million houses) having two occupants. One person households followed closely behind, with 8.1 million households in the UK having solo occupancy.

This means that the majority of UK houses are occupied by 2 or fewer people. With "only" 9.3 million of the UK's 26.4 million homes being occupied by 3 or more people.

Satisfaction with UK Houses

In its 2009 research and subsequent white paper (Drury, 2009), the Design Council looked at resident satisfaction with space in the home for 11,000 newly-built and publicly-funded households in London and the South-East.

In this passage from page 21 of the report, the Design Council's CABE team concludes that, overall, residents are:

- *'Neutral' to 'Very Satisfied' that there is enough circulation space in the home;*
- *Mostly 'Neutral' to 'Satisfied' that there is sufficient space to entertain guests;*
- *'Neutral' to 'Satisfied' about the location of the storage space provided;*

- *Mostly ‘Neutral’ to ‘Satisfied’ about the way the space in the home has been designed and*
- *laid out*
- *‘Dissatisfied’, ‘Neutral’ or ‘Satisfied’ that there is enough space in the home for privacy;*
- *‘Dissatisfied’ to ‘Neutral’ about the amount of space in the home for the furniture, or enough space for more than one furniture layout;*
- *‘Dissatisfied’ to ‘Neutral’ about the amount of storage space provided;*
- *Mostly ‘Very Dissatisfied’ or ‘Dissatisfied’ with the space in the kitchen;*

They specifically mention that the main areas that current residents were dissatisfied with were space in the kitchen — specifically when needing to supervise small children whilst cooking or when it comes to the storage of recycling and other bins — and with the amount of storage space available for their possessions and furniture, especially when this effected their choice of furniture and its layout.

The report also mentions that whilst the survey does look at the specific areas where residents are less than satisfied with their current arrangement, it does not identify specific improvements that could improve resident satisfaction, and that further research would need to be undertaken to understand potential solutions.

It can be seen from the results of the report that people are mostly dissatisfied with the space in their homes for privacy, furniture, storage, and for their kitchen. When designing a solution for the UK housing market, these will be key considerations in the process.

The report also mentions that the last substantial research into housing standards and how they affect resident satisfaction was the 1961 Parker Morris Committee.

Parker Morris Committee

The 1961 Parker Morris Committee (Wikipedia, 2017) drew up *Homes for Today and Tomorrow,* a report into housing space standards for publicly owned and built housing. It recommended the following, concerning the space of a house:

- A net floor area of 72 square metres for a semi-detached or end-of-terrace house with 4 occupants.
- A minimum enclosed area of 2.3 cubic metres for the kitchen in a dwelling for three or more occupants.

The committee also recommends that a house with three of fewer bedrooms should be fitted with at least one flushing toilet, which can be in the bathroom, and that when it is -1°C outside, the kitchen should be kept at 13°C and the other living areas at 18°C.

The latest development of these standards is in the London Housing Guide (London Development Agency, 2010) commissioned by Boris Johnson, the Mayor Of London. In summary 4.0 of this document, it is stated that all developments should meet minimum space standards. For a single storey dwelling housing 2 people, the minimum internal floor area is 50 square metres. For a two storey dwelling, this increases to 83 square metres.

When designing a single or two storey building as the outcome of this project, these minimums will be taken into consideration and will look to be surpassed.

Typical Plot Size

When looking to design a new kind of housing, understanding the amount of land typically available to you is vitally important — so that you can design a building that will be appropriate for the majority of cases. Unfortunately, typical plot areas for houses in the UK is information that has proven hard to find and verify.

The only source of information I was able to find was on www.ukselfbuild.com (2007), which states "the average 4-bed estate house is built on approximately 1/12 - 1/10 acre [about 38ft x 95ft, or 11.5 m x 29 m].” This results in a plot size of 333.5 square metres.

Investigation into typical plots in local Kentish towns, using the Google Earth application, found plot sizes of between 125 square metres and 500 square metres depending on location. Due to the satellite nature of Google Earth, it was not possible to find out the internal configuration of these properties and the houses within them.

Bringing It All Together

Now that my initial exploration into the current state of the UK housing market is complete, it's time to bring it all together into some initial insights and ideas that can inform my idea development and design work going forward.

The average UK house has an internal floor area of 71.2 square metres on a plot size of around 333.5 square metres. Though, this plot size could be as low as 125 square metres. It is typically occupied by one or two people, who are unsatisfied with the space available to them for piracy, their furniture, and for their kitchen. The occupants would have likely paid an average price of £225,000 for their property, about 7.6 times the average salary.

By combining my contextual research on the social aspects of the UK's housing market with my research into modernist and postmodernist design (see: "Understanding Context" document), I now understand the complex nature of this problem. I also understand the history and context around these areas of design, and how they play a role in influencing my designs.

To articulate this differently, my intention is to use a Modernist approach, meaning developing an efficient, minimalist and replicable design for a modern house - one that provides a comfortable living space in a more efficient footprint - combined with a postmodern approach giving the owner/occupier input on the design of their house, giving them ownership and a feeling of belonging.

As a Designer, my aim is to create solutions that add more to their environment than they take away. In the context of a building, this aim becomes quite literal, with the aim being to create a final design that is responsibly sourced, minimises its energy use through its lifetime, and is able to contribute back to the environment once it's one.

To accomplish this, I will be looking at breakthrough technologies and ancient techniques to understand the ways in which a low impact building can be built, whilst maximising the quality of life for those who live in and around it.

This doesn't mean that this will be a "hippy home" powered by a wood-lit agar and lit by candles. This will be a modern housing solution, using technology where it adds to the experience, and stepping back in time to use ancient techniques when they make the most sense.

When all of this information is brought together, it generates a list of parameters against which the final project can be compared and evaluated.

Product Parameters

Based on my initial research and my own aims for this project, I now have the following list of parameters for the product of this unit.

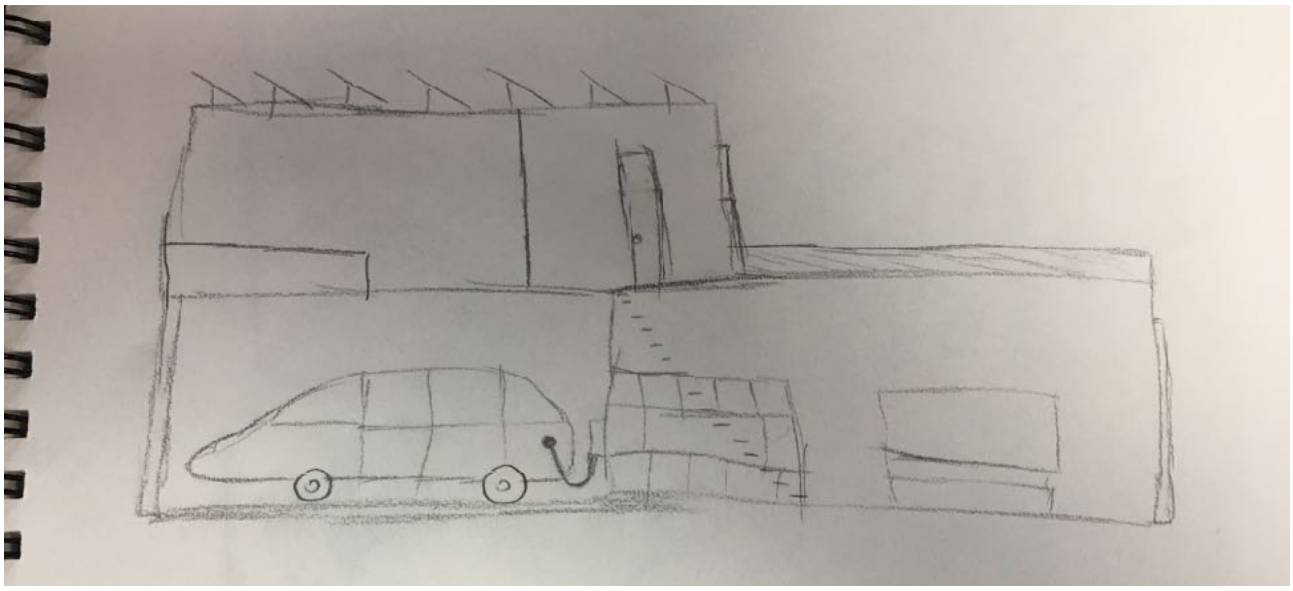
1. The final product will be a design for a residential building.
2. The internal floor area of the building must exceed 80 square metres.
3. The building must fit on a plot size as small as 125 square metres.
4. Able to scale up to the average plot size (333.5 square metres.)
5. The building must offer a comfortable lifestyle for 1 or 2 occupants.
6. Internal space must be flexible, allowing for privacy and dedicated cooking space.
7. The building should aim to be priced around 5x the average salary.
8. The building must add more to its environment than it takes away.

Initial Designs and Sketches

The subject of this unit has been on my mind for a long time. From before I even started the Art and Creative Design course. In early ideas and sketches, I called it the "Z-House" due to the shape my early sketches and ideas took. These initial designs and sketches were informed by my own experiences with and opinions of housing, but were not always informed by the research I've shown above.

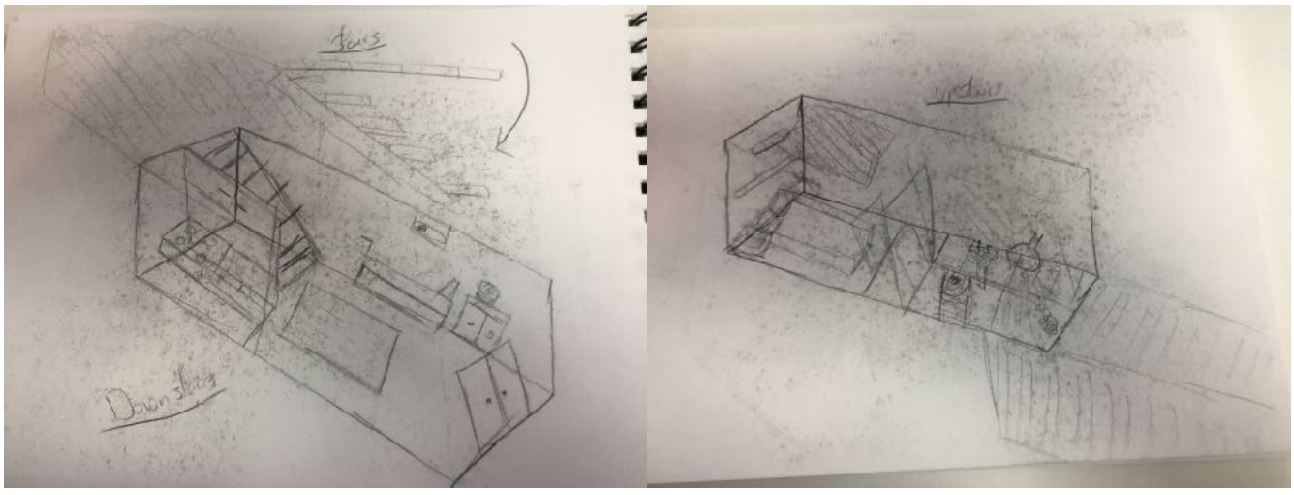
I present these initial designs and sketches the show the roots of this project, before the design was iterated upon based on the information I've been able to bring together.

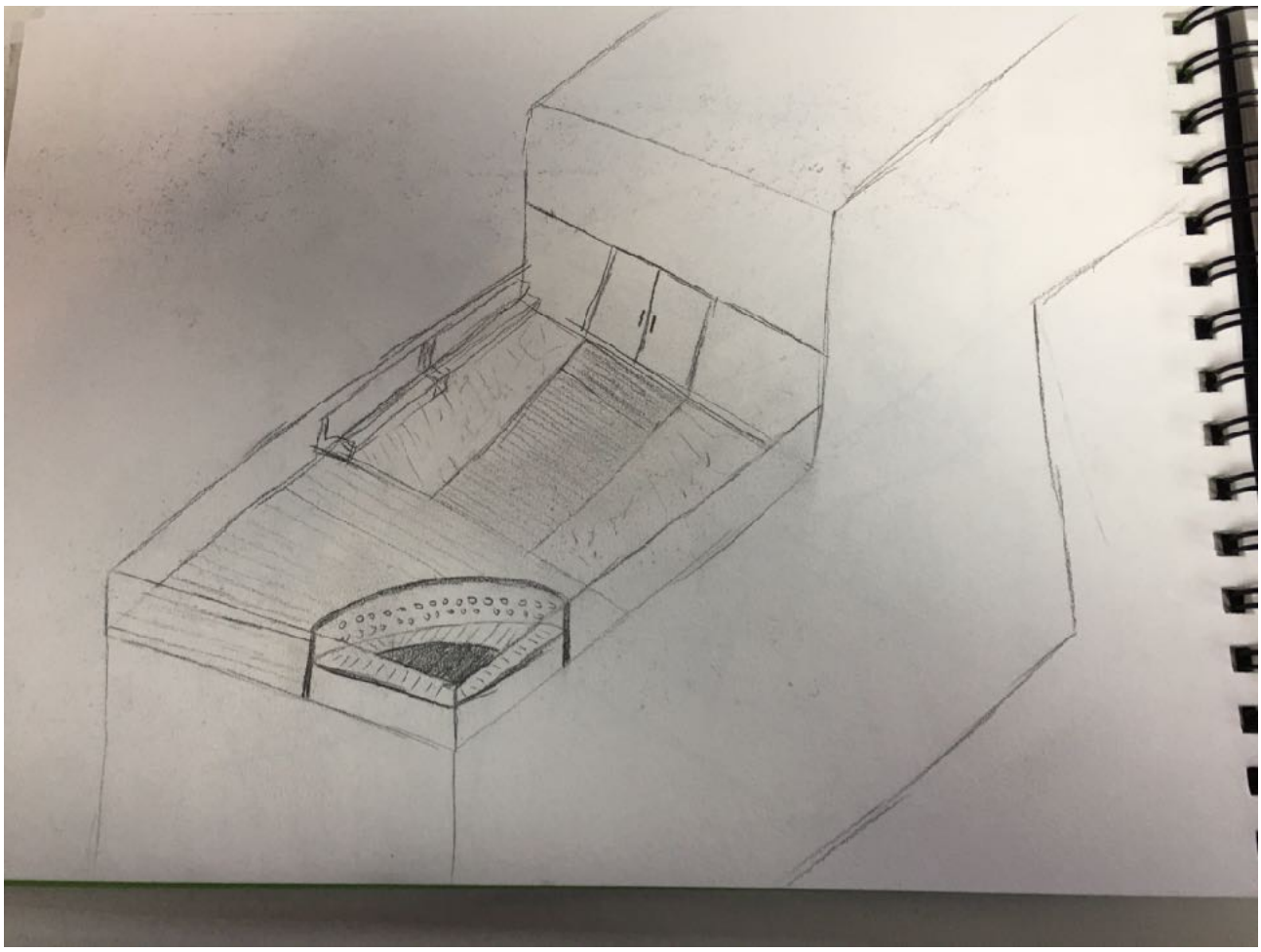
The Z-House



This initial sketch shows the original forms and features of the "Z-House". The idea behind these sketches was, as with this project, to create a type of housing that maximised the use of land whilst also giving a modern feel and look to the building.

Environmentally conscious decisions were made even in these early stages, with solar panels on the roof offering power for the building, as well as charging facilities for an electric vehicle in the covered driveway.

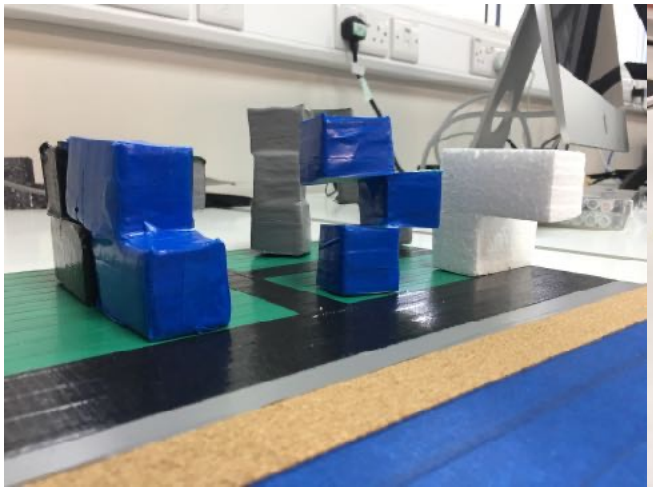


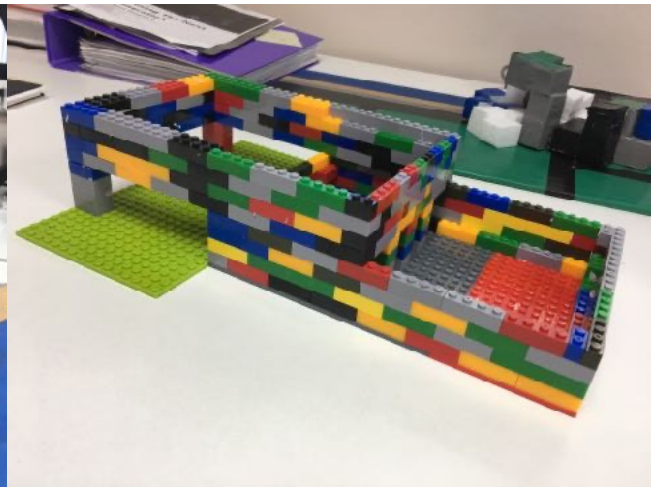


The above sketches show a development of this initial idea to add detail to the interior features of the building. At this stage, the scale of the ultimate building was mostly unknown, so the usage of internal space is not indicative of a true building of this style.

Early versions of the exterior of the building focussed on it as a luxury house idea, perhaps one for me to make for myself in the future, so the elevated garden — located on the roof of the ground floor section of the building, includes such features as decking and a jacuzzi.

Later developments of this idea saw physical sketches made of expanded styrofoam and toy construction blocks, so as to help visualise better the physical space within the concept, as well as model the interactions between multiple buildings. A level of modularity was added with the

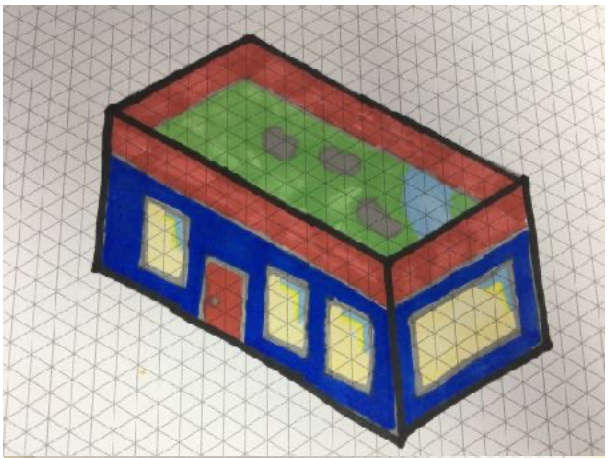




styrofoam prototypes, testing how multiple Z-Houses would fit together into a block, a tower, or more.

Isometric Buildings

After working on the sketches and prototypes for the Z-House, I developed a couple of other designs for "Isometric Buildings," based on the idea of houses that would use minimal forms but offer innovative solutions to inner-city and suburban living.



This simple house (left, top) offers a one-floor solution for suburban living, ideal for someone living on their own or a couple. The roof, instead of being tiled, offers an inner-city haven to the occupants, with a garden and water feature.

Whilst a design such as this does not score well against the parameters of this project, it does show how ideas have developed and how different approaches can be developed and looked into when working out the solution to a problem. A process I will continue in this project.

After this project, I worked on a more interesting design concept, using copper and glass as the main materials, and continuing some of the themes from the Z-House of using non-traditional divides and levelling to create an innovative design. This time, placing the building on an earth mound, so that the driveway can be hidden under the vehicle.

In this design, glass offers and open and bright living area, whilst copper conceals the more private parts of the home, whilst also developing a unique and evolving patina as the building ages and the elements take their tole.

Developing Ideas

My initial sketches and previous work look at the problem from a variety of angles, but they were drawn up before I did considered and deeper research into the current state of the UK market and what people are looking for. It is, therefore, important to develop these ideas to create a more optimal solutions that works within the parameters of the project.

As a reminder, these parameters are:

1. The final product will be a design for a residential building.
2. The internal floor area of the building must exceed 80 square metres.
3. The building must fit on a plot size as small as 125 square metres.
4. Able to scale up to the average plot size (333.5 square metres.)
5. The building must offer a comfortable lifestyle for 1 or 2 occupants.
6. Internal space must be flexible, allowing for privacy and dedicated cooking space.
7. The building should aim to be priced around 5x the average salary.
8. The building must add more to its environment than it takes away.

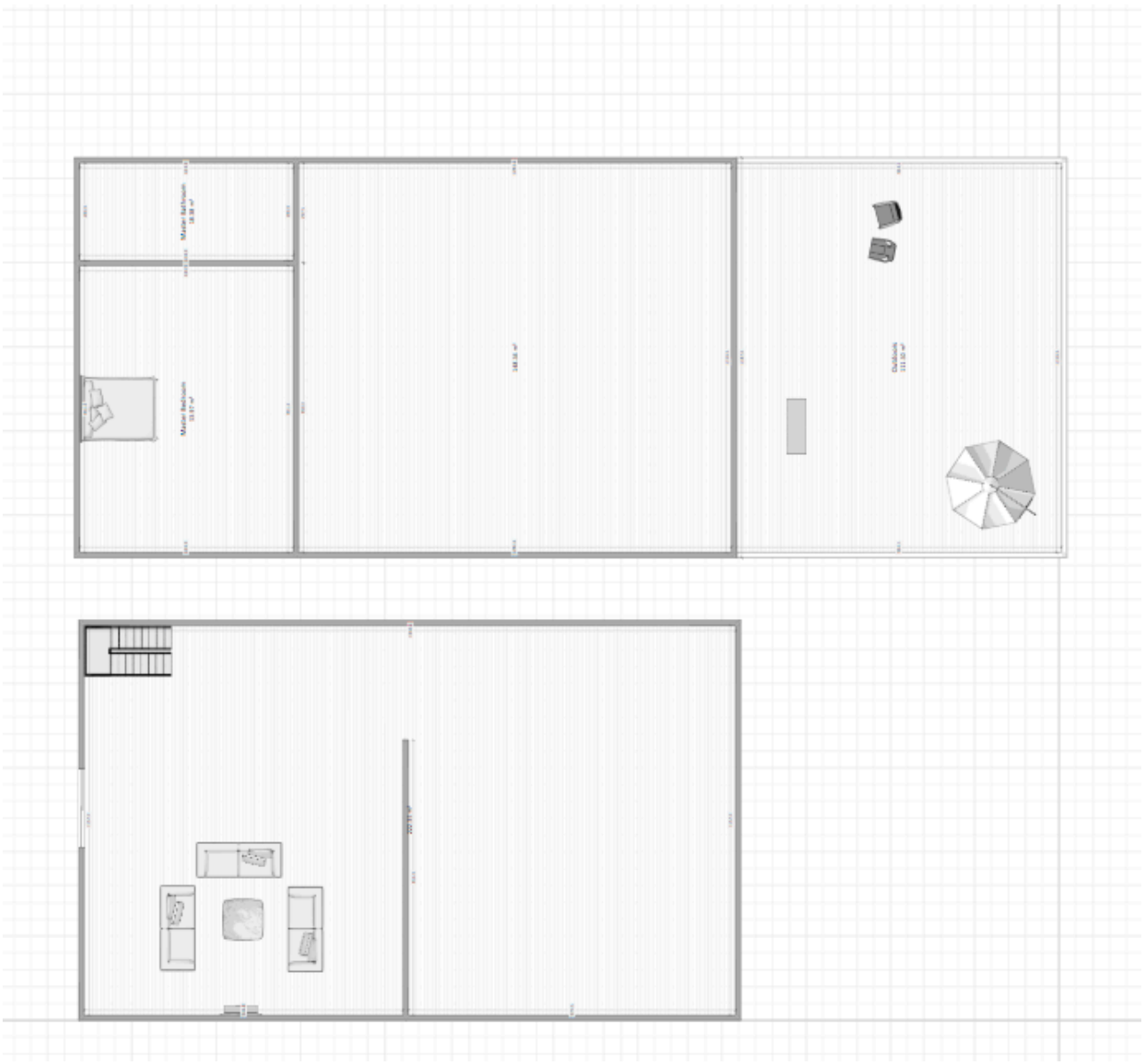
Z-House

As I am working on developing a building, it is important to experiment with various floor plans to see what space is possible within the given area (as little as 125 square metres [parameter 3]) to maximise the usable space for the residents [parameters 2 and 5].

With this in mind, I've designed floor plans for the Z-House based on both the smallest plot in my sample and the average plot in my sample, so as to see what works.

Z-House 420 - Average Plot Size

My initial floor plan is for the average UK plot size, which is 333.5 square metres based on outside dimensions of 11.5 m x 29 m.



It quickly became clear that a Z-House designed for this size plot would provide a lot of space for 1 or 2 occupants. Perhaps too much space, as furniture would be dwarfed by the space in which it is housed. The total internal floor area of the building is approximately 420 square metres, nearly 6 times the size of the 4-occupancy house size recommended by the Parker Morris Committee.

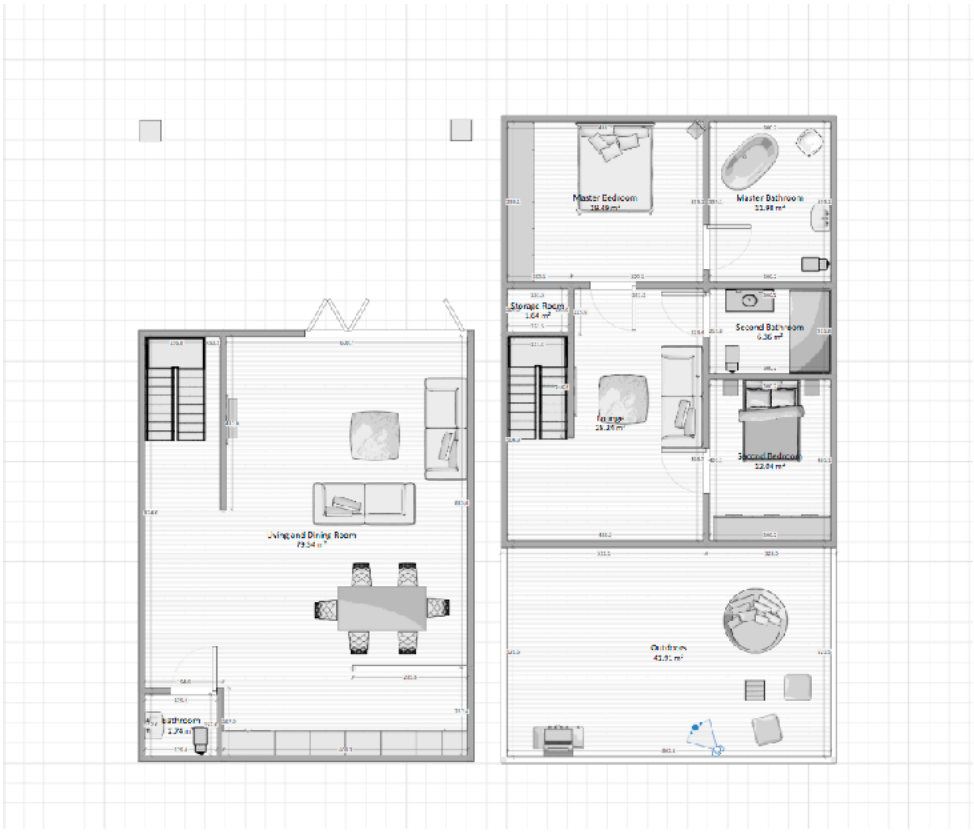
Whilst this house may create a great living environment for a large family or those looking for a lot of space, it doesn't fit within the criteria of creating a comfortable and affordable housing solution for the UK market.

Table 421

Parameter	Pass/Fail
The final product will be a design for a residential building.	✅
The internal floor area of the building must exceed 80 square metres.	✅
The building must fit on a plot size as small as 125 square metres.	❌
Able to scale up to the average plot size (333.5 square metres.)	✅
The building must offer a comfortable lifestyle for 1 or 2 occupants.	❌
Internal space must be flexible, allowing for privacy and dedicated cooking space.	✅
The building should aim to be priced around 5x the average salary.	?
The building must add more to its environment than it takes away.	?

Z-House 125 - 125 square metres house

Once it became clear that the average plot size created a Z-House that was overwhelmingly large for single or dual occupancy, I then went to the smallest plot size I was willing to consider - 125 square metres.



As can be seen from the above floor plan, the Z-House allows for a comfortably sized house to be built in a 125 square metres plot. This house provides a comfortable living space for 1-3 people, actually over delivering on the original parameters, allowing for a room to be provided for guest use, office space, or for a child. Or, if the house is being shared by two adults, two well-sized rooms each with their own bathroom.

The kitchen provides ample space for food preparation and cooking, with space for utilities such as a washer-dryer and dishwasher. It's connected directly to a spacious living and dining room, giving the ground floor an open-plan feel with plenty of room for configuring furniture.

A small upstairs storage room and downstairs bathroom complete the inside space.

Outside, a covered front driveway allows for the parking of vehicles — such as cars or bikes — as well as an ideal location for future technologies such as electric vehicle charging points or a home battery, such as a Tesla Powerwall.

This solution gives a total internal floor area of 170 square metres, twice the amount required by parameter 2 ("The internal floor area of the building must exceed 80 square metres,") as well as a total outside area of 80 square metres, split evenly between the front driveway and the upstairs garden. This gives a full utilisation of 250 square metres, doubling the usable space of the plot.

If scaling up this solution, the size and provision of inside rooms will increase with the size of the building. As the parameter here is just for the space to be adjustable, and not to have a full design of the average plot size house, I will not continue with development on this specific parameter for this idea.

Table 126

Parameter	Pass/Fail
The final product will be a design for a residential building.	✅
The internal floor area of the building must exceed 80 square metres.	✅
The building must fit on a plot size as small as 125 square metres.	✅
Able to scale up to the average plot size (333.5 square metres.)	✅
The building must offer a comfortable lifestyle for 1 or 2 occupants.	✅
Internal space must be flexible, allowing for privacy and dedicated cooking space.	✅
The building should aim to be priced around 5x the average salary.	?
The building must add more to its environment than it takes away.	?

Z-House 80 - 80 square metres.

Whilst Z-House 125 provides adequate space for 2 people to live in on a reasonably small plot of land, I wanted to take it to the small "extreme" of the size, and create a Z-House designed to give 80 square metres. of internal floor area, using the 1:2 scaling I've been using in the past. By doing this, I can work backwards and define what size plot would be required to build a Z-House with an 80 square metres. internal floor area.

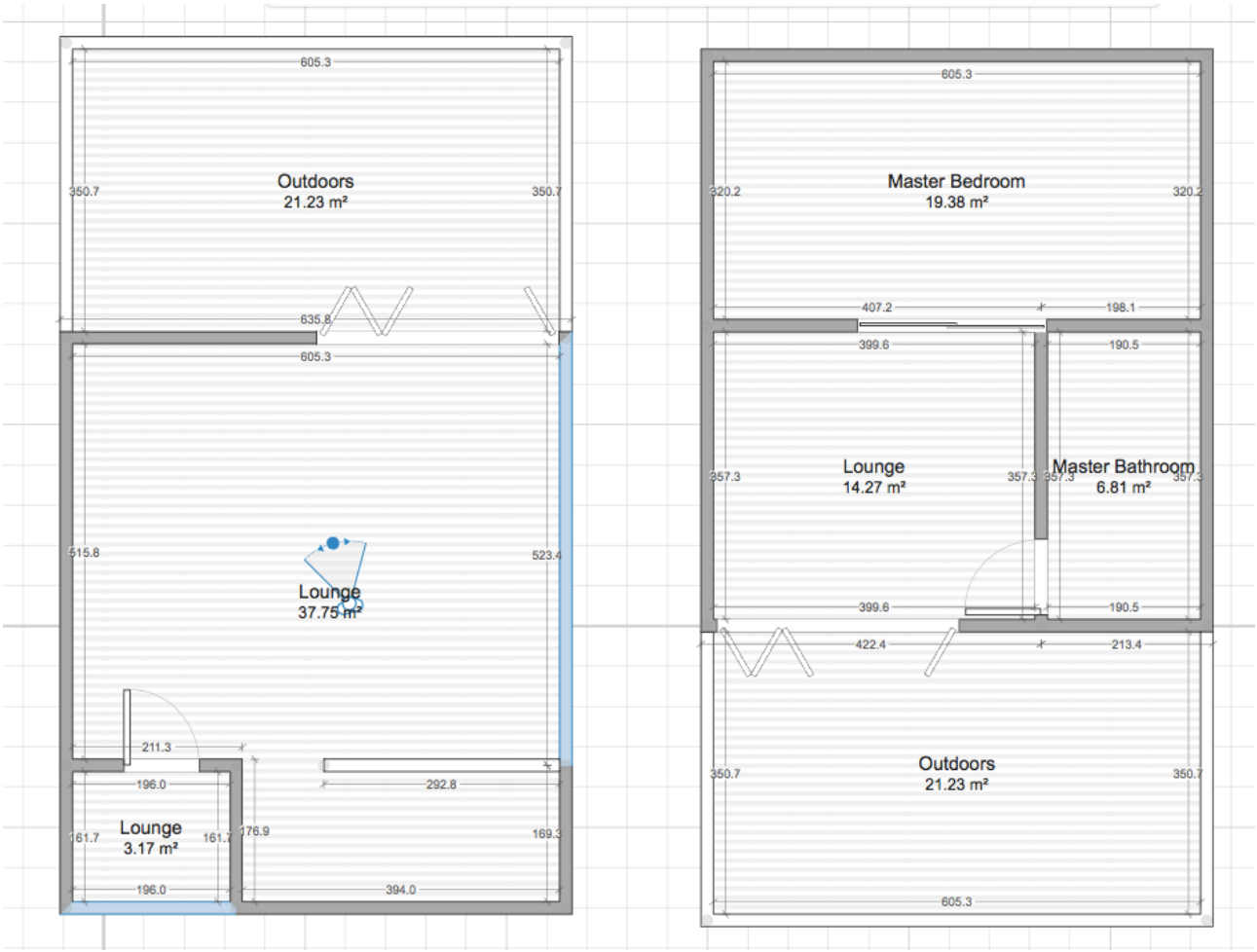


Table 81

Parameter	Pass/Fail
The final product will be a design for a residential building.	✅
The internal floor area of the building must exceed 80 square metres.	✅
The building must fit on a plot size as small as 125 square metres.	✅
Able to scale up to the average plot size (333.5 square metres.)	✅
The building must offer a comfortable lifestyle for 1 or 2 occupants.	✅
Internal space must be flexible, allowing for privacy and dedicated cooking space.	?
The building should aim to be priced around 5x the average salary.	?
The building must add more to its environment than it takes away.	?

Z-House 80 provides a total usable internal area of approximately 80 square metres, in a house that contains a kitchen, lounge, downstairs bathroom, upstairs bathroom, upstairs lounge, and a well-sized master bedroom. It also provides 42 square metres. of external space, split evenly between the upstairs garden and the covered driveway.

It provides all of this in a footprint of just 69 square metres - 6.35 m by 10.89 m. If you compare this to the footprint of the average housing plot in the UK, you have a design where five Z-House 80s can fit in the footprint of a traditional UK home.

Scaling the Z-House

Because the Z-House is designed to use the entire area of a plot for space provision, and is designed to be built in the same shape and proportions each time, it is possible to work out the living and outdoor space you would have in a Z-House for any given plot size.

A Z-House is essentially built of two blocks that are the full width of the plot and 2/3 of the length of the plot. This means, that for any given plot size, you will have a built area of 4/3 the area of the plot. For example, a 180 square metres. plot would house a Z-House with a built area of 240 square metres. A further 2/3 of the space would be outside space, with 1/3 being for the covered driveway at the front, and 1/3 being for the open, upstairs garden at the back.

In a more mathematical layout:

Area of Z-House = Area of Plot x 4/3
Area of Driveway = Area of Plot x 1/3
Area of Garden = Area of Plot x 1/3

You can see from this that the total area of the Z-House and its external spaces is twice the area of the plot provided. These equations also mean that you can work out the required plot area for a Z-House of any given size by working backwards.

For a Z-House of any given built size, the plot area needs to be 3/4s of the total area of the house. This means that for a Z-House with a built area of 100 square metres, you would need a plot of approximately 75 square metres.

Building the Z-House

When designing a solution, it can become easy to focus on the visible and aesthetic properties, instead of the functional properties. In the case of a building, this can lead to disastrous outcomes.

The Grenfell tragedy highlighted what can happen when the outward appearance of the buildings we create is put ahead of the safety of those who live within them. In the instance of Grenfell Tower, the cladding on the outside of the building — requested by other local residents to improve the outward aesthetics of the building.-were not up to standard (BBC, 2018).

If the Z-House were to be brought to market, all considerations would need to be made to make sure the materials it is built from are aesthetically pleasing, safe for habitation and provide great value for money.

Ideally, I would like for the Z-House to be built in two components, and then for these components to be married at the site, resulting in the final structure. This would allow for parallel construction of the upstairs and downstairs of multiple houses, shortening construction time, but also allow for the use of different skills and materials to maximise the building's economic impact whilst minimising its environmental footprint.

The base of the building would be built from traditional brick and mortar techniques, allowing for a row or block of houses to be built using local skills and labour. The upper floor would be built off-site, hopefully from an aluminium or other fire-resistant recyclable shell, as close to the build location as possible.

Furnishing the Z-House

The philosophy behind the Z-House is to create a building that is efficient in both materials and space to create an affordable, habitable living space. This philosophy must extend to the ways in

which the internal spaces are used, through furniture, to ensure that what space is used is not squandered.

The floor plans I created during the sketching stage made minimal use of furniture, focussing on purely the essentials from a selection of what's currently typically found on the market. Ideally, I would like to design a range of furniture to compliment the Z-House's design, but that extends beyond the scope of this current project.

Z-House Technology

Core to the philosophy and vision of the Z-House is the use of technology to ensure that it impacts the environment, the economy, and the residents in the best ways.

Environmental Impact

The Earth's resources are finite, so we must seek ways to use them more responsibly when we design and make things. With this in mind, the Z-House will use environmentally friendly technologies where available, or use existing technologies that help reduce the overall impact of the house during its life.

Renewable Energy

A main component of the environmental technology in the Z-House will be the use of photovoltaic cells to produce energy to be stored and used to power the house during the day and night. This system relies on two technologies — organic photovoltaic cells and in-home battery storage.

In her TED Talk, Hannah Bürckstümmer (2018) talks of the potential uses for organic photovoltaic cells, which allow for innovative new uses and applications for solar power production.

Suspended in ink, the photovoltaic particles can be printed or sprayed onto various surfaces, allowing for anything to become a solar cell. In designing the Z-House, the idea is for this ink to be applied to the upper portions of the building, allowing for the entire first floor to harness solar energy.

To make this energy usable, it needs to be stored so that it can be used when needed. In-house battery technology, such as the Tesla Powerwall (Tesla, 2018), allow for renewable energy to be generated when readily available and later used when needed — such as for lighting a house overnight.

By combining organic photovoltaic cells with in-house batteries, it's possible to create a house that gathers energy during the day, whilst the occupants are at work, and stores it for use for evening cooking, lighting, heating, etc.

Green Space

In a study of 10,000 participants, University of Exeter (2013) found "that individuals reported less mental distress and higher life satisfaction when they were living in greener areas" and that "that living in an urban area with relatively high levels of green space can have a significantly positive impact on wellbeing, roughly equal to a third of the impact of being married."

With access to green space proving so beneficial, it is important that the Z-House offers outside green spaces to its occupants, to help maximise happiness and offer an ongoing benefit to the local environment.

Water Collection

Whilst the roof of the Z-House looks flat from a distance, it isn't. Grooves and slopes in the roof provide a channel through which water can travel and be taken away from the roof, either to the

Top Material	Bottom Material
Aluminium	Red brick
Grey Brick	Jesmonite
Copper	Grey brick
Organic Photovoltaic	Concrete
Timber	Aluminium

front of the building to be routed away through the drainpipe, to the back of the building to be used for watering the garden, or to water recycling equipment inside the building.

The movement of the water ensures that the roof remains free of moss or other growths, whilst also ensuring that the photovoltaic coating to the roof remains clean and clear to maximise solar collection.

Natural Light

Whilst the design of the Z-House lacks traditional windows, allowing the occupants to set the ambient lighting of the building however the desire, the building is equipped with two main ways for natural light to enter the upper floor of the building.

The first is the door to the roof garden, which can be made either of the same material as the upper floor, or with a glass insert to allow natural light to enter into the space. The second is a glass skylight, around the edges of the solar roof, allowing light to stream down into the upstairs living areas.

All of these components of the Z-House help it give back more to the environment more than it takes. From taking up less ground space than a conventional house, driveway and garden combination, to creating its own renewable energy from the solar coating on the rooftop, the Z-House aims to take up fewer of our limited resources — like space and fossil fuels — whilst giving occupants a great living experience.

These technologies and improvements help tick off on more parameter in the Z-House list, one that was previously missing.

Parameter	Pass/Fail
The building must add more to its environment than it takes away.	✅

Modelling the Z-House

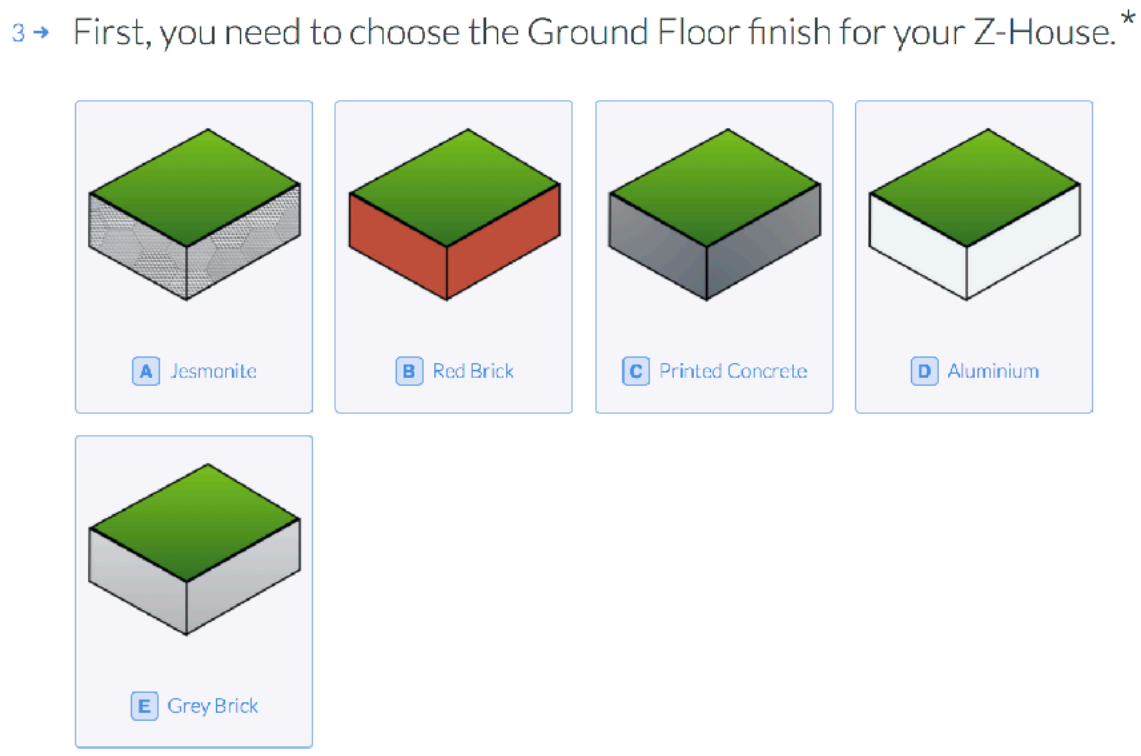
Early stages of development of the Z-House idea included the production of rough styrofoam and construction brick models, to help understand the proportions of the building and the space it would occupy.

As I develop the idea, it is important to once again create a series of models, to get feedback from my peers and prospective house buyers and industry professionals on the shape of the building, the construction materials, and the final aesthetic of the building.

I've also found that models help people to better understand the Z-House concept and get excited about its potential and design.

To this aim, I will be building five 1:100 scale Z-House models, each with a different material for their top and bottom floors. These models will be made of foam board, with vinyl stickers used to apply the building material texture to the forms. The two forms will then be held together with velcro, allowing for easy deconstruction and for the swapping of material pairings to see how these elements work together.

I have decided that the following materials will be tested on the initial five models:



These five Z-House models can then be interchanged into 25 different material combinations, allowing people to choose their favourite combination — which I can then record as I work towards designing and making my final Z-House model.

Research Activity: Material Finishes

Now the models are completed, the goal is to understand which finishes people are most likely to choose when designing their own Z-House, so that I can create a final model with the most popular combination, to be displayed at the end of the unit.

To collect this information, I will be going through a Research Activity with friends, family, and people around East Kent College and beyond. They will be given the 10 model components to play with and asked to create their favourite combination. This will then be recorded in a typeform, an online form, so that I can export the results into a report at the end of the research.

For those who may not be able to try the models in person, the typeform includes visual examples of the finishes, allowing people to remotely give feedback and take part in the activity.

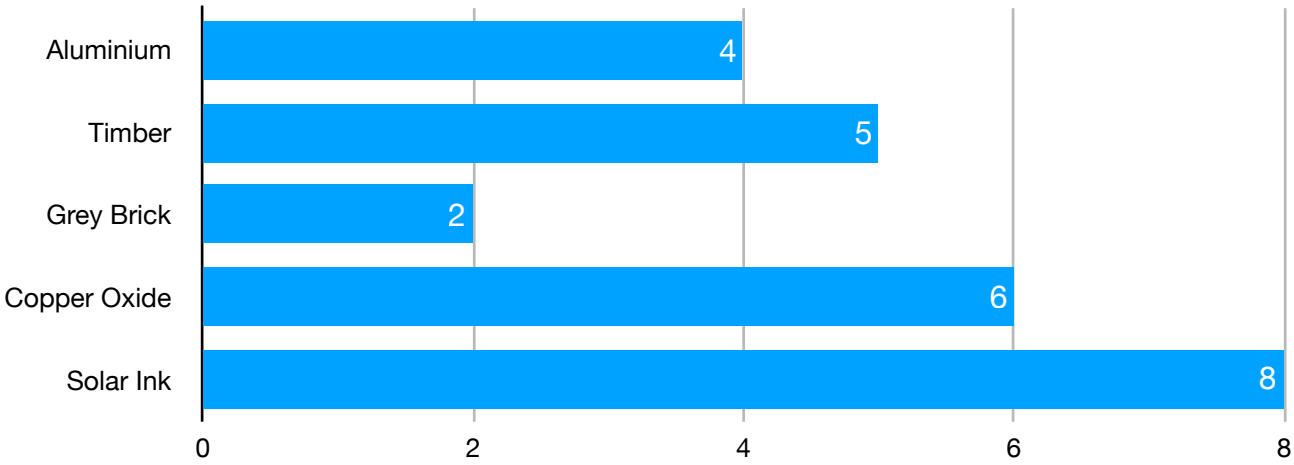
Results

I conducted this research with <x> people of varying background and interests. Some were supervised during their answering, with me able to help them configure the models and select their favourites. Others answered remotely, just by looking at the images in the typeform, so made their selection from a different perspective.

All identifying information has been stripped from the results you see here, and the information has been presented in graphs to show the number of selections for each material. I will begin by looking at the individual choices. But, as the combination is the important decision here, I will also be looking at the chosen combinations people have made, to find the most popular.

The raw results of this research can be found in "Appendix 2: Z-House Configurator Results".

Choice of Ground Floor Finish

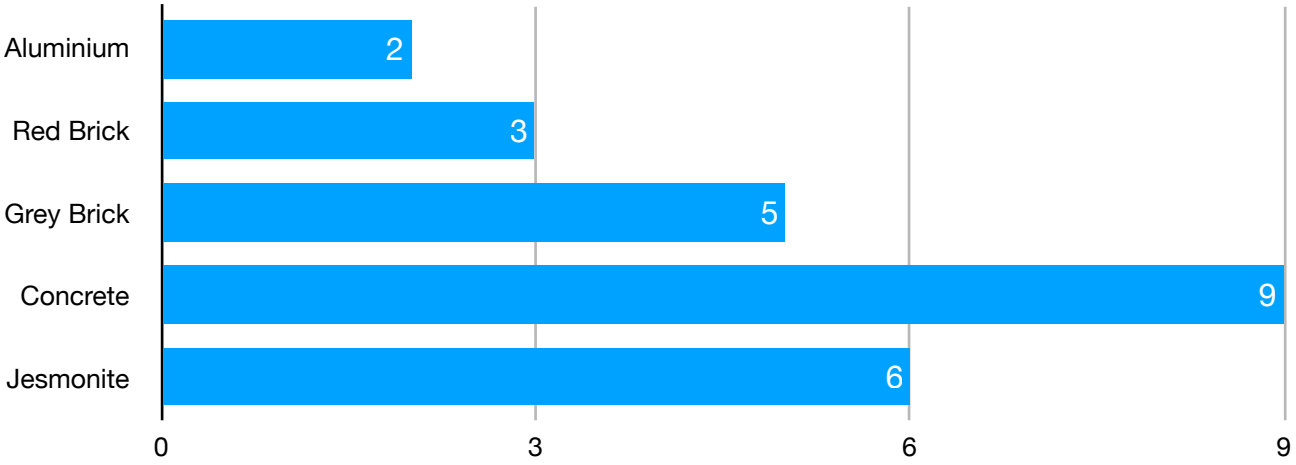


Firstly, respondents were asked to choose their preferred ground floor finish from grey brick, red brick, concrete, aluminium and textured Jesmonite. Some of these are quite traditional buildings materials, whilst others are more novel. The popularity of each choice is as shown:

Choice of First Floor Finish

Secondly, respondents were asked to choose their preferred first floor finish for the Z-House. The selection in this instance was copper oxide, grey brick, aluminium, timber, or solar ink (which has a reddish-brown hue).

For those who interacted with the models, their selections were made by putting the two parts together and seeing which was their favourite combination. For those answering online, each of the two selections is made with the other viewable on screen, so decisions can be made with context, rather than in a vacuum. The results of these choices are thus:



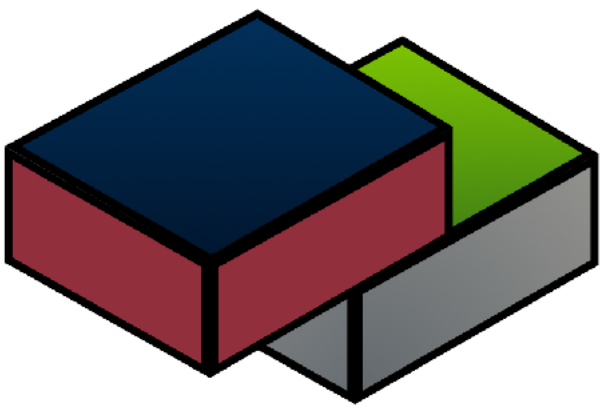
Combination Choices

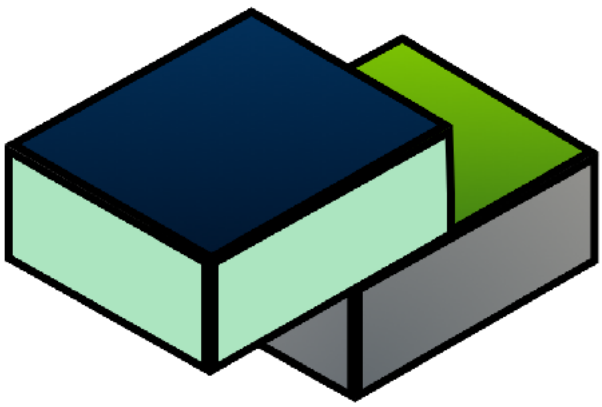
As respondents were asked to select their favourite combination of material finishes, it is important to not only look at the individual choices but at the combination choices as well. For, whilst it may look like Concrete is the most popular ground floor choice and Solar Ink is the most popular first floor choice, different conclusions may be drawn by looking at the combinations.

In the following table, I lay out the combinations and look at the popularity of each.

	Aluminium	Copper Oxide	Grey Brick	Solar Ink	Timber
Aluminium	1			1	
Grey Brick		1		2	2
Jesmonite		1	1	2	2
Printed Concrete	2	4	1	1	1
Red Brick	1			2	

Again, it is obvious here that the most popular choices are Printed Concrete and Solar Ink. But, only one person chose the two together as a combination. When it comes to the most popular combination, this is Printed Concrete and Copper Oxide, with 4 respondents choosing this as their preferred option.





So, there are two potential candidates for the finishes on the 1:10 scale model Z-House. One is Solar Ink and Printed Concrete (left), based on the two most popular individual choices. And the other is Copper Oxide and Printed Concrete (right) based on the most popular individual materials.

Workshop

Because the outcome of this survey was inconclusive, I decided to run a short workshop with some people who had not previously been asked their opinion on the Z-House finished, to decide on the final finish for the model.

The workshop was run by introducing 5 of my contemporaries to the Z-House and the different materials available for it. Before introducing the decision they would need to make — between Solar Ink and Copper Oxide - for the finish of the building.
They were also informed of the material differences between the two finished, before being asked to make their decision.

Once they had had a chance to familiarise themselves with the material and ask questions, I asked the group to split themselves into two groups. One which would prefer the Solar Ink finish to the model, and the other that would prefer Copper Oxide as a complimentary finish to the printed concrete.
Unanimously, all members of the workshop voted for Copper Oxide as their preferred finish. This means that the Z-House model will be built with this finish as a demonstration.

Building A Bigger Z-House

Now that I've built 1:100 scale models of the Z-House and used them to understand the sorts of materials people are likely to want their houses to be made from, I can now take what I've learned and create a 1:10 scale model.

This scale model will be of a Z-House 80, the smallest comfortable size configuration based on my initial research into the UK's housing market. It will use Printed Concrete for the ground floor and Copper Oxide for the first floor, based on the research I conducted using the 1:100 scale model houses.

Foam board should provide an adequate material for constructing the exterior walls of the Z-House, but this will need to be suspended from or attached to a more sturdy frame, something made of either wood or metal, to give the final model the structural integrity it will need to be sound.

I shall attempt to use vinyl once again to apply the texture finish to the model, but other techniques may need to be tried if this proves difficult.

Unlike the 1:100 scale models, which focussed primarily on the material finish of the housing, the 1:10 scale model will go into further detail. This means providing more detailed construction such as the garden wall, the solar panel arrangement on the roof, the supportive columns at the front of the driveway, and a printed internal floor plan, so that the scale of the building can be better understood.

Construction Process

Now that the material choices for the 1:10 scale Z-House model have been finalised, it's time to start constructing the model. In the previous section, I calculated

Construction Plan

My final model will be constructed of a wooden frame supporting foamboard external walls. The wooden frame will be glued and pinned together, providing a strong and stable frame upon with the foambaord can be suspended.

The foamboard will be glued and taped into the frame, providing a smooth transition between the foamboard and the wooden frame for painting and/or vinyl application.

The first floor of the Z-House will be held up using wooden pillars at the front of the model, with the main connection between the first and ground floors being maintained by gravity. This will allow for the two sections to be disconnected and the internal floor plan of both sections to be seen.

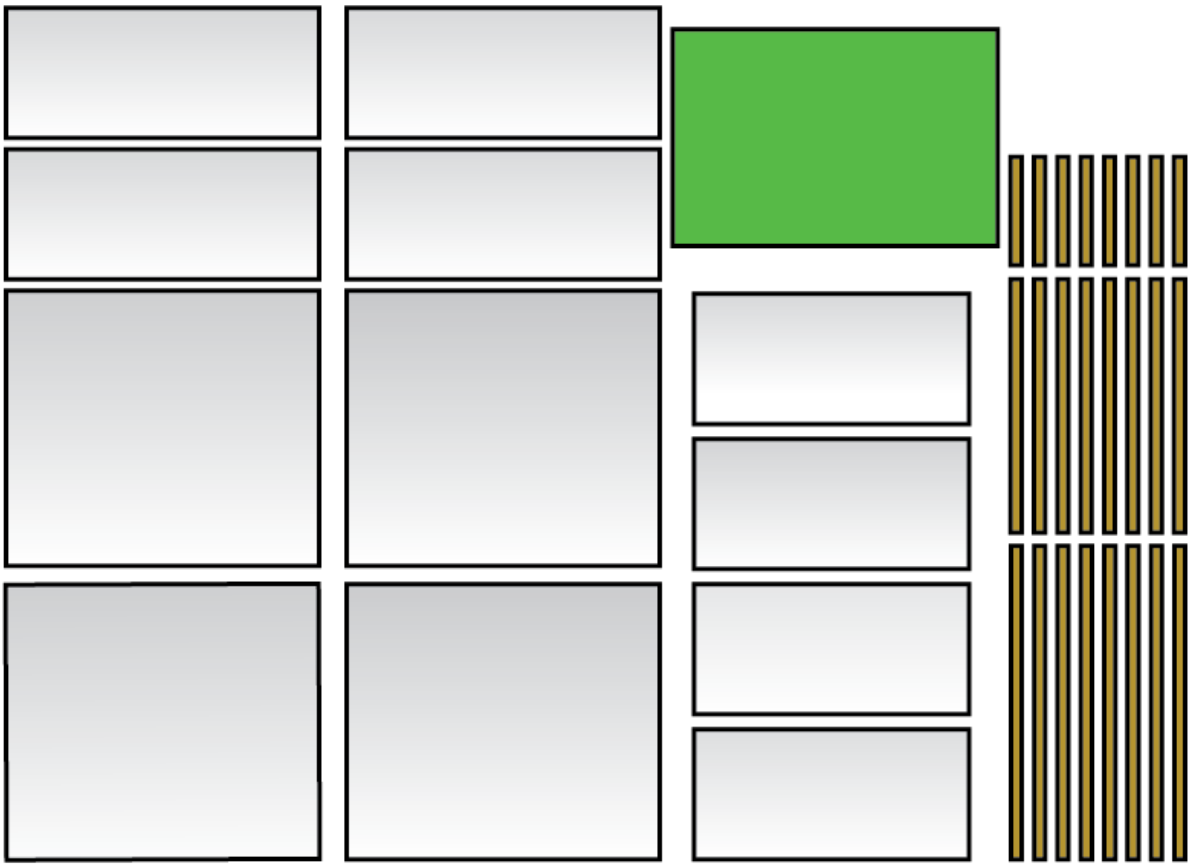
Required Materials

To construct the 1:10 scale model, I will require the following materials:

Material	Required Amount	Estimated Cost
25 x 25mm Planed Timber (m)	15.3	£10.27
Foamboard (sheets)	8	
Vinyl (m length)	6	£6.00
Glue	Unknown	Unknown
Wood Pins	Unknown	Unknown
Astroturf (Mat)	2	11.98

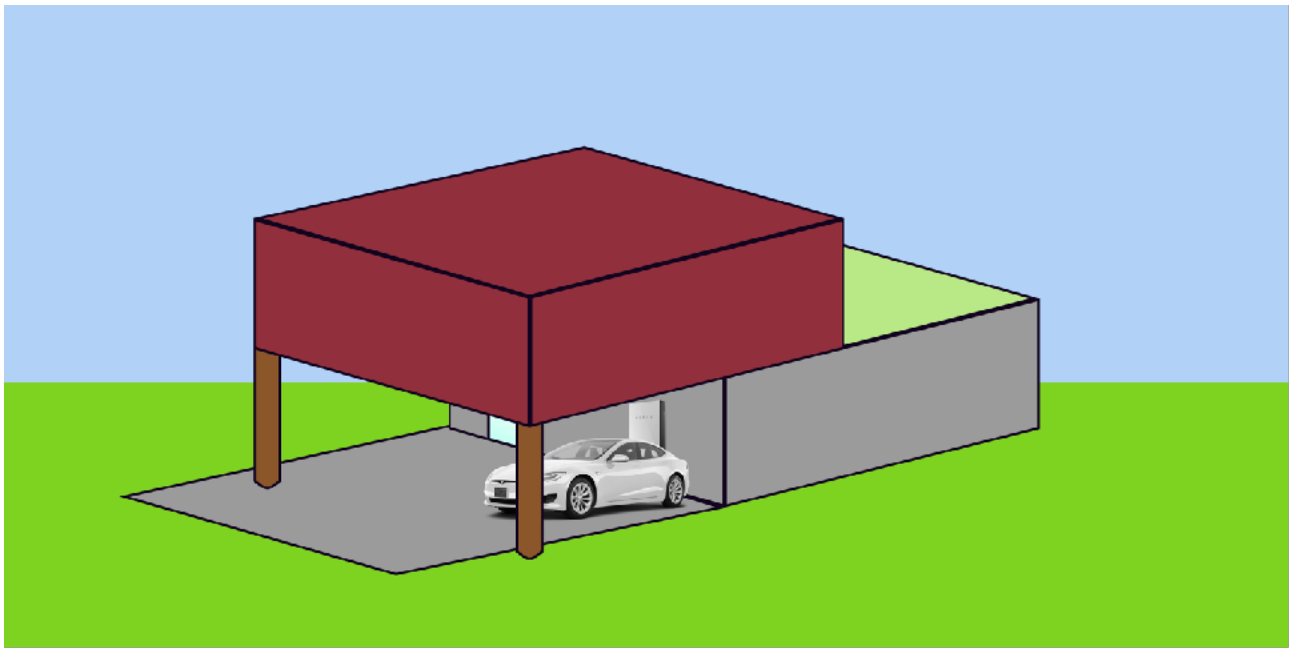
These materials can then be cut to size to create the components shown above. The final model will require 24 lengths of wood, 12 foamboard panels, and an astroturf doormat. The latter will be used to give a grassy look to the upstairs garden, adding realism to the model.

Whilst it would be brilliant to have a 1:10 scale model of an electric car — such as the Tesla Model S or smart EQ - because of the electric car-friendly features of the building, this is likely to be out of the budget for this project.



The quantities above are calculated by taking my 3D renders for the house and dividing the measurements of the exterior walls by 10 to get the cm value for each dimension. This is then converted into the materials I need.

As the timber is 25 mm across, this means that there is a reduction of 25 mm from each side of the foamboard, to ensure that they fit within the frame. A visualisation of the components can be seen overleaf, with the foamboard in grey, the timber frame components in brown, and the fake grass doormat in green.



Once constructed, these components will create a model like shown in the diagram on page 23. The Tesla Model S and associated Powerwall are shown for scale purposes only.

Acquiring Materials

Once the list of required materials was known, it was time to acquire the materials and bring them together ready for construction.

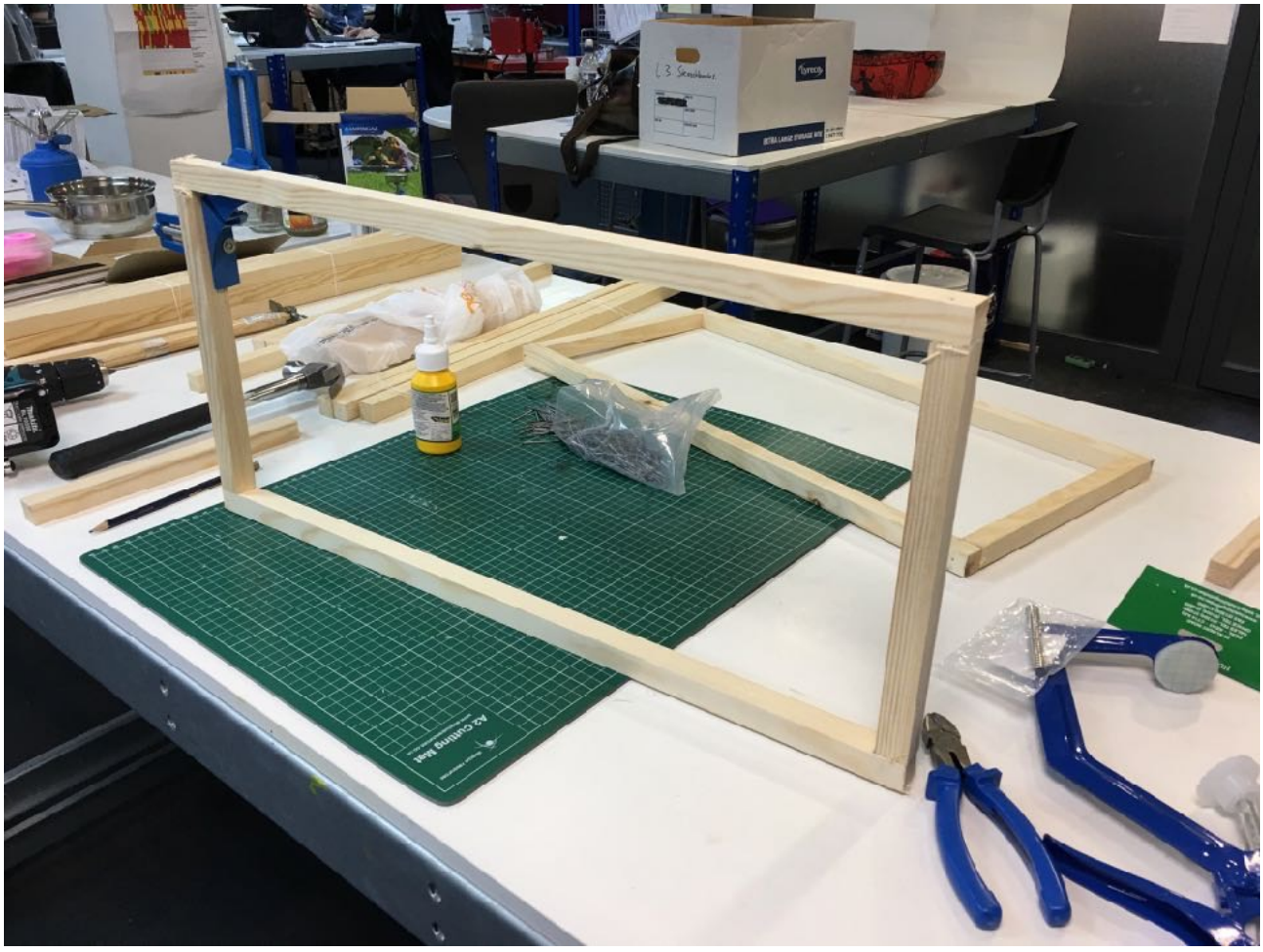
Some of the materials — including the foamboard and vinyl — were already ready available in the studio, so it was just required to gather the necessary quantities of each material and bring them together into my workspace.

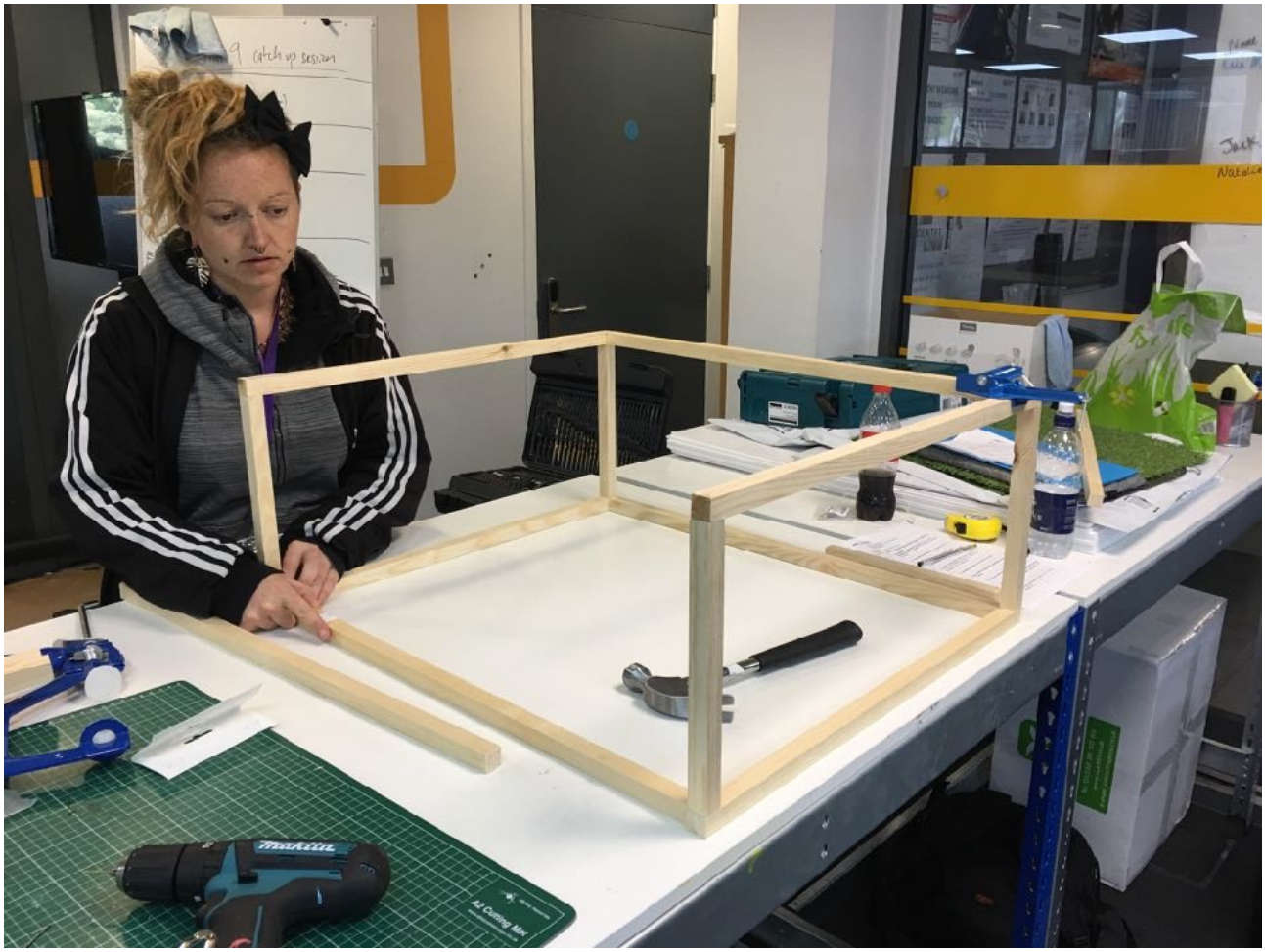
For other materials — such as the glue, pins, and timber — it was necessary to purchase these materials from retailers. The grass mats used for the upstairs garden and the magnets used to hold the two halves of the building together were all acquired from amazon.co.uk. The Timber was sourced from a local timber yard.

The timber was then measured and cut by myself at home, before bringing it into the workspace where it would be turned into the frame of the Z-House.

The Building Process

Once all there materials were brought together, it was time to start constructing the 1:10 scale model of the Z-House. This started with the construction of timber frames for the front and back ends of each floor. This was easily achieved by taking the pre-cut timber sections and pinning and gluing them together to create the rectangular frame.





Once these end frames were created, four lengths were connected to each of the corners to create the full cuboidal frame for the box. As this work was more complicated, clamps were used to ensure the connections were held tight and aligned whilst working, and assistance was garnered from other people in the studio as needed.

Once the first frame was constructed, the same steps were replicated to create the second frame. With these steps completed and repeated, two frames were created — one for each floor of the Z-House.

Once the frames were constructed, it became clear that the frames did not quite have enough structural integrity. So, two steps were taken to improve the strength of the frames. Firstly, a second pin was hammered into each corner, creating a stronger and non-rotatable connection between each timber.

Secondly, I went to the wood yard again and purchased two plywood panels, cut to size and shape, to fit to the bottom of each frame. This panel adds strength to the panels whilst also keeping them in shape and flat to the surface. This is particularly important for keeping the ground floor flat to the presentation area, and keeping the top floor aligned with the magnets used to keep the floors in place.

Once these two frames were strengthened, it was time to apply the interior and exterior walls to them. This is a house, after-all. The walls are made from cut foamboard, which is then glued to the timber frame to ensure a strong and long-lasting connection. A prototype was created using panel pins or staples to connection the foamboard to the frame, but my tests found that this process would damage the foamboard.

As the glue was drying, the foamboard was held to the frame using g-clamps, with smaller squares of foamboard used as a barrier between the clamp and the walls, spreading the pressure and minimising cosmetic and structural damage to the walls.

Once the walls were fitted to the ground floor, it was important to ensure that the two parts still connected correctly. An early test of the connection found that one end of the house had too much excess foamboard standing proud of the ‘ceiling,' causing issues with the connection. Using a miniature hacksaw, I removed the excess material and then sanded the cut surface to ensure it remained smooth and aesthetically pleasing.

Once this process was complete, the connection was tested again and was found to be as required for the project. As well as adding some strength to the connection, the magnets help to keep the two floors aligned whilst the model is being presented.

Once the walls were correct on the ground floor, it was time to repeat the same process on the top floor to ensure a good finish to the exterior surfaces of the model. Whilst these walls will later be covered in a printed vinyl to add texture and colour to them, it is still important that the surfaces beneath these vinyls are well-fitted and imperfection free to ensure a smooth finish to the model.

Once the walls were completed, it was time to create the lids for each section. As each box will be openable, allowing viewers to look inside and see a to-scale floor plan printed on the inside, to better understand the available space within the Z-House.

For the upper box, this was a case of cutting a foamboard sheet to size and adding corner supports so that it can be easily aligned and rested on top of the model. For the lower box, this process was slightly more complex, as this lid would need to support the upstairs garden as well as not interfere with the magnetic connection between the two boxes.

To create the life for the lower section, I took a plywood remnant from the cutting process and cut it down to size, so that it covered the open area of the box. I then installed foamboard corners to

the bottom of the panel, to again allow easy alignment and stability when the lid is placed back onto the model.

I then cut the faux-grass mat to match the size of the panel, and adhered this using glue. Once this combination had dried, it was fitted onto the bottom box and measurements were made to install the garden walls to the model.

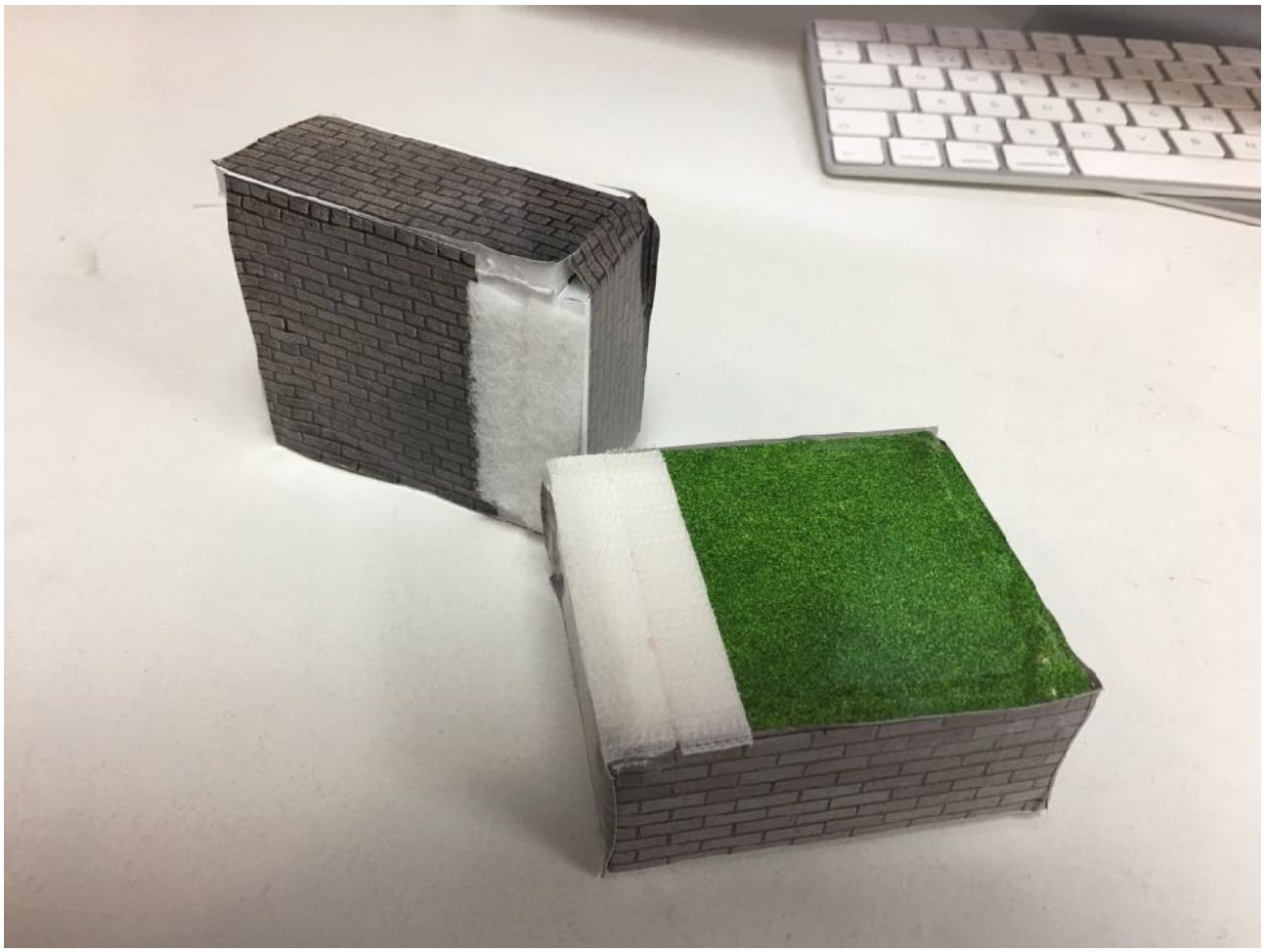
As wait time was required between different steps in the process, these were ideal times to work on other areas and features that would need to be completed. For example, whilst the lids were drying, it was a great time to install the vinyl coverings to the walls of the model, so that the Z-House can show off the material finish chosen earlier in the process - Printed Concrete and Copper Oxide.

Once the vinyl was applied, and the lids are installed, it's time to construct and install the front driveway and supports to the Z-House to finish the model.

Accompanying Material

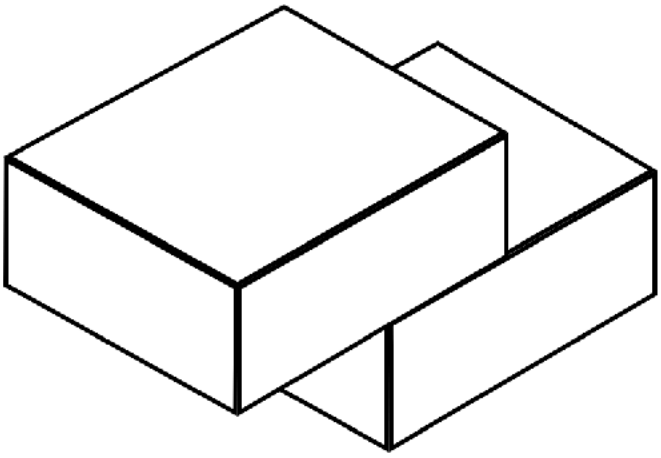
The model Z-House is not the only thing on presentation or resulting from this project. As well as the model itself, I created a short video showing some of the conceivable combinations for the Z-House which them fades into the Z-House logo.

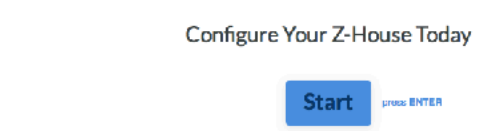
The small, 1:100 scale foamboard models of the Z-House will also be presented, allowing viewers to understand the material combinations and to put them together and take them apart to see how the combinations work together.

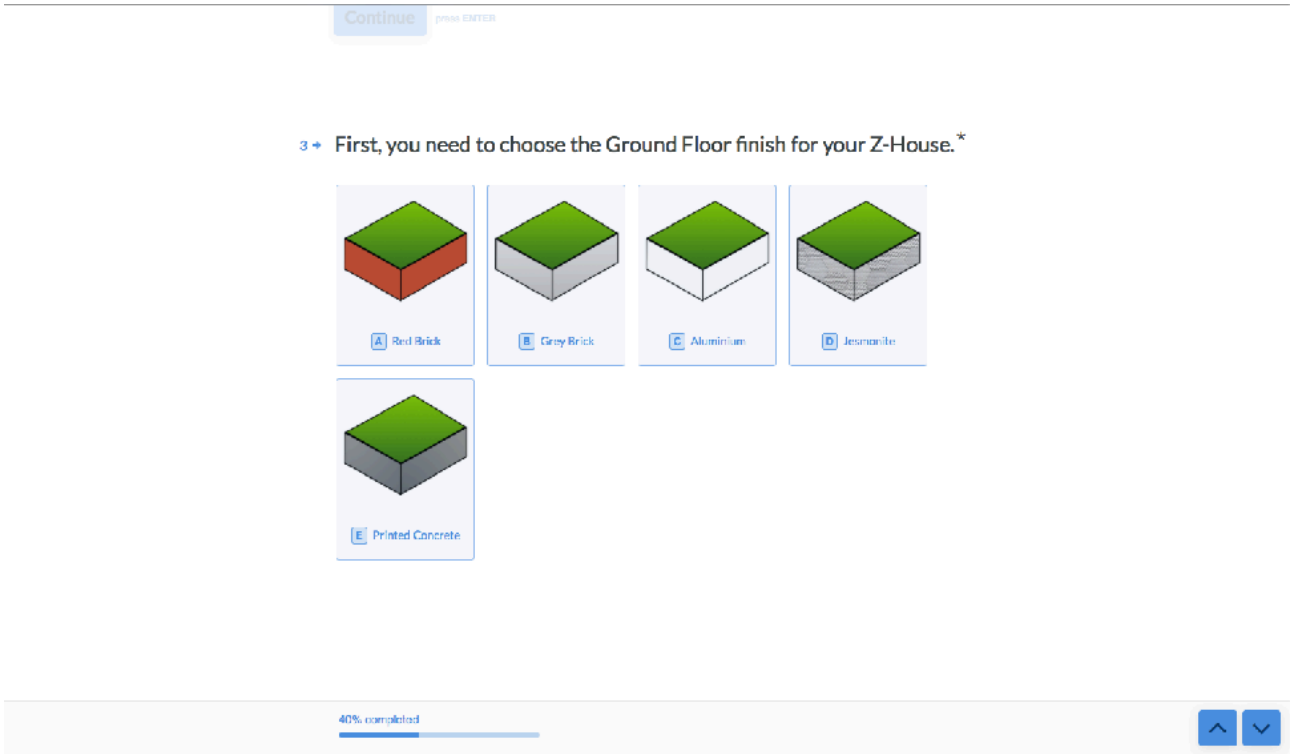


A Z-House configurator has also been created, using Typeform, to allow people to experience the desired pre-ordering process for the Z-House. The idea is to make choosing and reserving one of

these houses as easy as possible, to streamline the purchase process and help people get into their new home as easily and as painlessly as possible.







All of these come together to create the Z-House experience. One more akin to an Apple Store or a Tesla showroom than the office for your local estate agent. Where technology helps you understand the choices you're making, and expedites them were possible. Where a swathe of pre-configured and built houses are replaced with your decisions and your taste.

It's all part of creating the next generation of housing. And it's all there in the Z-House experience.

Evaluation

When I started working on this project, I started with a clear goal and a specific list of parameters against which to evaluate this project and the end result.

In my proposal, I said the following:

“The outcome of this project will be a model of the new housing solution, based on information and opinions I have collected and synthesised through my research. These will start with small-scale 1:100 foam board scale models with the aim being to create a 1:10 scale model to present alongside floor plans.”

Throughout this project, I have used the information I have collected through my research and discussions with others to guide my decision making towards the final solution. My secondary research has helped me understand the current state of the UK housing market and the problems it is facing, as well as get a generalised feel for what people are looking for in their housing solutions.

My primary research has helped to decide such things as the material finish of the building, as well as to butter understand the materials and processes I need to use to construct my models.

This process resulted in the creation of 10 interchangeable 1:100 scale Z-House modules, allowing for the construction of 25 different Z-House material combinations, helping people to understand the material finishes I have envisioned, and how they look in combination when deciding which they would prefer on a Z-House of their own.

It also helped lead to the creation of the 1:10 scale Z-House model, where research into the size of houses people prefer, the combination of materials people would like to see, and the size of house plot available in the UK all came together to help shape the design and size of the model. Whilst conversations with people such as my tutors, contemporaries, and experts in the field of timber helped my efficiently and safely create the model using appropriate techniques.

Against the objectives laid out in my project proposal, I would consider this project a success. Though, as we’ll get to later, there is always room for improvement.

As I developed the idea of the Z-House, I created a list of parameters against which the final model and housing solution should be assessed. These parameters are based on both objective and subjective criteria that I believed would lead to creating a worthwhile solution to the UK’s housing crisis.

As outlined on page 7, these parameters are:

1. The final product will be a design for a residential building.
2. The internal floor area of the building must exceed 80 square metres.
3. The building must fit on a plot size as small as 125 square metres.
4. Able to scale up to the average plot size (333.5 square metres.)
5. The building must offer a comfortable lifestyle for 1 or 2 occupants.
6. Internal space must be flexible, allowing for privacy and dedicated cooking space.
7. The building should aim to be priced around 5x the average salary.
8. The building must add more to its environment than it takes away.

These parameters were later turned into a scorecard against which each solution could be assessed. I will use this scorecard again now, to evaluate the Z-House as it currently exists, and better understand the solution.

As can be seen from the scorecard overleaf, the current Z-House achieves 7 out of the 8 parameters I outlined at the beginning of this project.

Parameter	Pass/Fail
The final product will be a design for a residential building.	✅
The internal floor area of the building must exceed 80 square metres.	✅
The building must fit on a plot size as small as 125 square metres.	✅
Able to scale up to the average plot size (333.5 square metres.)	✅
The building must offer a comfortable lifestyle for 1 or 2 occupants.	✅
Internal space must be flexible, allowing for privacy and dedicated cooking space.	✅
The building should aim to be priced around 5x the average salary.	?
The building must add more to its environment than it takes away.	✅

The Z-House is a design for a residential building. One that has an internal floor area of at least 80 square metres, but which also provides a garden and driveway in a plot size of less than 125 square metres. The Z-House 80 (the number referring to its internal floor area) actually provides an internal area of 80 square metres in a plot size of about 60 square metres, making it much more efficient than a typical UK house.

Further exploration of the Z-House design found that it is very capable of being scaled up to any plot size, where it will always provide a more efficient use of space than a traditional house design, due to its offset floor design allowing both the garden and driveway to essentially occupy the same horizontal space, due to their vertical displacement.

The design and size of the building allows for a flexible and comfortable internal space, whilst also ensuring privacy for the occupants and their neighbours. The elevated garden means there is less possibility for overlooked when paired with traditional houses, where neighbours can see into other gardens from being above them in the first or second floors. The new nature of the house also allows for people to take a different approach to laying out their houses, dedicating space to cooking and other areas in more innovative ways, as the traditional upstairs and downstairs ideas are disrupted by the placement of exterior space on both levels.

Due to the manner in which the Z-House is constructed, and the use of technology such as solar panels and energy storage, the building is able to add more back to its environment than it takes way. Its more efficient use of space also means that less of the environment is required, with up to five Z-House 80s able to be built in the same space as a traditional UK house. Both of these things minimise the environmental impact, whilst also helping to minimise the initial and long-term costs of the building.

And it is there where the question mark arrives. During the process of this project, I reached out to a couple of people to try and understand how much building a Z-House 80 would cost, to compare it to the current UK average house price and salaries, to try and achieve my price goal. But, unfortunately, I was unable to get an answer from these people during the duration of this project.

But, it can be approximated that the Z-House 80 would provide a more cost effective solution to traditional housing, due to the fact a Z-House requires a much smaller footprint to provide a comfortable living space, reducing the amount of land that needs to be procured for construction. Greatly reducing the upfront costs of building.

The unique way in which the Z-House is built, allowing parallel construction of both the ground floor and first floor, also reduces the construction time required for each unit, again helping to reduce the cost of the house.

And innovative technologies such as the solar roof and power storage allow for renewable self-generation of energy for the house, reducing dependency on energy providers and reducing the long-term costs of the building. So, whilst I am unable to give this parameter a definite yes, I am confident that the Z-House provides a financially efficient solution as well as a space efficient one.

Similar Solutions

As well as my own design development and ideas, the Z-House was inspired by external influences and similar solutions to innovate in the housing space. These include:

The Mountain, Bjarke Ingles

Mountain Dwellings by BIG (ArchDaily, 2009) is an innovative approach to building a block of residential dwellings, whilst trying to break away from the international modernist approach of building climate-controlled skyscrapers everywhere in the world.

The stacked building blocks that form the building inspired the stepped design of the Z-House, as well as the idea of using the same horizontal space for both the garden and the driveway, allowing for parking to be absorbed into the footprint of the building, rather than being additional to it.

The Z-House provides a smaller scale version of The Mountain, more suited for the UK's housing market and its traditional approach to home ownership and street layout. A nod to a major architectural project in an affordable package.

LEGO

No project that looks at modularity and construction can deny being inspired by one of the world's most popular toys, LEGO. This construction brick toy inspired the modularity of the Z-House and was the driving force behind the idea for construction, where the two parts are built in different places and are then joined.

During the prototyping stage of the Z-House, construction bricks like LEGO were used to construct a model, showing how it has inspired and played a part in the process. Inspiration also came from “The Lego House," again designed by BIG, which uses shapes, colours and materials in an innovative way.

The Z-House uses modularity in much the same way as LEGO, as well as using shapes and materials in an interesting an innovative mix. Bringing cutting edge architecture and design to the household.

Areas of Improvement

With any project, there are always areas in which improvement can be made. The Z-House project is no exception.

If I were to repeat this project in the future or work on it beyond this point, the main area I would like to improve on is the delivery of the final model. Ideally, I would like to deliver a small range of 1:10 scale models, exploring the modularity of the design as well as the potential for internal layouts and design, creating higher fidelity models. This would expand on the current single 1:10 scale model, with only a floor plan printed on the inside, which was what was possible in the time frame given.

On the subject of modularity, it is not essential that a Z-House takes the shape that has been shown throughout the development here. The idea behind its modular construction is to allow people to slightly customer their own houses. For example, a version of the Z-House could remove the upstairs garden, greatly increasing the internal floor area of the first floor enclosure, for those who may not want a garden. Other areas of modularity could also be explored, for example, for people who don’t want a driveway or would like to design the house in a slightly different orientation or layout.

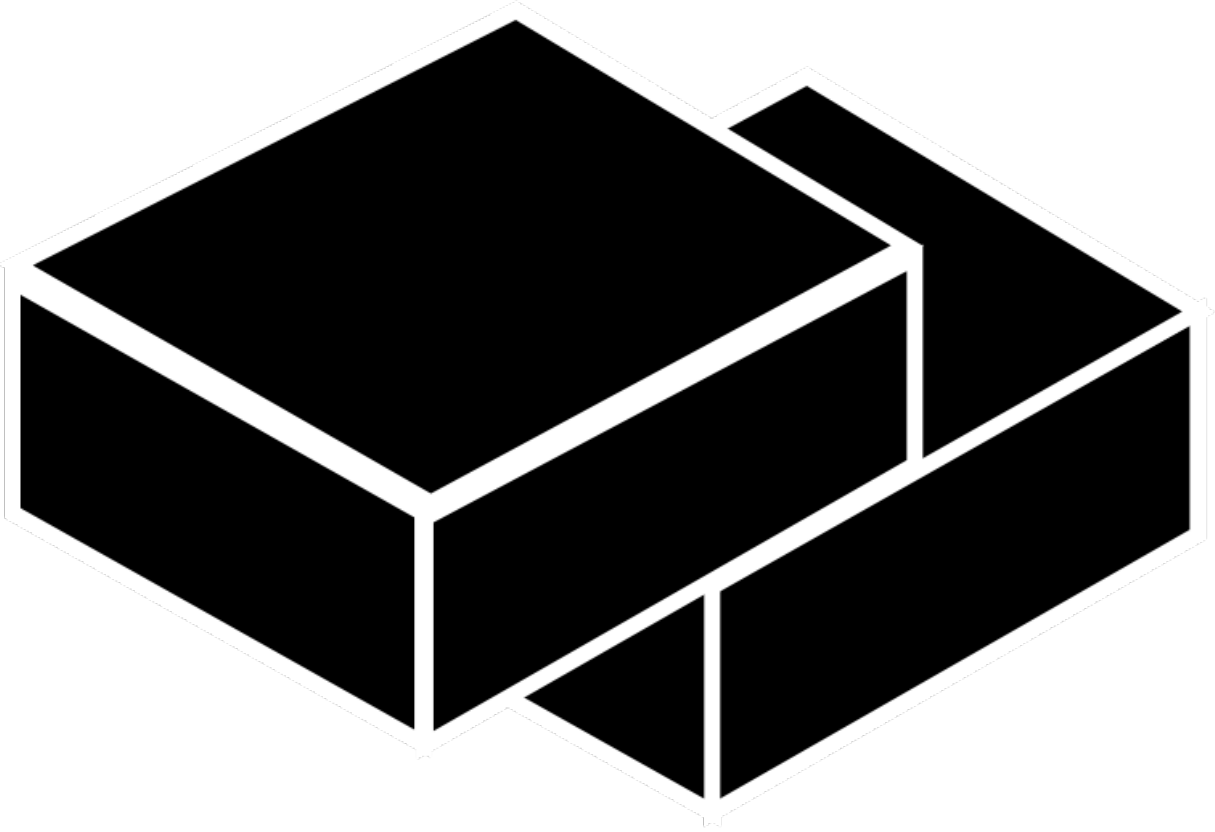
And obviously, I would like to improve the final scorecard of my Z-House design, by getting a professional to assess the construction costs and sale price of a building such as the Z-House 80, so that it can be evaluated against the UK’s average salary. This would help me understand if I was able to achieve my goal of creating a house that costs up to 5x the UK’s average salary, helping to reduce the cost of ownership for housing in the UK.

With all three of these areas explored, I feel the Z-House project would be in a better place. And I may continue work on this project beyond this point to achieve these goals and improve the project with an aim of bringing it to production.

Looking to the Future

The Z-House is the culmination of months of work and research into the state of the UK housing market, different housing solutions around the world, and a personal desire to build a better solution to the UK's housing crisis. Its scope and ambition are not limited to this project, so this is in no way the end of the development of the project.

Moving on from this unit, it is my intention to have architects and other professionals look over the viability of the design, to see how feasible it would be to develop and construct. Once this has been completed, I would love to see Z-Houses built in new and developing towns so that people can have their own slice of modernist architecture in the shape of a space-efficient and cost-effective house.



Z-House

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Appendix 2: Z-House Configurator Results

On the following pages you can view the raw results from my Z-House Configurator typeform. This form was hosted online at https://samhutchings.typeform.com/to/WtgahW.

	B	C	D	E
1	Played with Models?	Ground Floor	First Floor	Why did you choose this combination?
2	No	Printed Concrete	Timber	
3	No	Jesmonite	Copper Oxide	for the looks
4	No	Grey Brick	Solar Ink	Need to keep things looking nice (and real, which is why I went against printed concrete) on the ground floor, while I soak up energy with my first floor :)
5	No	Jesmonite	Solar Ink	
6	No	Printed Concrete	Aluminium	Aesthetically pleasing color combination
7	No	Printed Concrete	Copper Oxide	They seemed like a good choice
8	No	Aluminium	Aluminium	Minimalism
9	No	Grey Brick	Timber	I thought it would look nice!
10	No	Jesmonite	Timber	I like both finishes and think they flow well
11	No	Grey Brick	Copper Oxide	Appealing colours and materials
12	No	Printed Concrete	Copper Oxide	Cause printed concrete wasn't available for the second floor, and copper oxide is lit AF
13	No	Printed Concrete	Copper Oxide	
14	No	Red Brick	Solar Ink	I liked the red look
15	No	Red Brick	Aluminium	Aesthetics
16	No	Jesmonite	Grey Brick	Like the look
17	No	Aluminium	Solar Ink	I have absolutely no knowledge of house composition
18	No	Grey Brick	Timber	Cool and warm together
19	No	Printed Concrete	Grey Brick	I like it
20	No	Jesmonite	Solar Ink	
21	Yes	Printed Concrete	Solar Ink	Likes the red colour.
22	Yes	Jesmonite	Timber	
23	Yes	Grey Brick	Solar Ink	
24	Yes	Red Brick	Solar Ink	
25	Yes	Printed Concrete	Copper Oxide	
26	No	Printed Concrete	Aluminium	goes pretty well with art
27				

Above: Raw data from the Typeform. Personal information redacted to respect people's privacy.

Below: Results matrix showing the choices people made to determine the most popular choice.

	Aluminium	Copper Oxide	Grey Brick	Solar Ink	Timber	Total
Aluminium	1			1		**2**
Grey Brick		1		2	2	**5**
Jesmonite		1	1	2	2	**6**
Printed Concrete	2	**4**	1	1	1	**9**
Red Brick	1			2		**3**
Total	**4**	**6**	**2**	**8**	**5**	**25**

Appendix 3: Problem Log

On the following page is my problem log, recorded and maintained through my work process to document the problems I encountered and the solutions I identified to each problem.

This log is a very important part of the creative process, as it helps to better understand the pitfalls and gaps in my knowledge and skills and how I've worked to improve my skills and increase my knowledge, showing what I've learned.

Appendix 4: Budget

For this project, I had a £100 budget for the creation of my model. As can be seen in the budget breakdown below, the total cost of my bought materials was £53, bringing me £47 under budget.

This budget does not include in-stock materials used within the studio, which are part of the general use materials for all students.

MONEY IN	
Budget from The Edge	£100
TOTAL INCOME	£100

MONEY OUT	
Faux Grass Doormats	£10.98
Magnets	£6.99
Timber	£12.10
Glue	£11.07
Pins	£1.80
Ply Board	£10.41
TOTAL EXPENSES	£53

MONEY LEFT OVER	
Income minus expenses	£47