

Self configure your house

3 D Model | Floor plans

1. Shape/ Rooms
2. Exterior Materials
3. Interior Materials
4. Furniture
5. Siting
6. Confirm with us
7. Myhouse

Professional Library
Self-Design Library
Contact Architect

Design principles
Sustainability
Affordability
Design Quality
Prefab precedents

Download from Library
Upload to Library

Choose facing materials

Library of components

Modules	Walls
Windows	Shading E.
Bathrooms	Stairs
Eco Features	Floors/Roofs
	Landscape E.

Number of bedrooms: 3
Size: 137 sqm
Price: \$ 137000
Energy Demand H/C:
3 kwh/m²/a
Construction time: h

Choose your furniture

Master of Architecture by Research (Project)
School of Architecture + Design
Design and Social Context Portfolio
RMIT University
Submitted in fulfilment of the requirements for the degree of Master of Architecture.

Declaration;

I certify that except where due acknowledgement has been made, the work is that of the author alone, the work has not been submitted previously, in whole or in part, to qualify for any other academic award, the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; and, any editorial work, paid or unpaid, carried out by a third party is acknowledged.

Stefan Naumann
August 2007

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Introduction

Current challenges

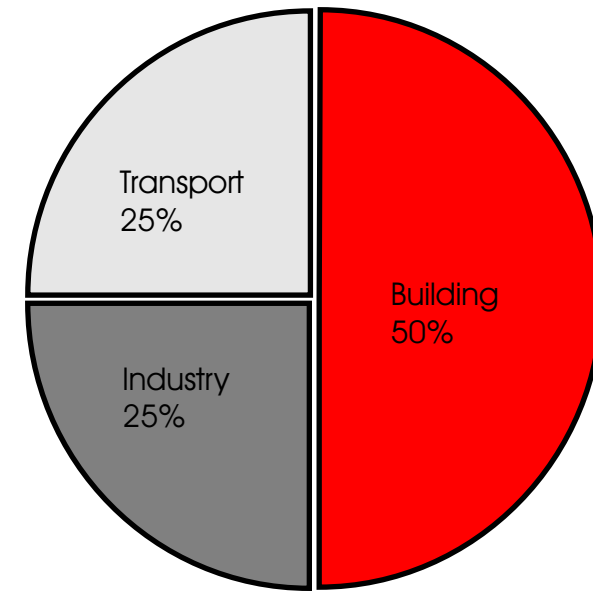
At 70%, Australia has the highest proportion of owner occupation in the world; with most of the housing being located in the suburbs. To own a home is still a dream for most people, yet “only 3% of Australian houses are designed by an architect” (Fairleight, 2006). There are predictions that by 2036, 71 % of new housing in Victoria will consist of detached dwellings. One of the reasons for this is that the detached dwelling continues to be the most affordable type of housing.

Within Australia there is an efficient and successful cottage industry providing economical housing. Volume builders in particular are professional in the way they market and deliver their product. Their homes however lack innovation, in terms of architecture, diversity and the use of materials, resulting in homogeneous, low quality and un – sustainable housing.

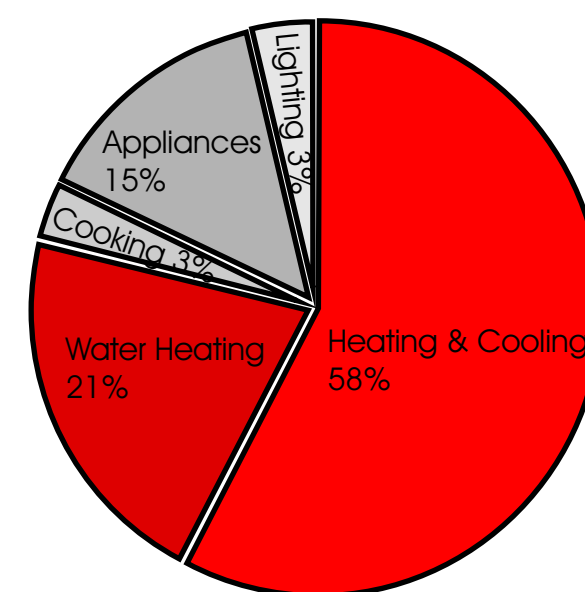
“Many of the new project homes being rolled out across metropolitan areas in Australia are reproduction designs of past styles and often poorly designed to suit environmental conditions and often are placed together in ways that create dull uninspiring environments.” (Chris Johnson, NSW Government Architect, 2004)

Sustainability

“Australia has the highest per capita greenhouse emissions of any industrialised country – 25 % higher than the US” (Flannery, 2005)



World Energy Consumption



Energy use in Victorian homes

The relationship between energy consumption and climate change is well documented. Buildings are responsible for 50% of all CO2 emissions.

Design, materials, and size of the house are playing a key roll in energy consumption.

The 5 star regulations which are currently the industry standard in Australia are by international standards inappropriate and should be higher and more specific. As a result, even new buildings waste energy in irresponsible ways.

Sustainability has to be understood as linked to affordability because a reduction in energy consumption results in lower running costs.

How to improve the sustainability and efficiency of the house without a large cost increase?

Affordability

For an architect to compete with the well established, economical cottage industry, affordability can be seen as a key issue.

Cost savings could be achieved by promoting smaller houses, streamlining the architectural design and production processes without sacrificing the design quality and creating diverse house sizes that fit their user’s needs. Over-consumption needs to be tackled towards reinvesting some of the savings into better environmental standards and quality.



Over- consumption(The Age, 8 | 2007)

Exploring new ways of delivering architecture. How can the knowledge of the architect be applied to ordinary houses without the perceived financial costs and risks of a one off architect designed house?

As has been demonstrated, by such examples as the small home plan service by Robin Boyd in Melbourne and Pettit and Sevitt in Sydney, modern architecture can be successful and widely accepted and can make a positive contribution to the lives of many people.

To be competitive in the market, and to compete with and challenge the volume builder's product, we need to consider new ways of delivering architecture. Digital design, production and marketing have the potential to make this challenge a success.

This dissertation speculates on the possibility of a design system integrated with a design interface, where customers can self-configure or customise their home online with the help of embedded programs and an architect consultancy service. This can be seen as an alternative option for the homebuyer to the volume built, standard house.

This new digital way of delivering architecture could lead to houses that are more adaptable to different users and site needs than volume builder housing.

The limitations of this research are that no industry testing (construction prototyping, marketing or costing) was carried out. The focus then was on the custom architectural service in a digital mass production context. The research is framed then as a series of possibilities for how a communication interface could interact with a series of existing technologies.

The key shift in the focus was from the construction technology itself, to the method of delivering a design and construct service.

In doing this I sought to address many of the difficulties of prefabricated systems in the past and many of the possibilities for such systems in the contemporary environment.

It could lead to houses with better orientation, engagement with new building materials, prefabrication technologies and the promotion of smaller houses resulting in more sustainable homes that are still reasonable in price.

Moving away from the one size fits all approach, this digital system of delivering architecture, will include the client in the design process, educating them so that informed decisions can be made, and so that the house is optimised to their needs and finances. Customisation would provide tailored solutions.

The design system displayed in this masters research was developed in three testing modes: speculative designs, site specific designs and user experiments. This was then integrated into a user interface. A construction system which allows prefabrication was then applied.

Sourcing knowledge from other industries

Many other products in other industries have become more sophisticated, with higher quality at lower costs.

I believe that we can learn from such examples as the international homewares store Ikea, that the idea of providing design for all can become a reality.

Ikea's aim is to combine good design and function with the right quality at an affordable price. This dissertation will argue that this can be applied to buildings, specifically houses.

Renewed interest in prefab.

Prefabrication was investigated during this research because there is the possibility to keep costs down, reduce waste and energy consumption during the production process and produce better quality houses.

Prefab has generally been a failure in the past whenever architects have tried to engage in this field. We are not necessarily smarter than architects 20 years ago, so what has changed? There is a renewed interest in prefabrication due to the possibilities of computer technologies and availability of new materials. Digital production and communication have the potential to make the old dream of prefabrication finally a viable reality.

The recent success of prefab in Japan and the USA shows that cost savings can be achieved. Mass customisation can allow for the creation of the individualised home, combined with the economic benefits of mass production.

What has changed for pre-design?

Digital design and communication have changed the possibilities for pre-design.

The computer and the Internet allow for more radical ways of involving customers.

The Internet opens up new procurement processes and the possibility for online design such as Ikea which offers a program to configure a kitchen online and Lego which sells its system via an interactive website.

1. Precedents + Context



The Volume Builder Market



CONTEMPO Trend

Live in Grandeur
The stunning Contempo provides the ultimate in innovative design and quality finishes. With the main living downstairs featuring vast formal lounge and dining area, study, gourmet open plan kitchen, as well as a spacious family and meal area for relaxed family living. Upstairs, the master bedroom includes a large walk-in robe plus stunning ensuite and retreat, three additional generous bedrooms and main bathroom, as well as a large rumpus/theatre room complete this flexible layout.

CONTEMPO 4500		
DIMENSIONS	SQ. M	SQUARES
Ground Floor	184.05	19.81
First Floor	186.1	20.03
Porch	11.17	1.2
Alfresco	39.04	4.2
Double Garage	38.43	4.14
Total area	458.78	49.38
Dimensions	W 16.54m	D 24.97m

There's no home like a **SIMONDS**
www.simonds.com.au

Simons Catalogue shows a 460 sqm house for \$265,000

Brick veneer construction



Australian volume builders operate on an industrialised scale. The industry is efficient and professional in its marketing. Builders, including Simons, Burbank and Dennis Family homes offer cheap products in terms of price per square meter. The houses are designed from the inside. Internally they are surprisingly modern and stylish (seen in the use of tiles, open planning, and furniture as featured in the display villages). Externally the front facade is designed to impress (here the most money is spent) while the sides are largely ignored. **These houses are designed to win over the affections of a buyer in 20 minutes, the average length of a realtor visit.** Arguably, what convinces the client to purchase the home in the first place – the size for the price is what causes the biggest problem. These houses are generally speaking, too large. The concept of “super sizing” the house seems to be attractive at first, but becomes a sustainability problem in the long term, from both a financial and environmental point of view.

An oversized house leads to over consumption, an increase in running costs and higher mortgage repayments. Do we really need a room for a home-theatre? The volume builder home typically fills up the whole site leaving little garden space for children to play and for families to gather.

The houses are generally of poor quality, usually with little insulation and single glazed windows. The use of electric air conditioning and heating leads to high amounts of energy consumption.

Volume built homes use standard designs and do not consider orientation. These large brick veneer boxes allow almost no natural control of heat gains or loss and can result in buried internal spaces that have no access to direct natural light and ventilation.

Furthermore, they are not adaptable to sites and peoples needs and lack diversity in terms of size, plan layout and design.



Simons Display village Epping. The Interior is modern and stylish

CHANGE your PLANS



Get extra room for only \$2000

Burbank advertisement > Supersize the house

Australian Precedent; Architects in General Housing

SMALL HOMES SECTION



Looking across the slate terrace to the sunroom (left), and the livingroom wing of the Sunshine House, on show at the exhibition.

Open until Saturday

The Sunshine House was designed by the Small Homes Service for the Jubilee Better Homes and Housekeeping Exhibition, open at the Exhibition Building until November 3.

It will be given away as a prize in a competition organised by the sponsors of the exhibition, the Better Housekeeping Bureau of Australia. Another feature of the show, which home builders should not miss is the three, vivid, modern, room sets, designed by Mr. Peter Melnyre, at the right just inside the entrance.

The Small Homes Service is operated by the Royal Victorian Institute of Architects in conjunction with "The Age."

Comparison of the two houses is inevitable. There are many points in common. The "House of Tomorrow" aroused much more disapproval, although it was later illustrated fully in "Arts and Architecture," U.S.A., one of the world's leading architectural magazines.

The "Sunshine House" could be classed as a tremendous hit compared with its earlier cousin, which leads us to suspect that public opinion on architecture in Melbourne has grown up considerably in the past two years.

—ROBIN BOYD, Director, "The Age" Small Homes Service.

The most criticised house of the year

Naturally the "Sunshine House" built at the Exhibition Building comes under a fire of criticism from many of the thousands who are visiting it. That was the idea.

IT WOULD HAVE BEEN disappointing to find that the house had not fired anyone with enthusiasm for or against.

The policy of the Small Homes Service has never been to provide the public with exactly what it wants. That is the role of the "spec" builder.

If we had wanted to build a popular house we undoubtedly would have reproduced the most familiar suburban villa, with a few touches of fancy bricks relieving an otherwise austere and grimly serious monument to habit.

"Habits attacked" Thoughtless habit is the principal vice of home building which the Small Homes Service wants to attack when it built the "Sunshine House" for this show—all the habits of building roofs, windows, walls, the habits of coloring, of planning, of living.

The "Sunshine House" was not planned to shock. The only criticism which takes a little is that which implies that the whole thing is a stunt, a frivolous bit of display work which no one would seriously consider putting into practice.

It is not meant to shock, but to arouse and stimulate.

circulate heat widely through the house.

The idea is old enough to be classed as "cranky and futuristic" by some visitors.

The habit attacked by this chimney is the very firmly fixed practice of almost every new Melbourne home—an external brick chimney which lets much heat escape to the night air and a tapestry brick fireplace which soasts your face and leaves icy your back.

Then, take the colors. They may look odd and even offensive to some people. They please others. This was to be expected. This proves the point—that color is a vital factor in the home which is totally ignored in the vast majority of cream-lined houses.

Of course the "Sunshine House" colors offend some. They offend because they are strong and determined and express a point of view instead of a neutral, timid evasion.

If you don't like any of the sometimes startling colors of this house, do not immediately reject the principle of using color in strength. Rather, consider the same room decorated with some of your favorite colors at the same total strength.

Some people like the house. In fact Small Homes Service representatives at the Exhibition report that a considerable majority seems to approve; but perhaps our judgment is too prejudiced.

Take, for instance, the chimney. A big copper hood stands inside the livingroom of the house. It inspires more comment than any other single feature of the building.

Its principle is almost as old as the hills. An iron flue inside carries the smoke away from the open fire. The copper jackets the flue. It is holed at top and bottom and convection currents, entering the bottom holes, attracted upwards by the flue's heat, emerge from the top holes to

SMALL HOMES

Service of the Royal Victorian Institute of Architects

building than those known to the outer suburban jerry builder and designer.

The queer chimney

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The combined kitchen-utility room of the Sunshine House, divided by a two-way cupboard.

The Small Home Service in Melbourne;

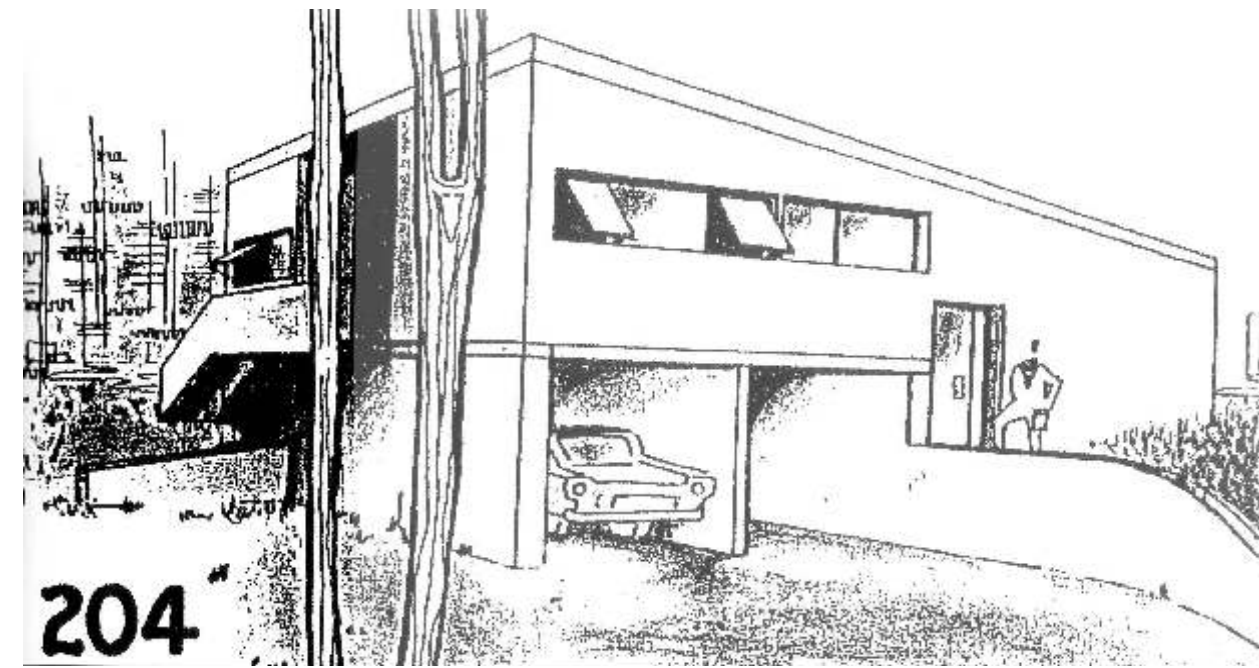
How architects successfully explored new ways of delivering architecture in the past.

In 1947, Robin Boyd established The Age Small Home standard plan service for the RVIA.

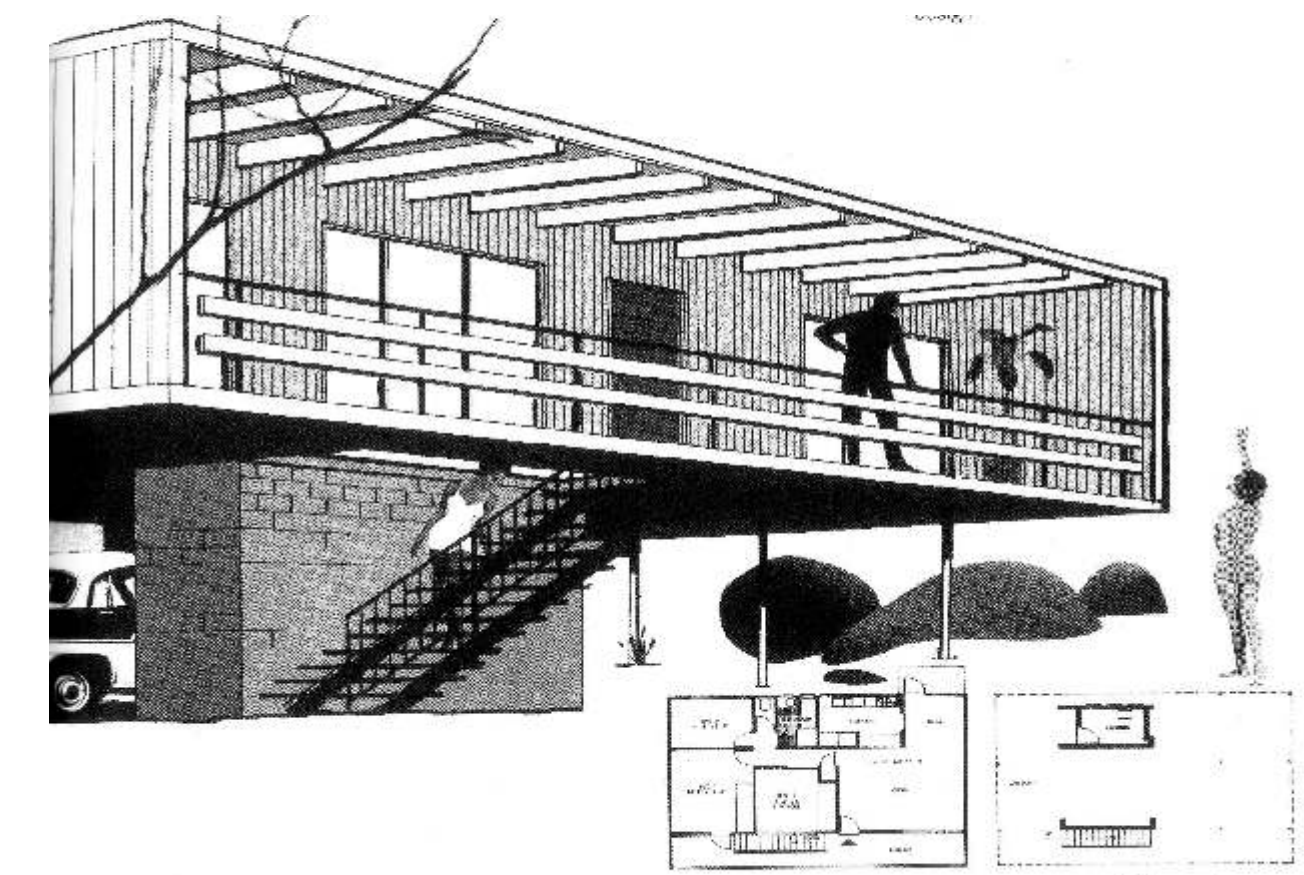
The service initially started with 40 plans for \$5 each. By 1949 more than 100 plans were available by more than 40 architects. To keep costs low, adaptations to the plan were made upon request by students. Architects were available to supervise building, but this extra service incurred a fee. Consequently, construction was often unsupervised and as a result, Boyd admitted that, half of the "designs were destroyed beyond recognition" by the time they were built.

Of particular note, as it relates to this research, was that Boyd was heartened by the degree to which clients had thought about, and read up on the subject and were prepared to accept modern designs. He noted "These were people who could not afford original paintings but were able to buy reproductions"

In response to criticism the small home service faced, Boyd pointed out that if architecture were to progress, then it needed to be available to all, not just the wealthy. The small home service provided one eighth of all houses being built in the metropolitan area and was a financial success for the RVIA. Interestingly Boyd always made clear though that "The policy of the Small Home Service has never been to provide the public with exactly what it wants. That is the role of the speculative builder."

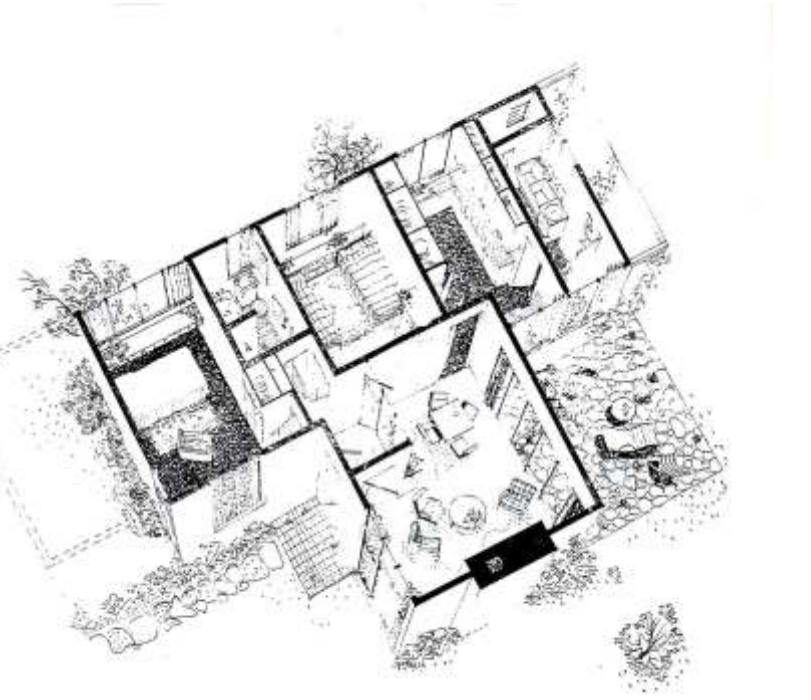


Harry Seidlers design for Land Lease, Sydney

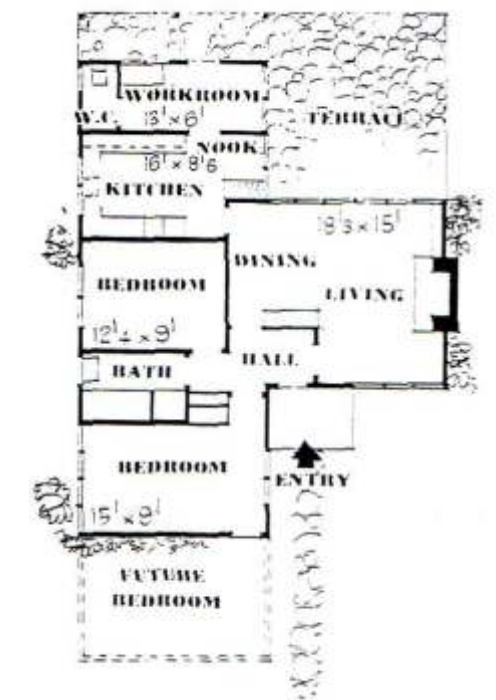


Nino Sydneys design for Land Lease, Sydney

The Age 1951



Small home design No. T 239 by Boyd, 1948



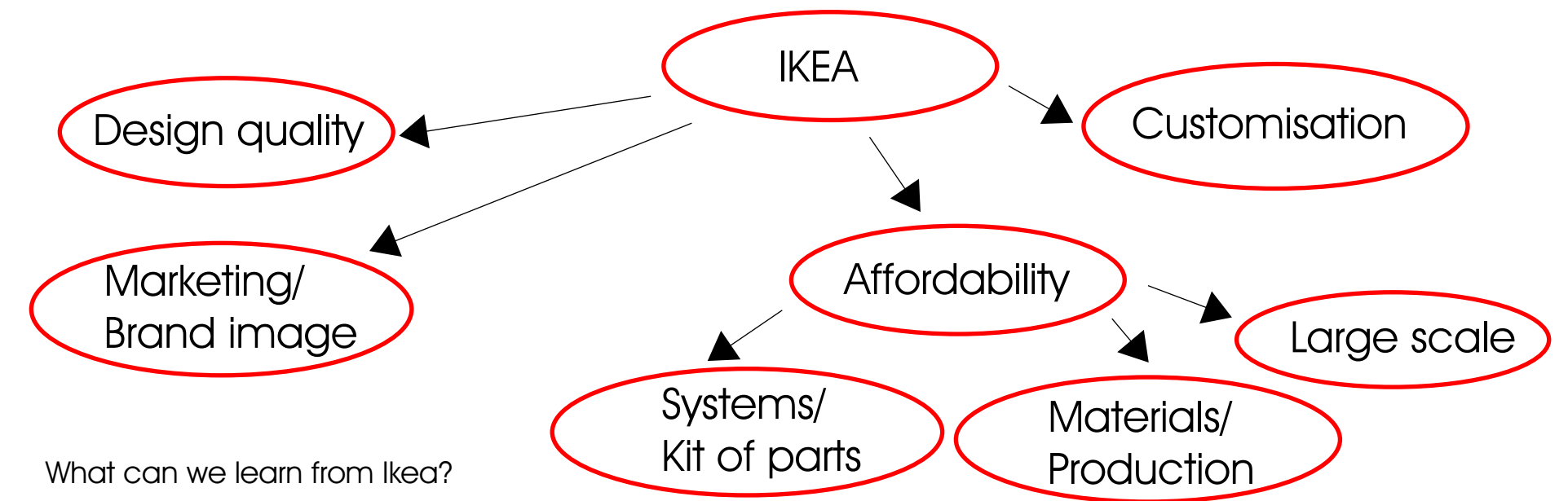
Learning from Ikea;- Design for All

Ikea

Ikea offers a wide range of products which are varied in style. The romantic at heart will find just as much as the minimalist. They do not however, have everything. **They do not for example have the very extreme or the over-decorated.**

Ikea claims to combine good design and function with the right quality at an affordable price. According to the company's ethos, to design a desk that costs a lot is easy, but to design something that is affordable to many can only be achieved by a truly talented designer and product developer.

By working together with skilled manufacturers, Ikea attempts to find ways to get the most out of raw materials. They know how to produce furniture at a low cost while still keeping the original design idea and aesthetic.



The



(Source IKEA)

Story





The "Ikea story" illustrates my personal experience about how we like to purchase products. As consumers there is an undeniable tendency to want to see and experience the product prior to purchase. Knowing how much the product costs is an extremely important aspect in the decision making process. It can be seen that new materials and production methods are explored in the furniture industry and help to reduce costs. The construction industry is certainly not as globalised and buildings are not furniture but it becomes clear that the one off architect designed house despite all the quality it has to offer is a risky, unpredictable and expensive enterprise in the average consumer's eyes. This may be why the volume builder offering a standard house is so successful. Is there a way to combine some of the advantages of the architect designed and the volume built home?

Customisation means an incredible variety and choice can be achieved within an overall system

FAKTUM planning guide

1 CHOOSE YOUR CABINETS
For overview and measurements see below.

2 ARRANGE THEM THE WAY YOU PREFER
You can dress your FAKTUM kitchen with different kitchen doors. See p. 200–201.

3 FINISH WITH WORKTOPS, KNOBS, HANDLES AND LEGS Visit the IKEA store!
Choose from a wide selection of worktops, sinks, taps, knobs, handles, lighting & accessories.

BASE CABINETS					DRAWER UNITS					
Prices include 2 shelves, drawers where shown and 130° hinges. H70, D60cm incl. door. H86cm incl. plinth. Legs, plinths, cover panels, benchtops and handles sold separately. *For under-bench oven										
Cabinet width in cm	30	40	60	60	80	40	60	40	60	*60×70
ÄRLIG white	\$97	\$109	\$133	\$145	\$173	\$290	\$370	\$151	\$185	\$187
APPLÅD white	\$127	\$140	\$180	\$205	\$235	\$335	\$415	\$185	\$230	\$195
NEXUS birch	\$152	\$170	\$205	\$255	\$295	\$355	\$445	\$220	\$275	\$200
HALLARUM brown	\$152	\$170	\$205	\$255	\$295	\$355	\$445	\$220	\$275	\$200
STÅT white	\$152	\$170	\$205	\$255	\$295	\$335	\$415	\$215	\$265	\$195
NUMERÄR stainless steel	\$187	\$215	–	\$325	\$385	\$440	–	–	–	\$220
KALSEBO beech	\$177	\$200	\$245	\$305	\$355	\$415	\$525	\$245	\$305	\$210
FAGERLAND antique stain	\$177	\$200	\$245	\$305	\$355	\$415	\$525	\$245	\$305	\$210
LILJESTAD dark brown	\$197	\$225	\$275	\$345	\$405	\$470	\$585	\$265	\$335	\$215
ÄDEL medium brown	\$197	\$225	\$275	\$345	\$405	\$470	\$585	\$265	\$335	\$215
ULRIKSDAL oak	\$217	\$245	\$305	\$385	\$445	\$500	\$615	\$295	\$365	\$220
Frame ONLY	\$65	\$70	\$85	\$85	\$100	\$70	\$85	\$70	\$85	\$110

DRAWER UNITS		CORNER BASE CABINETS		CORNER WALL CABINETS		FAN CABINETS			
Prices include shelves, drawers, carousel in corner cabinets where shown and 130° hinges. H70, D60cm incl. door. H86cm incl. plinth. Legs, plinth, cover panels, benchtops and handles sold separately.									
Cabinet width in cm	40	60	80	90×90	120	H70 60×60	H92 60×60	D37 60×35	60×57
ÄRLIG white	\$238	\$289	\$370	\$330	\$303	\$157	\$182	\$73	\$87
APPLÅD white	\$270	\$340	\$445	\$390	\$350	\$192	\$222	\$95	\$125
NEXUS birch	\$305	\$375	\$480	\$430	\$375	\$217	\$252	\$115	\$160
HALLARUM brown	\$305	\$375	\$480	\$430	\$375	\$217	\$252	\$115	\$160
STÅT white	\$300	\$365	\$470	\$430	\$375	\$217	\$252	\$115	\$160
NUMERÄR stainless steel	–	\$495	\$625	–	\$435	–	–	–	–
KALSEBO beech	\$350	\$445	\$565	\$490	\$415	\$247	\$277	\$145	\$185
FAGERLAND antique stain	\$350	\$445	\$565	\$490	\$415	\$247	\$277	\$145	\$185
LILJESTAD dark brown	\$390	\$495	\$625	\$540	\$445	\$267	\$307	\$165	\$205
ÄDEL medium brown	\$390	\$495	\$625	\$540	\$445	\$267	\$307	\$165	\$205
ULRIKSDAL oak	\$430	\$535	\$665	\$580	\$475	\$277	\$337	\$205	\$225
Frame ONLY	\$70	\$85	\$100	\$160	\$155	\$115	\$135	\$55	\$65

Kitchen

Kitchen

HALLARUM brown Brown stained, clear lacquered eucalyptus veneer on particleboard. AVSIKT door in tempered glass and aluminium frame. 244.300.00
See this door style on page 178.

FAGERLAND antique Antique stained, clear lacquered solid pine. Tempered glass door. Not available in Moore Park and Springwood.

KALSEBO beech Clear lacquered solid beech frame/beech veneer on particleboard. Tempered glass door.
See this door style on page 182.

ÄDEL medium brown Medium brown stained solid birch frame/birch veneer on particleboard. Tempered glass door. Not available in Moore Park. **See this door style on page 185.**

LILJESTAD dark brown Dark brown stained, clear lacquered solid oak. Tempered glass door. Not available in Moore Park. **See this door style on page 187.**

ULRIKSDAL oak Clear lacquered solid oak. Tempered glass door.
See this door style on page 190.

(Source IKEA Catalogue 2006)

Prefab

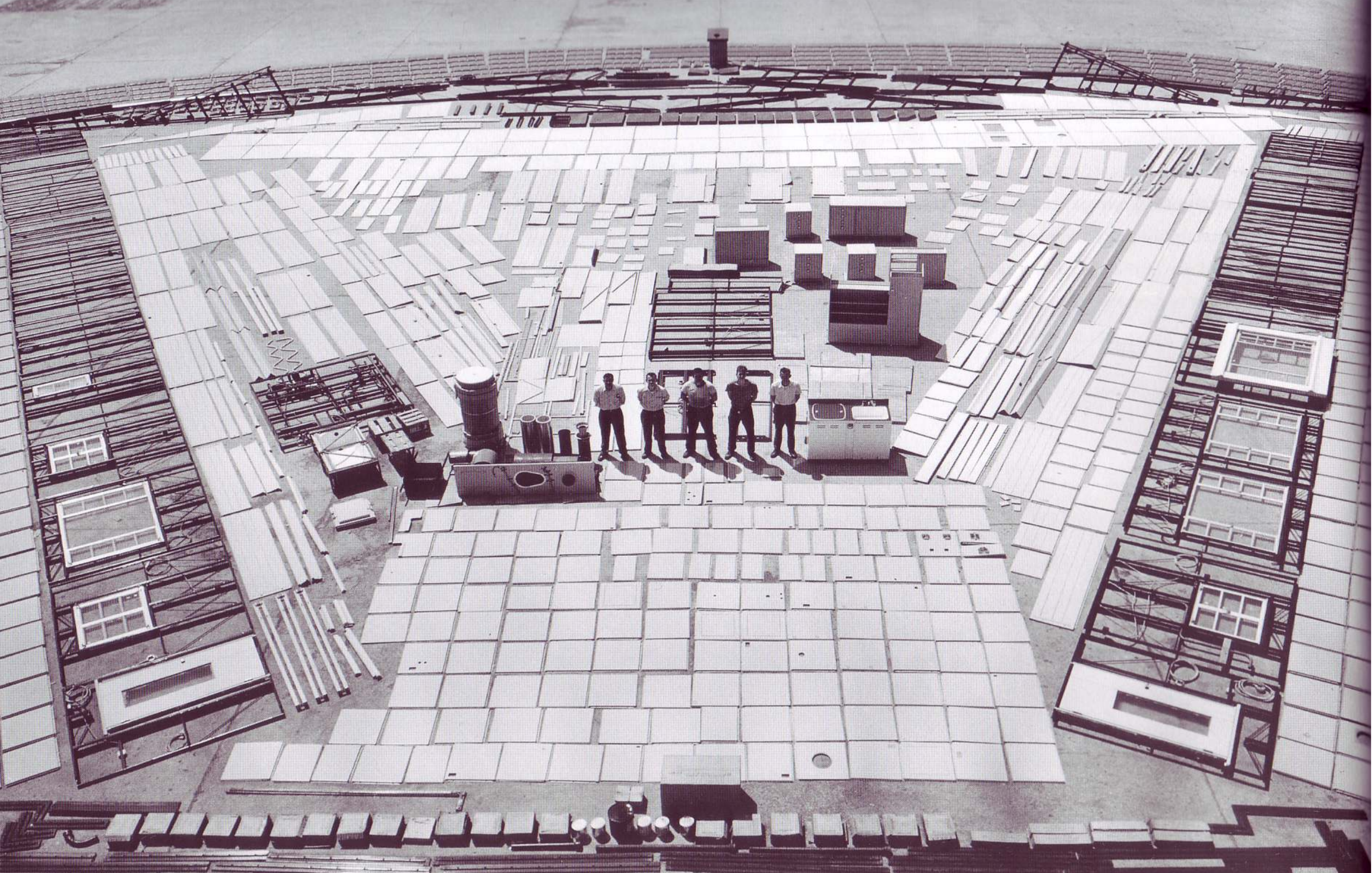
This research aims to investigate the possibilities of pre-design and prefabrication as alternative methods for architecture's involvement in the suburban housing market, towards delivering affordable, sustainable and well designed homes.

Architectural involvement with prefabrication in the past has largely failed. In contrast, non architectural ventures into prefabrication have been successful, for example Sears mail order homes sold over 100,000 designs.

With regards to new materials and in conjunction with digital production and communication, the potential for prefabrication has changed and improved. Prefabrication can now offer advantages in terms of waste reduction during the production process, optimised production processes in general, and better quality control.

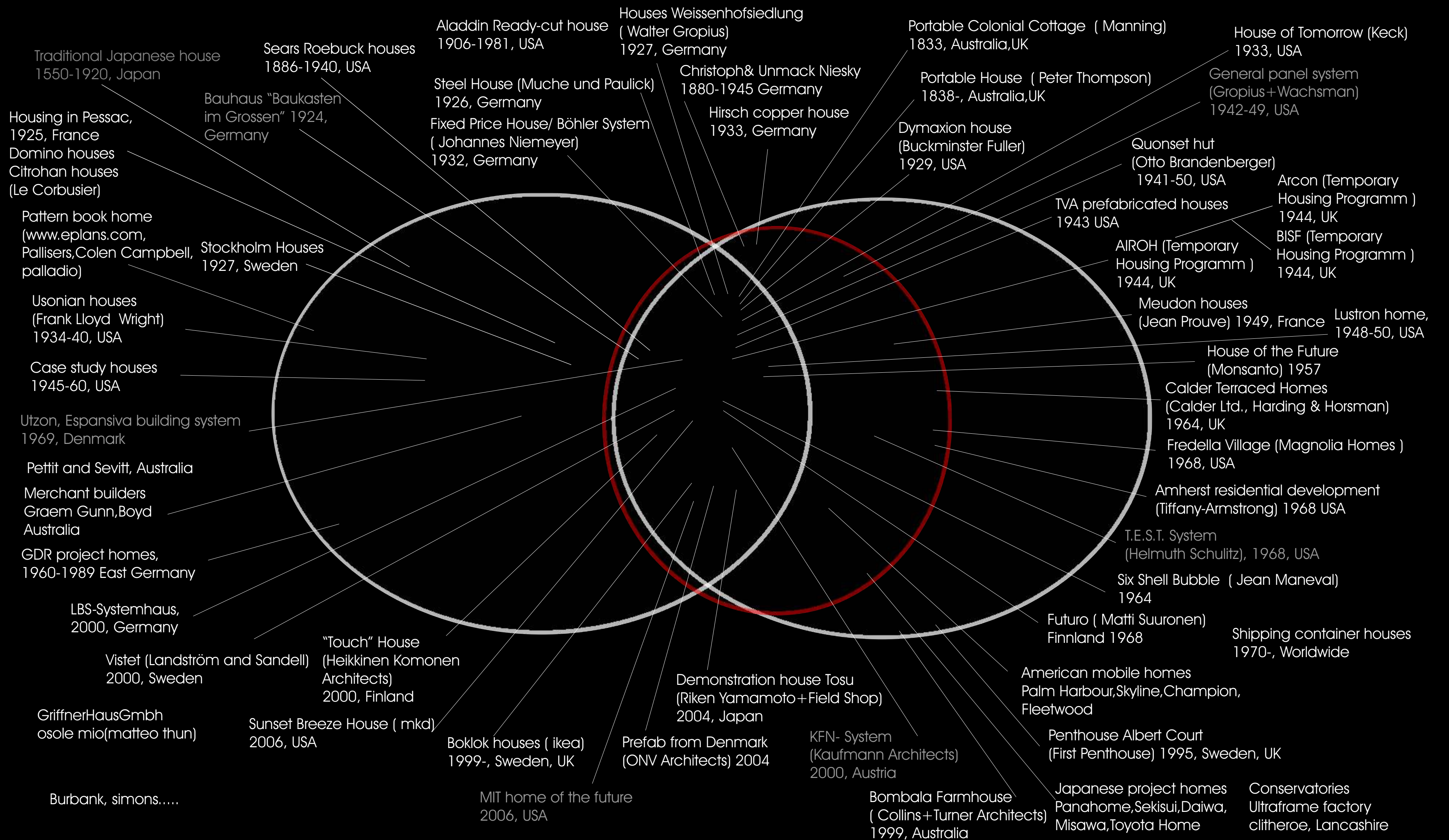


1920 Sears, Roebuck and Co Catalogue(Herbers,2004)



Pre-design

Pre-fabrication



The illustration on the facing page charts the international pre-designed and prefabricated homes that have been investigated as part of this research project. The left hand side details pre-designed homes, the right; prefabricated. The two groups overlap presenting a combination and further to this, there are also design systems.

To elaborate: There are buildings that are simply pre-designed without being prefabricated, for example the Australian volume built homes, the GDR project homes and the pattern book homes as offered in the USA. All of these homes are custom built but standard designs and are the most widely built types of houses.

Then there are houses that are prefabricated but not pre designed. They could be called one off prefabs, for example the penthouse of Albert Court, or the Bombala farmhouse.

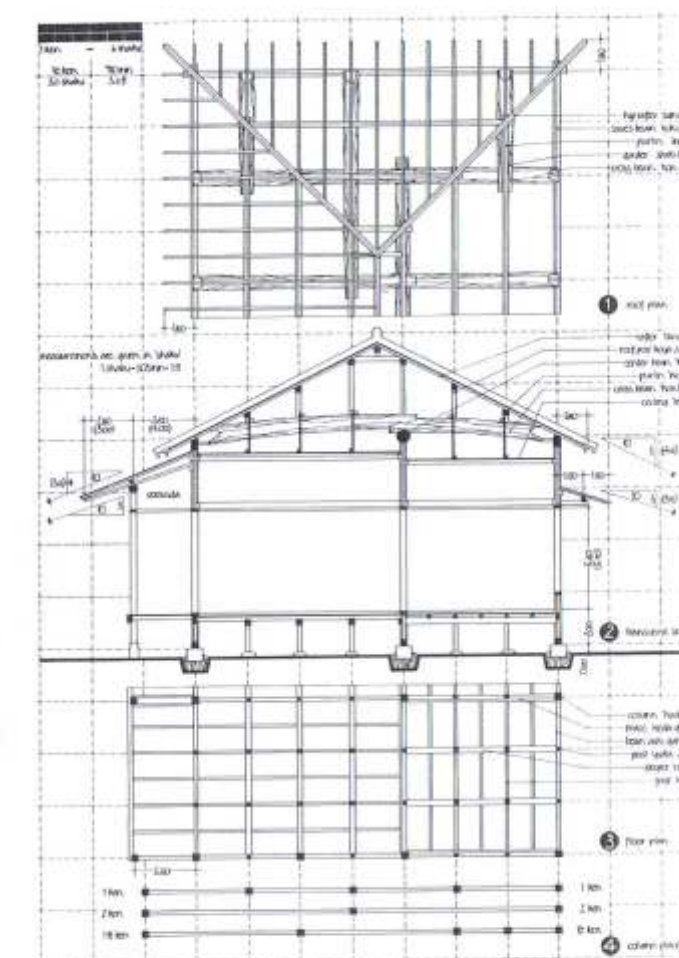
These buildings have used prefabrication to achieve cost savings, increase quality and save on construction time.

Then there are houses which are pre-designed and prefabricated, like the Ikea Boklok houses, Sears Roebuck homes, and Buckminster Fuller's Dymaxion house.

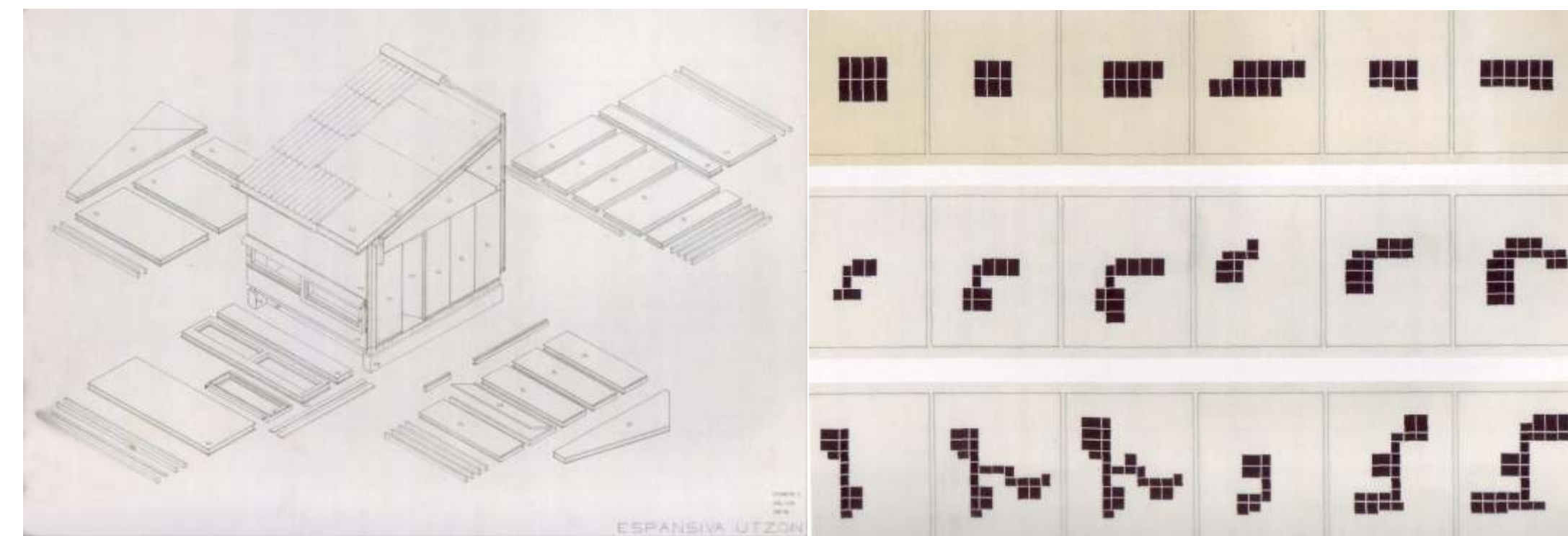
Further to these combinations there are design systems which can be prefabricated, for example the Utzon Espansiva building system and the Gropius and Wachsmans general panel system. Interestingly there are also design systems which are not prefabricated like the one used in the traditional Japanese house. These houses had a modular order or modular co-ordination. They used a building system in which every component was governed by fixed geometric rules. They were traditionally built on site by craftsmen and the reason for its modular nature was an aesthetic decision rather than a direct engagement with the benefits of prefabrication.



Ikea Boklok houses

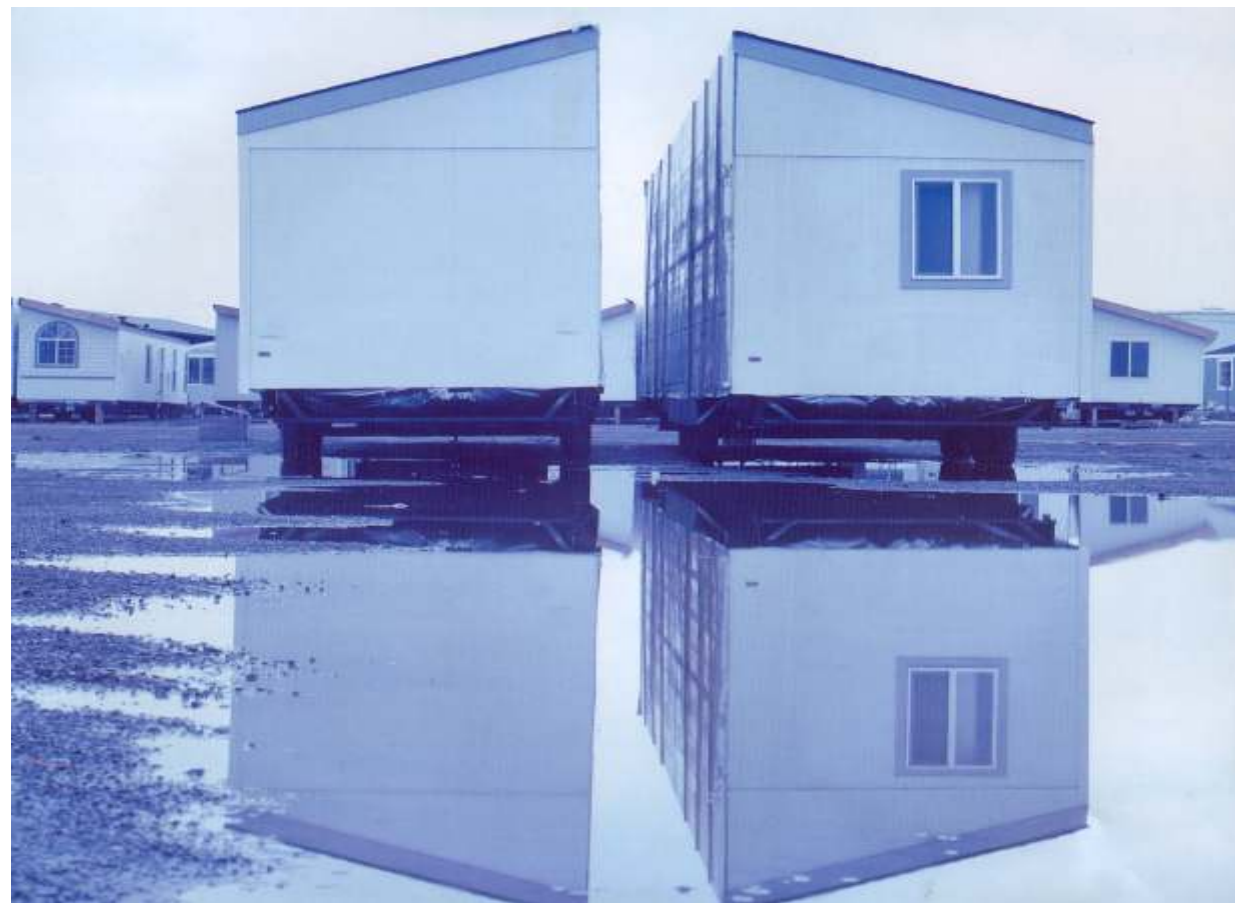


The modular order of the Japanese house (Engel, 1985)



Utzon, Espansiva design system

Contemporary prefabrication can be cheap, is popular and operates from an industrial base. In comparison, modern architecture is expensive, unpopular and removed from industrial production. Resultantly, past architectural attempts to enter into the territory of the prefabricated house has ended in disappointment more often than success. Despite this, Colin Davies argues that “prefabrication is the key to the reformation of modern architecture.”(Davies, 2005)



Mobile homes in the US (Arieff,Burkhart,2002)

Globally, prefabricated homes have been constructed widely and successfully. Mobile homes for example, account for 30% of all new single family homes in the USA. They are 50% cheaper than a comparable on-site built home.

80% of buildings by value built worldwide are not designed by architects. Due to being produced outside of the architectural realm, architecture claims prefabrication to be a failure.

However as Colin Davies points out “for 150 years or more the prefabricated house has managed perfectly well without the architect’s guidance”. (Davies, 2005)

Consequently, if architecture wants to engage within a wider market; its broader context and have an effect on peoples most intimate experience with buildings, it needs to embrace the conditions of prefabrication, in particular its insistence on the knowledge of production methods, marketing, distribution and construction. Davies argues that “if architecture could adapt itself to these conditions and succeed in the prefab business, then it might recover some of the influence it has lost in the last 30 years and begin to make a real difference to the quality of the built environment”

(Davies, 2005)



School in Jamaica made from shipping containers(Herbers,2004)

The picture below shows the National Panahome factory in Japan where detached houses are produced in a fully automated process.



National Panahome factory interior, Japan (Davies,2005)

In Japan close to 50% of new housing comprises of detached dwellings. Of these, one third is prefabricated. Japan produces 120,000 factory made homes a year illustrating the potential for prefabricated homes.

In the past, mass production called for standardisation. However the contemporary use of Computer Aided Manufacturing allows for Lean production, flexibility and a response to specific demands. This consequently allows for a reduction of waste, material, time and effort.

Computer aided manufacturing allows for a customisation of components without a large cost increase. In conjunction with lean production, it makes the non-standard factory-made building a real possibility. As consumers are, generally speaking, not designers or inventors, the limitations would be human, not technical. Customisation can only work within an overall system.

When products are mass produced and custom made, it is referred to as mass customisation. Car manufacturers now see their products as a range of components: chassis, bodies, engines seats, interior linings, radios etc, that can be put together in different combinations. Cars can now be built to order, increasing the number of possible component combinations.

The Japanese prefab industry uses customisation and lean production. It gives customers what they want. Surprisingly this mass production does not reduce choice or create monotony. The delivery and erection of the house is fast and efficient. The homes are high quality products and the company that produces them provides an after sale service. Customers seem to take pride in their participation in the whole customisation process. They identify with the brand. The major problem is its poor design quality.



Display Village, Osaka (Davies, 2005) The houses are of poor design quality.

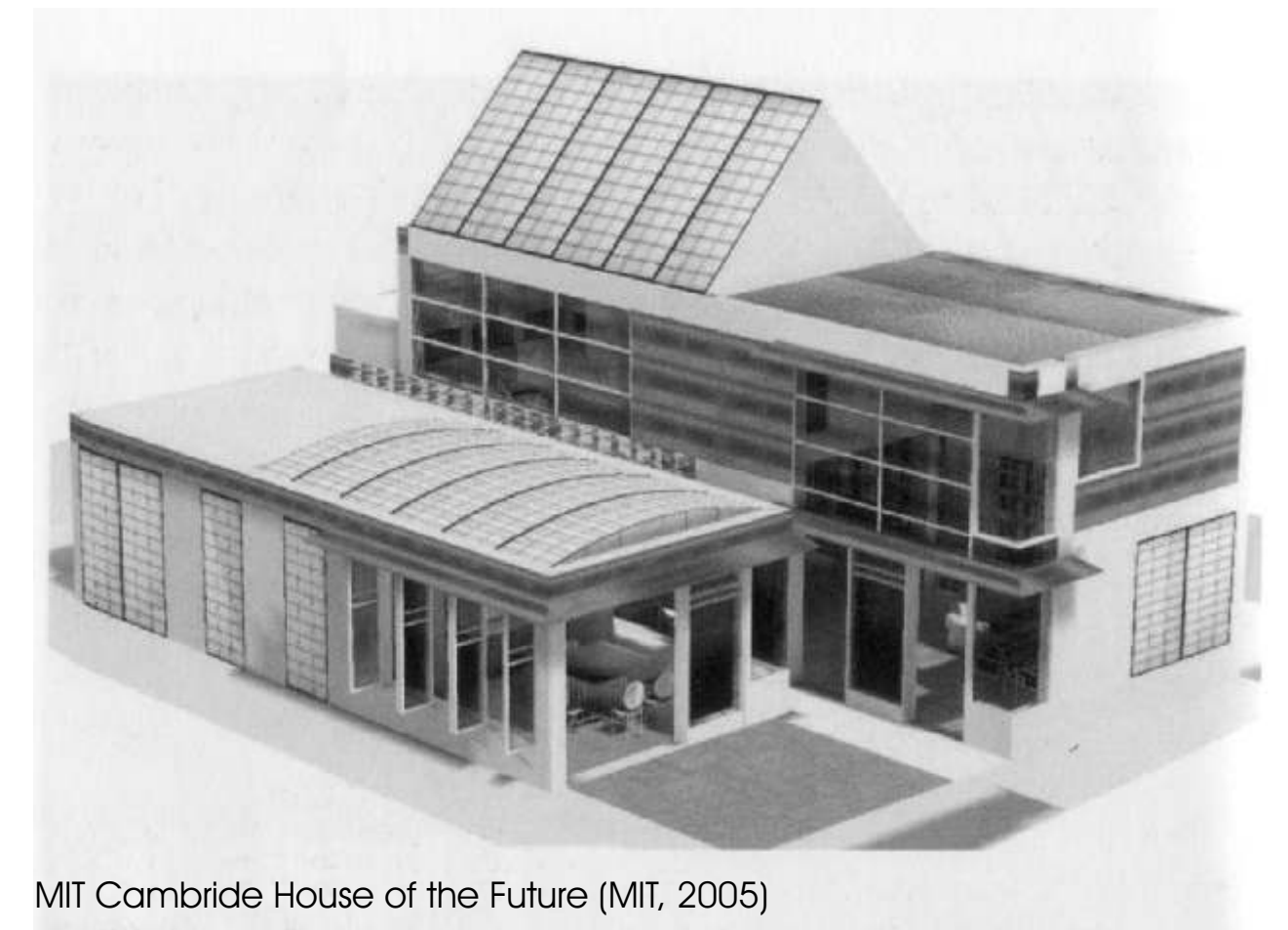
MIT open source building.

At MIT's home of the future laboratory, architect and researcher Kent Larson is attempting to apply mass customisation to housing. He argues that "in the near future companies as varied as Ikea and BMW will manufacture house components."

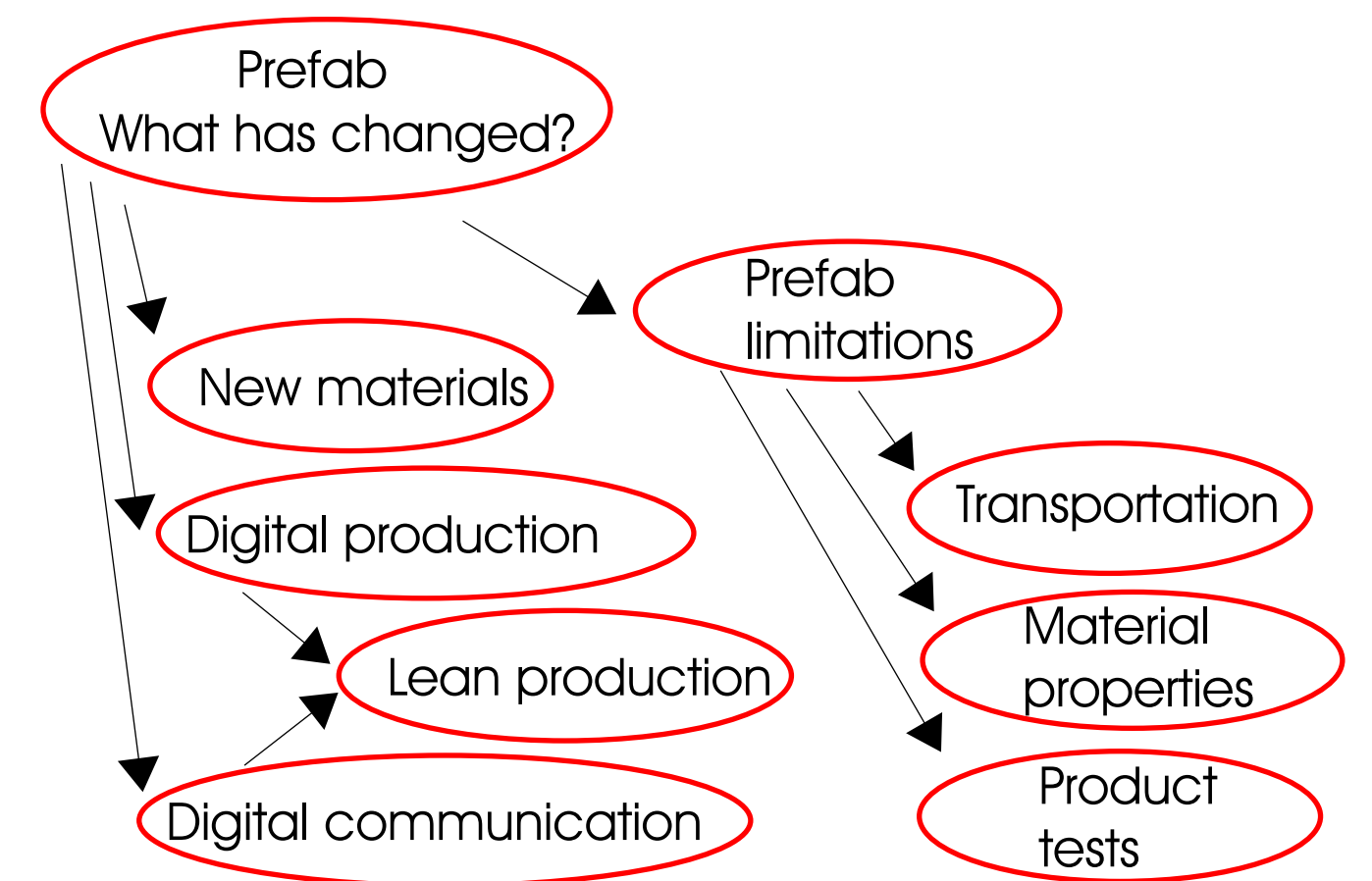
His open source building alliance proposes a system which consists of chassis and infill panels. The chassis functions as structural support and contain utilities and the infill panel can be customised.

The first open source building was assembled in 2006. It was completed in less than a month and the waste produced during production fit into just two small rubbish bins.

The open source building alliance is also experimenting with design engines and user interfaces.



MIT Cambridge House of the Future (MIT, 2005)



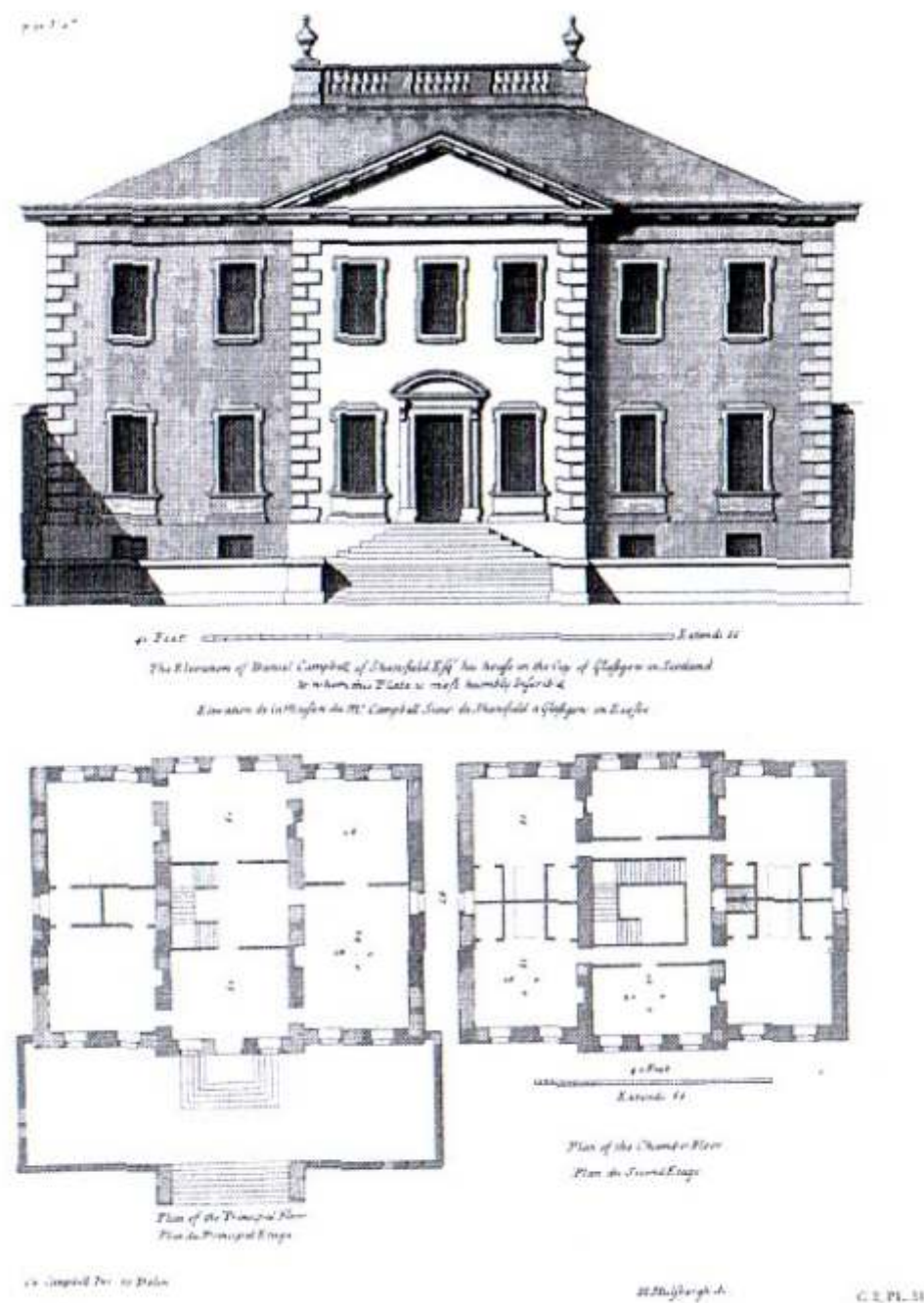
What has changed for Prefabrication? Where are the ongoing limitations?

Pre-design

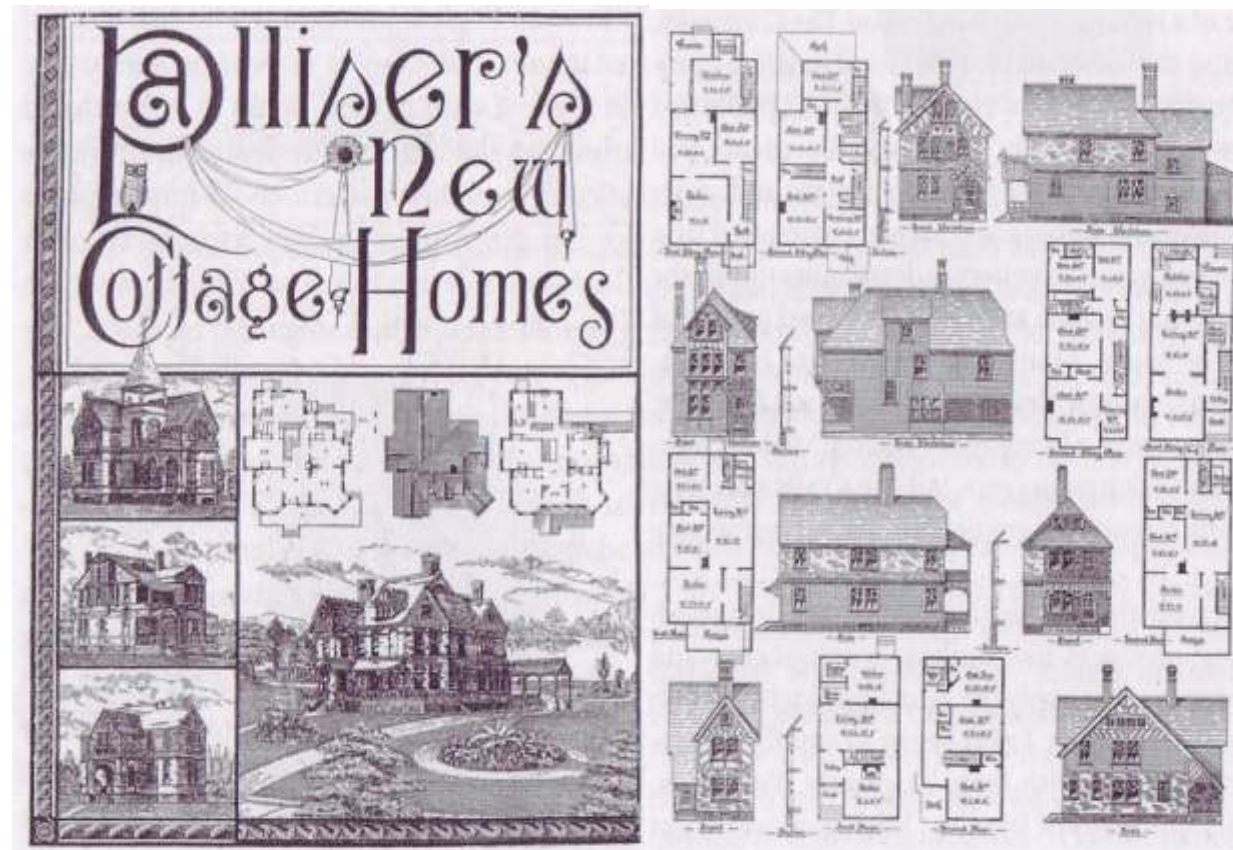
Outside the field of architecture, most buildings today are serially produced, and are standard products, and have been so for many years.

The traditional English house is a standard product, not prefabricated but rather pre-designed.

Before the 20th century, architects were not so obsessed with specific sites and it was perfectly normal to design speculative buildings without reference to any particular site. Collections of speculative designs were published in pattern books.



18 Pattern book, Colen Campbell England 18th century



Pattern book Pallisers, New Cottage homes (Davies, 2005)

American architects, such as Pallisers, used pattern books as advertisements for their practice. Blueprints could be bought by mail-order and they offered an architectural consultancy based on the adaptation of a standard design.



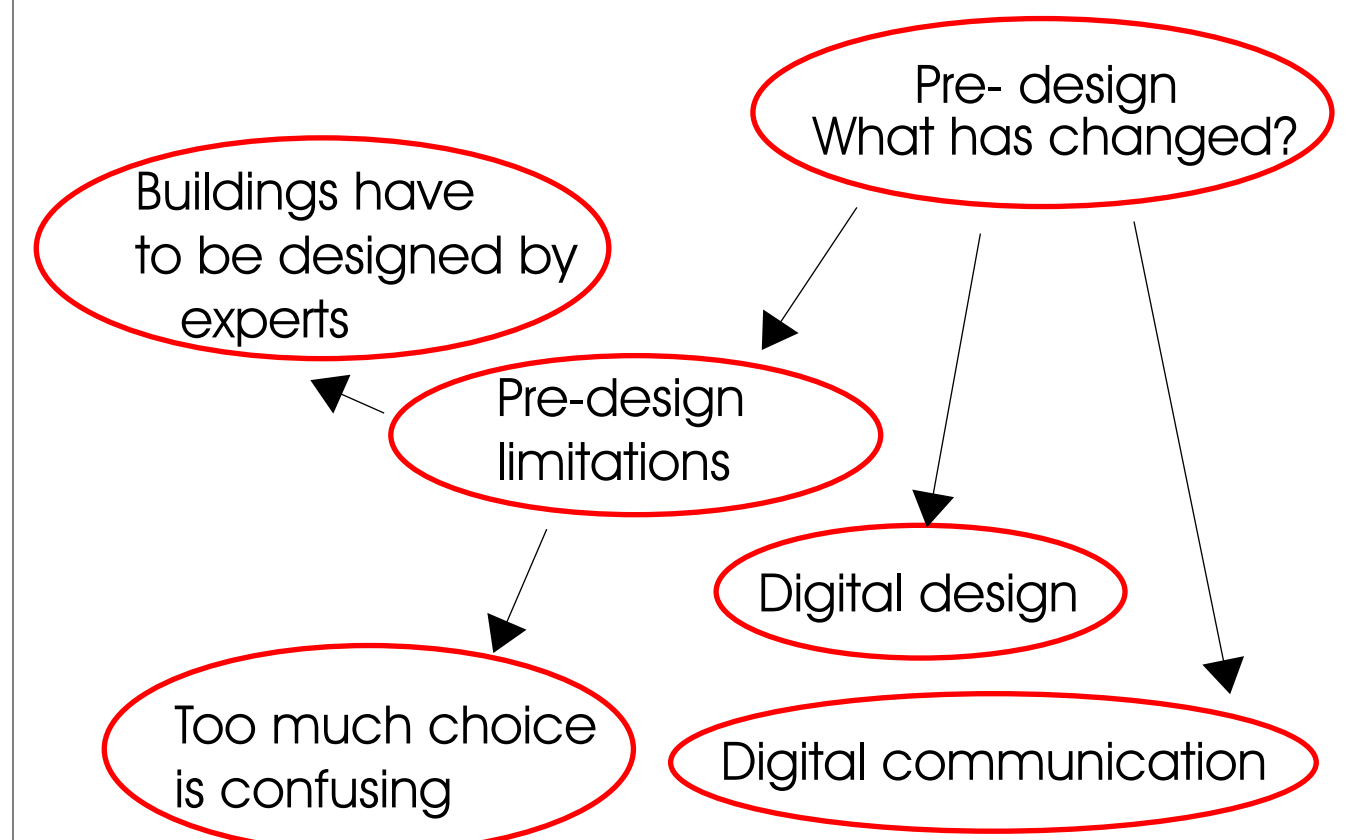
Typical Swedish pattern book (Davies, 2005)

In a Swedish pattern book, the customer finds the plan that comes nearest to meeting his/her requirements and then refines it with the help of a draftsman.

Pattern book companies are especially popular in the USA. Nowadays they have web sites, with thousands of houses in databases searchable by size, number of bedrooms, style and so on.

These Web sites offer plans and often have customisation gimmicks. However architects are not involved and the designs are conservative and are generally of poor design quality. These houses are not prefabricated, rather they are built on site by a local contractor, chosen by the customer, making price and quality less predictable.

Easy to use consumer CAD programs demonstrate how the computer could allow even more radical ways to involve customers in the design process.



What has changed for Pre-design? Where are ongoing limitations?

2. Creating a Design System

Modules + components.

To achieve affordability and sustainability and to make the architect competitive in the detached housing market, we need to consider new ways in which we deliver architecture.

Generally speaking, clients are presumed to lack the required aesthetic knowledge and are assumed to be disinterested in modern architecture. I do not however believe this to be true. Arguably, modern architecture has excluded ordinary people.

At present the potential homebuyer has two options, he or she can purchase a generic house produced by a speculative developer (The choice of almost every one) or buy a one off architect designed house which is often expensive, time consuming and risky (the choice of a minority).

In response to these problems, I am interested in exploring the possibilities of a design system created by the architect that consists of modules and components on a web based interface that can be used by non professionals to create sustainable and affordable architecturally designed homes.

The Customisation allowed for in the proposed design system would allow houses to be adaptable to particular sites in terms of such things as orientation and topography. The flexibility of a design system also offers great potential for engagement with passive solar design.

Adaptability to clients needs such as size and layout is also offered by the design system.

The customer could self arrange his or her house with an additional architectural consultancy service.

The design system places a price tag on each component thus making the cost more predictable.

The aim of the design system is to combine much of the quality and advantages of a one off architecturally designed house - in particular, the consideration of user and site needs, with the affordability and predictability of a completely pre designed volume builder house.

Traditional architecture has often used building systems for aesthetic as well as practical reasons.

Regularity and repetition are features of most architectural traditions and only rarely are they motivated by the efficiency of production.

For Le Corbusier, standardisation of components was a philosophical and artistic as much as a practical concept.

The system approach has in the past been misused. During the 1950 and 60's, for ideological reasons, it was applied on a rigorous and limitless scale. Technical problems occurred that negated the claimed cost reduction.

The accuracy of the modules as they applied to construction was not good enough and discrepancies occurred which multiplied over the length of the building (supposedly identical panels had hidden variants). Manufacturing was not understood by the architects. Less ambitious architects and engineers produced dull, monotonous buildings.

Contemporary technology can prevent these problems. Computer controlled machines and lean production allow for greater flexibility. Manufacturing on a relatively small scale can now be applied to buildings.

The perfect modular system, or the universal module architects envisioned, never existed in other industries. Car manufacturers just fit their own components together without trying to make them fit into other cars from a different manufacturer. Components don't have to be interchangeable but they do have to be designed by an expert.

In the design interface that I am proposing, the module would not be static, but could rather change over time. It would be used to simplify the design process by using it as a pre-designed element where the knowledge of the architect is embedded. Computer technology would allow us to store a great number of these modules and their variations in an electronic library.

To find out what the design system needs to provide it was tested in speculative designs, site specific designs and user experiments.

Testing mode - Speculative designs; Catalogue Houses Part 1

First phase of the module development

The first step in the process of creating the interface was the development of the modules and components for the design system. This system developed over three phases. The first being "Catalogue Houses Part 1". The second, site specific designs in Richmond and Broadmeadows and the third, "Catalogue Houses Part 2" and user experiments.

Module phase 1.

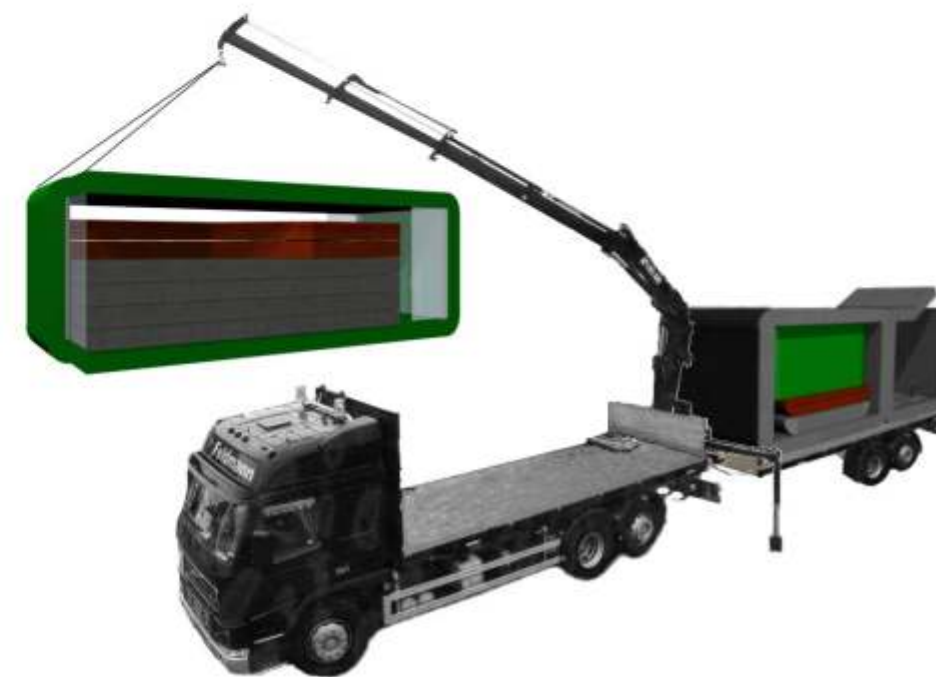
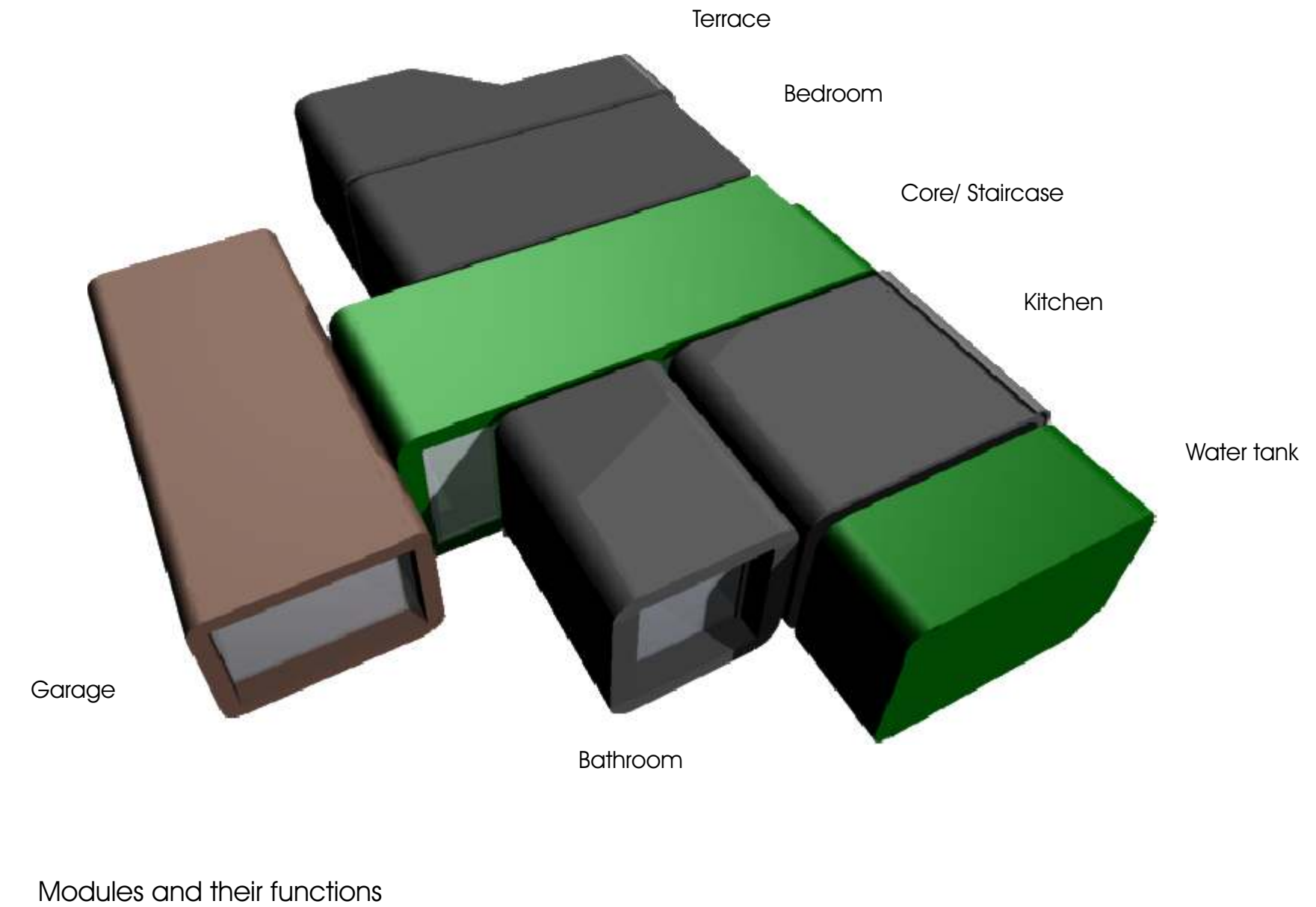
The first modules were determined and created by the functions of the room. The modules were made using simplified, reduced forms. They all had flat roofs and round edges and were seen as futuristic, high tech, almost space ship like objects. They would rely on expensive high tech materials to be constructed.

Initial designs of the prefab house showed the additive principle of the module.

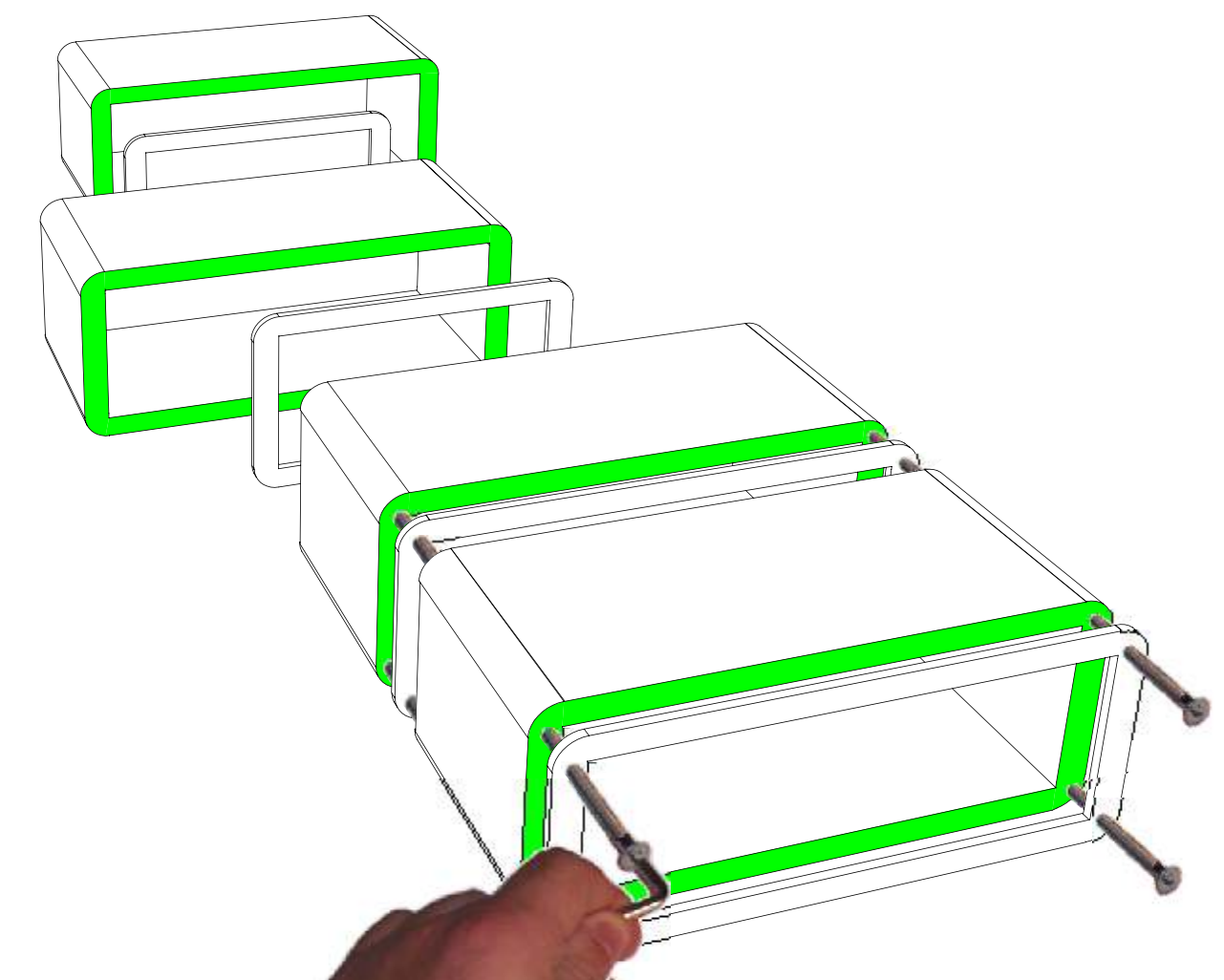
One important question in the development of the module was, how much choice is needed in terms of design aspects such as spatial quality and the architectural formal language.?

Technical aspects that were considered, include the joining of the modules, specifically reducing the number of joints, limitations of transportation and production (panel size is 6x3 meters), and the structural performance of the roof and floor.

The modular System includes sustainability features like water tanks, solar hot water systems, solar panels as window shutters and a highly insulated envelope. Optimised orientation was intended to achieve heat gains in winter to reduce energy demand for heating.



Transportation of the module to the site



Catalogue Houses Part1

Can the architect designed house be a product with a price tag?

Should the price tag be designed first? Designing the price tag first is Ikea's approach to design.

Can the house be an object like a piece of furniture?

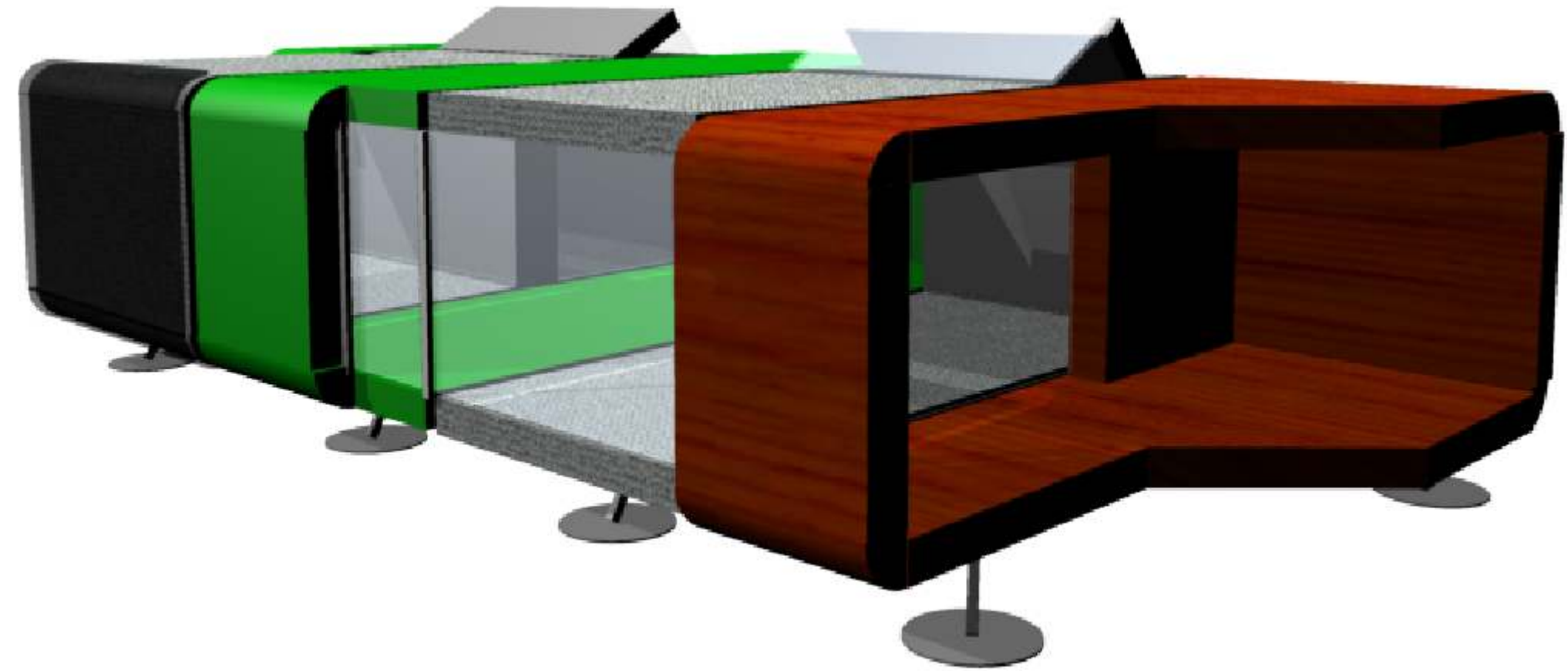
The intention of these designs is to demonstrate the adaptability of a design system to different user needs within an overall system.

Optimised orientation was intended to achieve heat gains in winter and to reduce energy demand for heating. Shading elements prevent overheating in summer.

The first houses were raised above the ground on legs. They looked temporary and were intended to be portable. They are neutral to their location, objects which are distinctly foreign.

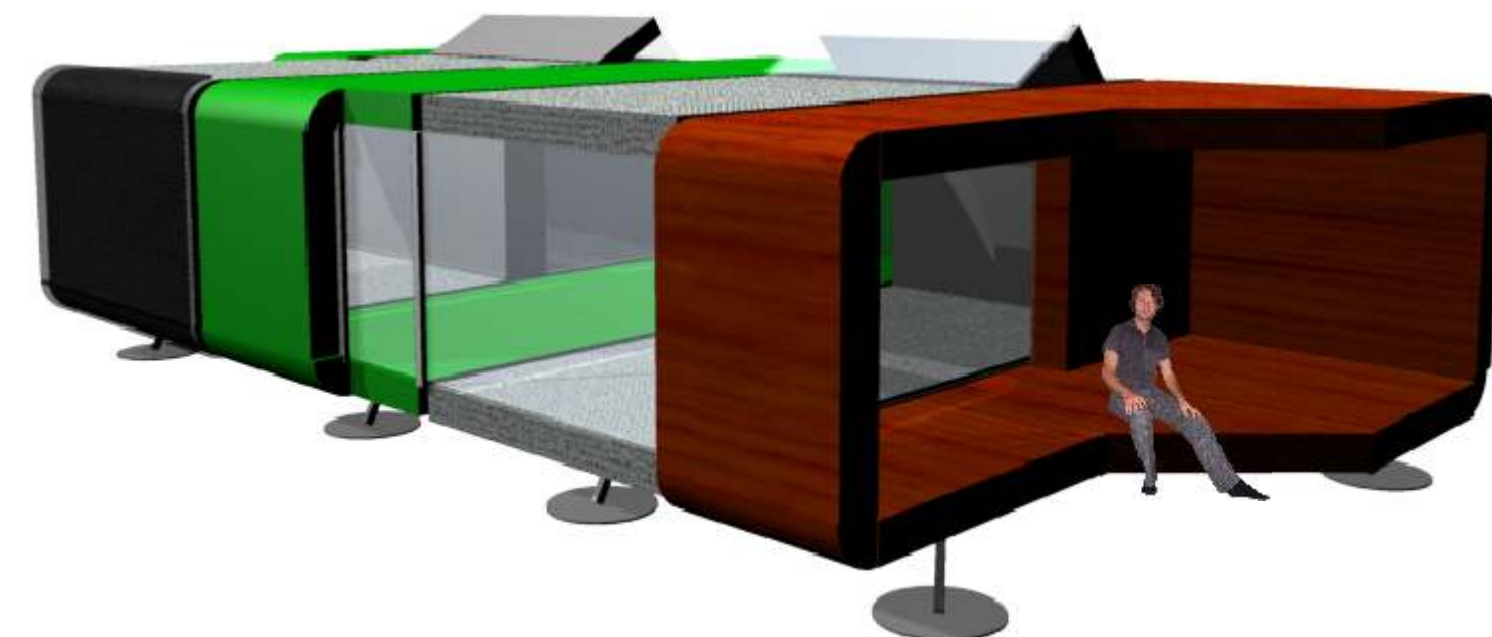
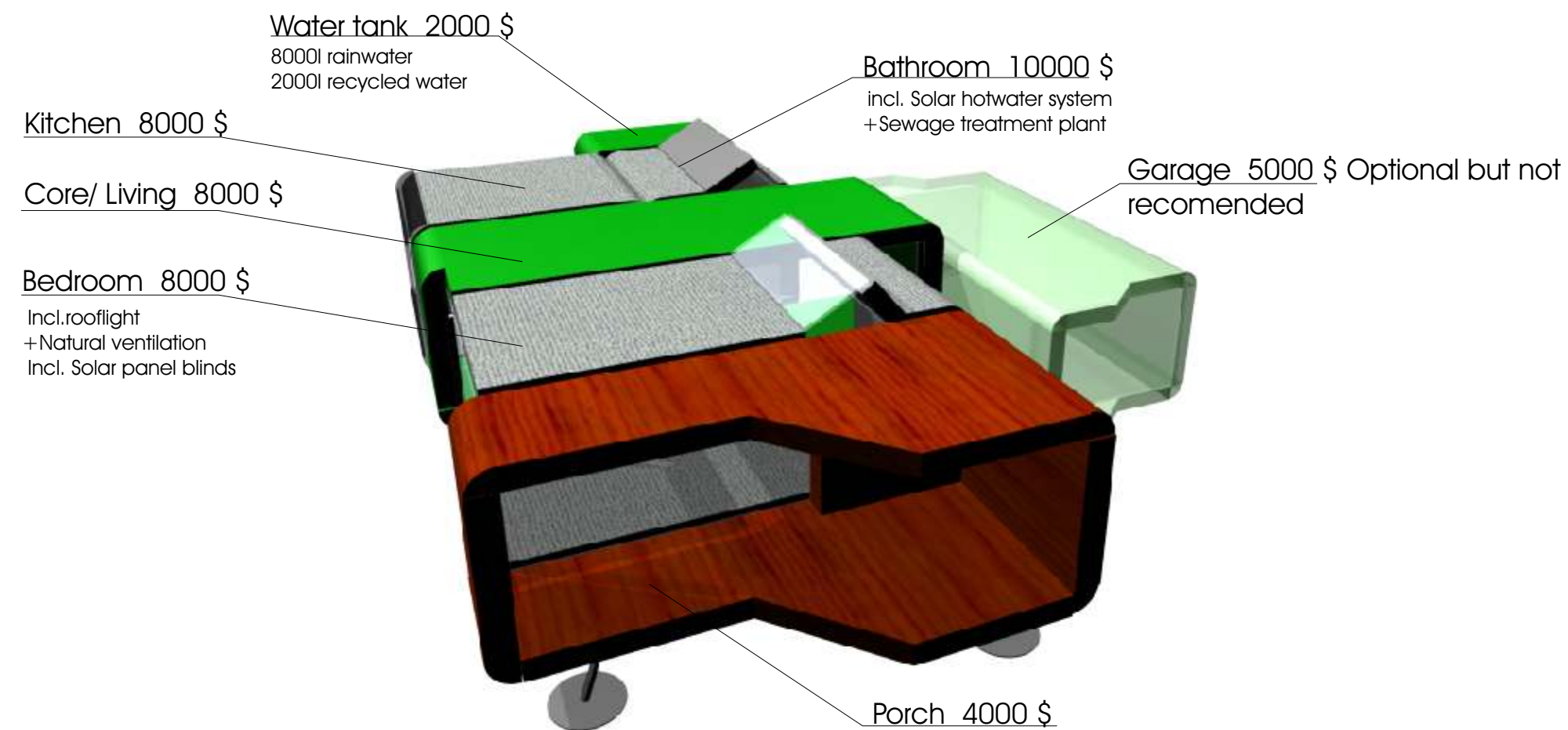
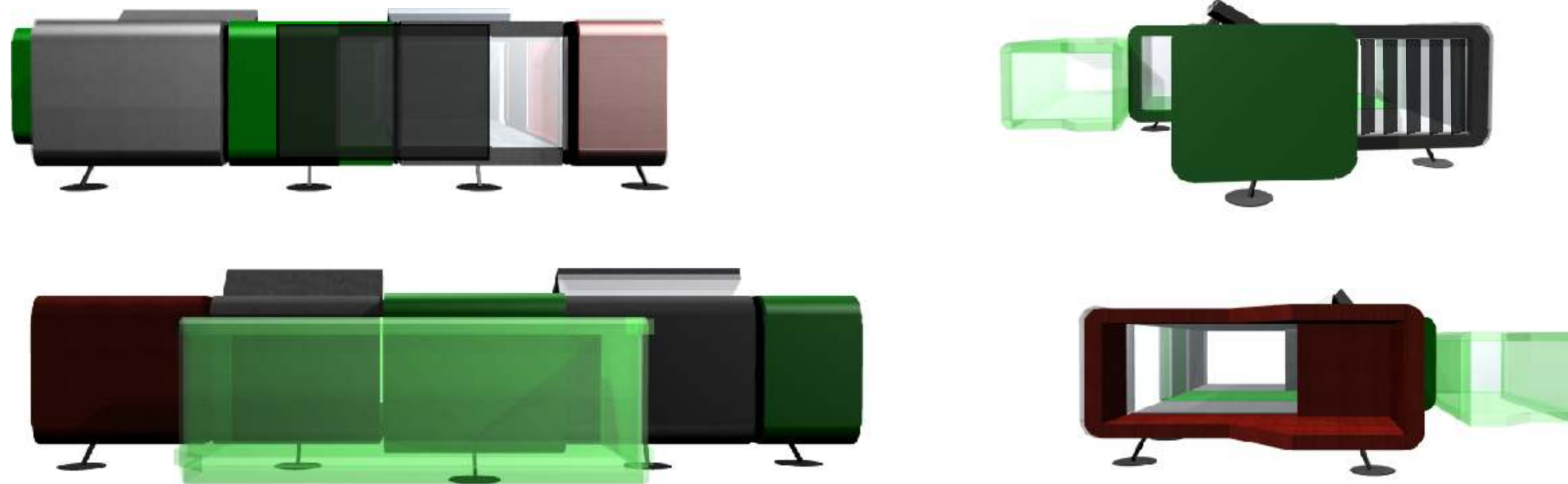
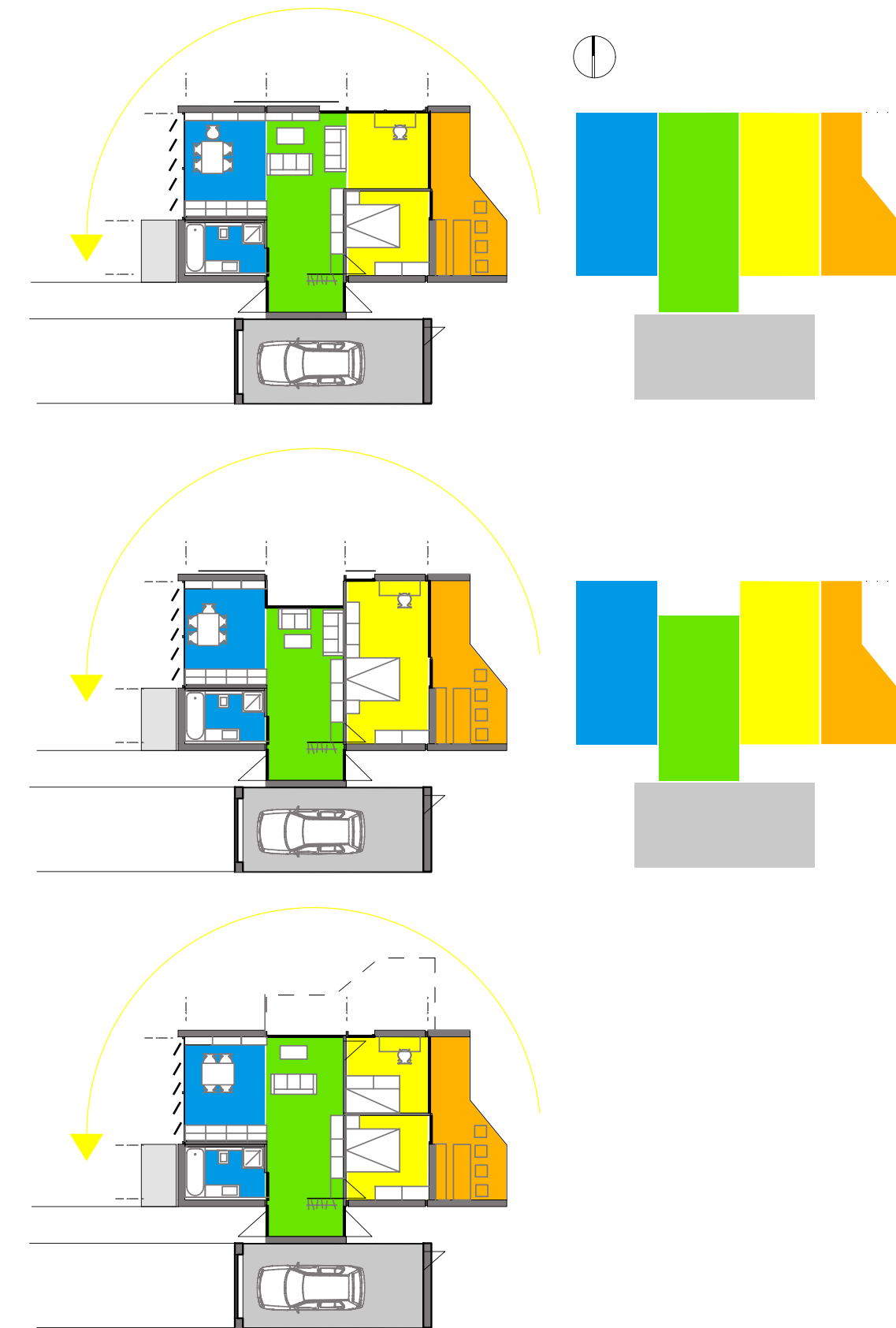
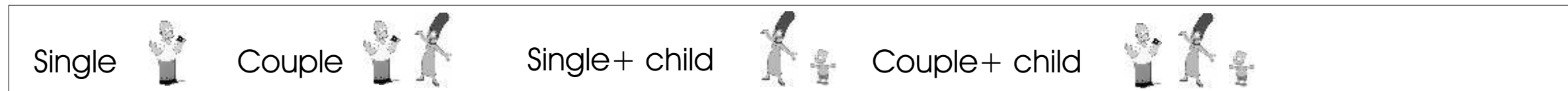
The attempt to find the one "universal" module that can provide everything proved impossible. In order to overcome the stereotype of prefabrication, the designs were intended to be seen as "groovy" and futuristic, the additive principle was 'architecturally' expressed.

There are similarities to the 70`s futurists, for example, Richard Rogers "zip up" house .



Catalogue house 'Single'

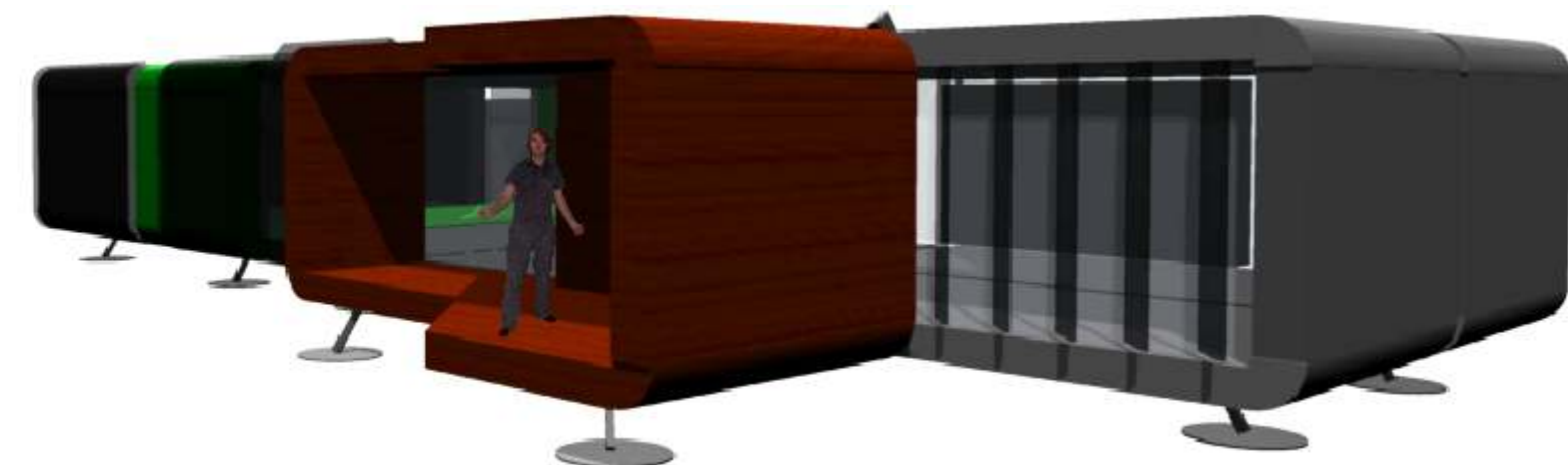
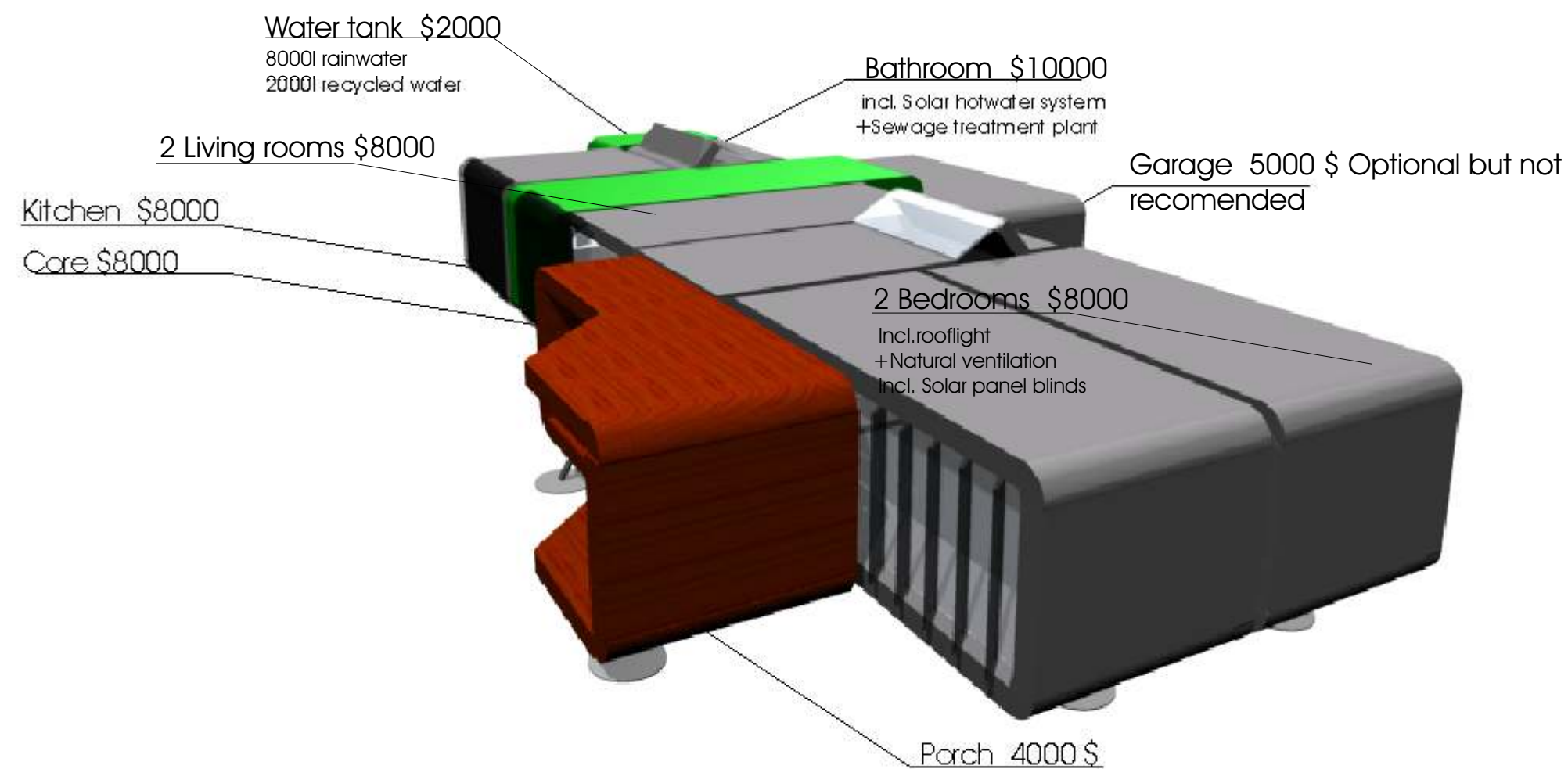
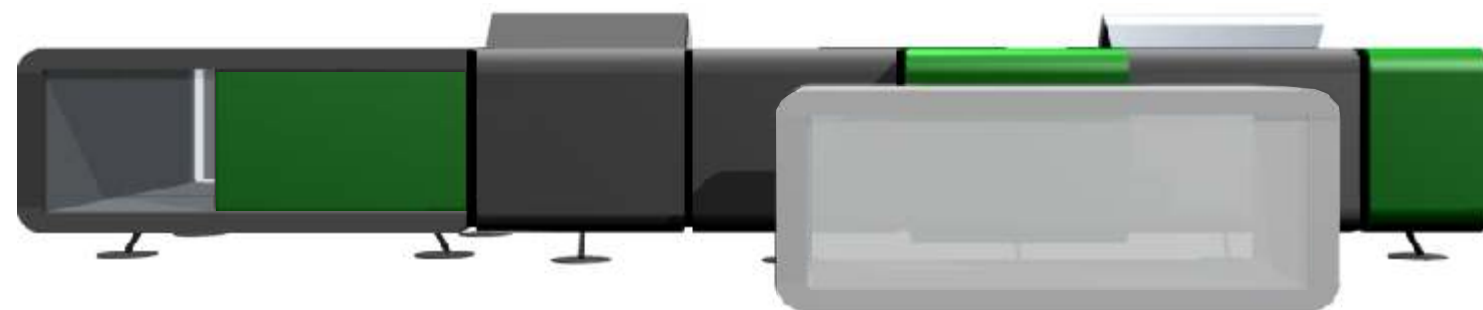
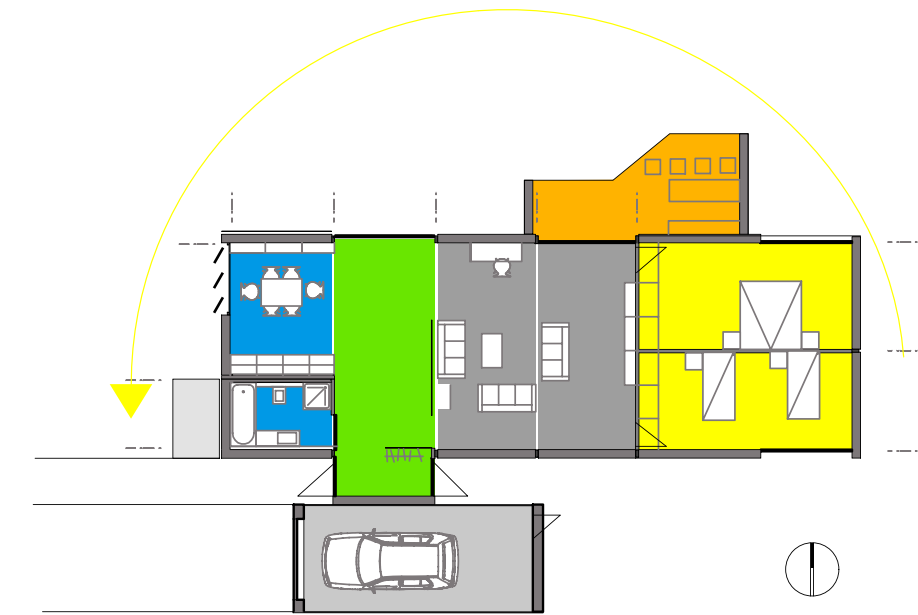
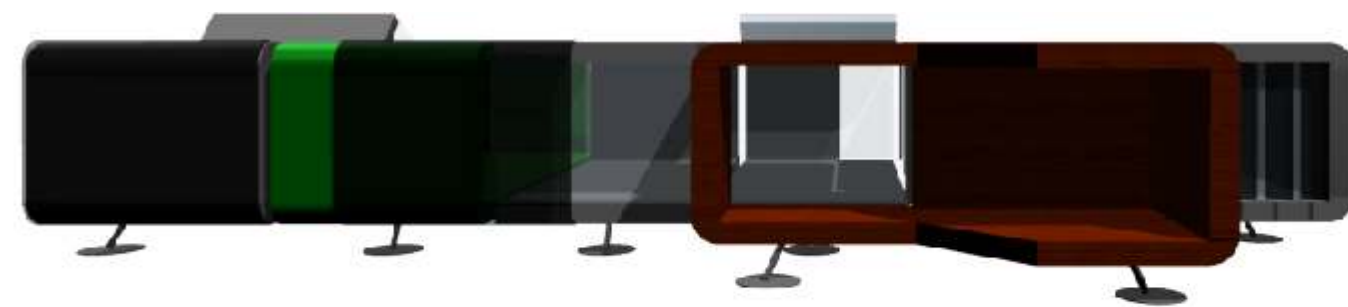
Single \$50000 / 55sqm



The modular design system allows adaptability to different user needs. The customers would purchase the modules they require for their lifestyle. Houses with different sizes for different user scenarios were created as an answer to changing demographics and to show the intended flexibility of the system. The smallest version is the 1 bedroom, 55sqm house for a single/ couple which could also be a 'granny flat'.




Double \$ 100000 / 110sqm

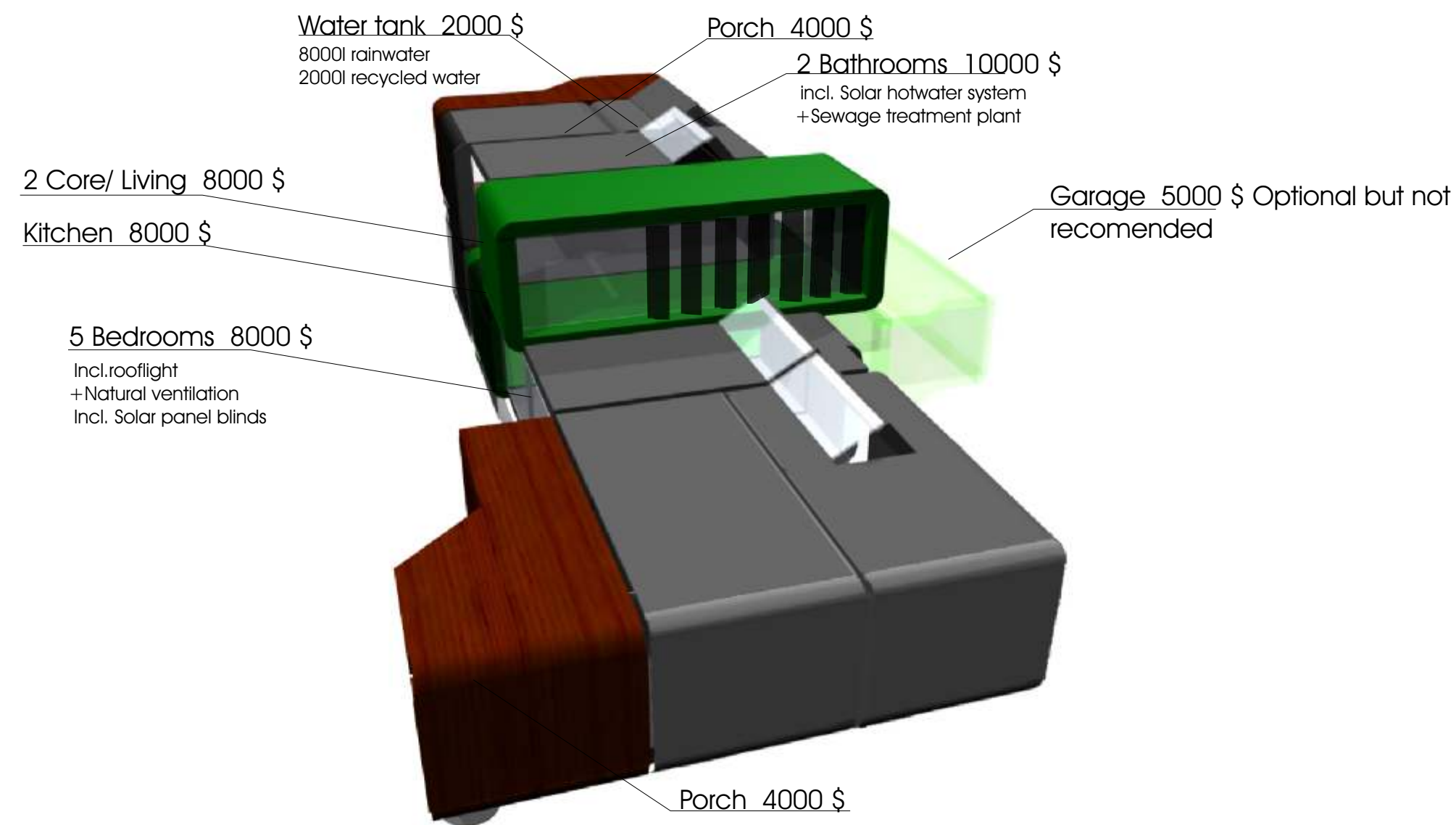
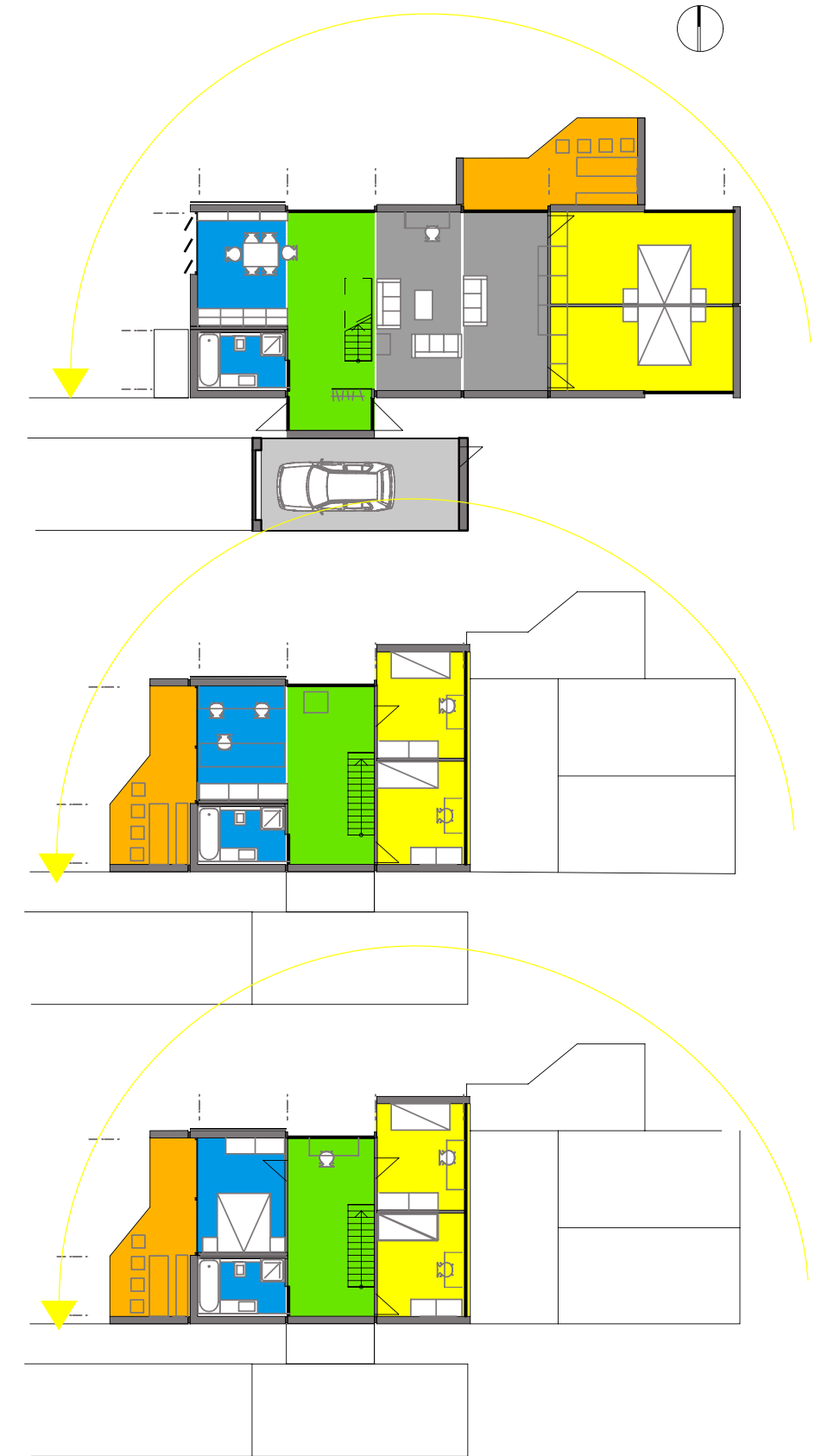
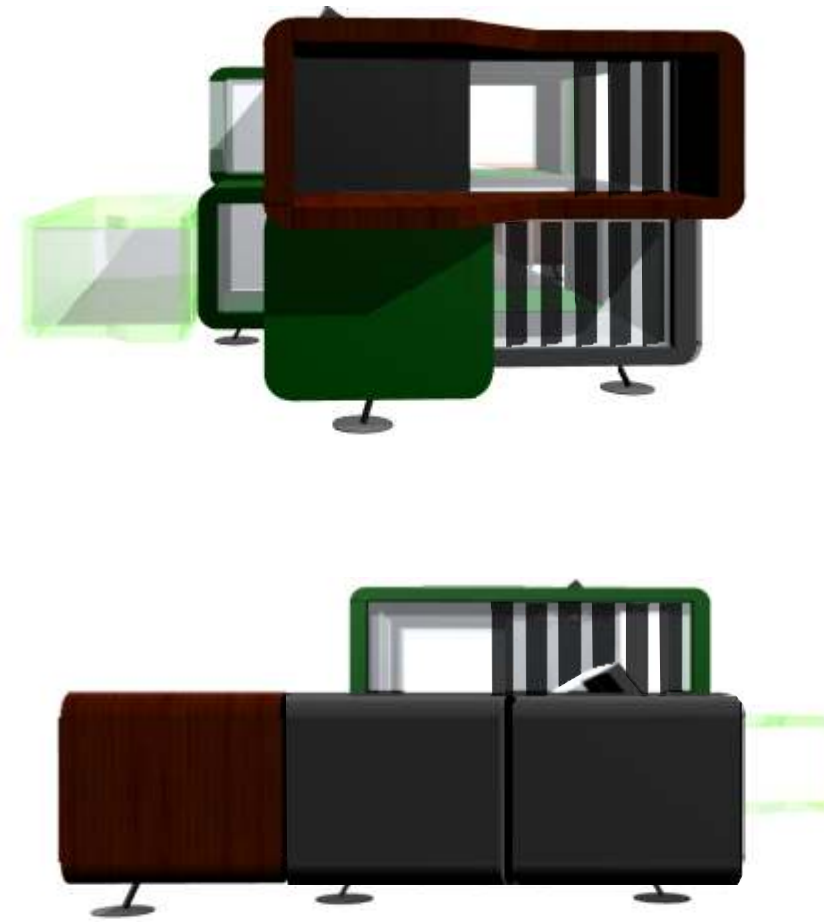
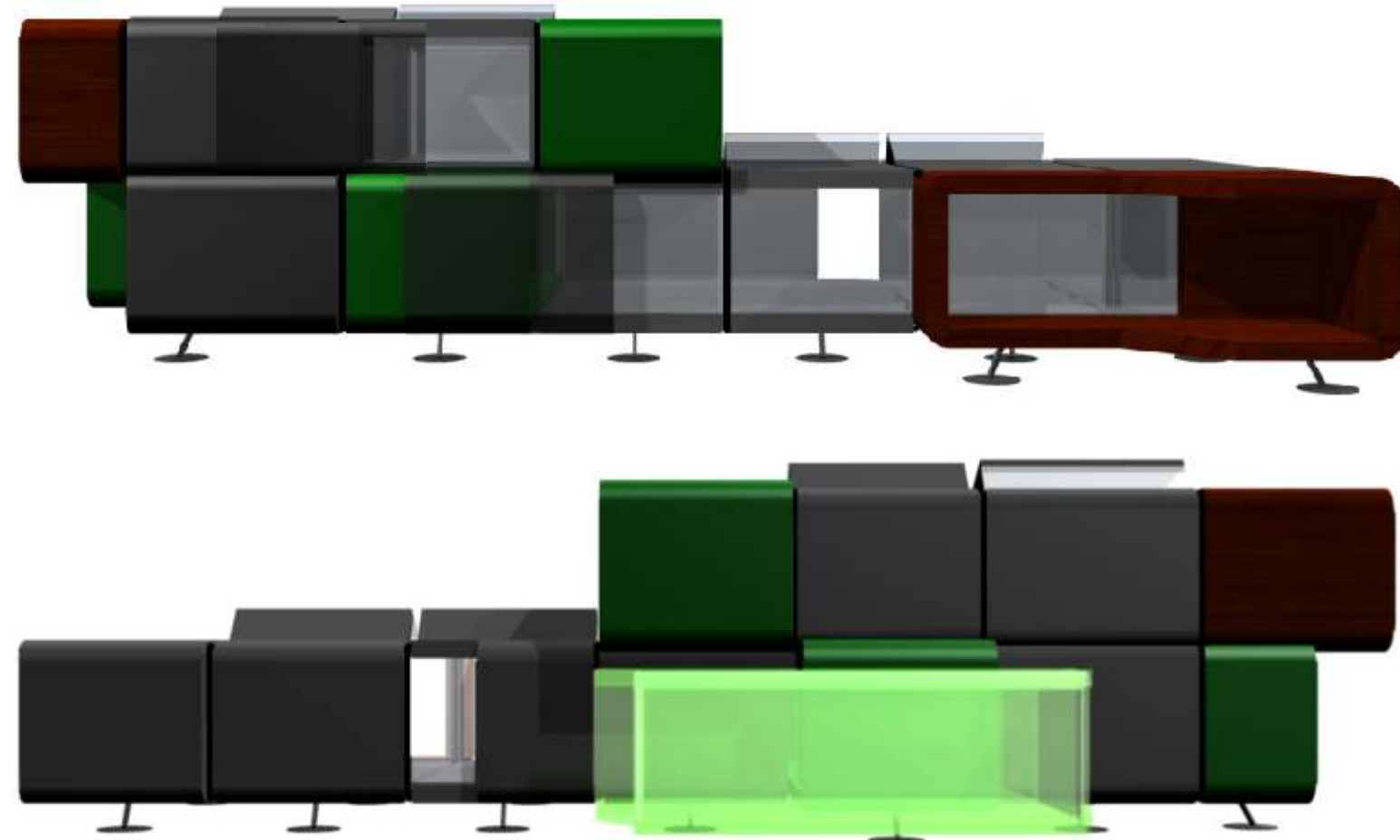
Couple  Single+ child  Couple+ child  Couple+ 2children 



The "Double size" house is designed for a couple with up to 2 children; it offers 2 bedrooms and is relatively small. The garage was offered as optional but is not recommended, in order to reduce the footprint of the house and to make it more affordable.

Queen \$150000 / 165sqm

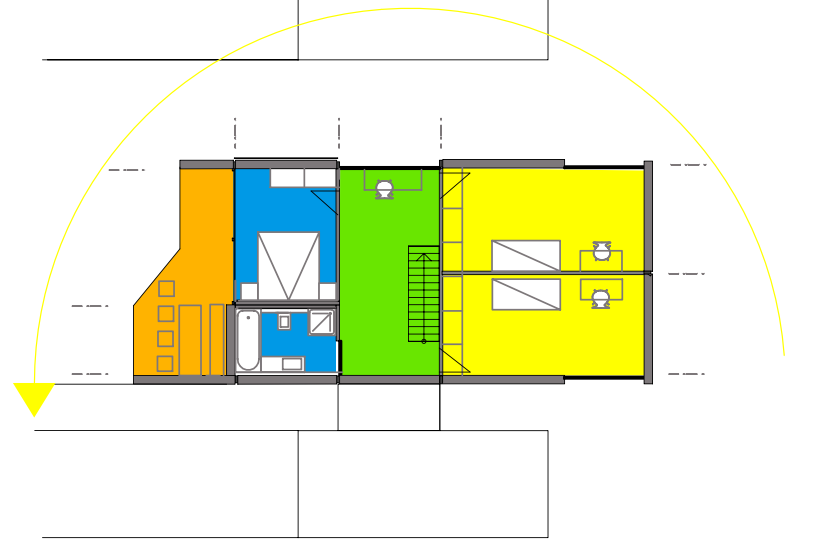
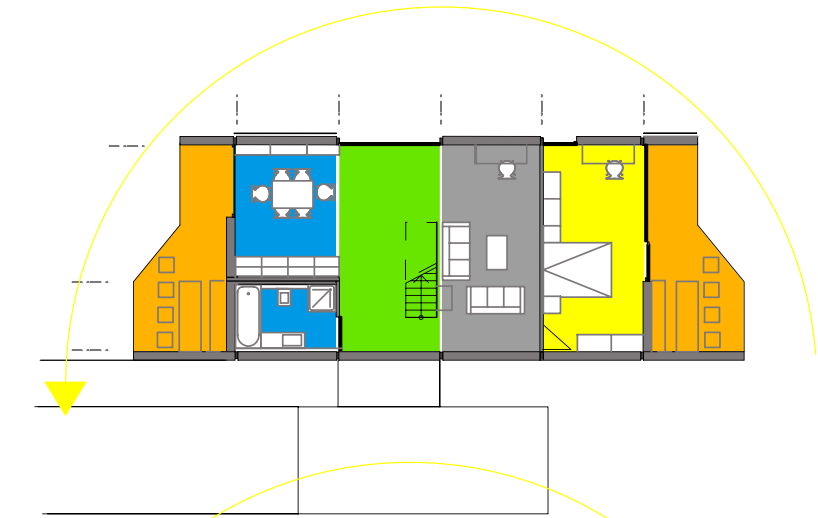
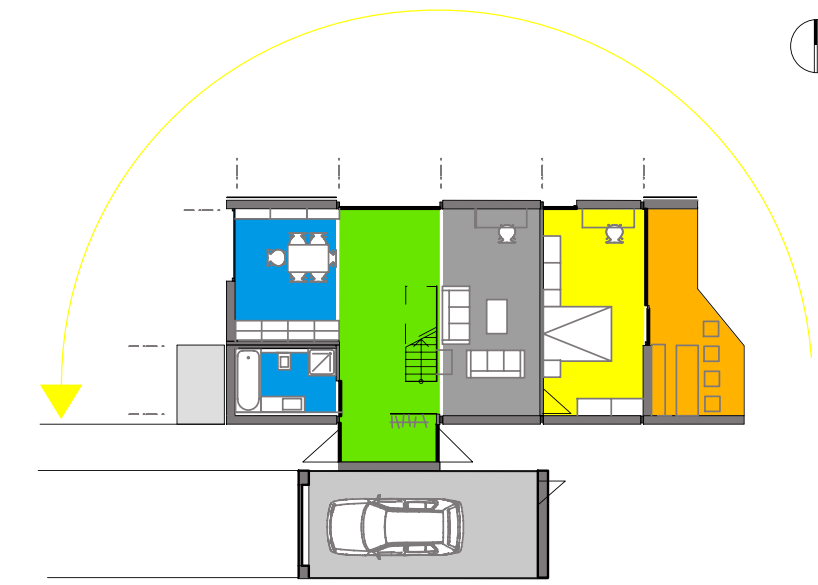
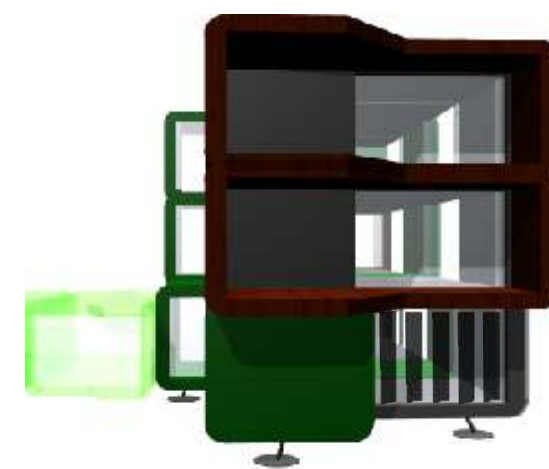
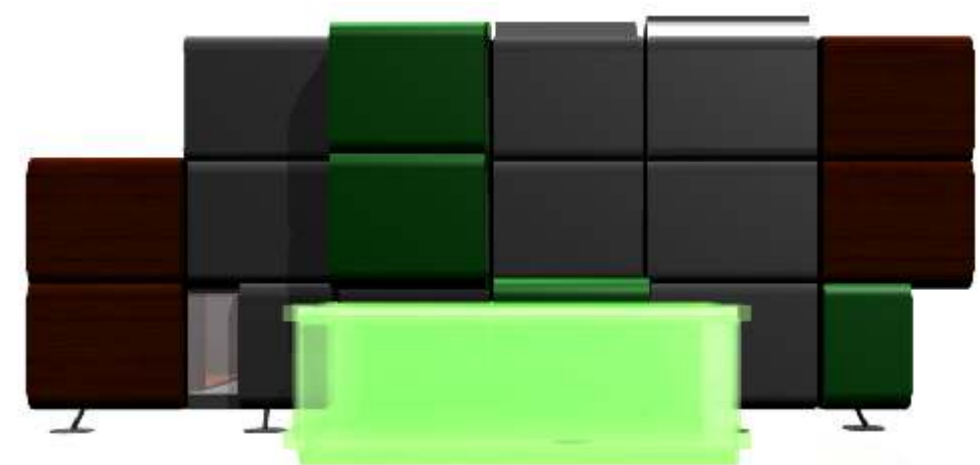
Couple+ child  Couple+ 2children  Couple+ 3children 



24 The "Queen size" house offers room for up to 6 people and a small home office. Most rooms have large glazed areas to the north which are shaded by movable elements to prevent overheating in summer.

King \$200000 / 220sqm

Couple+ 2children  Couple+ 3children  + Grandp  + Siblings 



Water tank 2000 \$
8000l rainwater
2000l recycled water

Porch 4000 \$

2 Bathrooms 10000 \$
incl. Solar hotwater system
+Sewage treatment plant

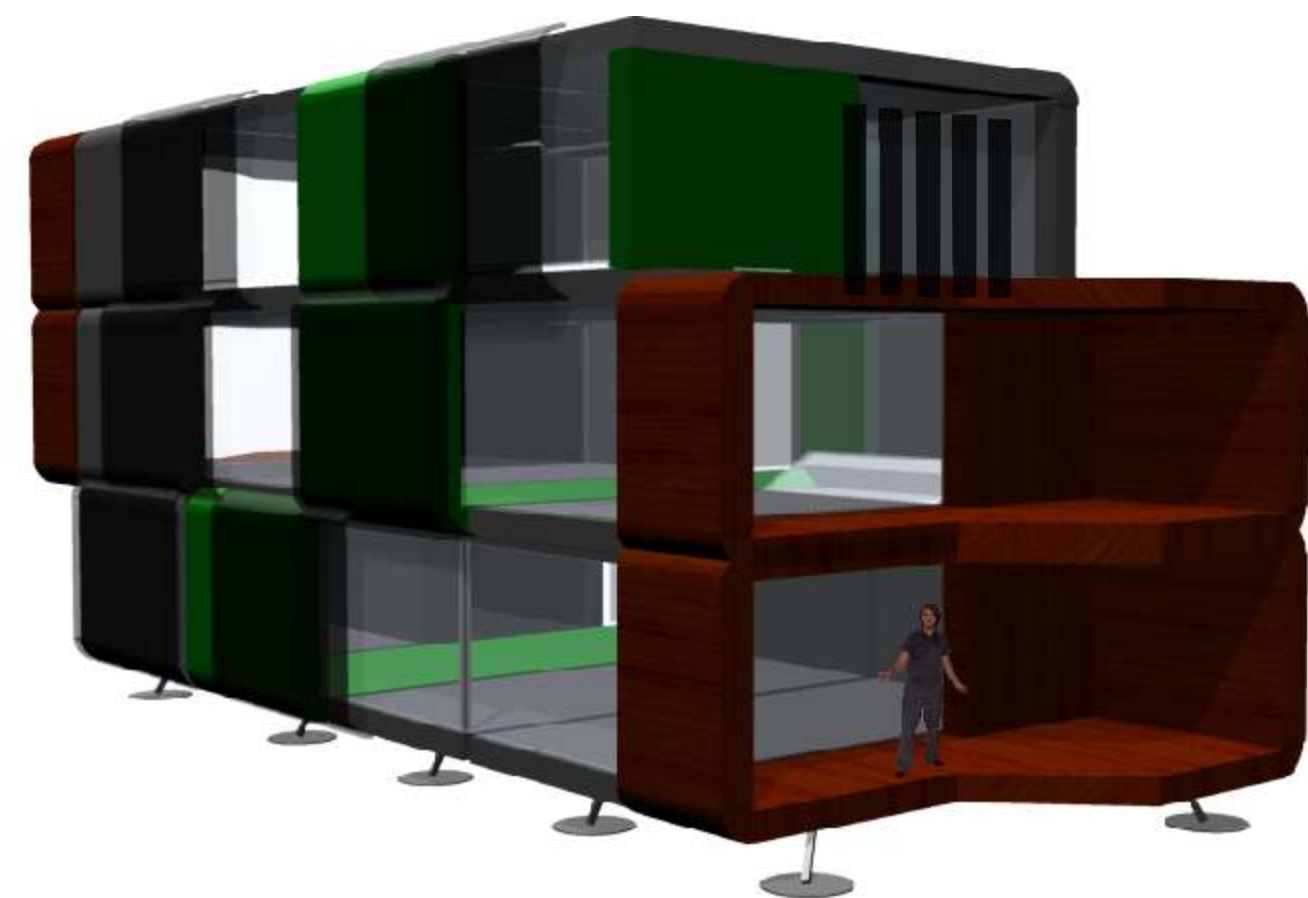
Kitchen 8000 \$

2 Core/ Living 8000 \$

5 Bedrooms 8000 \$
Incl.rooflight
+Natural ventilation
Incl. Solar panel blinds

Garage 5000 \$ Optional but not recommended

2 Porch 4000 \$



The 220 sqm "King size" house is the biggest offered with 2 separate living areas for the potential co-inhabitation of 2 generations of a family. The footprint of the houses is much smaller than average. Compact living is encouraged. Optimised orientation was intended to achieve heat gains in winter reducing energy demand for heating.

Testing mode - Site specific

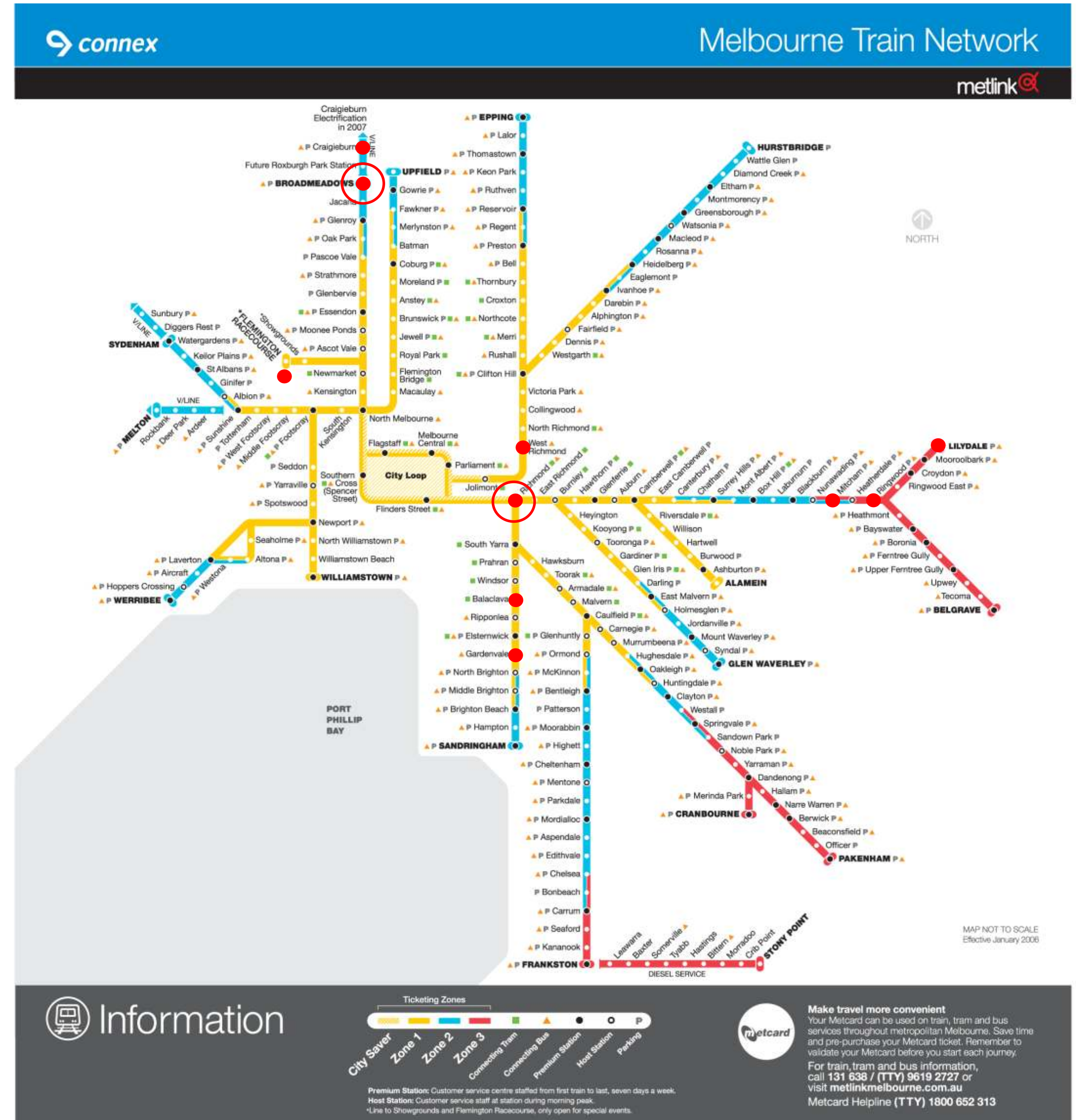
The aim of this testing mode is to assess the adaptability of the design system by using it on different sites, while also investigating how siting affects the building's sustainability and affordability.

Choosing a particular site and deciding how the building is placed on it can have a significant impact on its environmental performance and cost.

The knowledge gained during this testing mode led to the recommendations in the educational section of the user interface, where potential clients can access information about siting.

Site related affordability and sustainability issues: Both the Broadmeadows and Richmond projects were sited **strategically within walking distance to public transport to reduce car dependency and to offer access to public transport**, facilities and infrastructure.

The availability of affordable land was investigated on realestate.com. a website where people can buy and sell real estate. Closer to the city, the land is much more expensive. Affordable land is likely to be in the outer suburbs and in greenfield developments. This poses the question; can living in low density areas, on the fringe of the city be environmentally sustainable? This is an important question as Australians have long embraced living in lower density suburbs.



Melbourne Train Network

Density and sustainability: According to a team of building experts from the University of Melbourne there is “no necessary relationship between ecological sustainability and crowding people into smaller spaces. We need a range of types of dwellings and living environments for our increasingly diverse population. Neither high rise nor low rise is inherently good or bad: it comes down to sensible layout, design and use. “(Low, Gleeson, Green, Radovic, 2005)

In their book ‘Green City Sustainable Homes and Suburbs’ the authors point to European examples to show us that we don’t all have to live packed together into space saving high rises to live sustainably. “Europeans have shown us that it is possible to produce diverse, inclusive and ecologically efficient neighbourhoods”.(Low, Gleeson, Green, Radovic, 2005)

By acknowledging mistakes that have been made in the past, for example “replacing green space with buildings and producing car dependent medium and high density residential landscapes”, these experts argue that there is no reason why we can’t build sustainable, new suburbs with detached dwellings and garden space.

Can life in a suburban house be sustainable? It would certainly require lifestyle changes. One would need to organise their life in a particular way, ideally reducing the travel distance to work and or school, buying the right type of car – for example a hybrid resulting in a co2 reduction by 70 % and of course building the right type of house with a CO2 reduction of 100% (saving 11 t of CO2 for average household per year). I believe life in a suburban house can be sustainable. It doesn’t matter where you live and in what type of building, what matters is how one lives and interacts with one’s environment.

Broadmeadows
Adress:
172 Widford Street
Price: \$ 200000
Size: 16x45m



Richmond
Adress:
66 WellingtonStreet
Price: \$ 495000
Size: 13.5x24m



West Richmond
Adress: 60 York Street
Price: \$ 349 000
Size: 6.5x26m



Lilydale
Adress:
2 Bastow Road
Price: \$ 150 000
Size: 15x29m



Mitcham
Adress:
17 Culwell Avenue
Price: \$ 190 000
Size: 17x30m



Balaclava
Adress:
13 Rosamond Street
Price: \$ 300.000
Size: 6.5x12m



Edgewater
Adress:
20 Lakeside Crescent
Price: \$ 260000
Size: 10x26m





Broadmedoaws

The Broadmeadows site is located close to shops and public transport. The land is affordable (\$200.000). It is an infill project on a site where a detached house would be appropriate. The neighbourhood is currently dominated by detached dwellings and is not suitable for apartment buildings.





Site plan showing existing building to be demolished

The old building was moderate in size, had a garage behind the house and a front and back yard.



Site plan with proposed development

Three 2 bedroom houses have been proposed on the site by a developer. This means up to 9 people could live there. Almost the entire block will be covered by a large driveway and the footprint of the buildings, leaving little space for gardens and vegetation.



Alternative design proposal

Siting

The proposed subdivision of the site would reduce the land costs for each house owner by half. Additionally the density on site would be increased by 50% which is ecologically beneficial as less land is consumed per dwelling, yet still leaving green space.

Increasing the density any further would create problems of overshadowing and would not allow for the optimal orientation of the building.

It is proposed to park the cars next to the road. This will reduce the amount of sealed space on the property.

This model of parking works well in older neighbourhoods in Melbourne and could be applied here, despite current laws enforcing cars to park on the property.

Removing the garage could save money and space. The access to the building is on the south side via footpaths.

Testing the design system.

Two houses, one with four bedrooms, one with three, are proposed for up to 9 people. Each house still has its own garden. Smaller than average houses (100sqm) are proposed.

The layout of the house is fairly conventional but it has a large living room with an open plan kitchen.

Private outdoor space is created in north oriented courtyards, that are partly covered with sun roofs.



Sustainable Landscaping

Hedges could be used to create privacy instead of fences.

The goal is to increase the level of vegetation by planting more native trees. Doing so will create a better quality space, control solar access and provide habitat and shelter for wildlife.

Space will be provided for small vegetable gardens allowing for food production.

The small garden would be also an ideal place for people to gather, and for children and dogs to play.



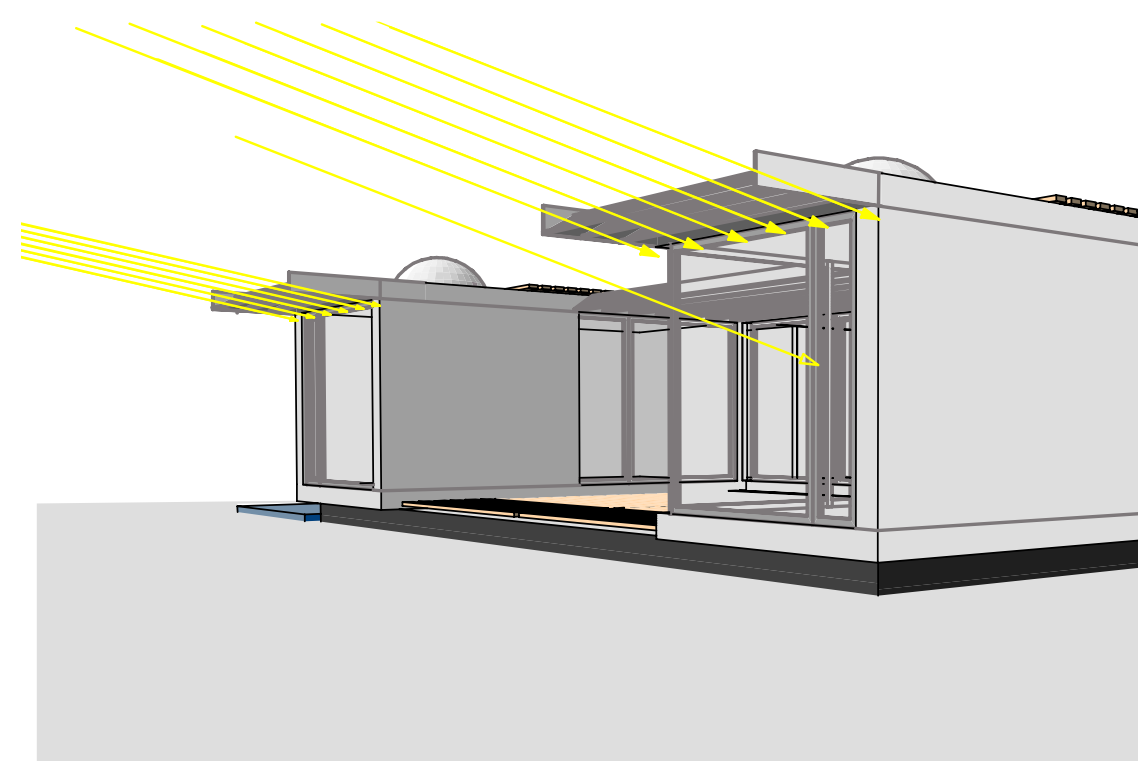
View of proposed house from the street

The adaptability of the design system to site conditions in regards to orientation was tested. The two design principles used in this project to reduce the energy demand of heating and cooling by up to 100% are passive solar design and passive cooling.

1. Passive solar design

For passive solar design principles, optimised orientation is imperative. As higher temperatures are required, living areas should be situated on the northern side of the building. To allow for heat gains in winter, large glazed areas must be to the north. In order to reduce over heating in summer, northern glazed areas require overhangs to provide shade.

Glazed areas to the east and west also need protection from the summer sun. To avoid heat loss in the winter, glazed areas in the south need to be reduced.



The view from the north shows the large glazing areas to achieve heat gains in winter and the shading elements to prevent overheating in summer

To minimise heat loss in winter good insulation, draught sealing and advanced glazing solutions are necessary.

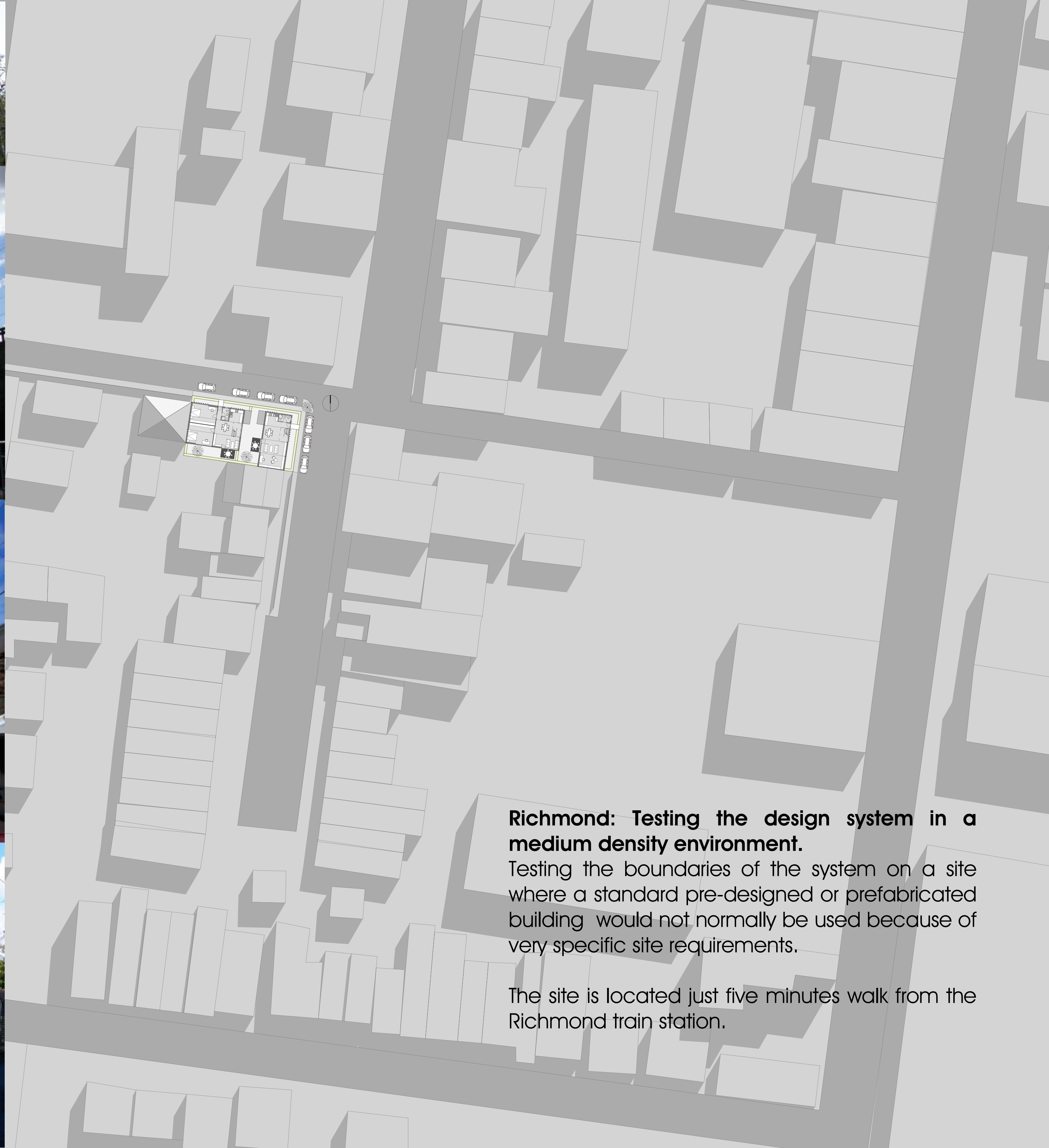
2. Passive cooling

To allow for passive cooling, windows that can be opened must be used in every room, as this will allow for cross ventilation.

Concrete floor slabs need to be used as they can substantially lower temperatures by absorbing heat as it enters the building.

Shading elements are required on north, east and west facing glazed areas.

How these principles are applied will be described in detail in the construction system section of this dissertation (page 55).



Richmond: Testing the design system in a medium density environment.

Testing the boundaries of the system on a site where a standard pre-designed or prefabricated building would not normally be used because of very specific site requirements.

The site is located just five minutes walk from the Richmond train station.

In this inner city suburb, property is relatively expensive (in this case \$495,000)

To reduce costs, a subdivision of the property is once again proposed.

Two houses were designed; one for a large family with three bedrooms and a home office. The other is a four bedroom house with two separate kitchens and living areas. This can allow for two generations of the same family to co-inhabit the house, or for a shared house with 4-8 adults.

The proposed buildings are up to 3 storeys high and have a small footprint.

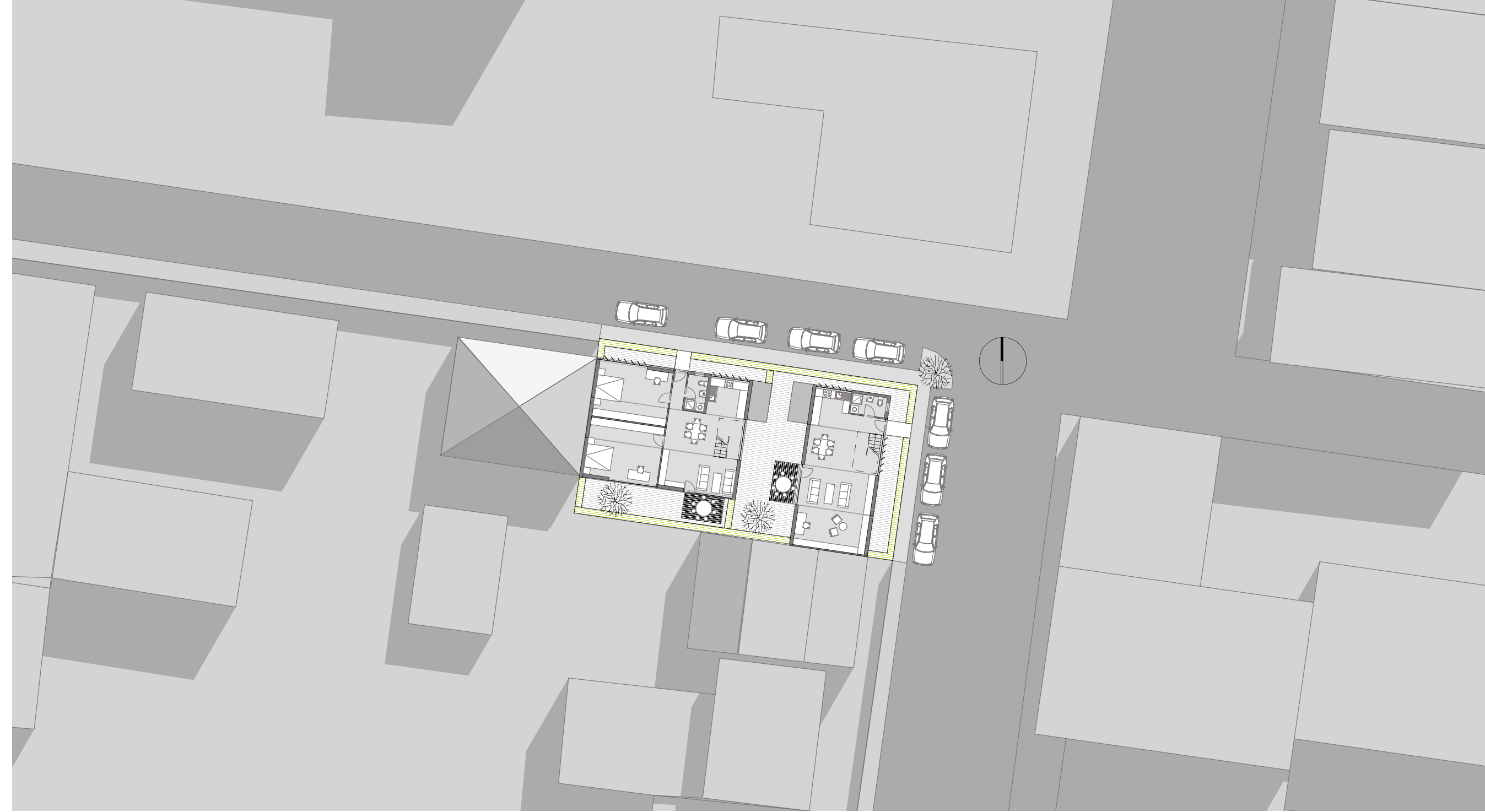
The houses are built to the boundaries of the property like many other buildings in the neighbourhood.

As in many of Melbourne's older suburbs, car parking on street is common for this area of the inner city, saving space and money.

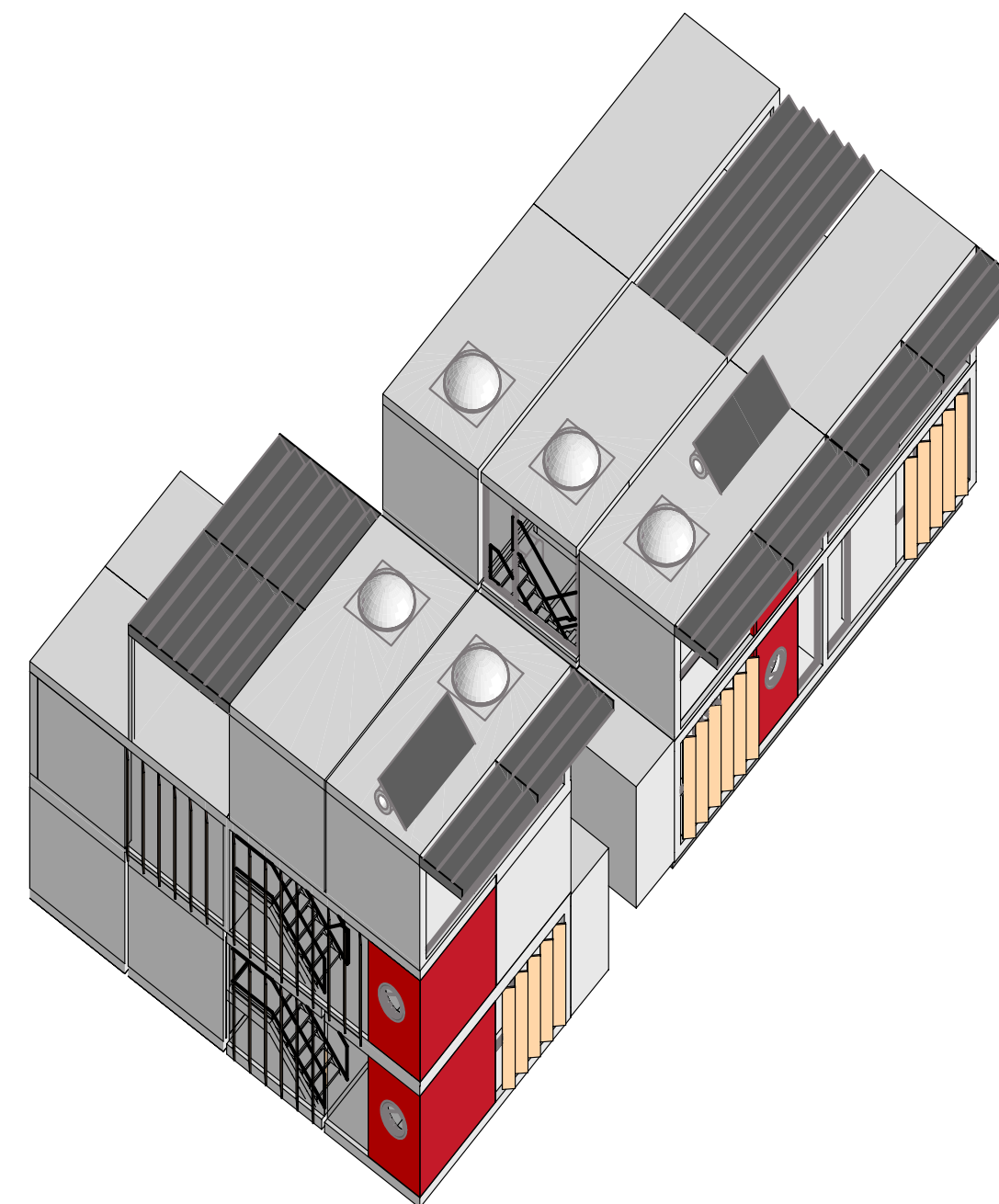
Hedges are proposed instead of fences to create privacy.

The houses have rooftop terraces and courtyards to create additional outside space.

The proposed colour and materials for cladding are typical of the area.



Ground floor plan



Axonometric of proposed building

Again the adaptability of the design system to site conditions regarding orientation was tested.

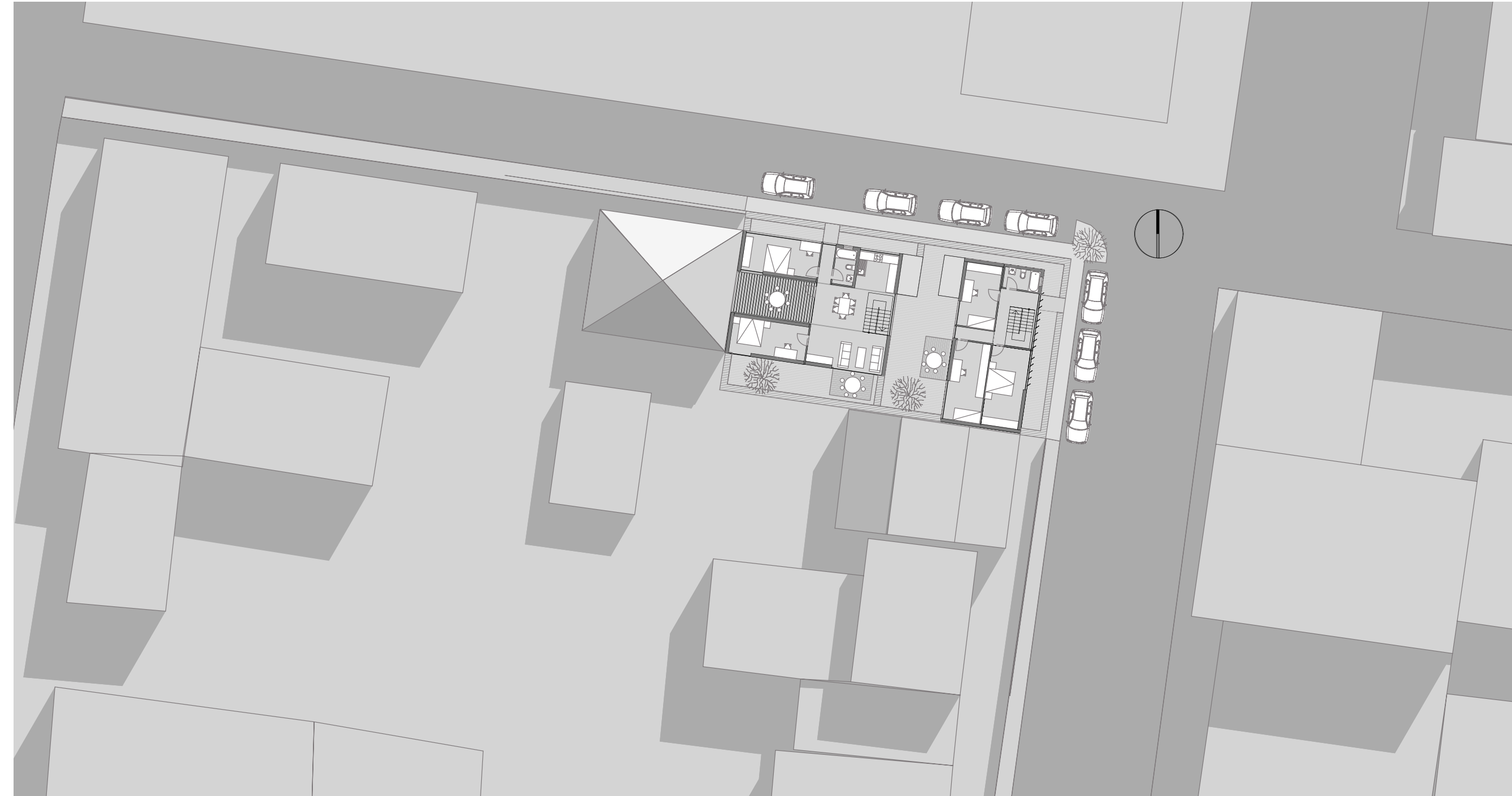
As with the other test sites, passive solar design and passive cooling principles were applied; large glazed areas to the north fitted with overhangs for shading, glazed areas to the east and west fitted with adjustable shading to provide protection from the summer sun, and a reduction of glazed areas in the south. Draught sealing, good insulation and advanced glazing solutions are mandatory.

To allow for cross ventilation, windows that can be opened need to be used. Concrete floor slabs are used for earth coupling to absorb heat in summer.

See “construction system” on page 55 for a detailed explanation of passive solar design and passive cooling principals.

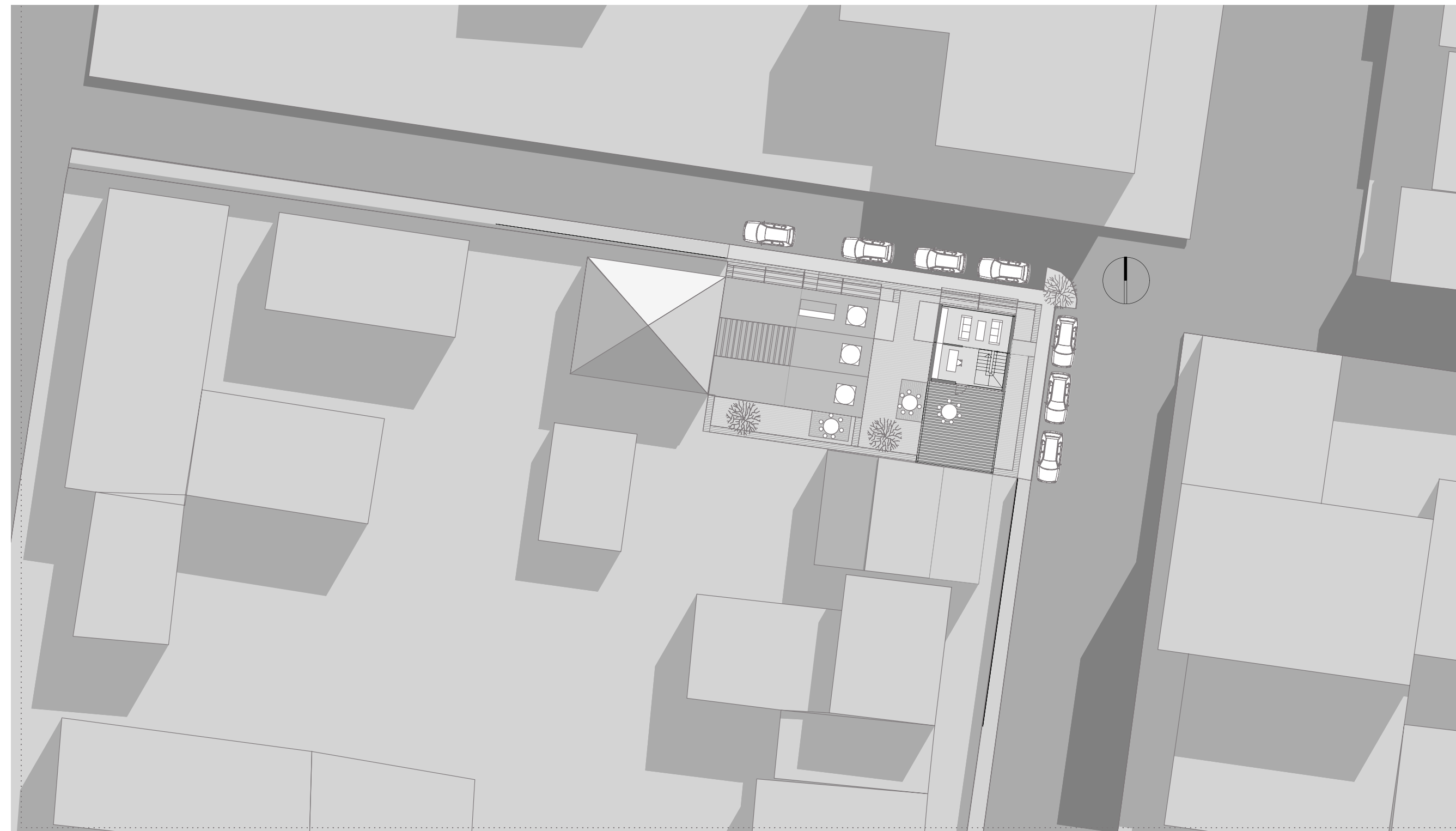
Even in this denser urban environment passive solar principles can be applied. However compromises will need to be made as other issues will need to be addressed i.e. overshadowing by surrounding buildings, privacy and noise reduction concerns.

Siting is a complex issue which needs to be carefully evaluated in every individual case. This can be best done by an architect. The right orientation and placement on the property can positively contribute to the environmental performance of the house, its living quality, and building and running costs.



First floor plan

Second floor plan





View of proposal from the north

Second phase of the module development

The second phase in the development of the design system resulted in the modules evolving into components. Rather than designing the prefab home with composed modules, the second phase allowed for the client to arrange the modules with pre – designed components.

Form was reduced even more - no round edges were included this time, to make adding of modules in all directions possible. It is surprising how much variety can be achieved with less.

Shading elements were introduced according to passive solar design principles as were more specific and practical window types.

The overall design of the house still expressed the additive principle of the modular components.

Prices for the components were estimated but cannot be exactly predicted without actually producing them.

The question how the components would be used by non professionals arose. In response, a house planning guide was developed. This presented a shift in my research, from designing a prefab system to focussing on how people would interact with it.

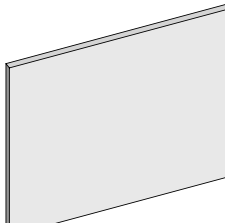
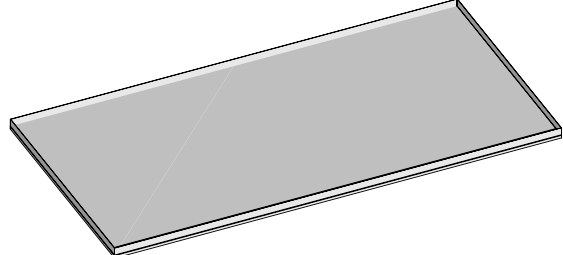
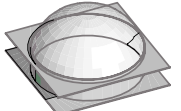
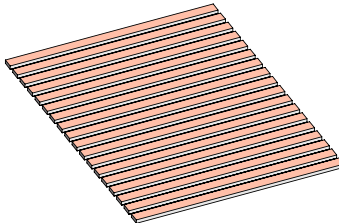

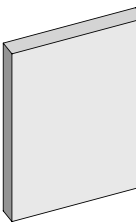
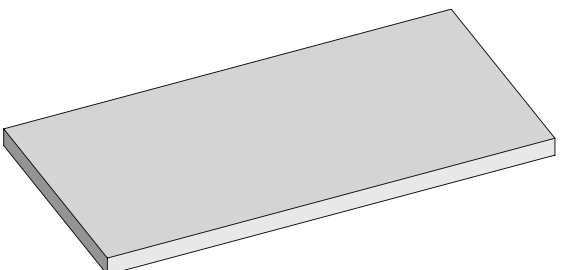
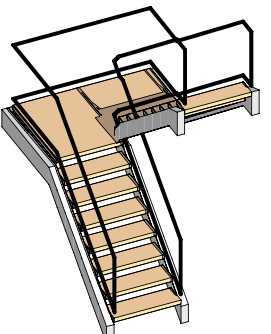
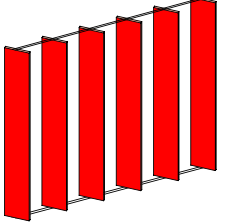
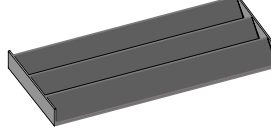
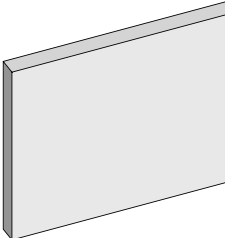
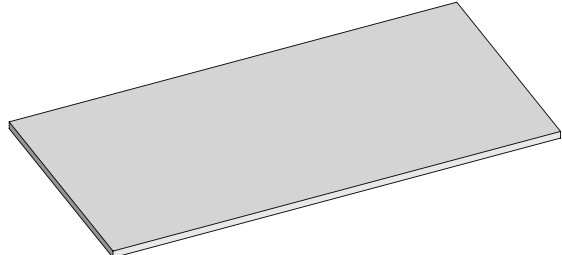
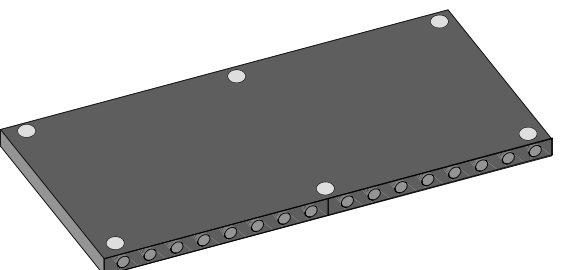

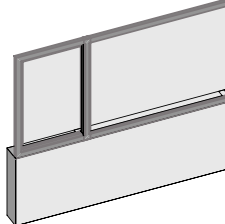
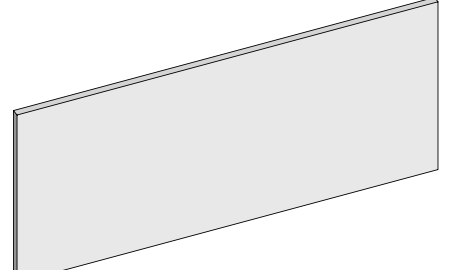
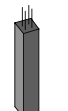
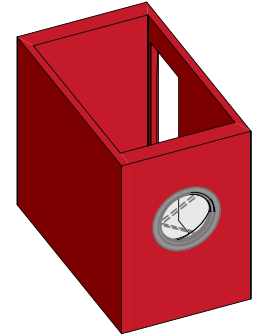
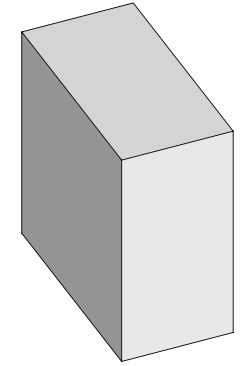
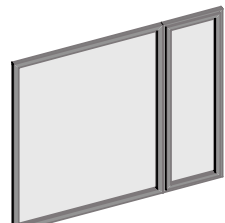
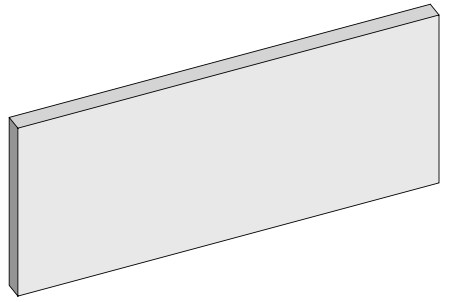

It was during this phase of the research that I realised that by focusing too heavily on the technical aspects of the module, the design system became too rigid in regards to its form. The rigidity of many prefab systems has been a major reason for their failure in the past.

This rigidity can be overcome through customisation, which is made possible by user interaction. As later tested in user experiments.

The intention to order things or standardise is one of architecture's aims, but in doing so there is the danger of becoming a slave to the geometric system, or of creating perceivably dull architecture. The order has to be combined with complexity. The complexity of the system was increased in Phase 3 of the module development.

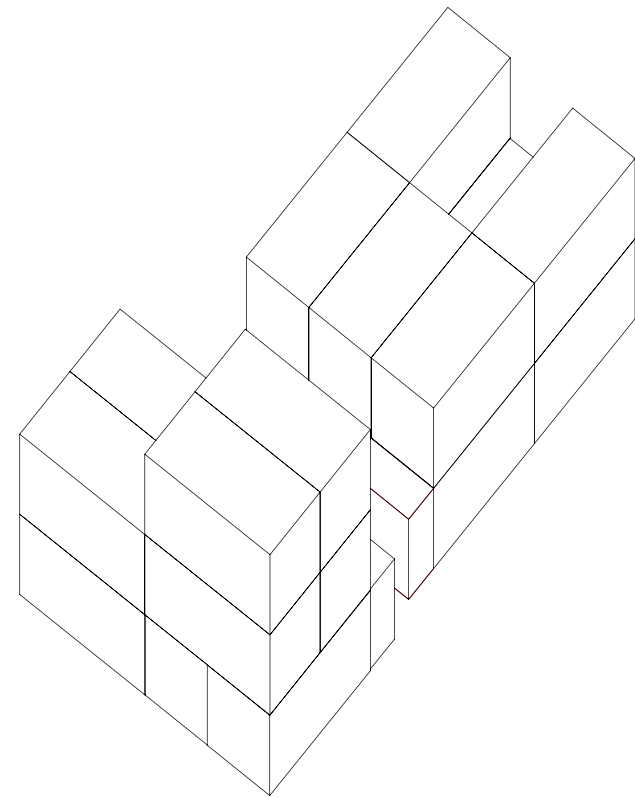
Second phase of the module development

Components and measurements

 <p>\$ 400</p> <p>internal wall 3X3 m: 4-3/8" agriboard panel</p>	 <p>\$ 500</p> <p>roofing 3 X 6m: sheet metal</p>	 <p>\$ 450</p> <p>rooflight 1X1X0.4m</p>	 <p>\$ 500</p> <p>terrace 3X3m: timber</p>	 <p>\$ 7500</p> <p>shading element for terrace 3X3m: steel frame/ solar cells (1200KWH/ year)</p>
 <p>\$ 400</p> <p>external wall 3X2 m: 7-7/8" agriboard panel</p>	 <p>\$ 1000</p> <p>floor / roof 3 X 6m: 7-7/8" agriboard panel</p>	 <p>\$ 4000</p> <p>stair 2X3X3m: steel frame/wooden steps</p>	 <p>\$ 1200</p> <p>shutter (east/west) 2.5X3X0.5m: fiber cement</p>	 <p>\$ 3500</p> <p>shutter (nord) 3X1m: steel frame/ solar Cells (600KWH/ year)</p>
 <p>\$ 500</p> <p>external wall 3X3 m: 7-7/8" agriboard panel</p>	 <p>\$ 800</p> <p>floor 3 X 6m: 4-3/8" agriboard panel</p>	 <p>\$ 1000</p> <p>footing 3x6x0.25m: precast concrete slab</p>	 <p>\$ 3000</p> <p>solar hot water system</p>	
 <p>\$ 1500</p> <p>external wall 1X3 m: 7-7/8" agriboard panel windows 1.5X3 m double glazing/wooden frames</p>	 <p>\$ 800</p> <p>internal wall 2.5 X 5.5m: 4-3/8" agriboard panel</p>	 <p>\$ 150</p> <p>footing 1x0.25x0.25m: precast concrete</p>	 <p>\$ 3000</p> <p>bathroom 2X3X2.5m: 7-7/8" agriboard panel</p>	 <p>\$ 2500</p> <p>water tank 3X3X1.5m plastic, fiber cement facing</p>
 <p>\$ 2250</p> <p>windows 2.5X3 m double glazing/wooden frames</p>	 <p>\$ 1000</p> <p>external wall 2.5 X 5.5m: 7-7/8" agriboard panel</p>			
 <p>\$ 650</p> <p>windows 2.5X1 m double glazing/wooden frames</p>				

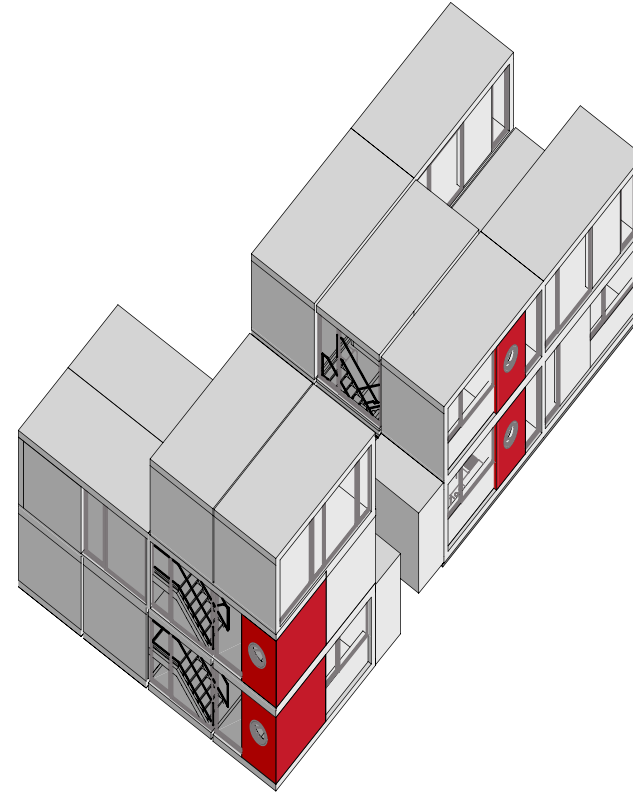
House planning guide

1



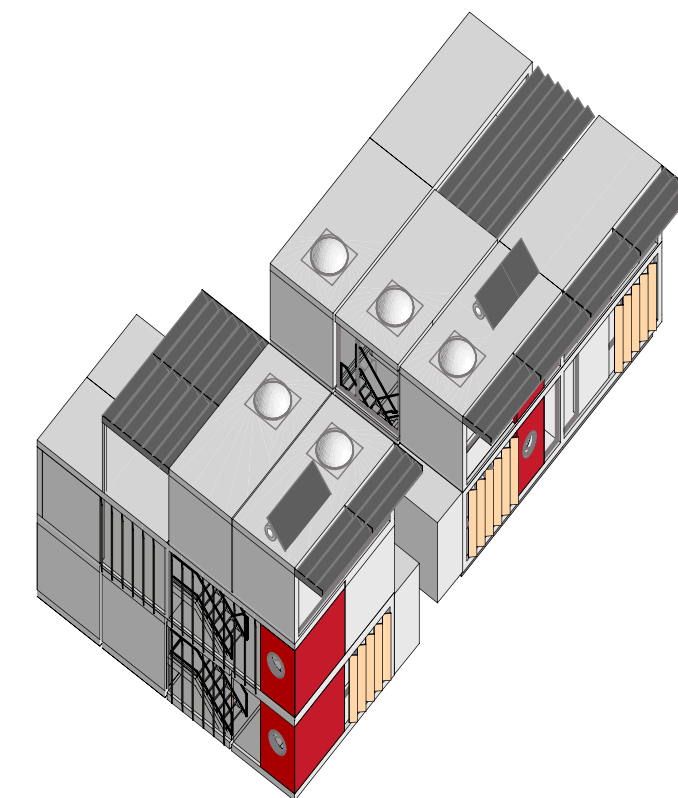
Choose and arrange your rooms

2



Choose and arrange your walls, windows, doors, roofs bathrooms and stairs

3



Choose and arrange your additional rooflights, windows, doors, shutters and other accessories

4

Finish with colours, materials, lighting



House Richmond 175 sqm

\$155k

Testing mode-Speculative designs; Catalogue Houses Part 2



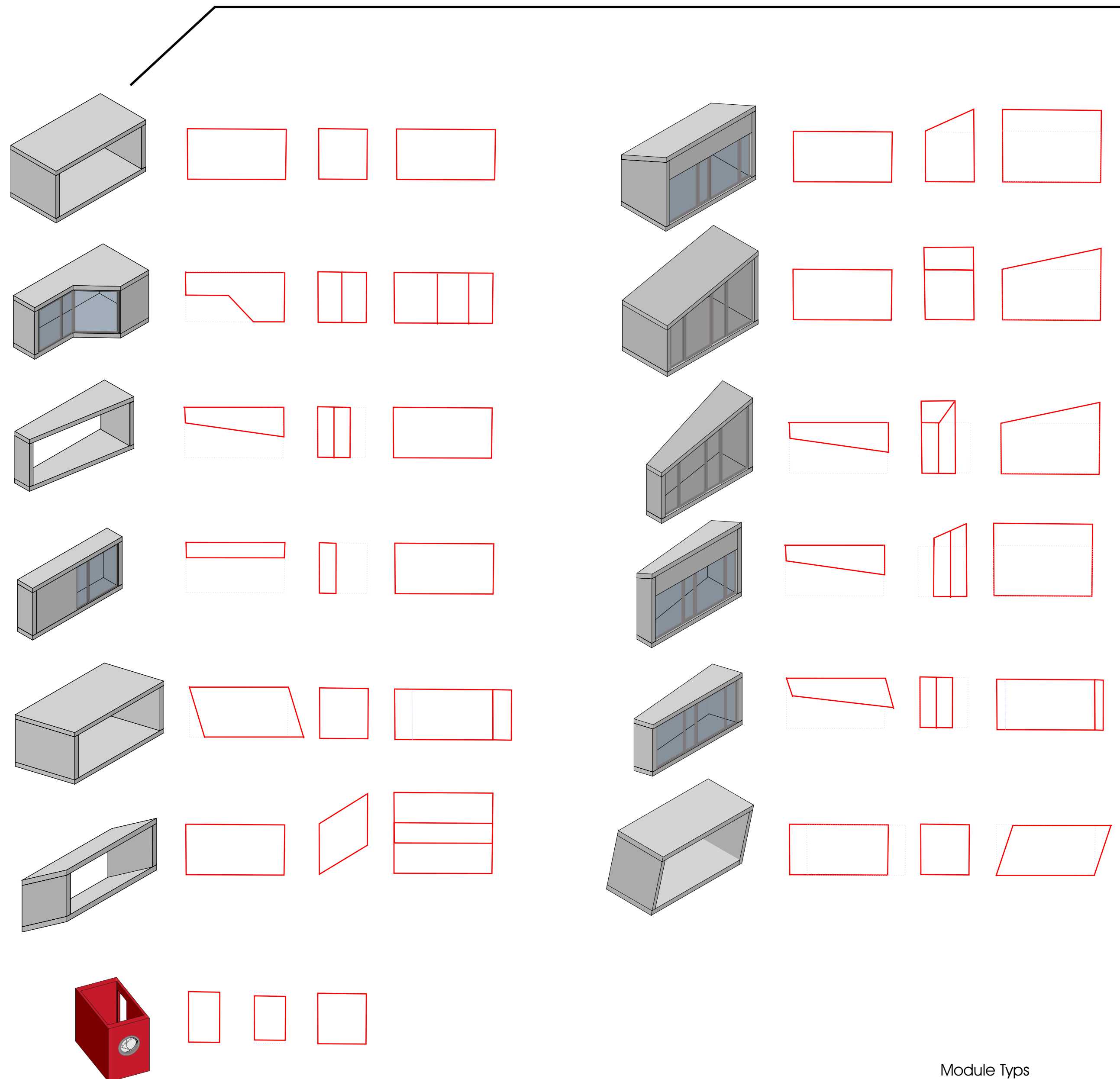
Third phase of the module development

The third phase in the development of the design system had the modules pre arranged with the components by the architect. Furthermore, every module would come in various types, for example with windows, no windows, verandas etc. The complexity of the system became far greater. It became imperative that the design knowledge of the architect be embedded in the modules and components.

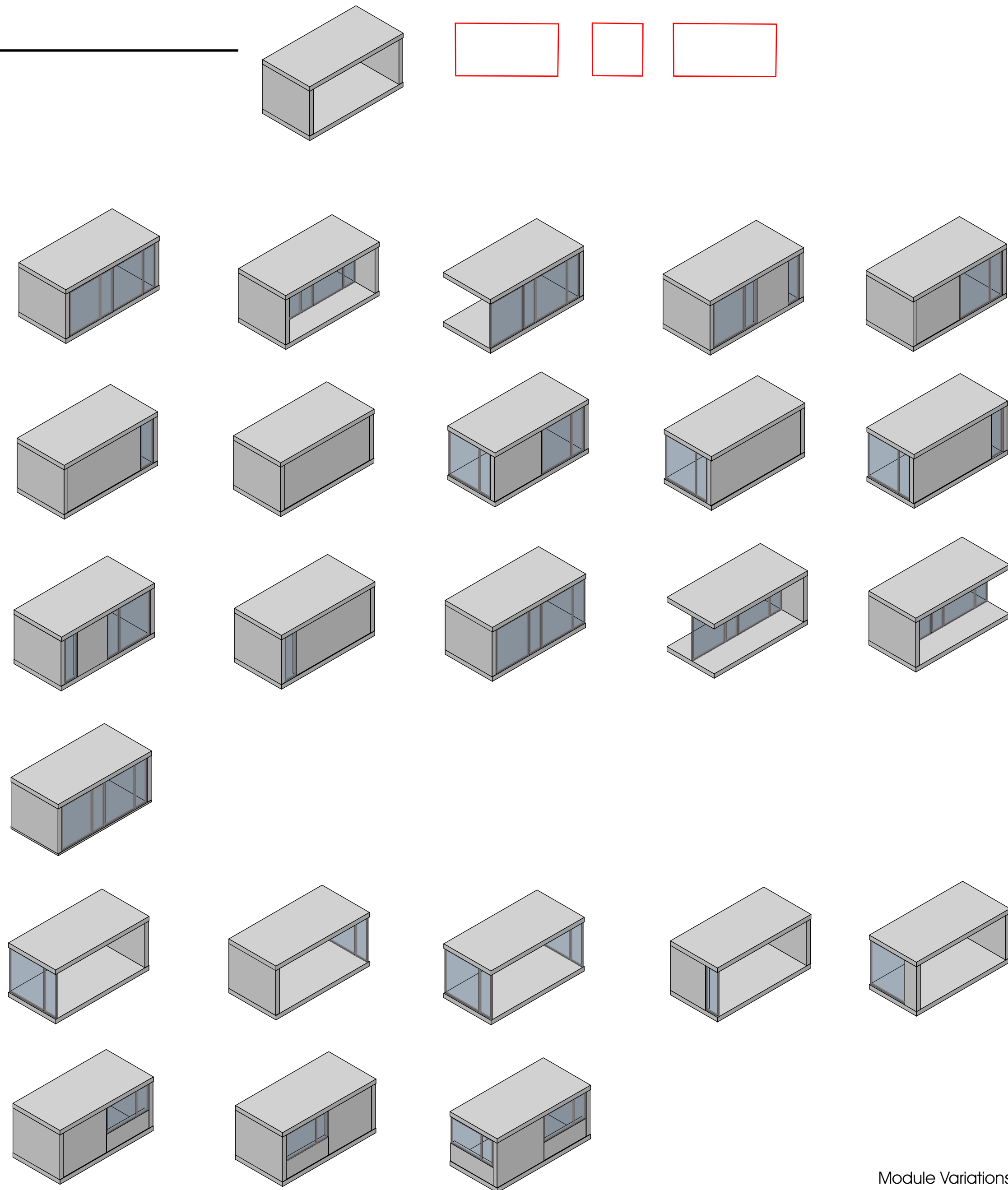
Pitched roof types were introduced to give the homes a more domestic look and feel and allow for more options within the system. These roof types provide a rhythmical rise and variation in height of the room.

Whilst adding pitched roofs, the modules still remained abstract in form. This created an almost cubist modern form. Even though the latest versions of the modules are more domestic, they still keep an architectural design intention and are distinguishable to the hipped roof houses and reproductive designs of past styles commonly seen in the suburbs. The houses however recognise certain vernacular elements of the Australian house such as pitched roofs, verandas and porches.

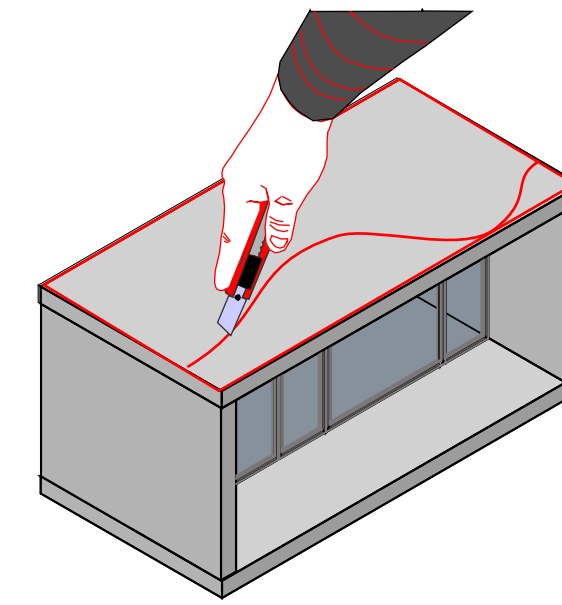
Further to the introduction of pitched roofs, the third phase in the development of the design system included the more decorative treatment of the façade. The cladding material doesn't always follow the module.



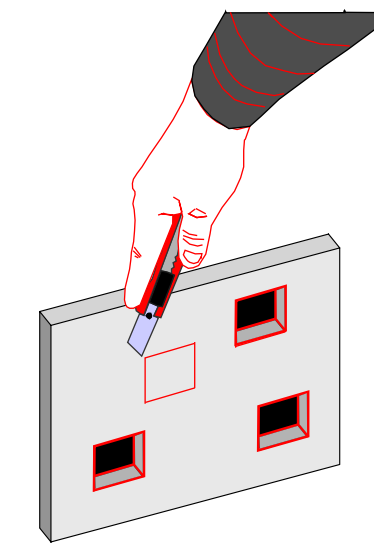
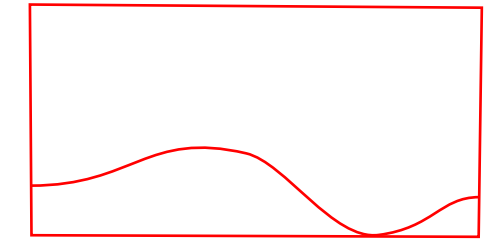
Module Typs



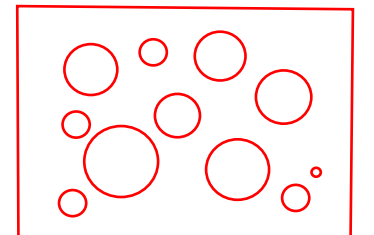
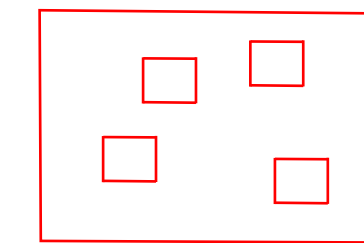
Module Variations



Customisation of the module



Customisation of wall panels

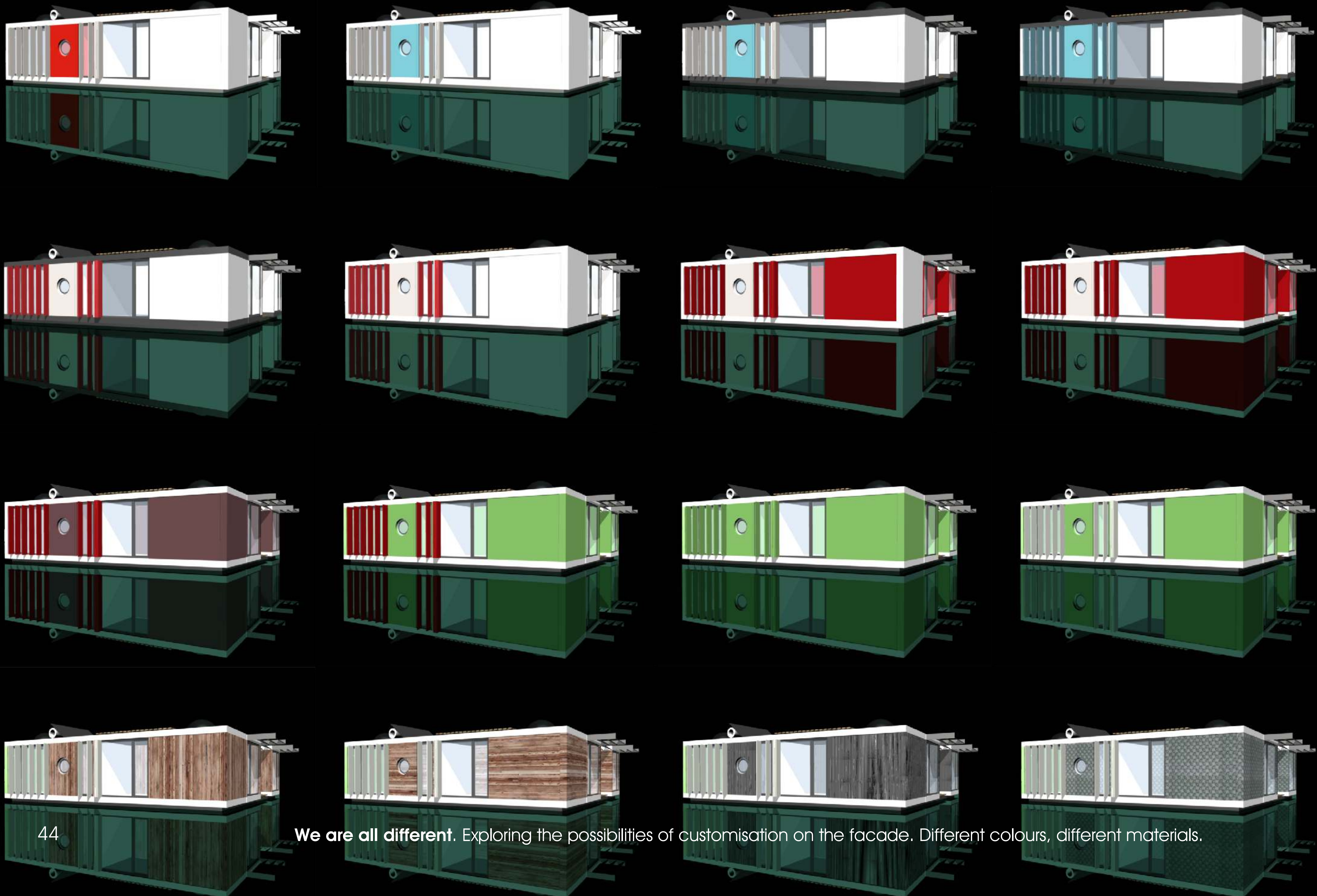


Further to this, the module itself can be modified by cutting which could lead to curved types (as requested by one person in the user experiments).

Walls can be modified as well. These interventions need to be discussed with the consulting architect to achieve optimal outcomes. These modifications can then become new library elements.

Printing on the facade and the use of different colours and materials gives the client more options for customisation and decoration but the appearances of the house remains contemporary as opposed to reproductions of old styles.

The engagement of non-architects through the user interface might lead to an even more domestic appearance over time if it is demanded.



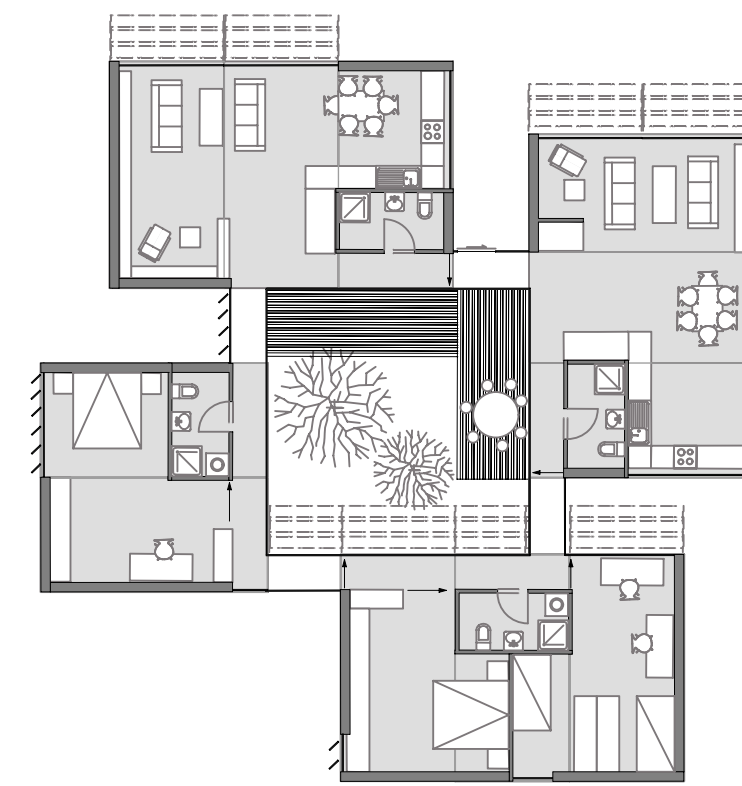


Printing your individual picture on the wall. The same house can be different by simply changing the cladding material. The house as a white board, which can change appearance of the house constantly.

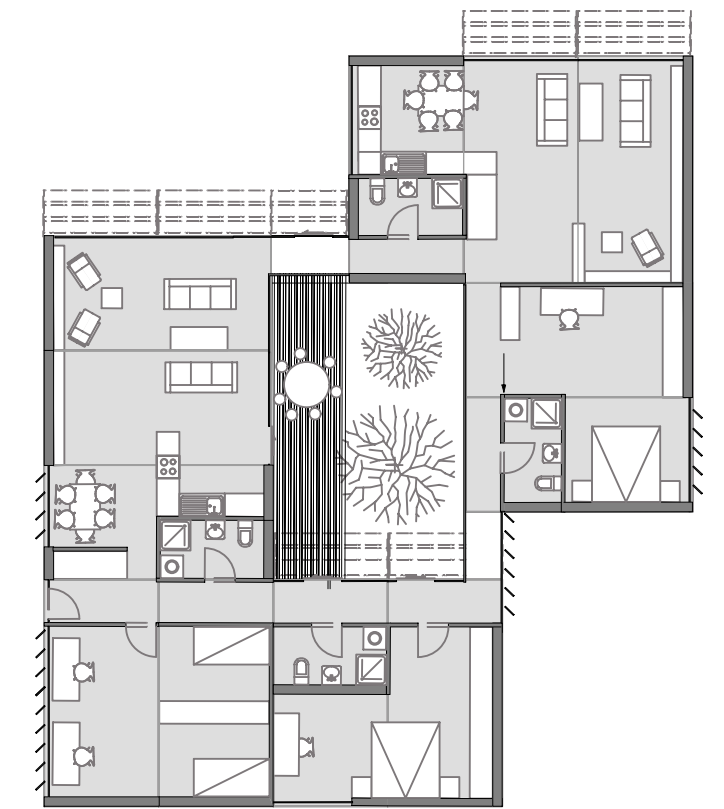
Catalogue Houses Part 2

These designs are speculations on “useful” arrangements of the modules creating different house sizes for different user scenarios. This provides for a potential response to changing demographic trends and demonstrates the intended flexibility of the system.

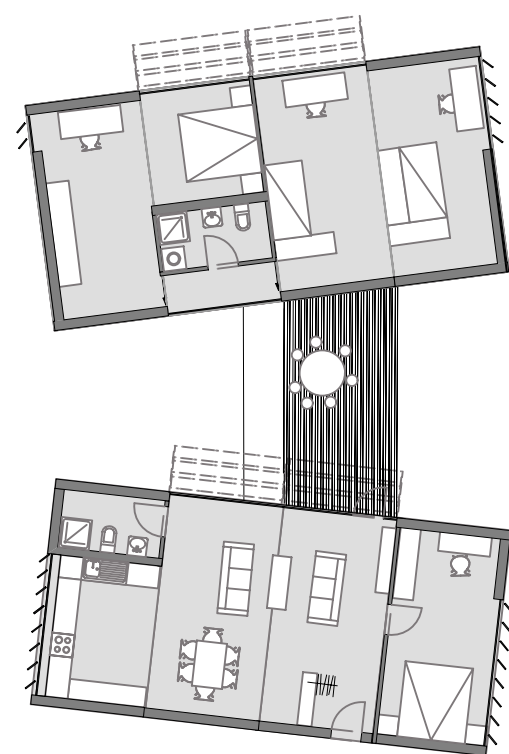
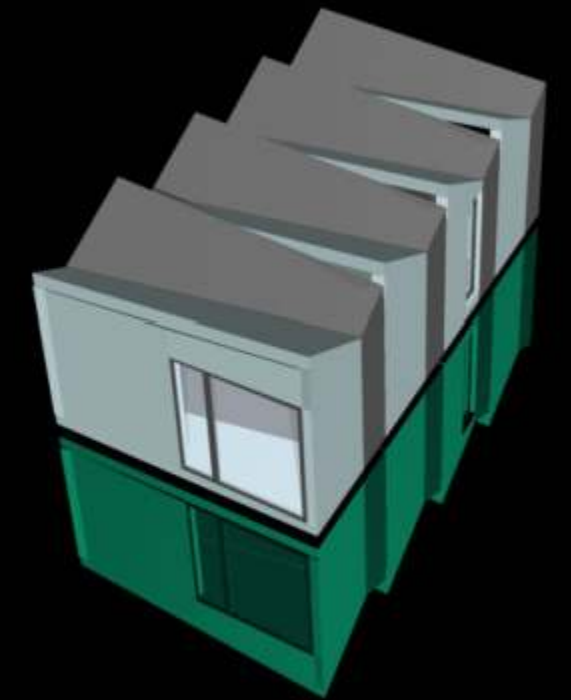
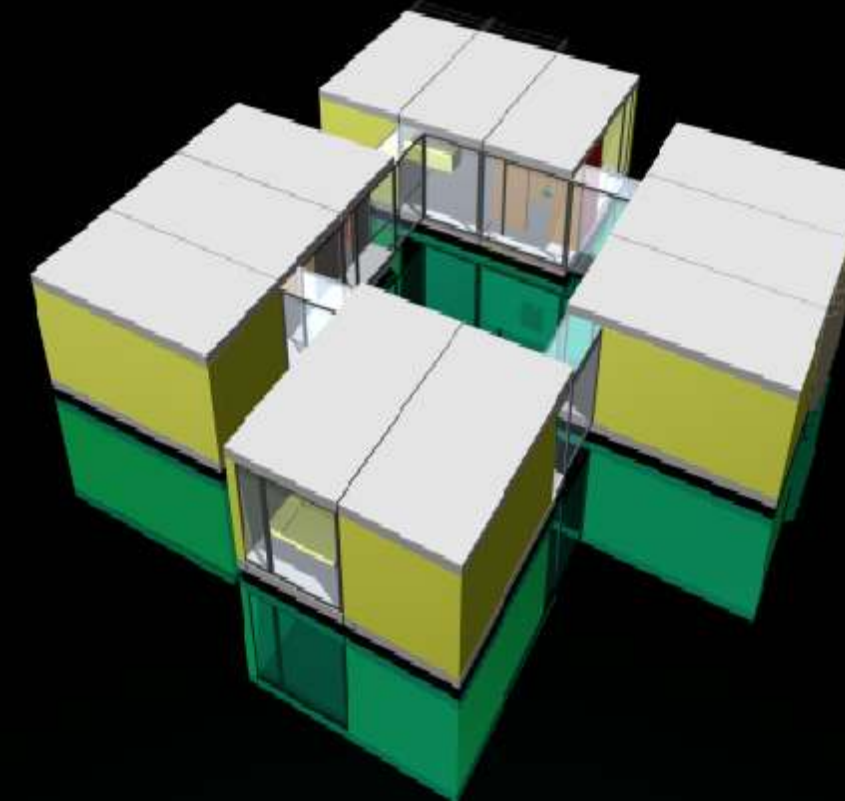
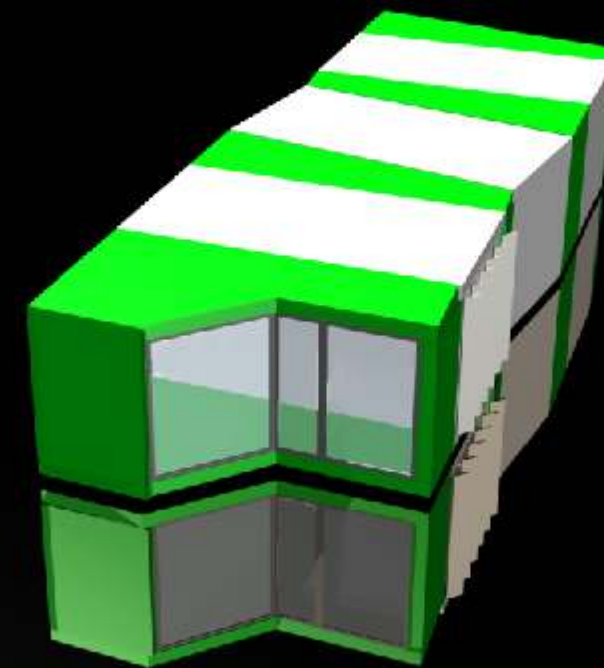
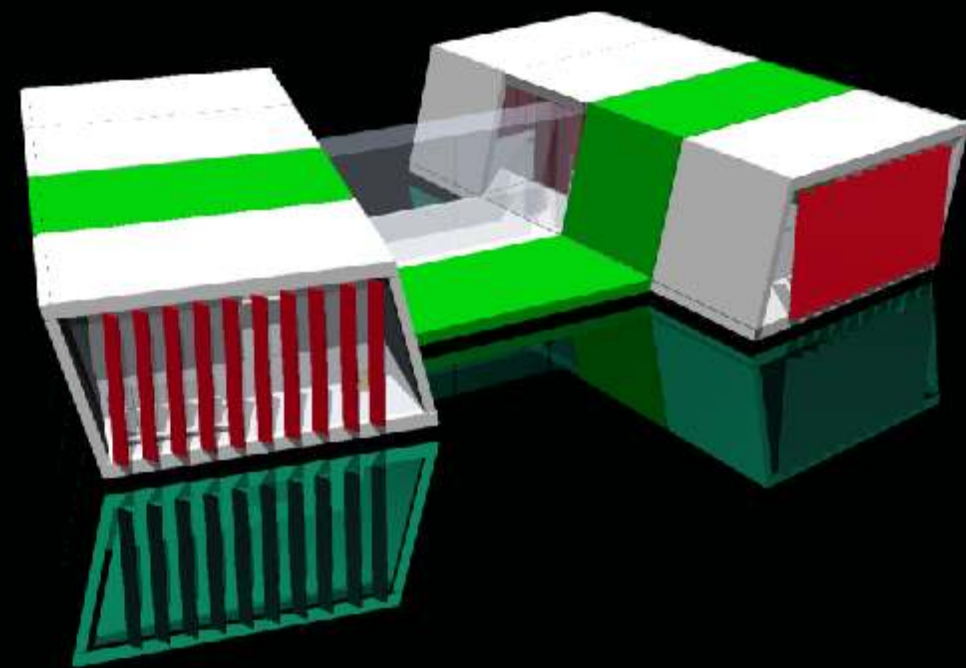
Different courtyard types were developed as an alternative model to create outdoor space with acoustic and visual privacy. The bigger courtyard houses are designed for the co-inhabitation of two families.



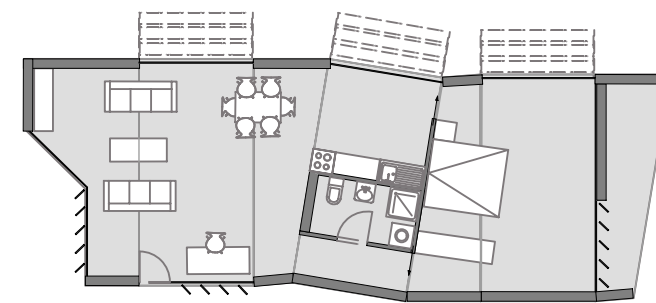
User Scenario: Flat 1: Couple and 2 children
Flat 2: Grandparents



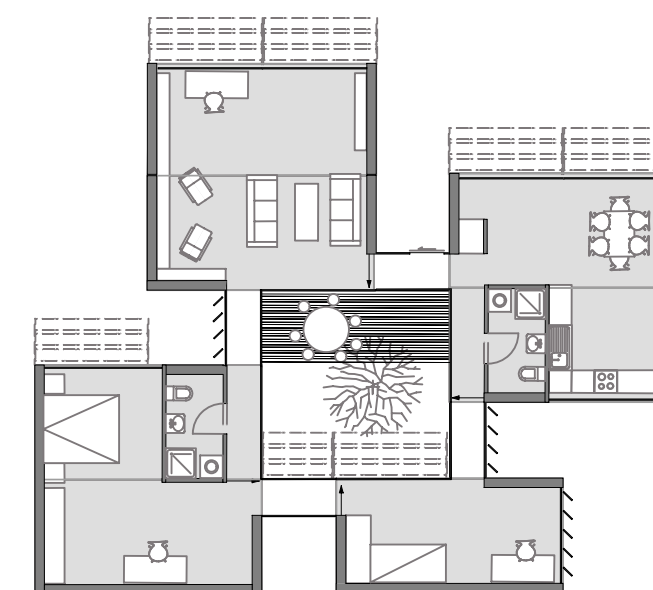
User Scenario: Flat 1: Couple and 2 children
Flat 2: Grandparents



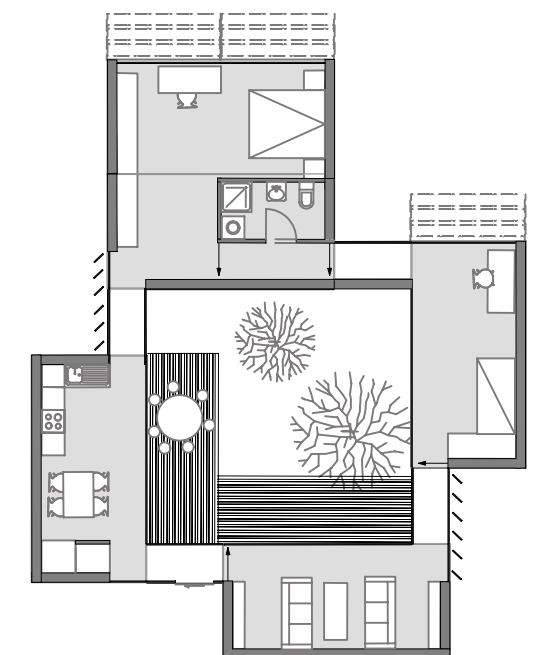
User Scenario: Couple and 3 children



User Scenario: Couple or single



User Scenario: Couple and 1 child

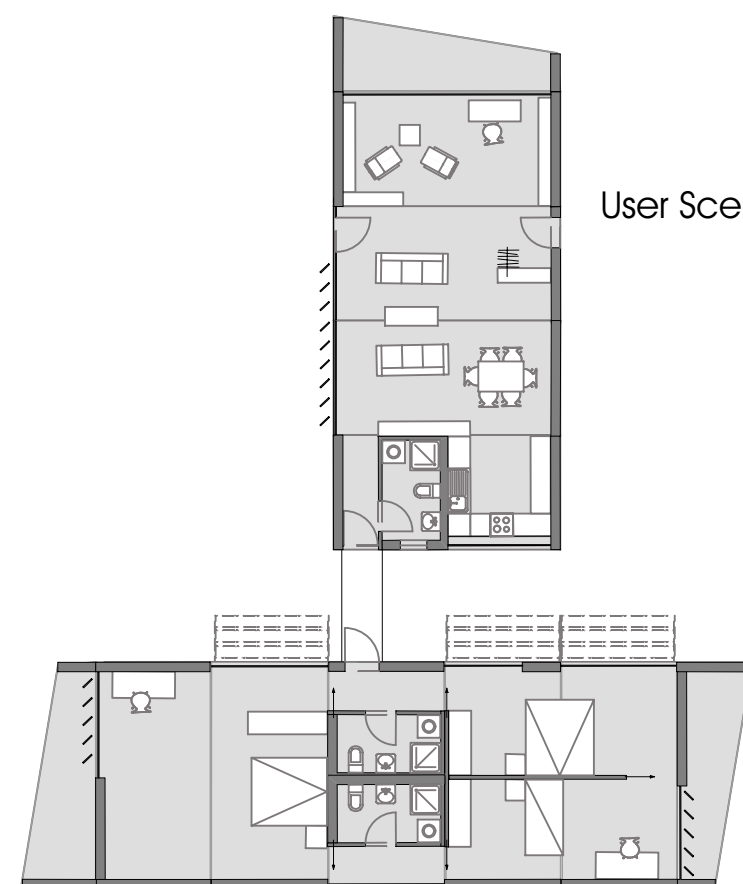
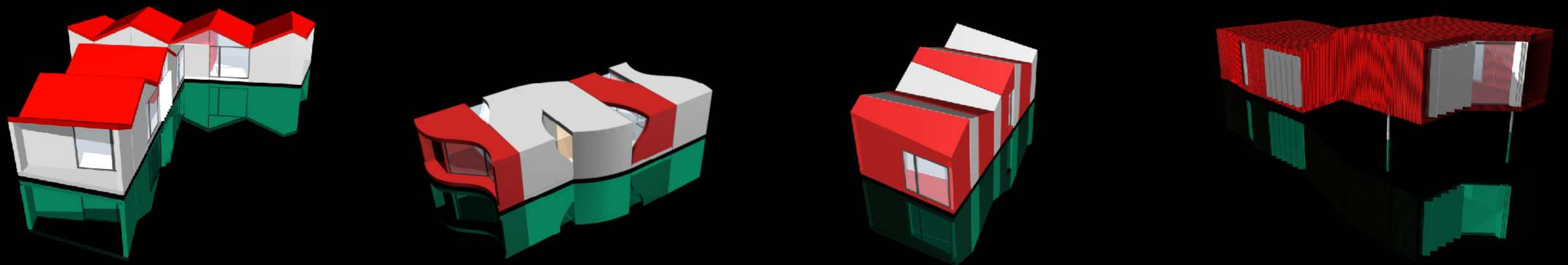


User Scenario: Couple and 1 child

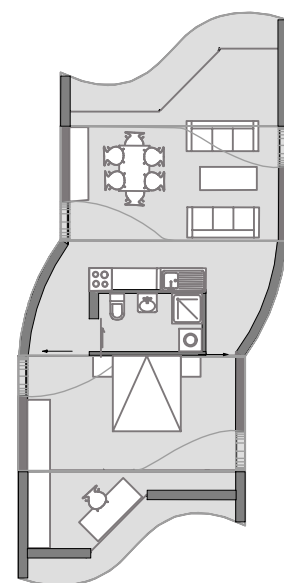
Form finding: The effect of different roof types was explored. Pitched roof types were introduced to give the homes a more domestic look.

More module types were introduced to create greater complexity and variety within the system. Smaller houses with enhanced quality, such as more light and air instead of buried internal spaces were proposed.

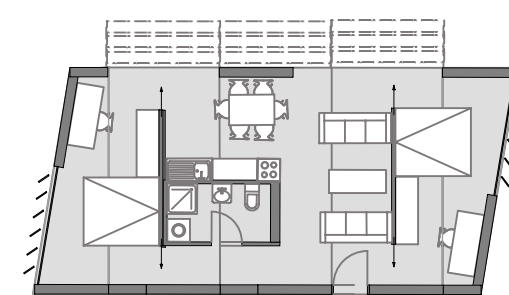
The footprint of the houses are much smaller than average. Optimised orientation and passive solar design principles were applied to create heat gains in winter to reduce energy demand for heating.



User Scenario: Couple and child
+ Couple or single



User Scenario: Couple or single



User Scenario: 2 singles or 2 couples

3. Construction system

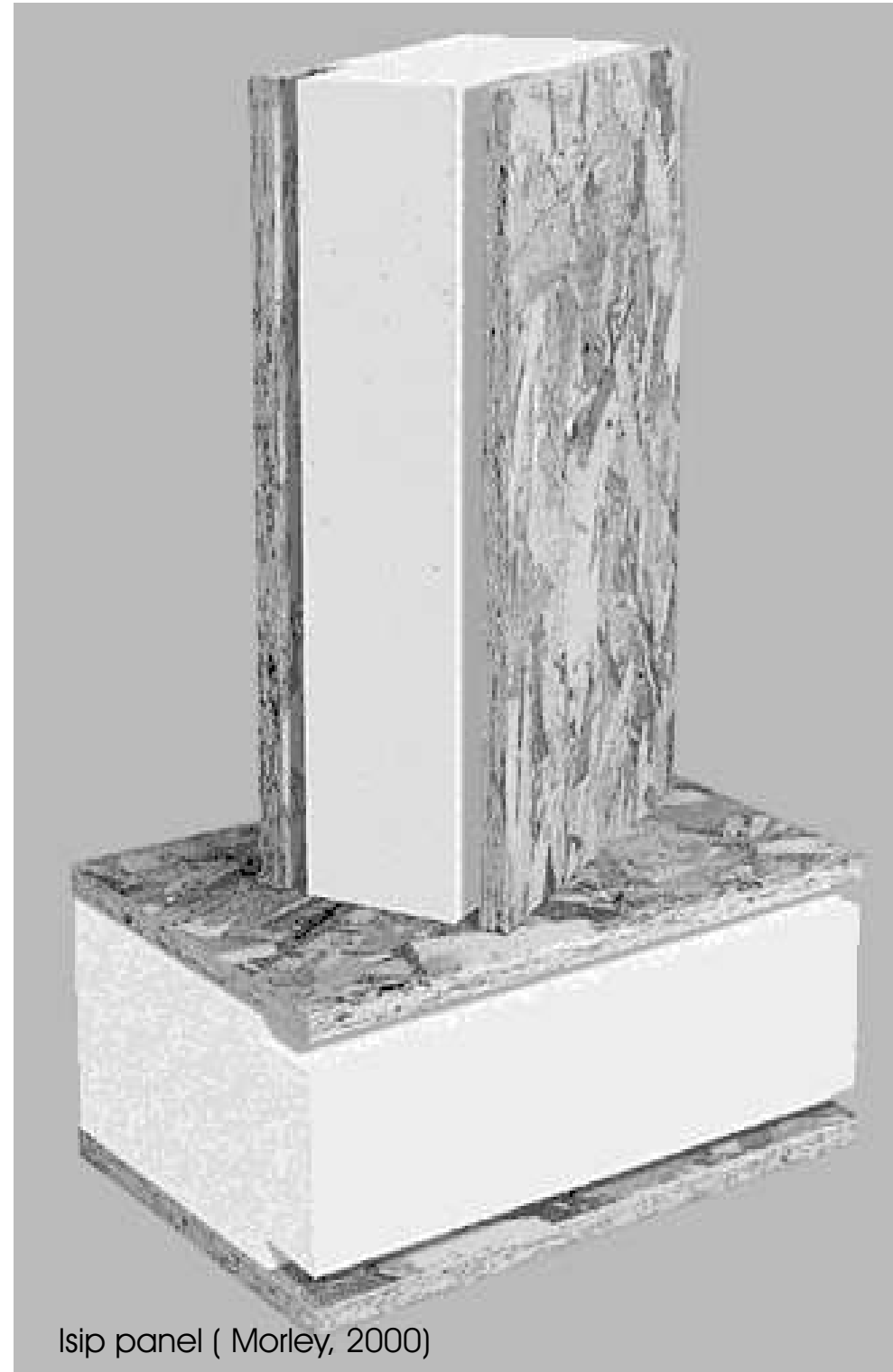
Structural Panel Construction

It was important to find the right construction system to achieve the goal of improving the environmental performance of the house while also to keeping costs down. Additionally, the system needed to allow enough flexibility for the intended customisation.

Due to their low cost and existing use in the prefabrication industry, structural insulated panels (SIP's) were chosen. There is evidence that the construction time can be reduced dramatically by using these composite material panels.

Structural insulated panels have no frames which make customisation, for example cutting out windows, uncomplicated. They are structural, and work "like an I-beam"(Morley,2000).

Instead of using polystyrene for insulation, straw can be used as the core material. The panel would then be made from completely renewable materials. It would be biodegradable and would not contain any hazardous chemicals. What's more, these panels have an excellent insulation value.



Isip panel (Morley, 2000)



Installation of a Sip panel (Morley, 2000)

Structural Panel System

The brick veneer construction system which is widely used in parts of Australia does not perform well in terms of insulation. The bricks on the outside are pure decoration and do not perform thermally. The timber frame on the inside does all the structural work. I will demonstrate the benefits of challenging this type of construction.

Existing materials and processes are used for the construction system because one of the reasons for the failure of prefabrication in the past was that often totally new, complex and expensive processes were developed. Wachsman and Gropius for example, had to design a factory and new machines for the general panel system they developed in 1942-49, which proved to be both expensive and time consuming.

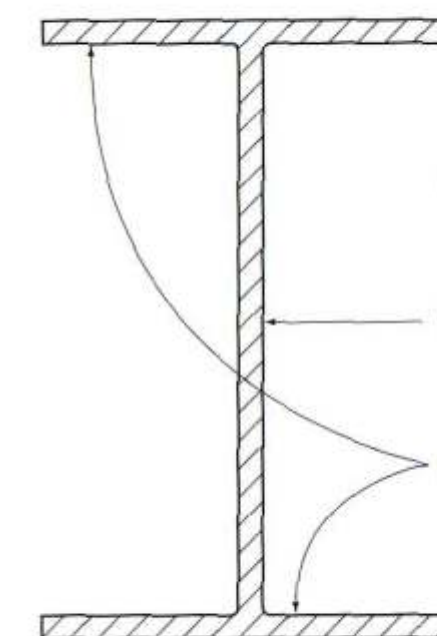
SIP panels are an existing product, being widely used in the USA and there are standard details and rules on how to use them. They are a further development of the balloon frame, developed by experts from the building industry. They are cheap, costing around AU \$90-100 per sqm (brick veneer=\$120, precast concrete= \$220)

There is also proof that buildings can be erected quicker. The construction time can be reduced by up to 70% in comparison with conventional timber framing, (Agriboard Ind. 2007) and has better thermal performance in comparison to traditional construction approaches. SIP panels have inherent flexibility in that they can be used as wall, roof and floors.

While it is true that there are higher upfront costs involved by introducing a new construction system, the possible advantages could offset these costs before long. The cost for the equipment to manufacture SIP panels is US\$ 100,000 (Michael Morley, 2000) All the materials necessary to produce these panels are available in Australia.

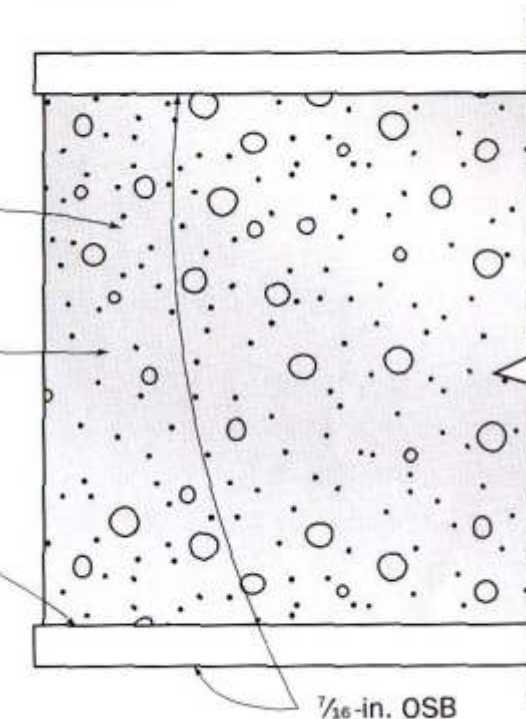
A SIP Is Like an I-Beam

Structural Insulated Panel (SIP)



A SIP works like an I-beam. The facings act as the flanges and the core acts as the web.

I-Beam



(Morley, 2000)



Preferred SIP panel wall connection, 2 thin splines (Morley, 2000)



Cutting out a window opening in a SIP panel is a simple, straightforward task.

OSB (oriented strand board) as a facing material and durra straw panels as the insulation core if combined, would result in a **high insulating, low embodied energy containing material at a competitive price.**

Combining the SIP panel technology with the computer controlled machine for cutting the panels would allow great variation in design such as window opening shape and configuration at an affordable price. Computer controlled machines are used in the Japanese project home industry already and therefore no new technology needs to be designed (these machines cost approx. AU\$120,000)

These processes are not complicated and no large new factory would be needed. Furthermore, lean production reduces investment costs as it is unnecessary to produce any materials up front.

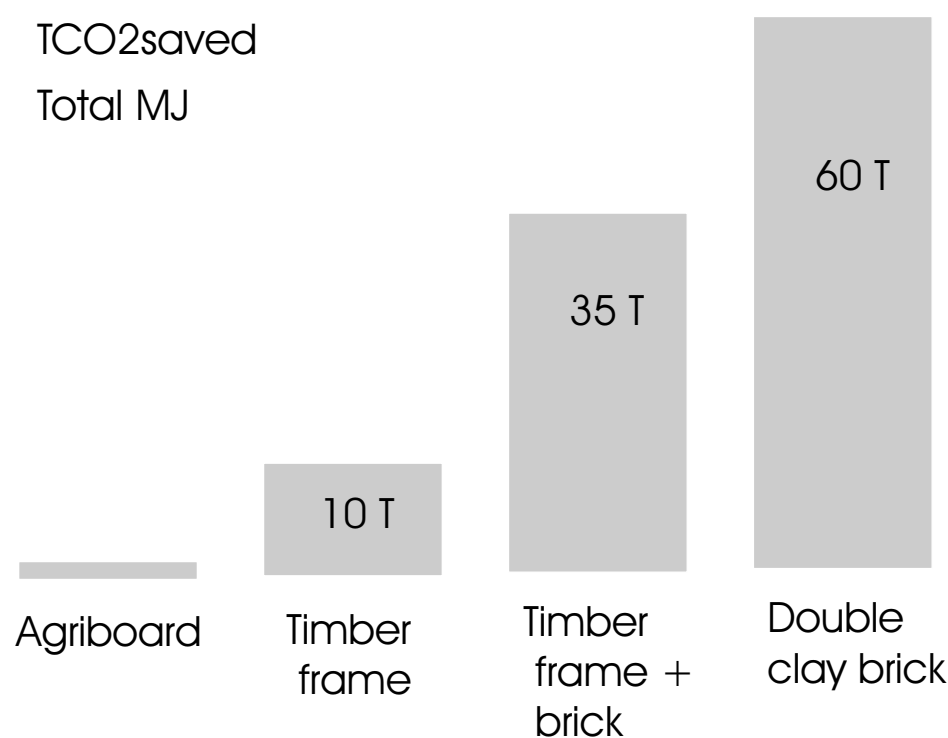
For the assembly on site, a small crane would be needed. A modular crane that can be mounted to a trailer costs US\$20,000 (Michael Morley, 2000). In comparison to standard timber construction, the joining of the components are low tech and do not require any special skills or tools.

Working with these light weight panels can also reduce safety issues on the construction site and make scaffolding obsolete.(Ortech Industries 2007)

“The proposal shows that by combining existing products in an innovative way, the environmental performance of residential buildings can be significantly improved. The economical analysis indicates that massive savings can be generated by using light weight structural panels instead of the commonly used timber frame with brick veneer while at the same time safety issues are substantially reduced.”(Begert 2007)

Colin Davies says about SIPs:

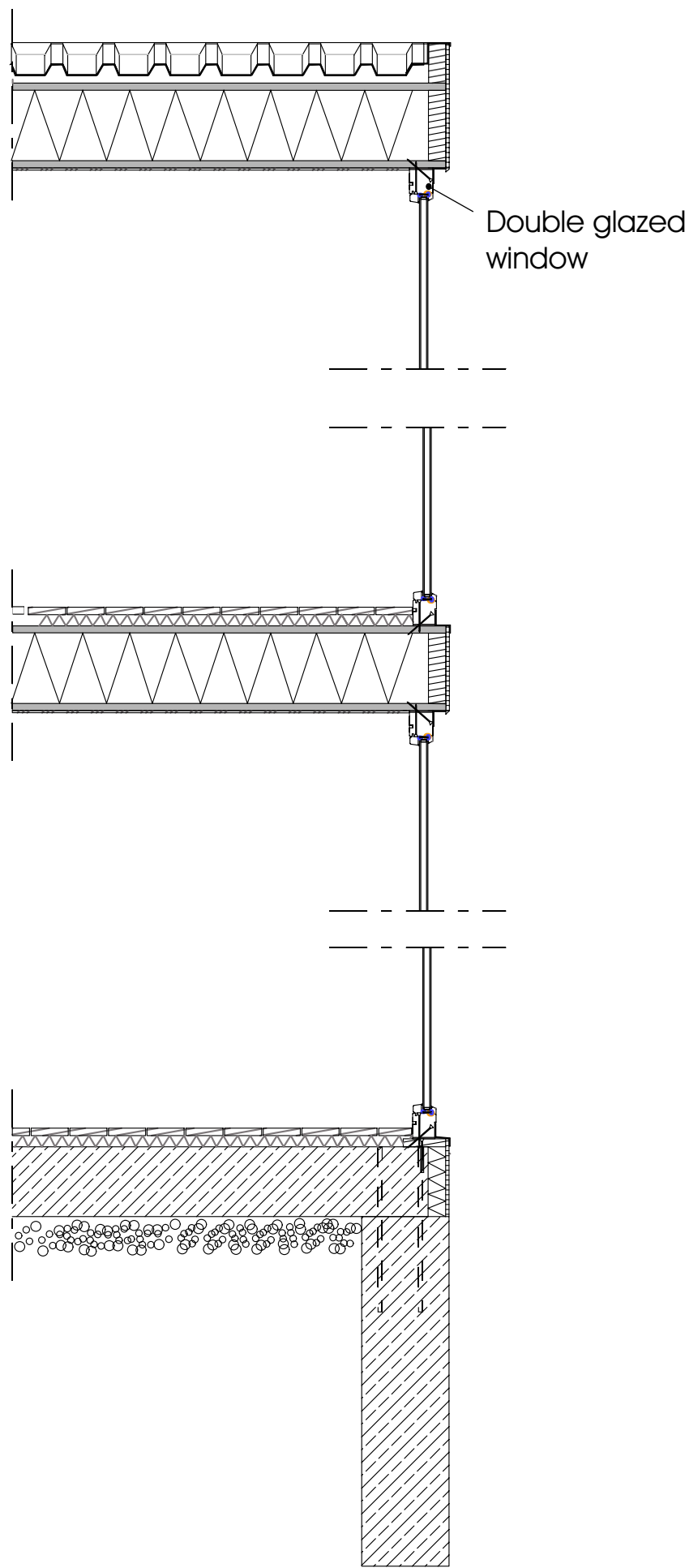
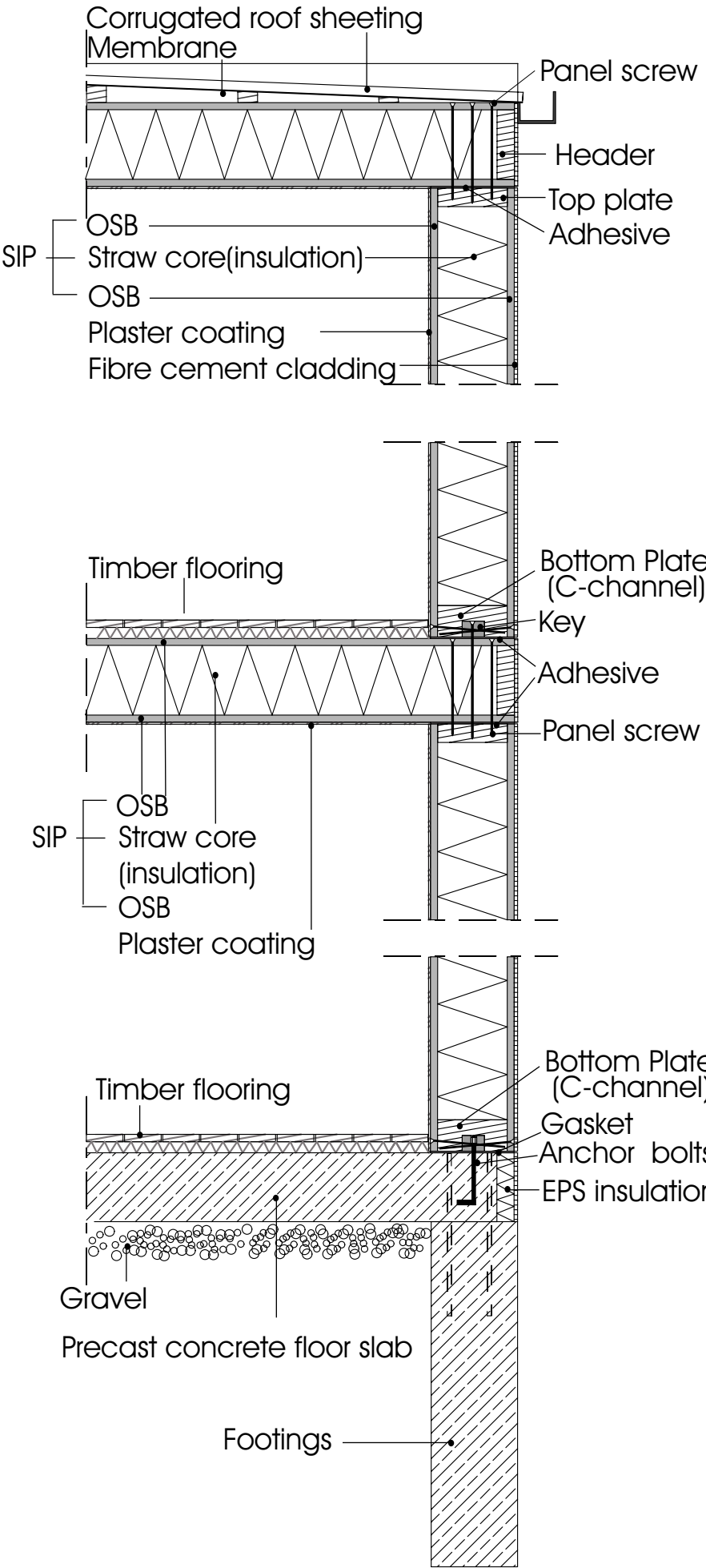
“Form board models are said to encourage a tendency among students to ignore the structural and constructional aspects of their designs (beams and columns, the depths of floors, the thicknesses of walls) and deal only with abstracted form and space. Real buildings, so the argument goes, are not made from universal structural boards of even thickness, cut to shape and glued together. Well this view may have to change, because in the US houses are increasingly being made that way.” (Davies, 2005)



Large panels allow a quick assembly on site . A crane is an essential tool

Construction Details

Section Details



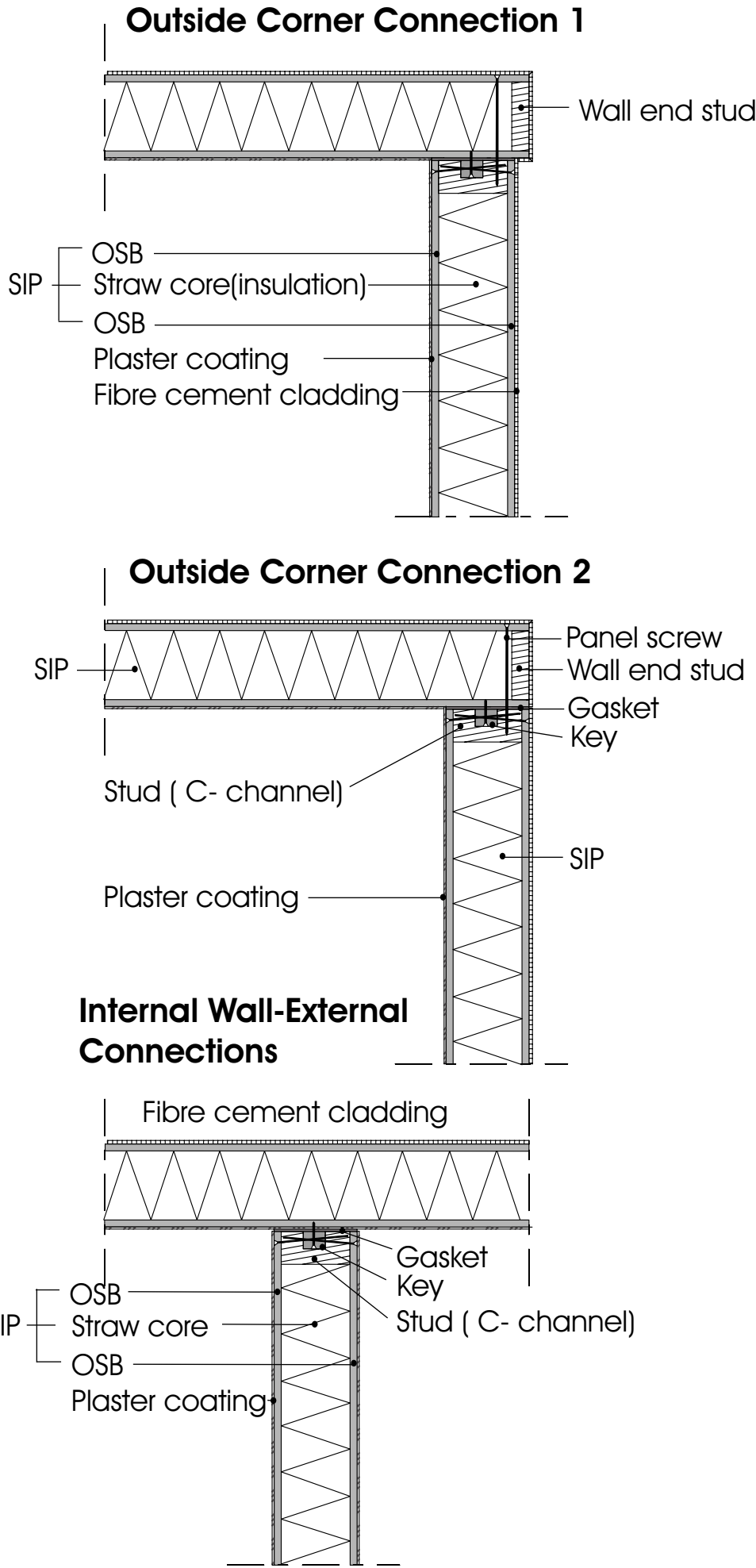
Window /Roof Connections

Window /Floor Connections

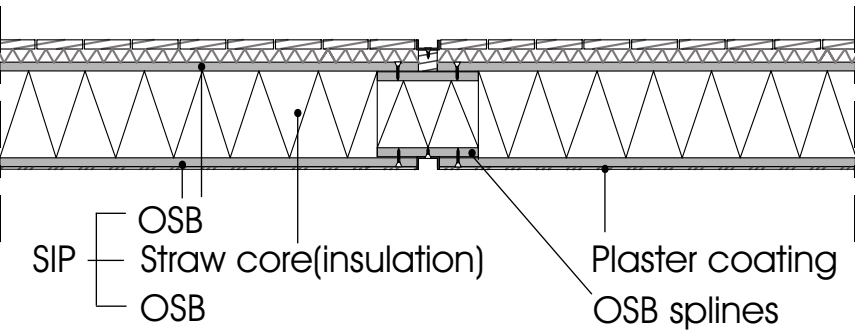
Window /Wall Connections

Wall to Foundation Connections

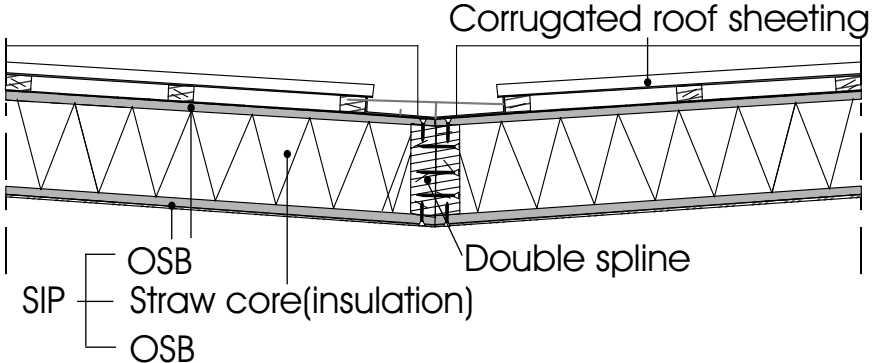
Plan Details



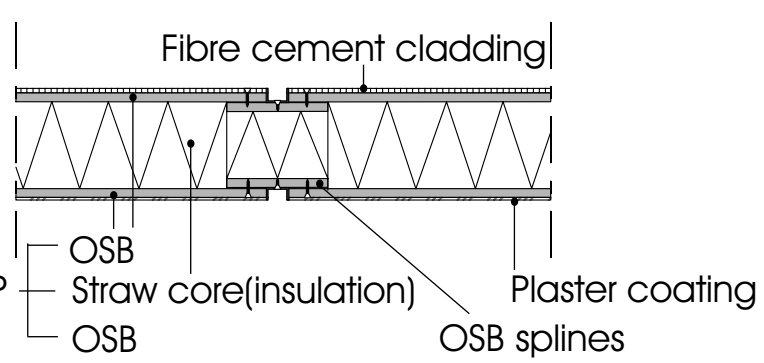
Floor Panel Connections



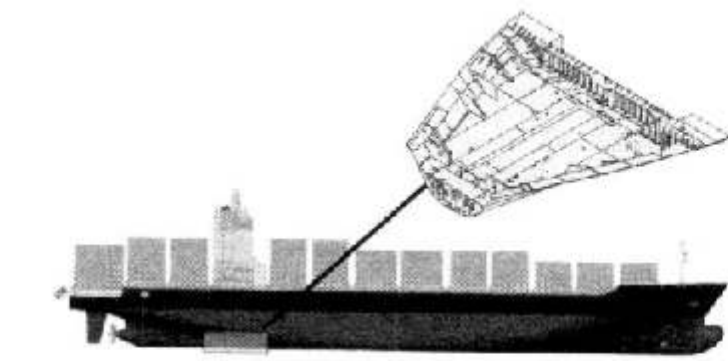
Roof Panel Connections



Wall Spine Connections

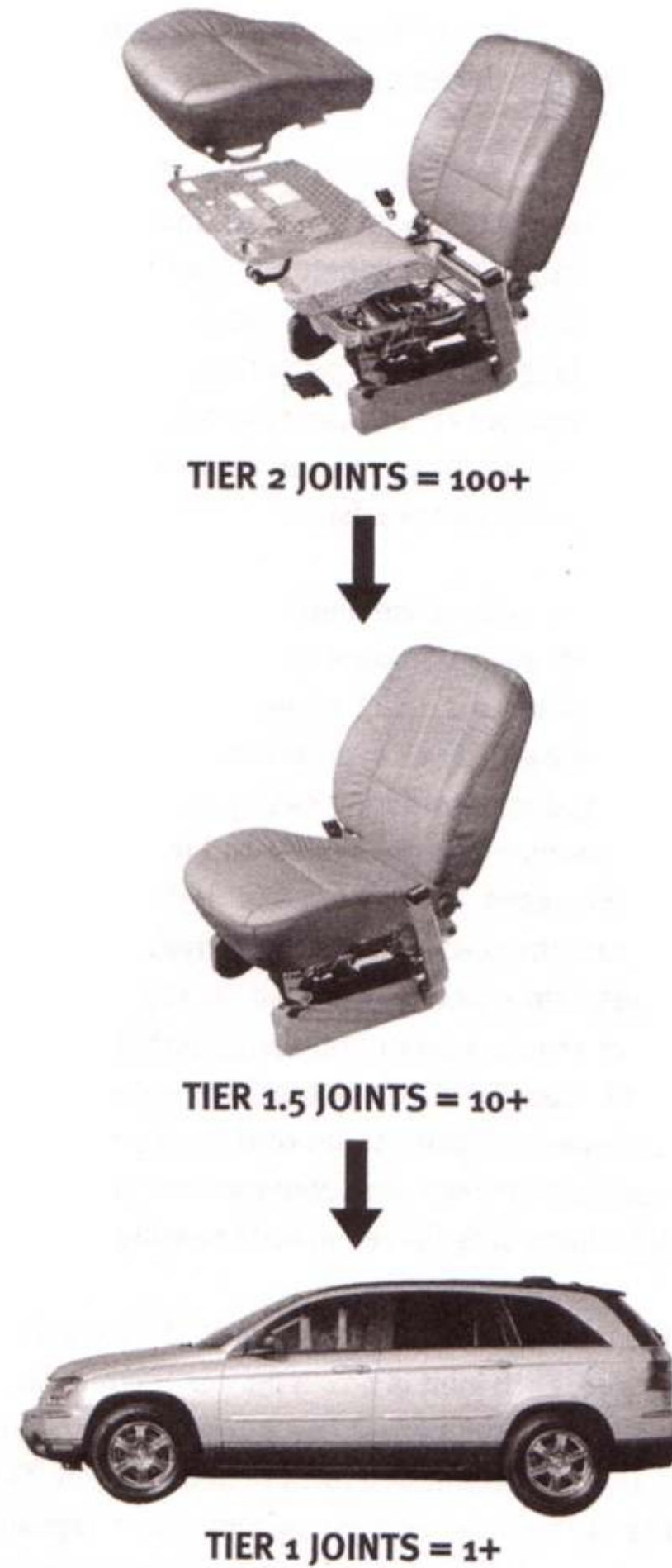


As stated in "Refabricating Architecture" (Stephen Kieran, James Timberlake, 2004), reducing the number of parts at final assembly saves time in other industries. The authors compare the building industry with the production of large objects like ships, cars and aeroplanes, pointing out that the production of larger components and reduction of joints makes the process of manufacturing more efficient.



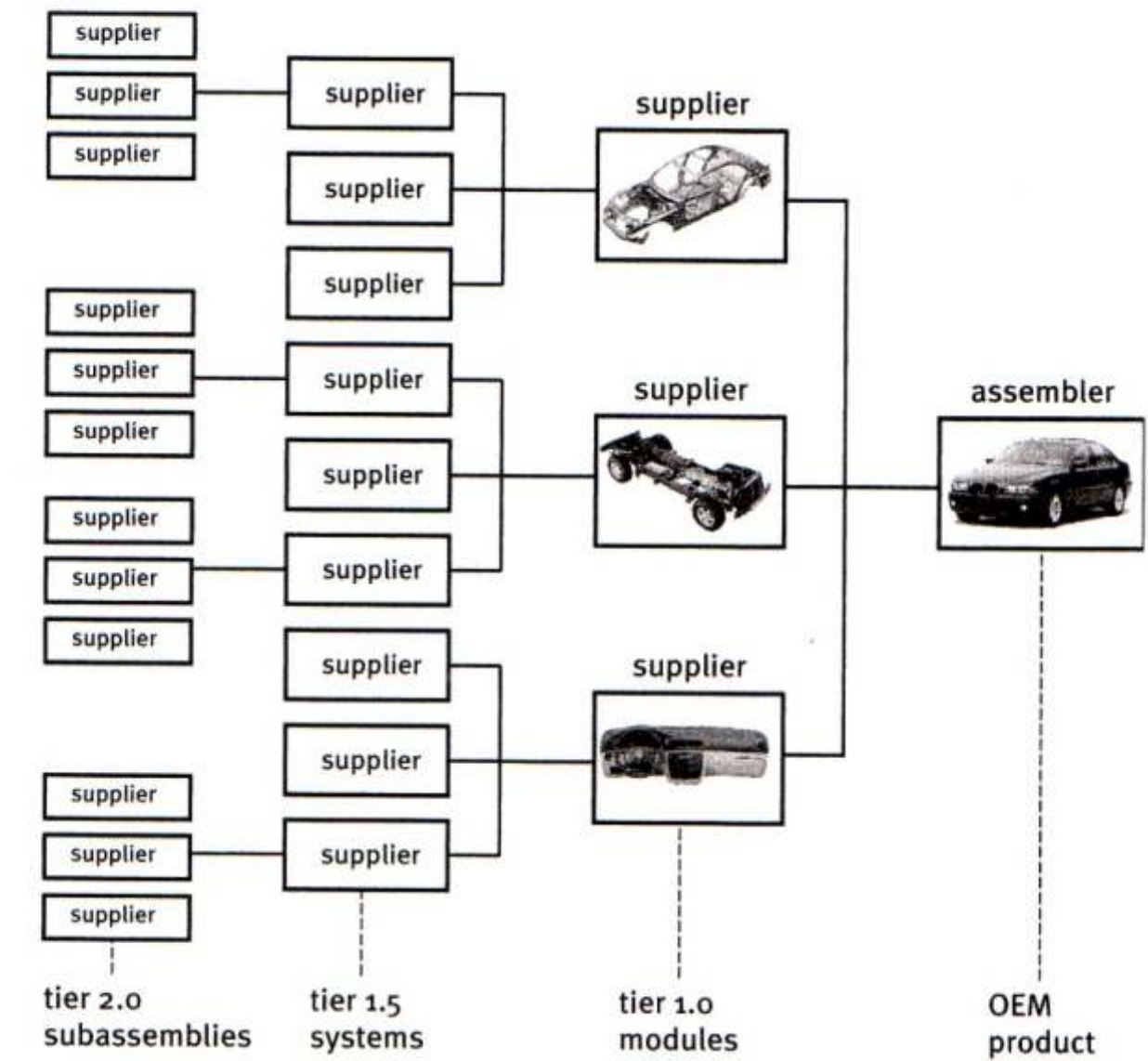
BLOCKS, CHUNKS, MODULES

DEFYING GRAVITY The assembly of large objects used to be dictated by the laws of gravity. Building would typically start with a structural frame, proceed from the bottom, and move upwards hierarchically, adding elements until completion. Today, most of these industries have moved toward nongravity-based processes where pieces of the object are framed and outfitted independently of the whole and brought together only at final assembly. (Images: Kvaerner Philadelphia Shipyard Inc., Audi AG, Faurecia.)



PUTTING THEORY TO PRACTICE The seat module shown above illustrates how the joint theory works in the automobile industry. The effectiveness of component assembly in more systems and joints are included in the modules. (Images: courtesy Delphi Co DaimlerChrysler.)

A modular production supply chain organises the production process in an efficient way to reduce the wasting of time, money and resources.



MODULAR PRODUCTION

THE MODULAR PRODUCTION SUPPLY CHAIN The hierarchical tree for parts supply in the automobile industry is broken down into four levels, or tiers. It begins with an oem who subcontracts out the production of many large chunks of a vehicle. Those sub-contractors in turn sub out the smaller chunks of their modules. This ladder continues until a chunk is reduced to pure parts.

Calculations



Heating and cooling are the major energy consuming activities in a house. Combining the SIP construction system with double glazed windows and the right house orientation (passive solar design principles) contributes greatly towards making a heating and cooling system redundant. This was proven in cooperation with Begert and Szatow, RMIT Master of Sustainable Energy research students. The heating and cooling demands and the embodied energy of the Broadmeadows house were calculated. They also wrote an ecological and economical assessment of the proposed construction system.

The right orientation can be achieved within the design system without any additional costs. This will further result in savings due to a reduction in running costs.



Double glazed window

Additional costs incurred for eco features

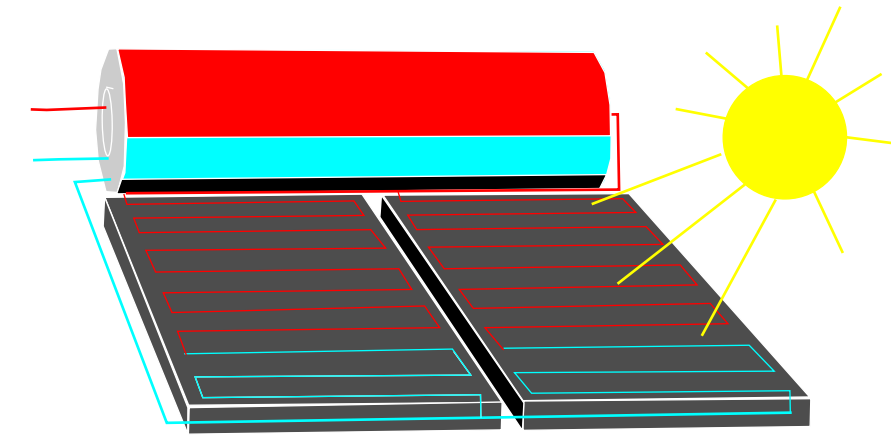
- double glazing: \$7000 for the 108 sqm Broadmeadows house (Begert & Szatow 2006)
- Solar hot water system:\$2500 (Begert&Szatow 2006)
- Photovoltaic electricity: \$14000- 8000 subsidies= \$6000 (Begert & Szatow 2006)
- Shading elements: \$ 2500
- Water tank: \$ 2500

All these features add \$ 20000 to the price of the house. However the "costs could be completely offset by the savings in labour costs allowed for by the construction system" (Begert & Szatow 2006) and by a slightly smaller house.

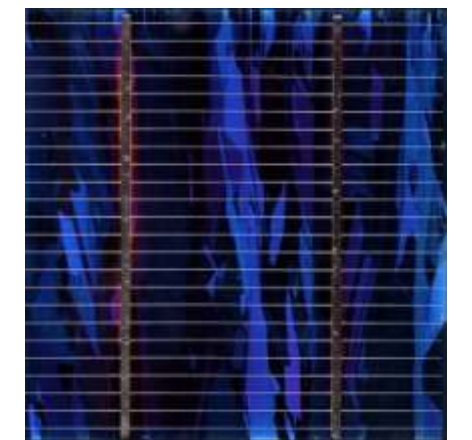
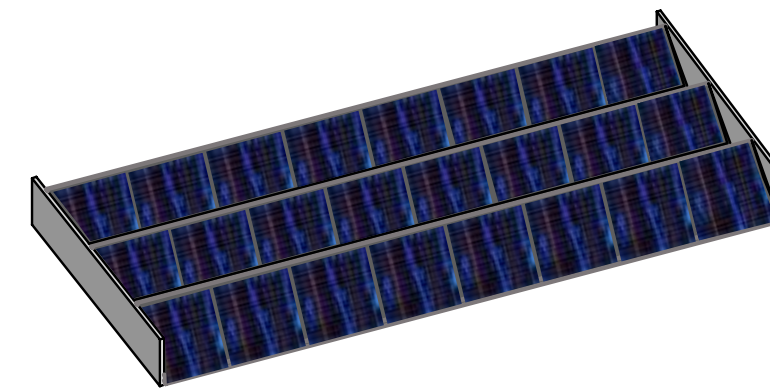
"The eco features could generate yearly savings of up to \$760 for the 100 sqm Broadmedoaws house, based on a price of \$0.14 per kWh." (Begert 2007)

The annual savings in comparison to a benchmark house, have shown that sustainability and affordability are linked because the running costs of the house over a 50 year period could easily reach the costs of its initial construction price.

Energy/ water related services to be supplied as part of the system

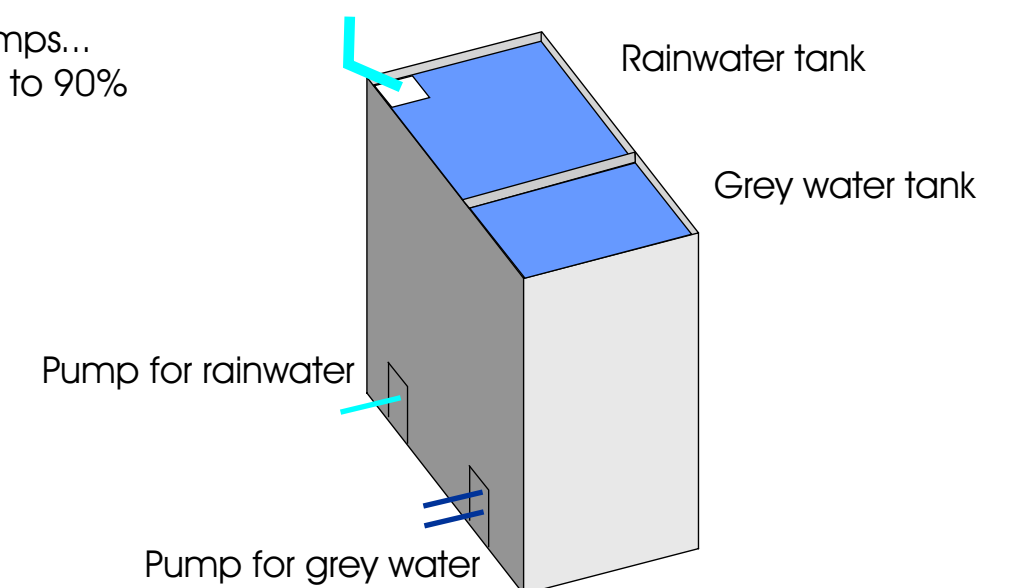


Photovoltaic electricity



Integration of solar cells into the shading elements

Integration of a rainwater + grey water tank+pumps... into the system could reduce water usage by up to 90%



FirstRate Report



YOUR HOUSE ENERGY RATING IS: ★★★★★★ 6 STARS
 in Climate: 27 **SCORE: 40 POINTS**

Name: Ref No:
House Title: Date: 08-09-2006
Address:
Reference: F:\MODULAR ARCHIFANCY HOME RVALUE11

IMPROVING YOUR RATING

The table below shows the current rating of your house and its potential for improvement.

Star Rating	POOR		AVERAGE				GOOD			V. GOOD		
	0 Star	★	★★	★★★	★★★★	★★★★★	★★★★★	★★★★★	★★★★★			
Point Score	-106	-105	-61	-60	-32	-31	-15	-14	2	3	14	15
Current	40											
Potential	40											

Incorporating these design options will add the additional points required to achieve the potential rating shown in the table. Each point represents about a 1% change in energy efficiency. This list is only a guide to the range of options that could be used.

Design options Additional points

Better environmental performance of the house guaranties long term affordability.

The current practice of creating more space for less cost, in a low performance house is not just resulting in environmental problems but also in long term affordability problems.

Begert and Szatow calculated the heating and cooling demand with the "First Rate" software and I used a program called "Passive House Package" by the Passive House Institute to calculate the energy demand for heating and cooling.

Only the temperature and radiation data has to be changed for Melbourne. It is relatively easy to design a house which doesn't require a heating or cooling system due to the city's mild climate. The program calculates heat loss through the building's envelope and ventilation and heat gains through the windows and internal sources like appliances and people. The program is very complex but easy to use by non-experts. It is also possible to calculate electricity demand and it recommends the right size for your solar hot water system.

This program is a scientific way to estimate the energy consumption of a building before it is built. This is a good tool for the designer and could be combined with CAD software because all the information such as measurements of the building and materials could be automatically transferred into the program.

It would be easy to integrate this software in a user interface where customers design houses with the design system.

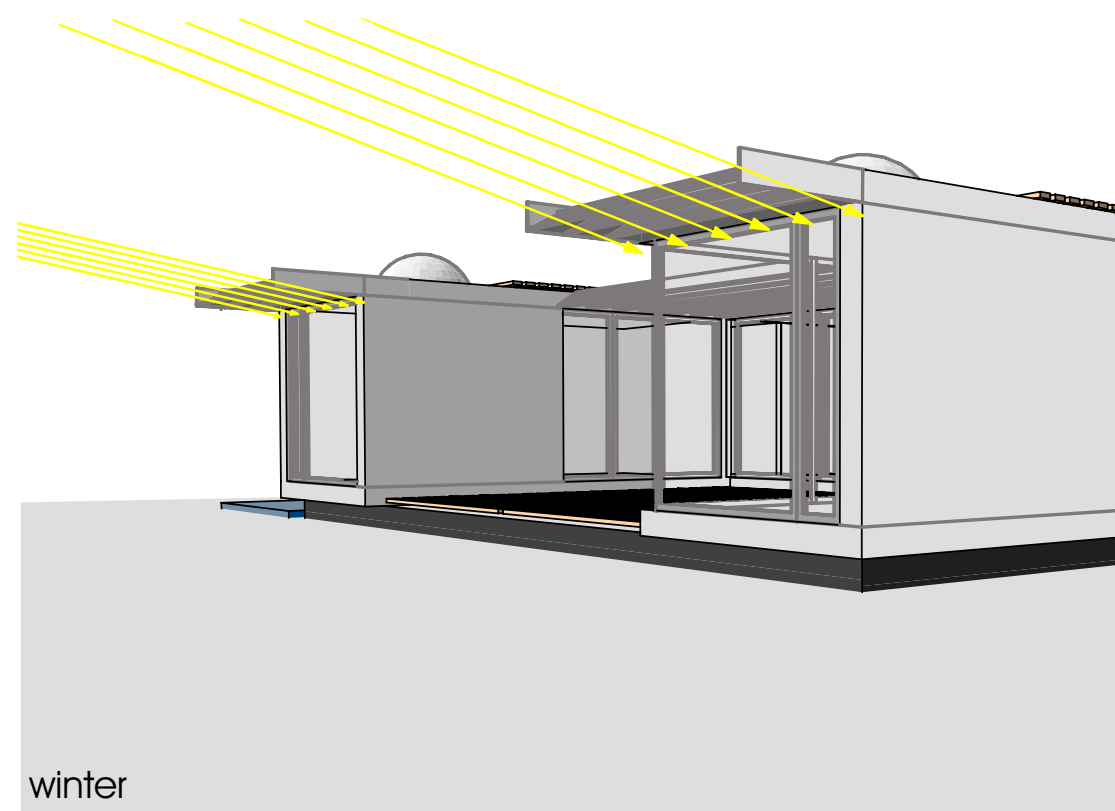
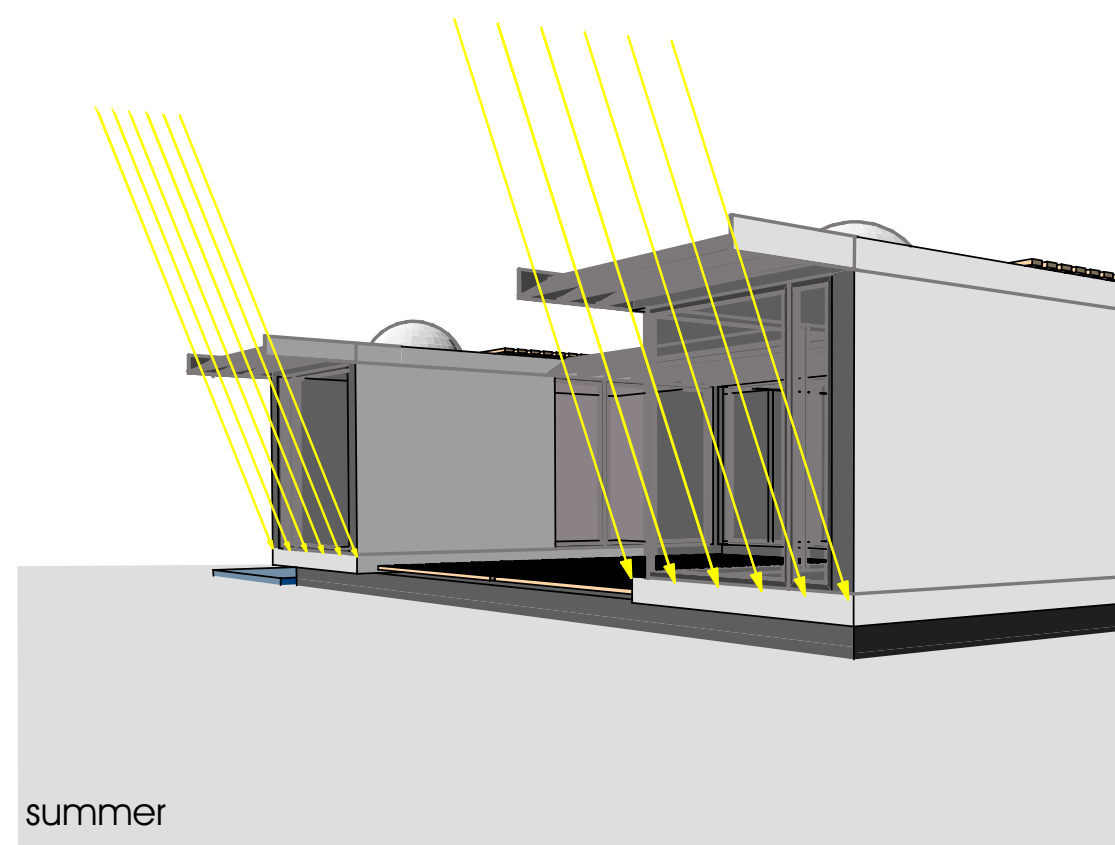
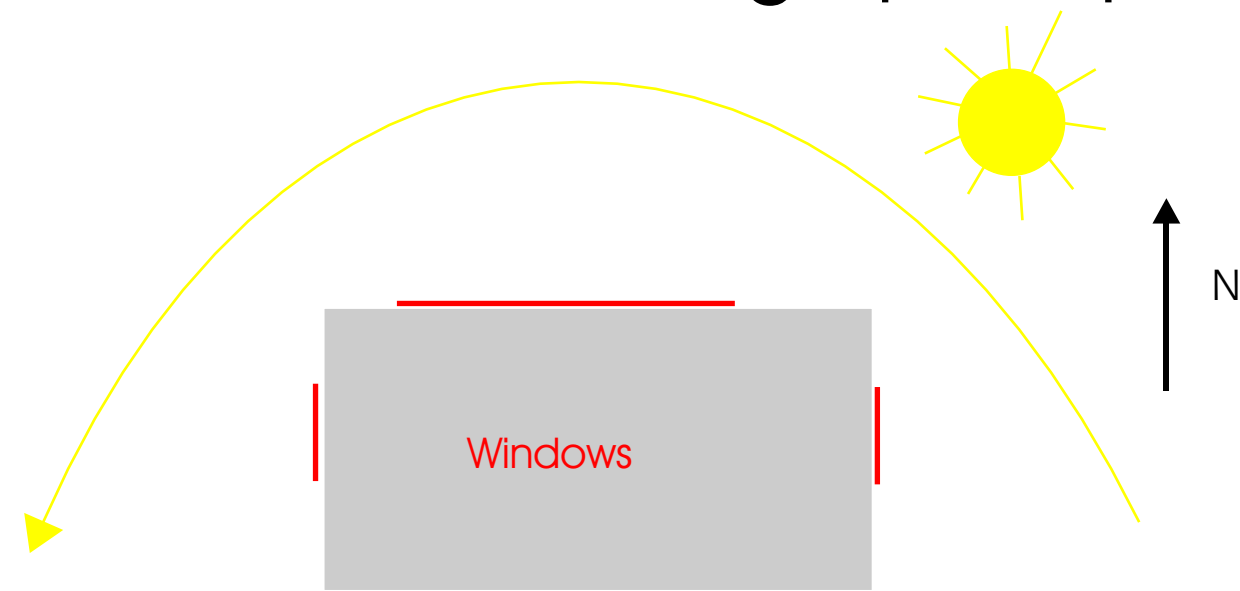
- Demolition and disposal costs 3%
- Follow-up costs 40% energy, heating, cooling, electricity, hot water
- Follow-up costs 40% maintenance, improvement, conversion
- Planning+Erection costs 17%

Follow up costs are often underestimated by the home buyer
 Conventional construction Germany (Detail 6/2007)

Simulation of energy demand with a complex program called pphp2004 designed by the Passive House Institute Germany.

First Rate program used to evaluate the performance of the Broadmeadows house

Passive solar design principles



north facade

The two design principles used to reduce heating and cooling energy demand by as much as 100% are:

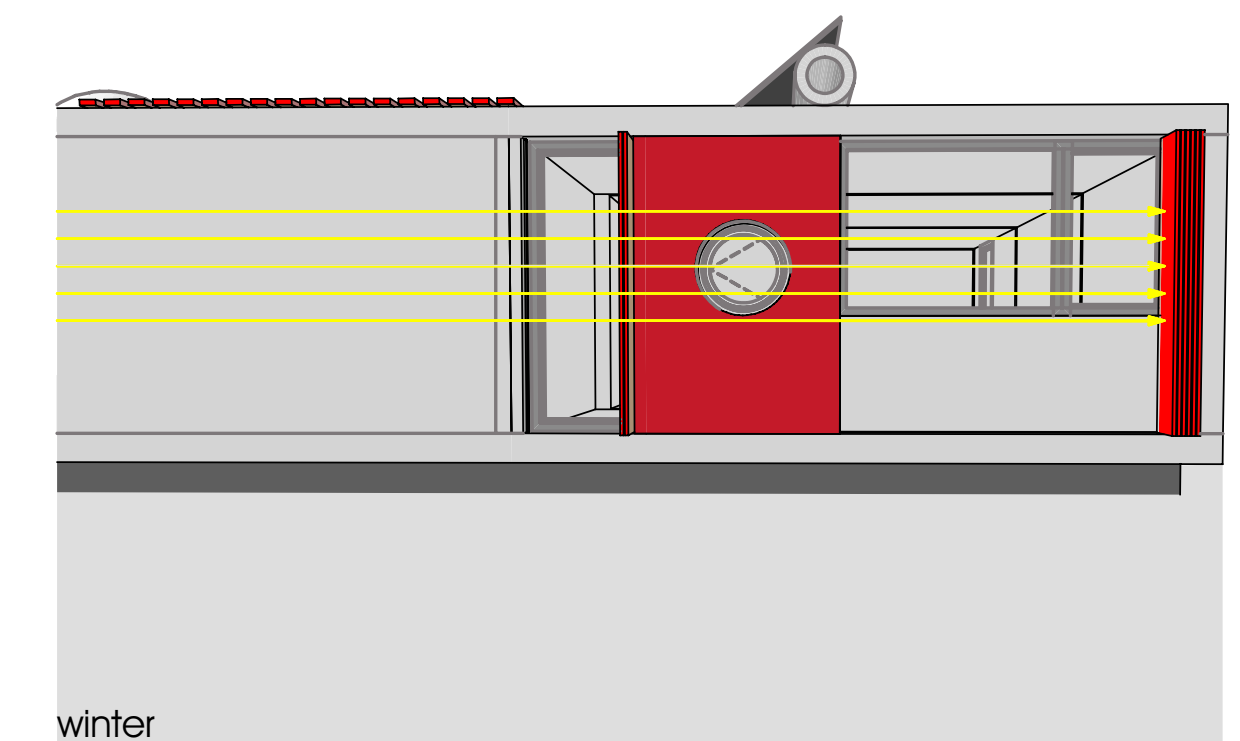
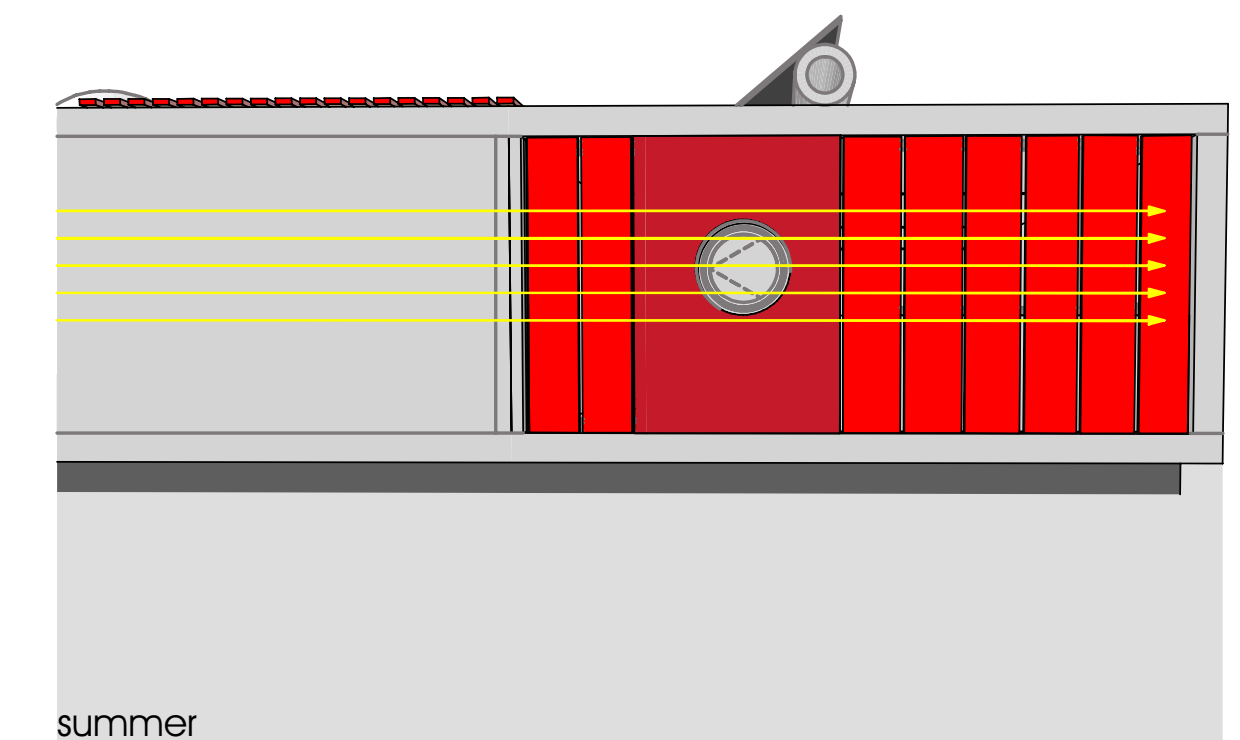
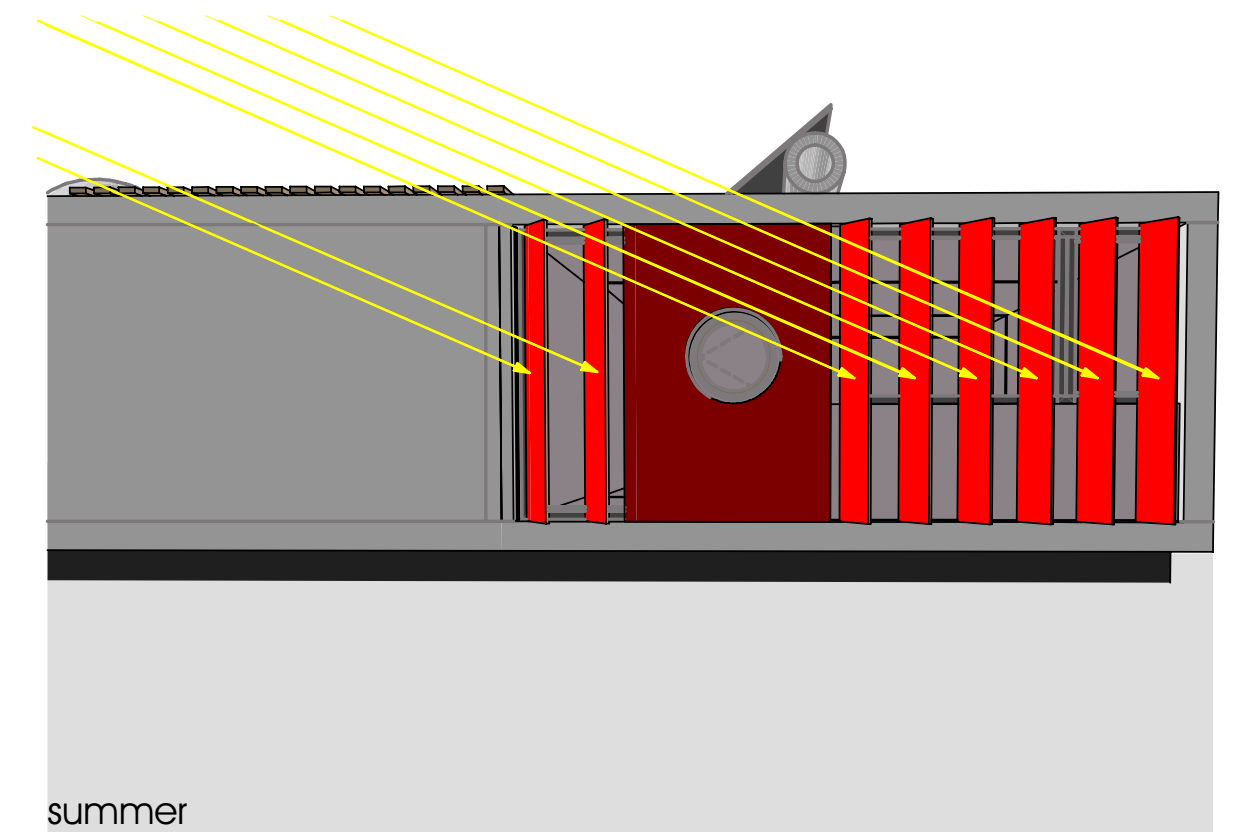
Passive solar design

- Optimised orientation leads to large glazing areas in the north for heat gains in winter.
- East and west facing glazing has to be shaded with adjustable shading.
- South facing glazing has to be reduced.
- Overhangs for shading of glass on the north to avoid heat gains in summer and allow them in winter.
- Good insulation, draught sealing and advanced glazing solutions are necessary to minimise heat loss in winter.
- Zoning of the interior
Higher temperatures are required in the living areas which should be ideally placed on the north side of the house.

Passive cooling

- Cross ventilation is allowed for by openable windows in every room.
- Earth coupling of thermal mass (floor slabs) which are protected from external temperature extremes can substantially lower temperatures by absorbing heat as it enters the building
- Shading elements as described and good insulation.

A compact floor plan would be beneficial but a balance needs to be found between minimising heat loss and achieving adequate daylighting and ventilation.



east /west facade

Rules for shading elements according to passive solar design principles

4. Customisation

From clothing, to computers, and into the automobile industry, customisation is used as a response to customer demand for choice, expression and individuality. Companies such as Dell computers, Nike and Swatch “have organised their companies to meet the mandate by providing choices, in real time, at lower cost, and higher quality.....By breaking down their products into smaller parts these companies can assemble the parts to meet the demand for choice” (Kieran/Timberlake 2004)

An incredible variety and choice can be achieved within an overall system as seen in the furnishing industry, Ikea in particular.

When products are mass produced and custom made, it is referred to as mass customisation. Car manufacturers now see their products as a range of components that can be put together in different combinations. Cars can now be built to order, which increases the number of possible component combinations.

The Japanese prefabrication industry uses customisation and lean production to offer their customers choice.

As an experiment I invited nine people, of various cultural and professional backgrounds, to design a house using the design system that would suit their own needs.

It was intended that the house would be located on a site in Swan Hill, a Vic Urban development in country Victoria. Each participant was provided with information about the site, including lot dimensions. Interestingly, people designed smaller than average houses.

Involving the client in the design process provides for streamlining the procedure, while also allowing for the inclusion of the client’s personality and individuality. Most importantly, it allows for the client to create a house that fits his or her needs while also taking into consideration architectural problems, i.e. building form and spatial relationships. It provides the possibility of educating the client and applying architectural knowledge.

This level of inclusion creates a situation that encourages a further quest for architectural knowledge and a reflection of what one actually needs, as opposed to what one desires. The clients’ participation in the design process is in stark contrast to the simple passive act of purchasing the volume built home.

I believe these homes are not produced in the best interest of the client or society, but rather in the interest of the company who sells it. As a result, the customer ends up with a home that is too large for their needs.

My proposed design system asks the customer to think about his or her own requirements which has the potential to create new houses that are smaller and more diverse.

In the design experiments, people chose their own pictures for the facade, added additional windows and customized walls.

They configured houses with sizes from 100 sqm up to 220 sqm, with varying spatial arrangements.

In comparison to the standard house, customisation could make the design system more adaptable to the client’s cultural background, finances, spatial needs, and also to the site in terms of orientation, topography and building regulations.

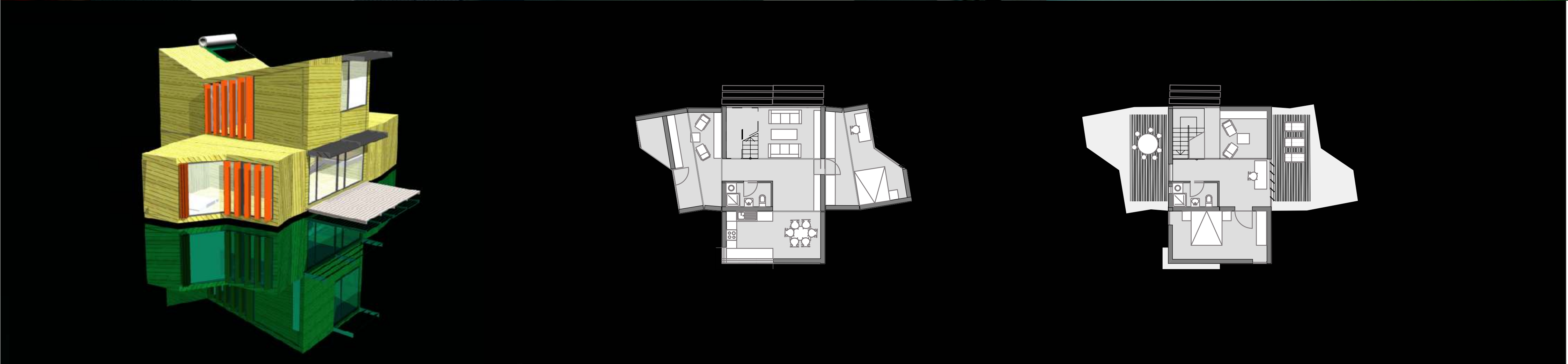
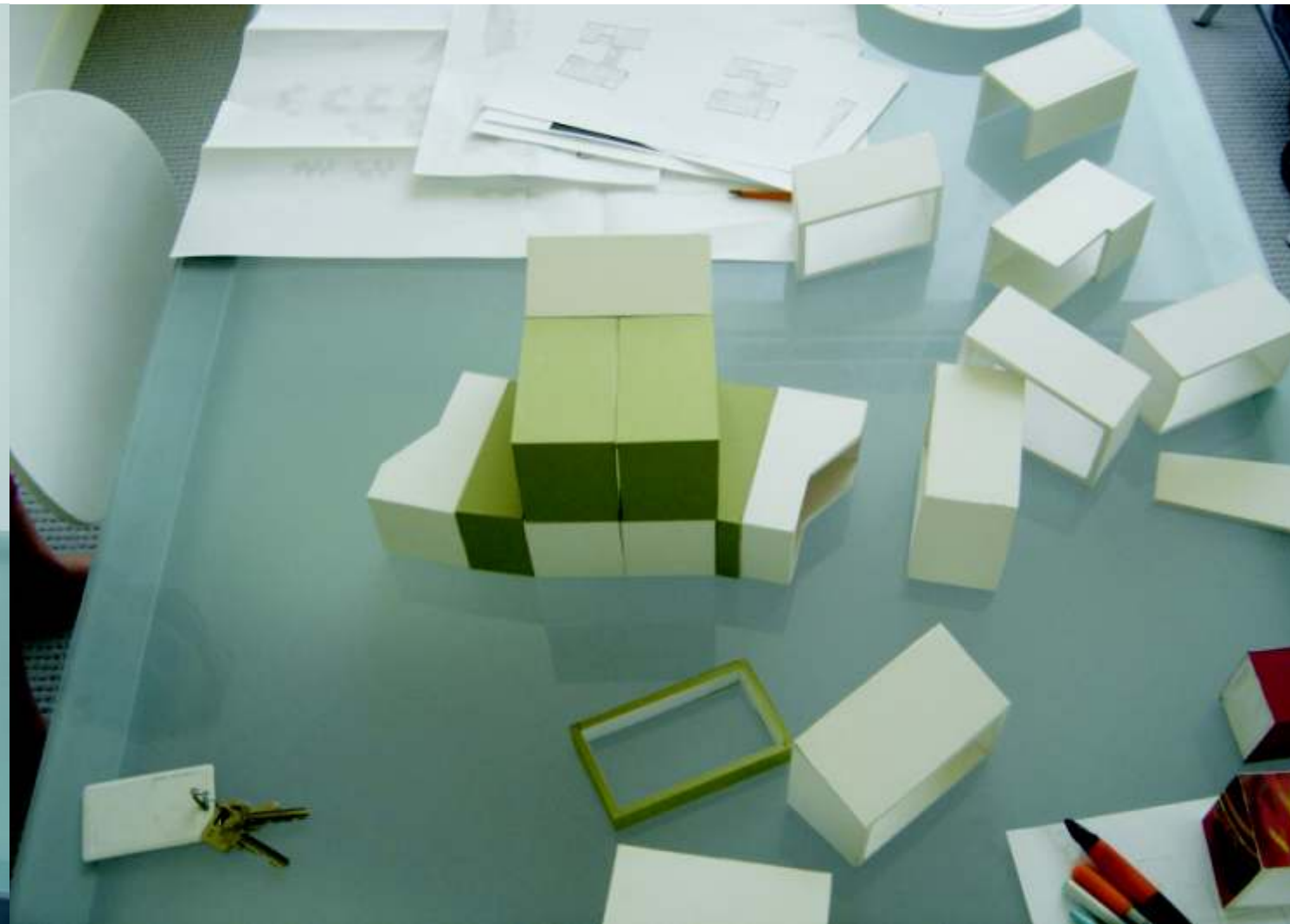
Customisation with an architect created design system and an architect consultancy service is presented as an alternative to the standard designs offered by the volume builder.

Volume built homes present a double negative; the owner pays for customisation in the way that the house is built, yet does not actually have the home customised to suit his or her needs.



User experiments

Sarah



Non Architects arranged houses by using the models and drawing simple plans , these designs were later transferred into the computer by the architect. Then exterior materials and furniture could be chosen by the clients.

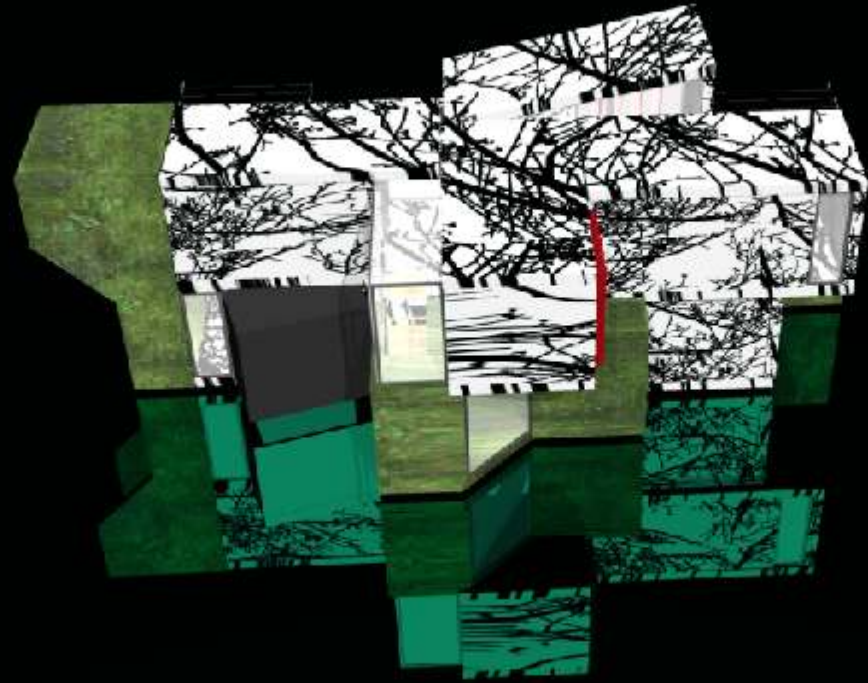
Tobi



Areli



Arthur



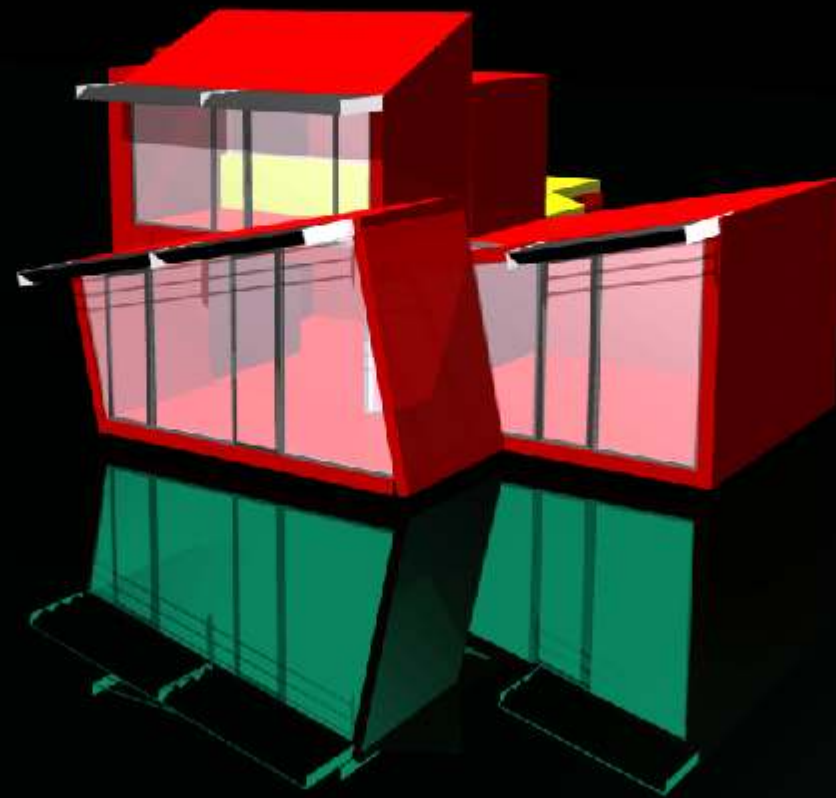
Yukako



Chris



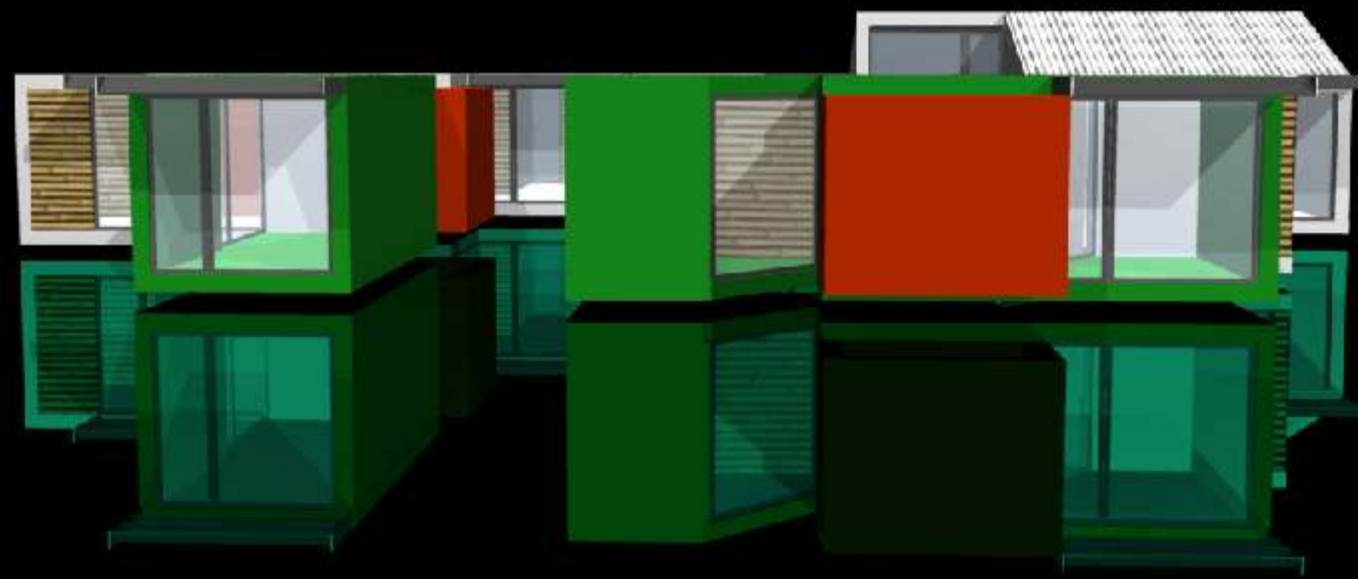
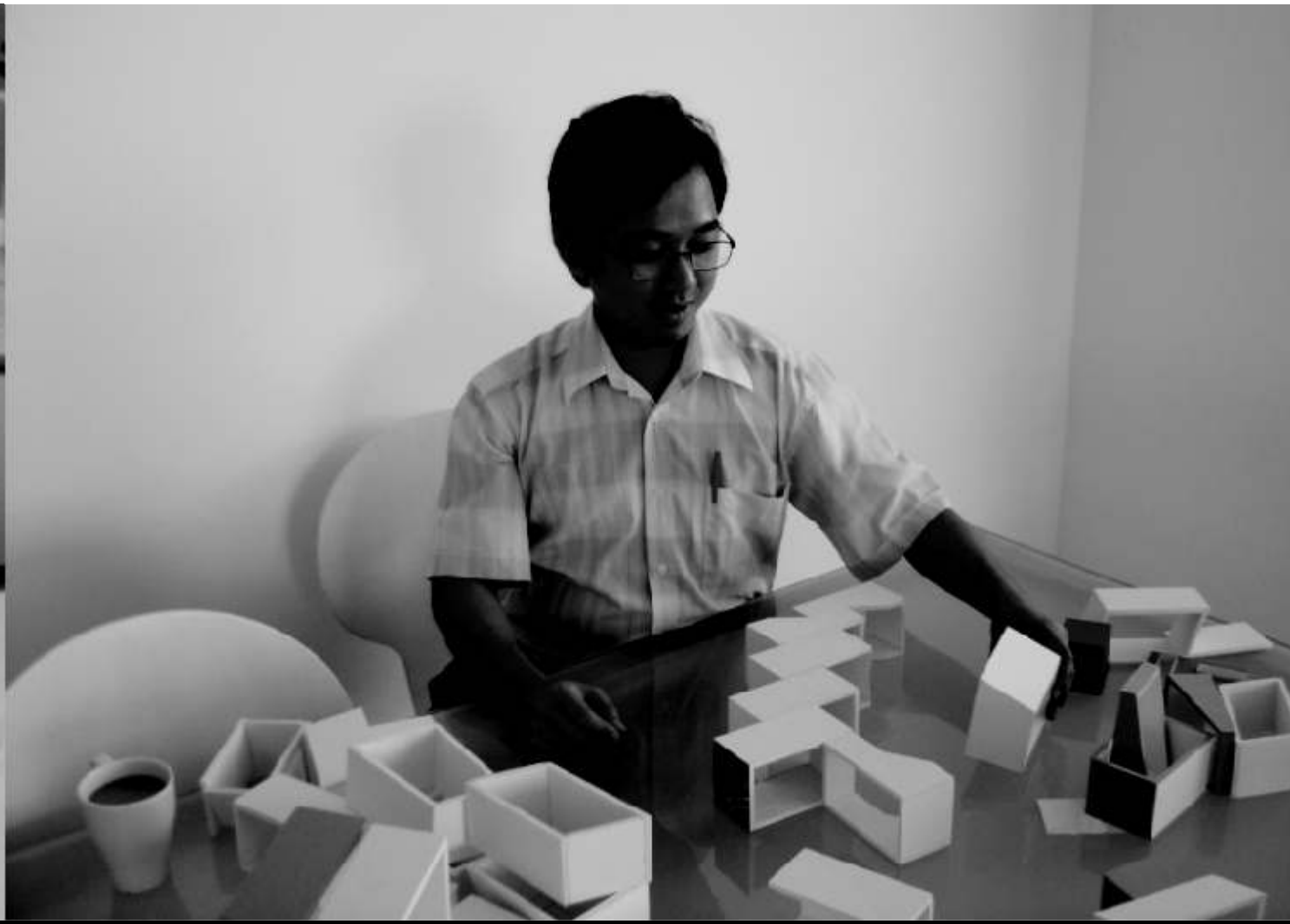
Anja



Ross



Hung



Architects testing the design system



Site Response - Swan Hill

Siting the designs from the user experiments on an existing subdivision of the Swan Hill development.

Swan Hill is a rural town in Victoria with a population of 10,000. Vic Urban (the Victorian Government's urban development agency) is developing the Tower Hill site for 1200 new homes. The site is located 15 minutes from the town centre on the periphery of Swan Hill.

Siting the house is a highly complex process which should be done with the help of an architect to achieve better orientation of the house. Passive solar design principles would be used, shading elements would be applied, and the main glazing areas would be faced north.

There are rules set up in the educational section of the website which explain these principles alongside an embedded program in the interface to check if the desired outcomes are achieved.





Current practice of siting

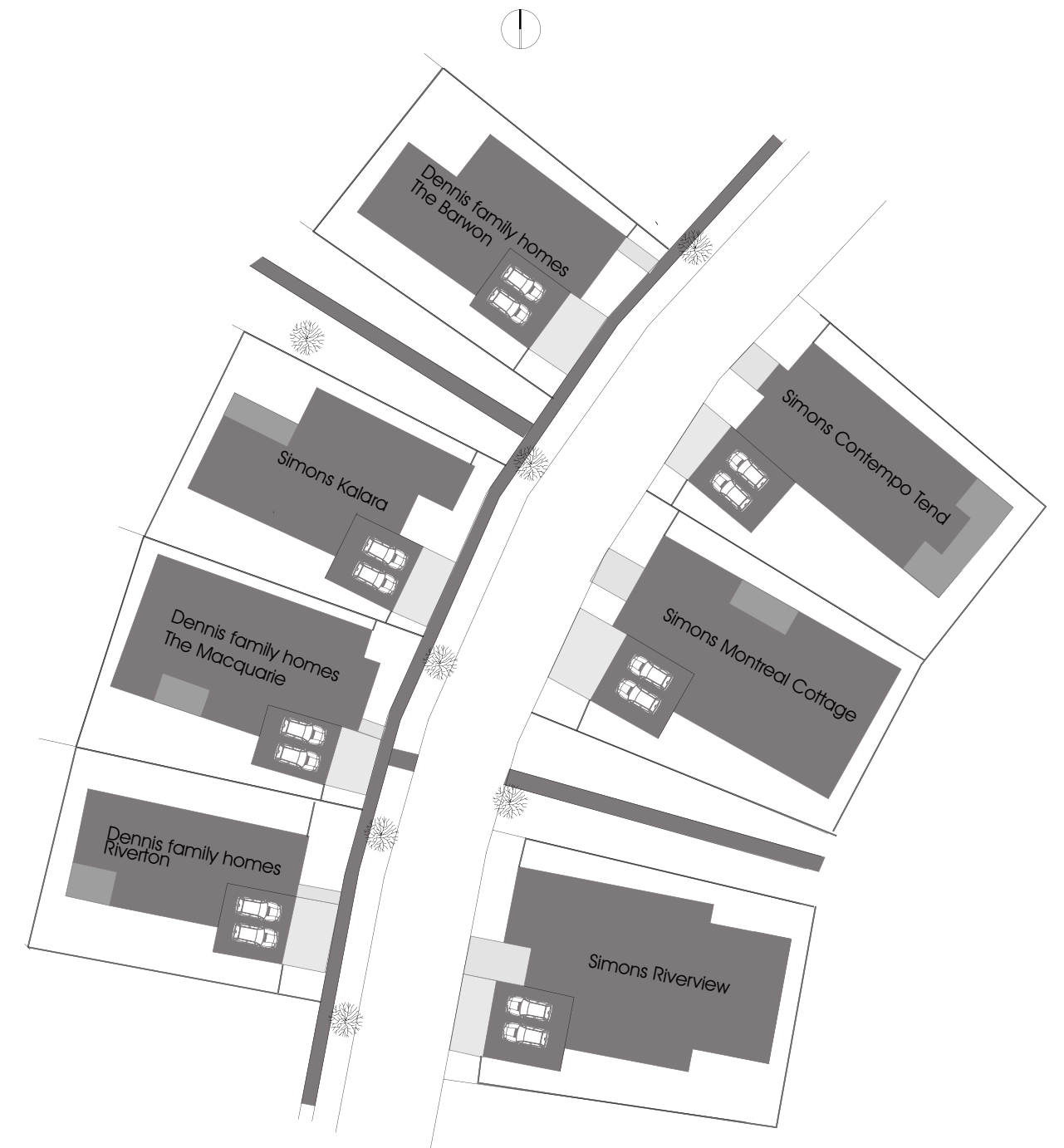


Current practice

The volume builder home typically fills up the whole property. The common double garage and huge driveway seal much of the site, leaving little garden space for children to play and for families to gather.

The houses are standard designs and generally do not consider orientation. These large brick veneer “boxes” allow almost no natural control of heat gains or loss and the “buried” internal spaces have no access to direct natural light and air.

Furthermore they are not adaptable to sites and peoples needs and lack diversity in terms of size, plan layout and design.



The Swan Hill site with houses from the volume builder catalogue



Sustainable Landscaping

The current practice of clearing the properties from all existing vegetation before houses are built is unsustainable and should be avoided where possible. Existing trees should be kept and more native trees be planted. Native hedges could be used to create privacy instead of fences.

This increase in vegetation is intended to create shade, private space and habitat for wildlife. Spaces for small vegetable gardens could also be provided.

The Individual houses from the user experiments were customised by the owner in consultation with the architect. Adaptability to a site and the user needs are an advantage in comparison to the pre-designed house of the volume builder. Houses that fit their user's needs, might possibly lead to more diverse types and smaller houses.

Smaller houses with smaller footprints are recommended. This will result in less energy consumption and a reduction in costs.

Free space on the property could, for example be used later to build an extension or additional building such as a 'granny flat'.

The private garden is recognised as an important element of the detached dwelling. It is the playground for the children and a place to gather. It is seen as an essential part of the Australian lifestyle. The lack of attractive outdoor space is interlinked with such societal health problems as child obesity.



The removal of the ubiquitous two-car garage and instead parking the car next to the road would reduce the sealed space on the property. This would result in a major cost saving.

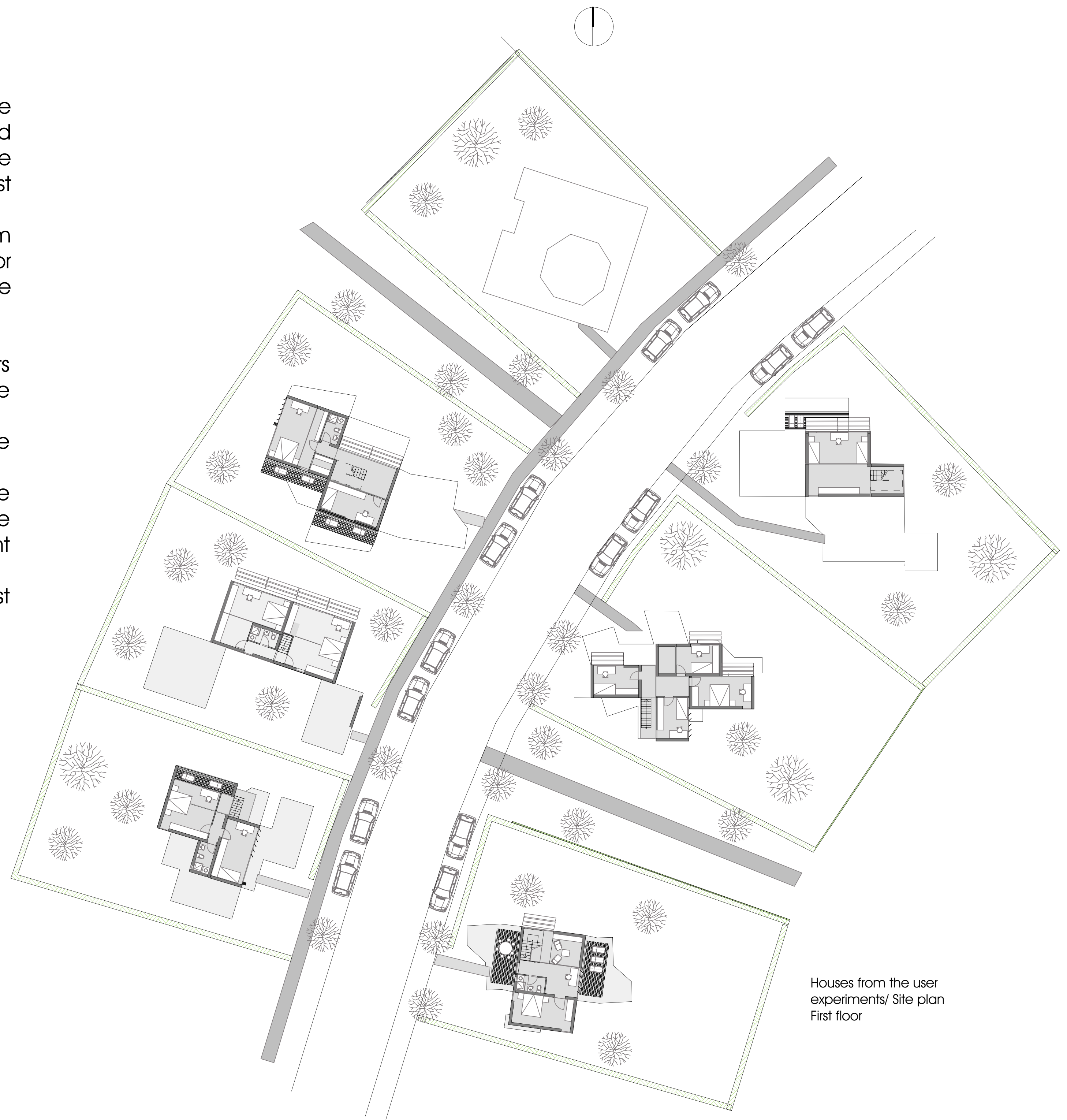
For smaller houses, smaller property sizes seem to be appropriate. Different property sizes for different house sizes could be offered in the future.

All seven houses from the user experiments applied passive solar design and passive cooling principals.

Optimised orientation was achieved with the architect's assistance.

All living areas face to the north, all with large glazed areas to allow for heat gains in the winter. All are fitted with overhangs to prevent over heating in summer.

All houses have adjustable shading over east and west faced glazing.



Houses from the user experiments/ Site plan
First floor

View from the street of adapted user experiments in Swan Hill

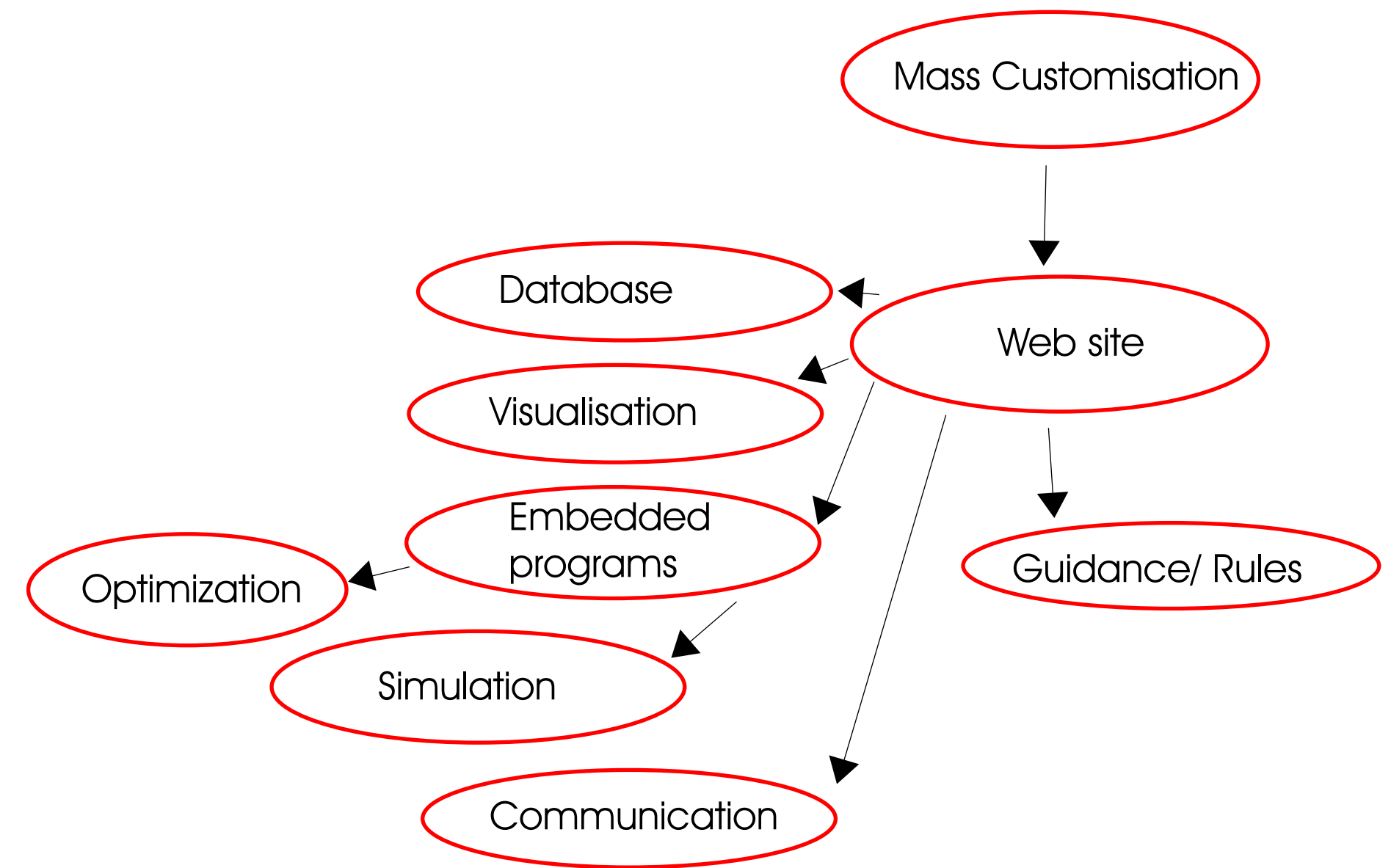


5. User Interface

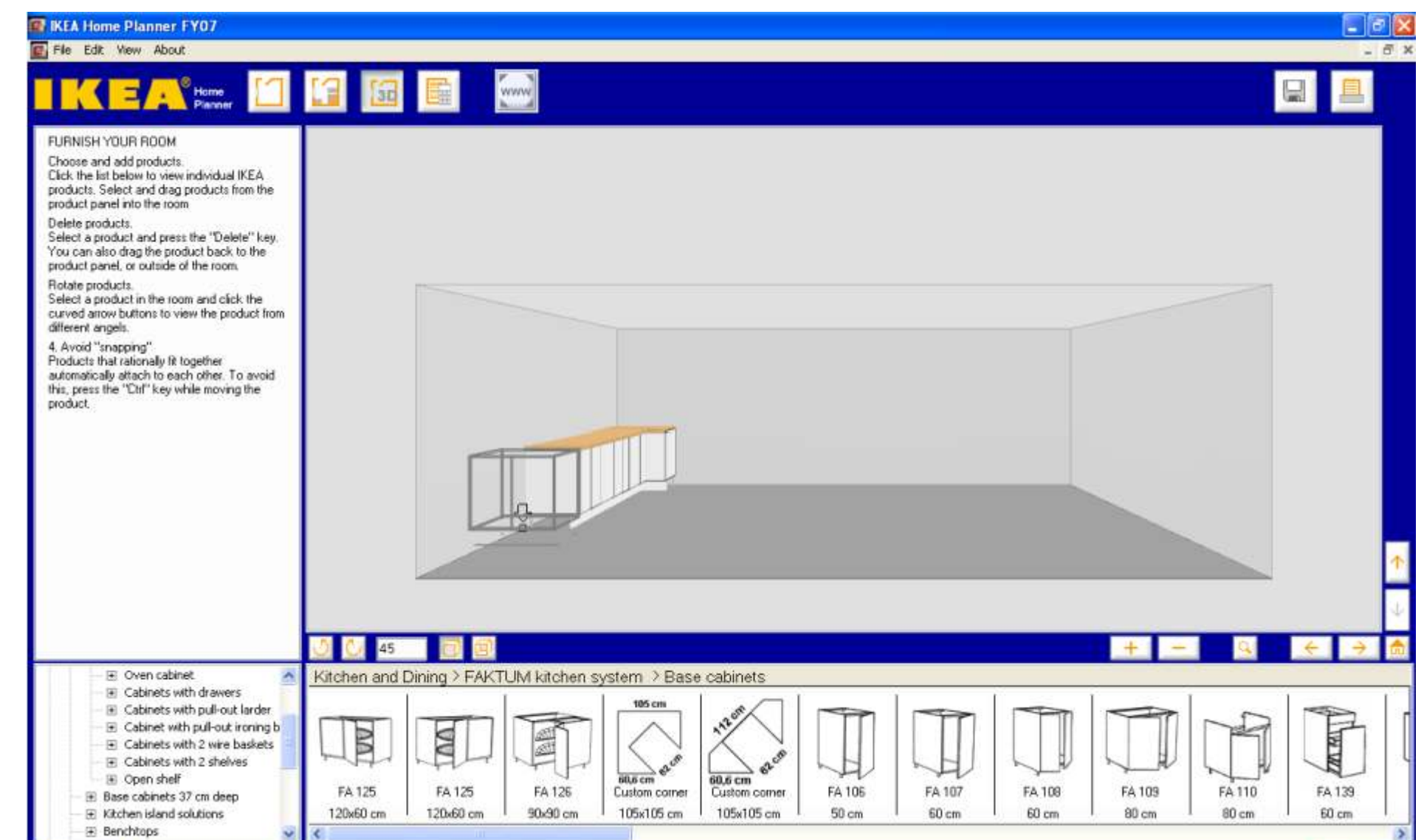
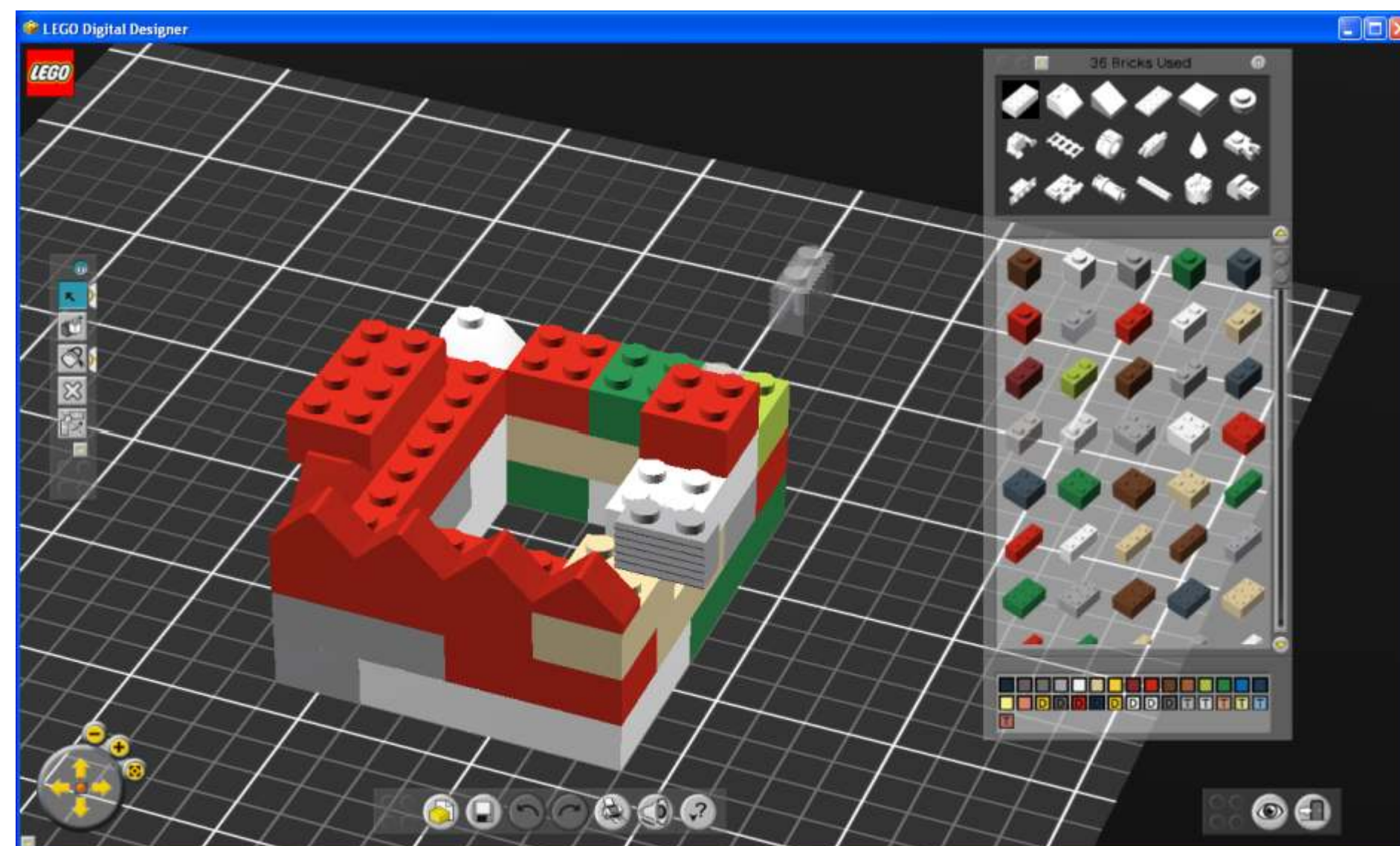
New procurement and design processes offered by the internet are currently used in other industries. Ikea for example offers downloadable programs of its kitchen designs, and Lego sells its systems via an interactive website.

In the housing industry, the internet is simply used for advertising purposes. Some home builder's websites do offer customisation options but this is arguably just a marketing gimmick. There are no interactive sites or programs to configure a house online.

Customisation of a house is a more complex and challenging process than that of kitchens, however this does not mean that it can not be achieved.



Functions a Website can provide to allow customisation of houses by non experts



The Interface

The last stage of the project was the integration of the tested design system, and the SIP construction system as explained earlier, into the user interface.

The proposed interface demonstrated here, is a screenplay, a speculation on how it might work. Further testing and involvement of IT and other experts would be necessary to achieve a useable program.

In the proposed interface, the computer program guides clients through the arrangement of their individual house using the design system and aided by an architecture consultancy service.

The concept of the interface is to optimise the process of delivering design. Applying the knowledge of the architect whilst splitting the costs for the service through a number of people.

The web site is seen as a marketing tool, but also as an ongoing market survey.

The web based interface would allow customer interaction as tested in the user experiments.

The internet widens the possibility of the clients' involvement in the design process.

These new online procurement processes are more instant and accessible and could result in an enlightened purchaser.

There is the possibility to educate people, so informed decisions could be made.

In the user interface for example, smaller houses are promoted and better orientation and use of passive solar design principles are encouraged.

The client's individuality would be integrated through the customisation process. It would be possible to create houses that fit the spatial and financial need of the client and could result in more diverse types of houses. The one size fits all approach of the volume builder does not respond to changing demographic trends. **The interface is an ideal tool for mass customisation as it allows for the creation of a database, gives clear guidance, immediate visualisation, and through embedded programs, provides simulation and calculation of costs and energy demands.**

Database

The database would contain a large number of components and modules. Huge numbers of speculative designs could be saved and reused in a modified version. Data of these already built houses in regard to energy demands and costs could be measured and collected and might be used in order to improve the system.

Guidance

The interface would provide guidance, directing the non-professional through the decision making process of self arranging the house. The architectural knowledge would be embedded in this guidance. Rules would be set up in the program and advice would be given automatically.

Visualisation

The program would provide easy and immediate visualisation of the house, thus improving the clients understanding of the design. It would assist in the decision making process and allow the client to see exactly what they are purchasing.

Simulation+ Calculation

Through embedded programs, the user interface will be able to simulate and calculate complicated technicalities that would otherwise be outside of the clients and architects understanding and knowledge.

Embedded programs:

These programs could make calculations so that the user knows exactly how much the house will cost while they are arranging it.

Energy demand would be calculated by using software that demonstrated the energy demand of the Broadmeadows house as an integrative part of the interface. It would give the customer feedback, advising if the orientation of their house is ideal according to passive solar design principles. Savings per year for running costs against a benchmark house would be shown.

Having this information on hand when decisions are made would create a greater awareness of the relationship between the design of the house, it's performance and it's running costs.

This additional information is not normally presented to the prospective home buyer and would subsequently have an educational aspect for the client.

Also, estimated construction time could be displayed, and the compliance with building regulations could be checked.

The collection of the estimated and actual performance of all buildings would result in a growing database which could help further research in improving the house's performance and would also be helpful in improving the software.

Using the Interface: The interface allows different levels of pre-design and customisation. From the architect designed standard house, to the self arranged house with customised components. When the user enters the site they have different options to choose from.

Option 1. The architect would provide speculative designs that could be modified by the client according to the user needs and to the site requirements. Modifications concerning orientation would need to be made.

Choose from a range of "professional" pre-designed houses
Pre-designed houses, measurements and prices

1. Shape/ Rooms
2. Exterior Materials
3. Interior Materials
4. Furniture
5. Siting
6. Confirm with us
7. Myhouse

Professional Library
Self-Design Library

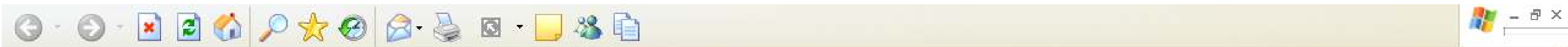
Design principles
Sustainability
Affordability
Design Quality

70
Prefab precedents

Stefan 1
Stefan 2
Stefan 3
Stefan 4
Stefan 5
Broady
Richmond delux
Richmond
Stefan 6
Order 3d model kit
Self design your house

Fertig Arbeitsplatz

A standard house from the library can be modified in regards to orientation and user needs.
In this example, cladding material does not follow the module and is seen as an alternative to a `expression` of the components approach.



Modify a pre- designed house from the " professional" library

Pre-designed houses, measurements and prices

3 D Model

- 1. Shape/ Rooms
- 2. Exterior Materials
- 3. Interior Materials
- 4. Furniture
- 5. Siting
- 6. Confirm with us
- 7. Myhouse

Professional Library

Self-Design Library

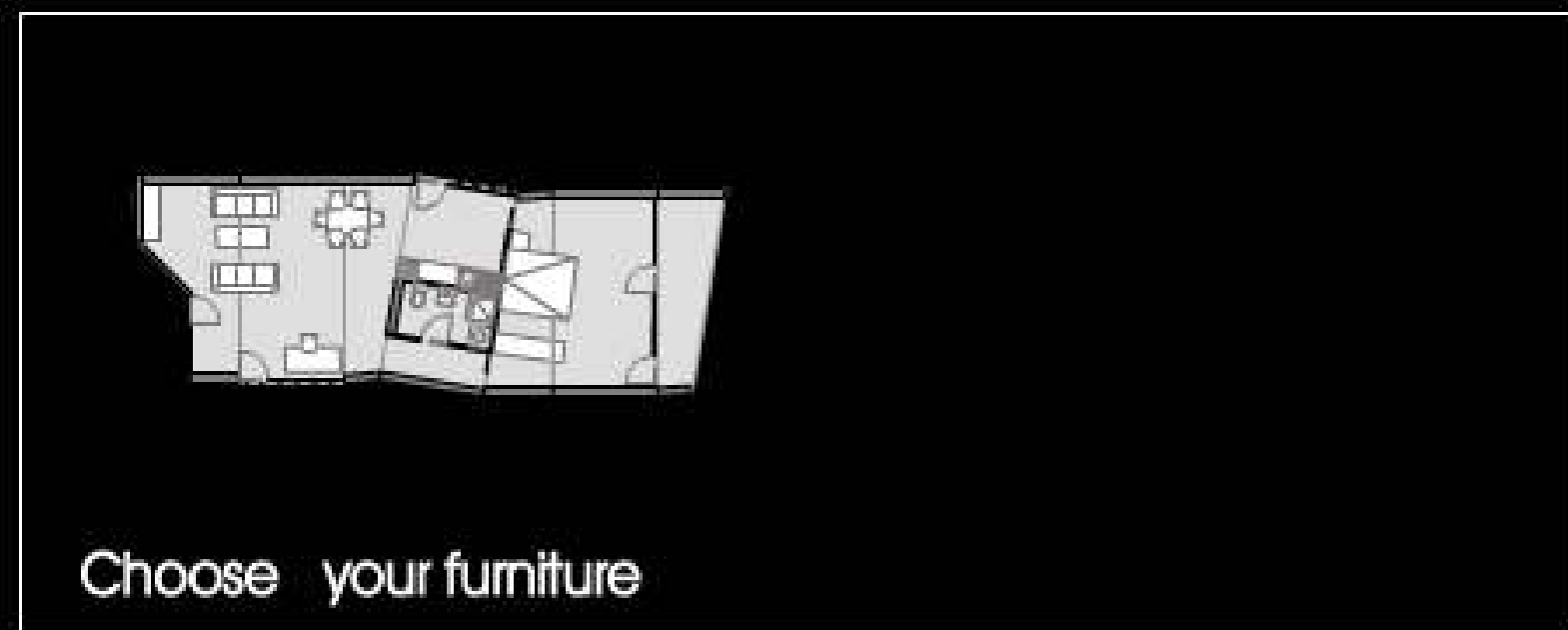
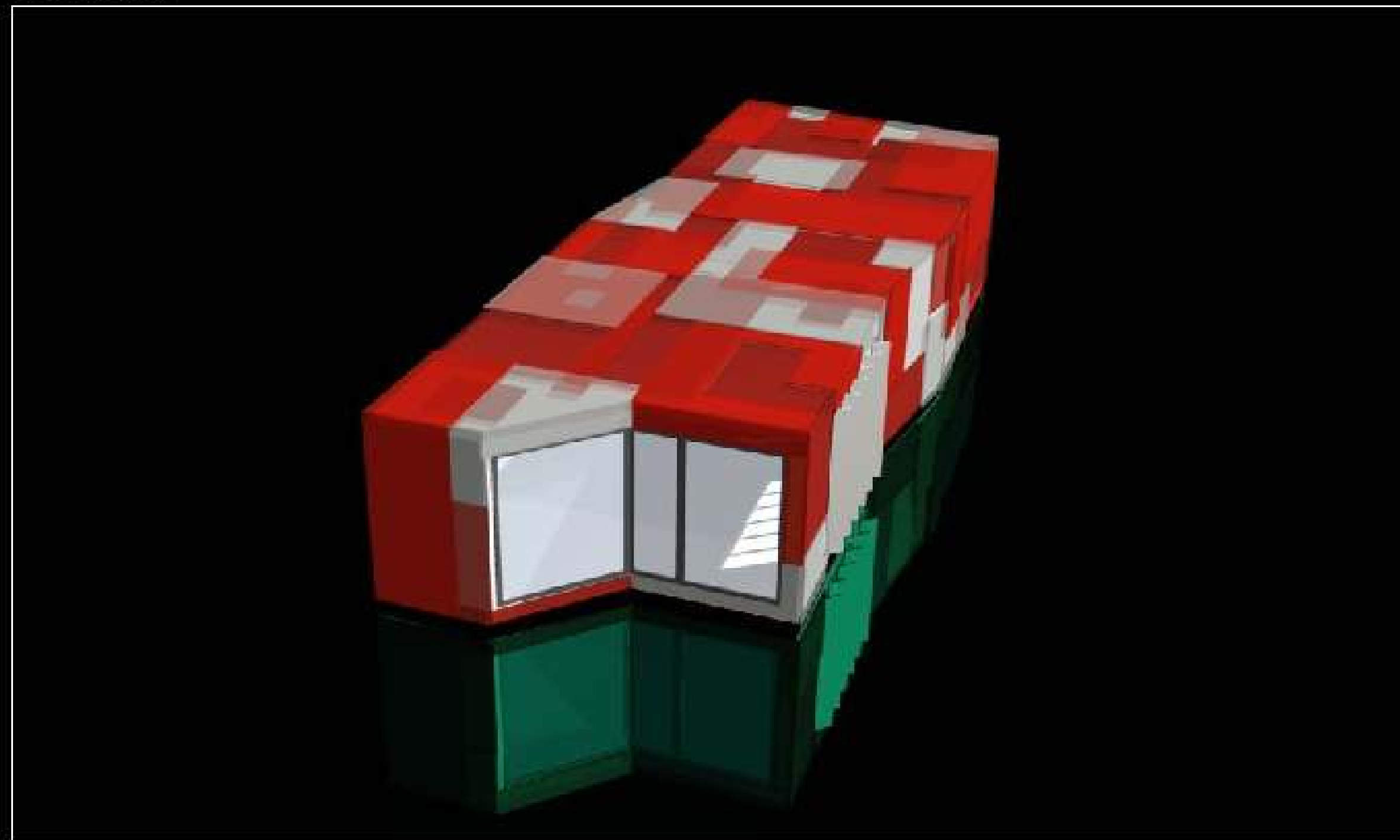
Design principles

Sustainability

Affordability

Design Quality

Prefab precedents



Number of bedrooms: 1
Size: 86 sqm
Price: \$ 86000
Energy Demand H/C:
0 kwh/m²/a
Construction time: h

Option 2. The houses previously designed by other people could be seen in a library and could be modified by the new client. Sharing house designs would lead to a large number of design variations. Already available houses would be sorted by price, size, number of bedrooms and energy demand.

Choose a pre- designed house form the self design library
Pre-designed houses, measurements and prices

1. Shape/ Rooms
2. Exterior Materials
3. Interior Materials
4. Furniture
5. Siting
6. Confirm with us
7. Myhouse

Professional Library
Self-Design Library

Design principles
Sustainabilly
Affordability
Design Quality

Hung

Order 3d model kit

Self design your house

Fertig Arbeitsplatz

Option3. An individual design can be arranged from scratch which would work in the following order:

After a video introduction, the user would start to arrange their rooms and the form of the house by choosing a module type and selecting one of the variations.

The screenshot shows a web browser window with a toolbar at the top. The main content area is titled "Self design your house" and is divided into several sections:

- Navigation Menu (Left):** A vertical list of buttons: "1. Shape/ Rooms", "2. Exterior Materials", "3. Interior Materials", "4. Furniture", "5. Siting", "6. Confirm with us", "7. Myhouse", "Professional Library", "Self-Design Library", "Contact Architect", "Design principles", "Sustainability", "Affordability", "Design Quality", and "Prefab precedents".
- 3 D Model (Top Center):** A 3D perspective view of a house model. Above it are buttons for "Download from Library" and "Upload to Library". Below it is a button for "Choose facing materials".
- Library of components (Top Right):** A grid of component categories: "Modules", "Walls", "Windows", "Shading E.", "Bathrooms", "Stairs", "Eco Features", and "Landscape E.". Below these are 3D models of components and their corresponding 2D floor plan footprints.
- Floor plans (Bottom Center):** Two 2D floor plan views of the house. Below them is a button for "Choose your furniture".
- Specifications (Bottom Right):** A text box containing: "Number of bedrooms:3", "Size: 137 sqm", "Price: \$ 137000", "Energy Demand H/C: 3 kwh/m²/a", and "Construction time: h".

Choose a module type from the library

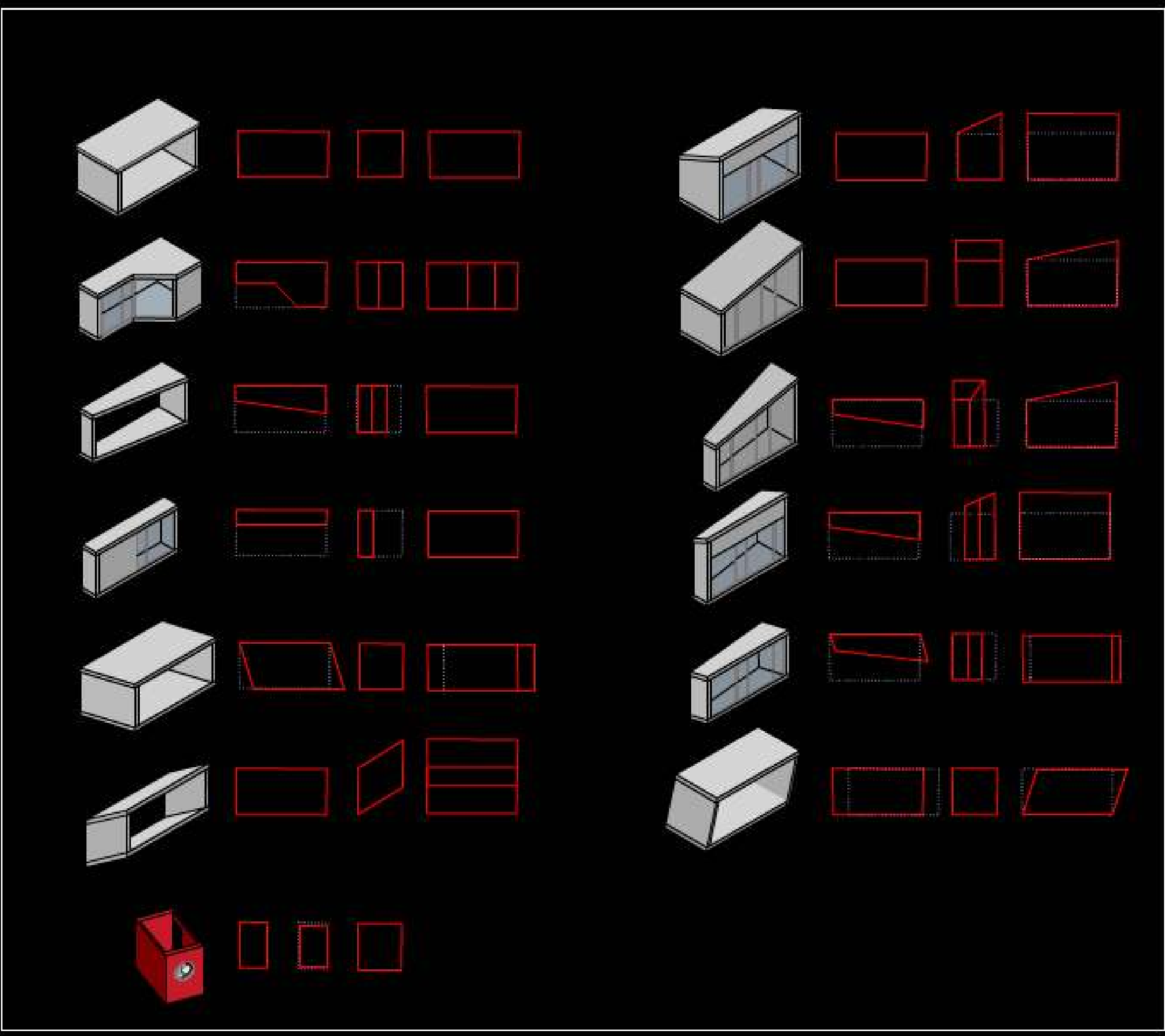


Self design your house

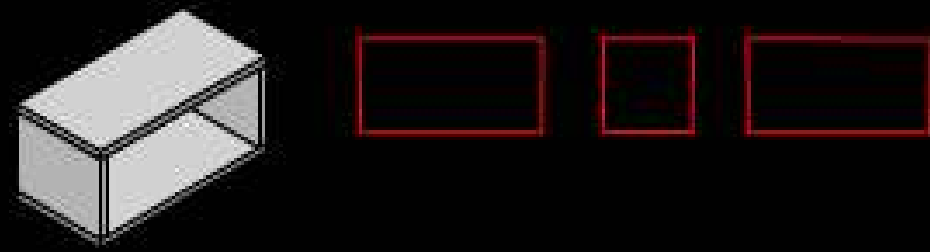
Module types

- 1. Shape/ Rooms
- 2. Exterior Materials
- 3. Interior Materials
- 4. Furniture
- 5. Siting
- 6. Confirm with us
- 7. Myhouse

- Professional Library
- Self-Design Library
- Contact Architect
- Design principles
- Sustainability
- Affordability
- Design Quality
- 74
- Prefab precedents



Select one of the predefined module configurations



Module 1 configurations

1. Shape/ Rooms

2. Exterior Materials

3. Interior Materials

4. Furniture

5. Seating

6. Confirm with us

7. Myhouse

Professional Library

Self-Design Library

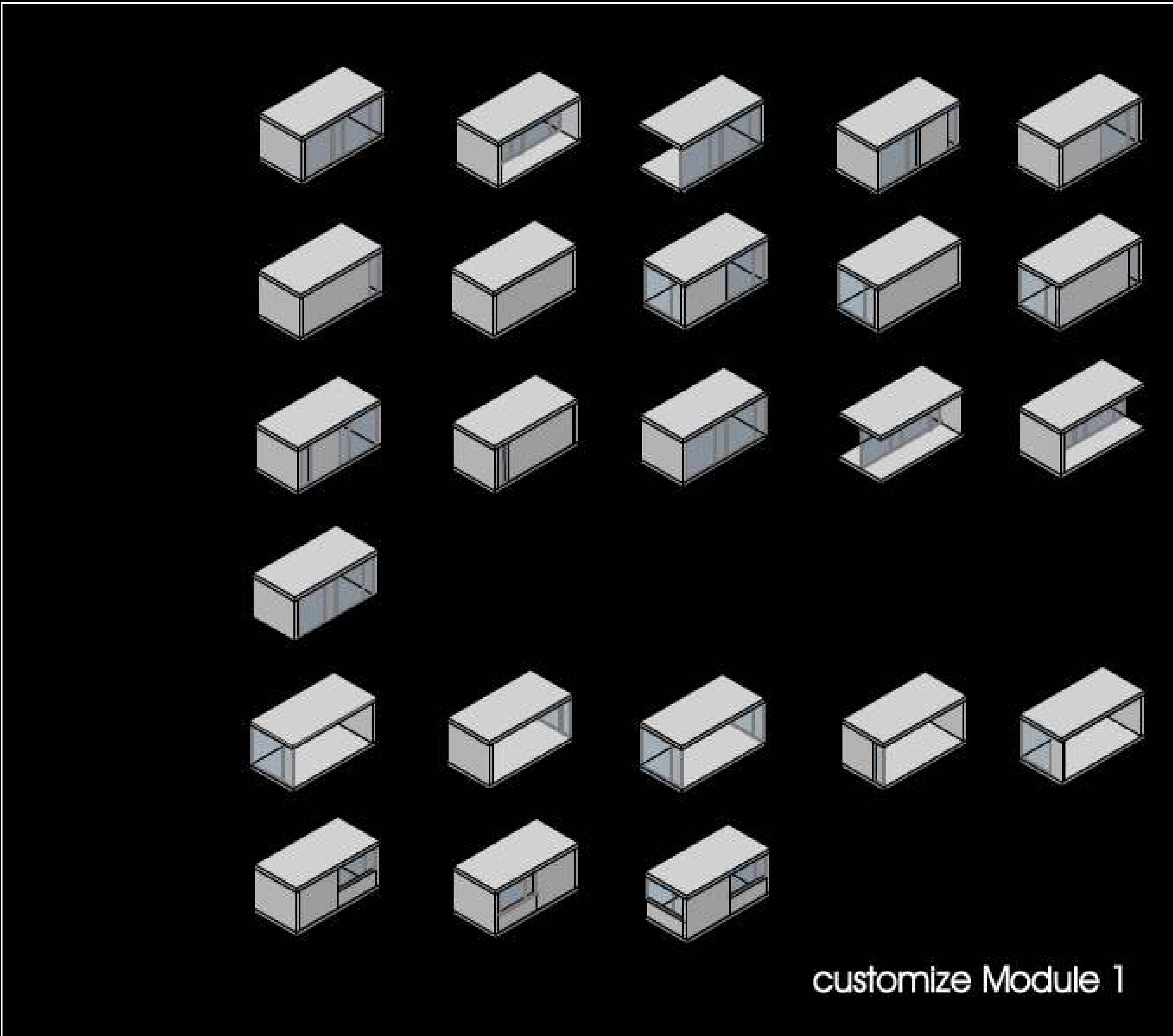
Design principles

Sustainability

Affordability

Design Quality

Prefab precedents



customize Module 1

The selected Module can be customised by cutting,

The screenshot shows a web browser window with a toolbar at the top. The main content area is titled "Self design your house" and is divided into several sections:

- Left Navigation Menu:** A vertical list of buttons for navigating through design stages and libraries: "1. Shape/ Rooms", "2. Exterior Materials", "3. Interior Materials", "4. Furniture", "5. Siting", "6. Confirm with us", "7. Myhouse", "Professional Library", "Self-Design Library", "Contact Architect", "Design principles", "Sustainability", "Affordability", "Design Quality", "76", and "Prefab precedents".
- Central 3D Model:** A large 3D rendering of a house module. A hand is shown using a red pen to draw a cutting line on the top surface. Below the 3D view is a 2D top-down view of the module with a red cutting line. A button labeled "Return to 3d model" is located at the bottom left of this section.
- 2.1 customise the module:** A section with two columns of options. The left column lists "Modules" (Windows, Bathrooms, Eco Features) and the right column lists "Walls" (Shading E., Stairs, Landscape E.). Below these lists are 3D models of different module shapes and their corresponding 2D red cutting outlines.
- Summary Panel:** A box at the bottom right containing key statistics: "Number of bedrooms:3", "Size: 137 sqm", "Price: \$ 137000", "Energy Demand H/C: 3 kwh/m²/a", and "Construction time: h".

The wall can also be customised with openings for windows.

Self design your house

3 D Model

2.2 customise the wall

1. Shape/ Rooms

2.Exterior Materials

3.Interior Materials

4.Furniture

5.Siting

6. Confirm with us

7. Myhouse

Professional Library

Self-Design Library

Contact Architect

Design principles

Sustainabiliy

Affordability

Design Quality

Prefab precedents

Return to 3d model

3 D Modell

Number of bedrooms:3
Size: 137 sqm
Price: \$ 137000
Energy Demand H/C:
3 kwh/m²/a
Construction time: h

Modules	Walls
Windows	Shading E.
Bathrooms	Stairs
Eco Features	Landscape E.

- \$ 400
internal wall 3x3 m:4-3/8" agrilboard panel
- \$ 400
external wall 3x2 m: 7-7/8"agrilboard panel
- \$ 500
external wall 3x3 m: 7-7/8"agrilboard panel
- \$ 1000
external wall 2.5 X 5.5m: 7-7/8"agrilboard panel

The bathrooms and the stair are placed, shading elements and windows are placed according to the guidelines (passive solar design principles). The energy demand will be displayed and allows for fine-tuning.

Windows Explorer toolbar

Self design your house

3 D Model | Floor plans

1. Shape/ Rooms

2. Exterior Materials

3. Interior Materials

4. Furniture

5. Siting

6. Confirm with us

7. Myhouse

Professional Library

Self-Design Library

Contact Architect

Design principles

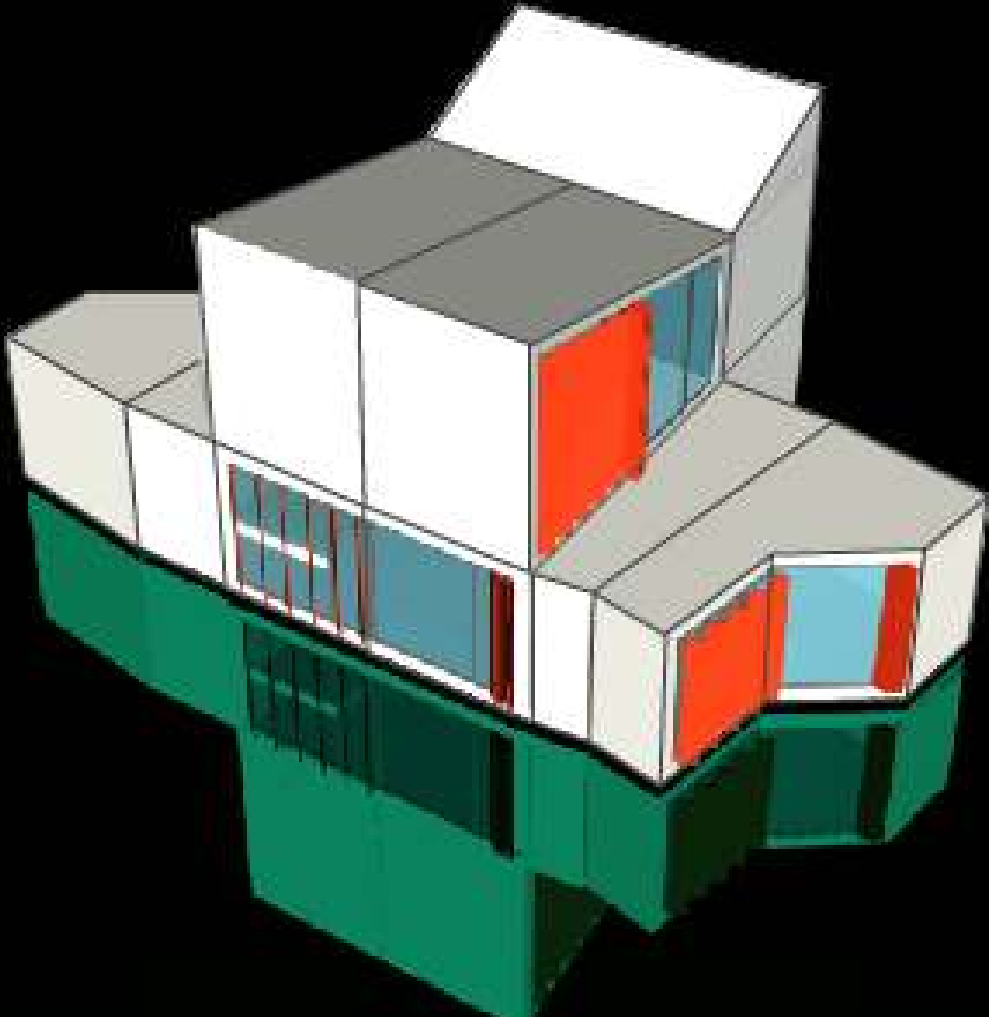
Sustainability

Affordability

Design Quality

78

Prefab precedents







Download from Library

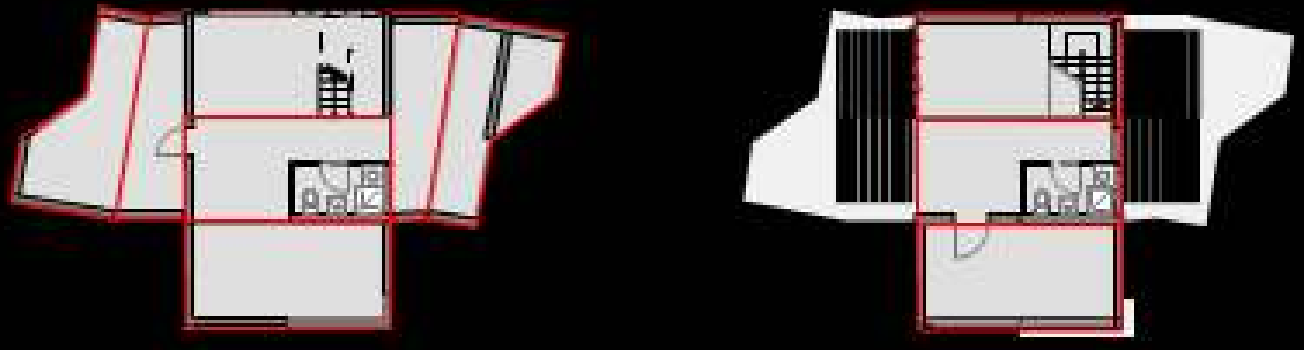
Upload to Library

Choose facing materials

Library of components

Modules	Walls
Windows	Shading E.
Bathrooms	Stairs
Eco Features	Landscape E.

-  \$ 450
rooflight 1X1X0.4m
-  \$ 500
windows 2.5X1 m double glazing/
wooden frames
-  \$ 1200
external wall 1X3 m: 7-7/8" agrifboard panel
windows 1.5X3 m double glazing/wooden
frames
-  \$ 1500
windows 2.5X3 m double glazing/wooden
frames



Choose your furniture

Number of bedrooms: 3

Size: 137 sqm

Price: \$ 137000

Energy Demand H/C:
3 kwh/m²/a

Construction time: h

Windows Explorer toolbar

Exterior materials would be selected which are provided by different manufacturers. Pictures can be uploaded to customise the house further. Price and other detailed information would be provided.

Self design your house

3 D Model

Choose your furniture

Return to 3d model

Library of exterior materials

Wood
Metal
Tiles
Stone

Images
Coloures
Grapics

1. Shape/ Rooms
2. Exterior Materials
3. Interior Materials
4. Furniture
5. Siting
6. Confirm with us
7. Myhouse

Professional Library
Self-Design Library
Contact Architect

Design principles
Sustainabiliy
Affordability
Design Quality
Prefab precedents

Upload pictures/ textures for printing on facing

Number of bedrooms: 3
Size: 137 sqm
Price: \$ 137000
Energy Demand H/C:
3 kwh/m²/a
Construction time: h

Interior materials are chosen. Manufacturers provide detailed information and 3D visualisation allows the user to get a realistic impression of the interior.

The screenshot shows a web browser window with a toolbar at the top. The main content area is titled "Self design your house" and features a navigation menu on the left with seven numbered steps: 1. Shape/ Rooms, 2. Exterior Materials, 3. Interior Materials (highlighted), 4. Furniture, 5. Siting, 6. Confirm with us, and 7. Myhouse. Below the menu are links for "Professional Library", "Self-Design Library", and "Contact Architect".

The central part of the interface is split into two main sections. The top section, labeled "3 D Model" and "Floor plans", displays a 3D rendering of a modern interior with a staircase and large windows. Below this is a 2D floor plan showing the layout of the house, including a small 3D model of the house.

The right section, titled "Library of interior materials", lists various material options in a grid:

Timber floor	Parquet
Wallpaper	Coloures
Tiles	Stairs
Carpet	Poweroutlet

Below the list are several material preview images with their respective prices per square meter:

- White tile: \$35 sqm
- Dark red tile: \$30 sqm
- White grid tile
- Orange grid tile
- Light blue grid tile
- White and light blue checkerboard tile
- Grey tile
- Light blue and white checkerboard tile

The bottom right section provides key project statistics:

- Number of bedrooms: 3
- Size: 137 sqm
- Price: \$ 137000
- Energy Demand H/C: 3 kwh/m²/a
- Construction time: h

At the bottom left, the number "80" is displayed, and at the bottom right, the text "Arbeitsplatz" is visible.

Furniture can be downloaded from various companies and are a test for the "usability" of the arranged rooms.

Self design your house

3 D Model Floor plans

1. Shape/ Rooms
2. Exterior Materials
3. Interior Materials
4. Furniture
5. Siting
6. Confirm with us
7. Myhouse

Professional Library
Self-Design Library
Contact Architect

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Library of furniture

Sofas	Kitchen
Table	Wardrobes
Chairs	Stairs
Bookshelves	

Download furniture library from ikea website

3 D Modell

Number of bedrooms: 3
Size: 137 sqm
Price: \$ 137000
Energy Demand H/C: 3 kwh/m²/a
Construction time: h

Fertig Arbeitsplatz

The location of the site would need to be selected to provide the right radiation data for the calculations. A plan of the property can be drawn by the client or an existing plan can be scanned in and submitted to the architect. There is advice regarding orientation of the house and its ideal position on the property. Siting is a complex issue and it is here that the architect would be most needed as a consultant.

Self design your house

1. Shape/ Rooms
2. Exterior Materials
3. Interior Materials
4. Furniture
5. Siting
6. Confirm with us
7. Myhouse

Professional Library
Self-Design Library
Contact Architect

Design principles
Sustainabiliy
Affordability
Design Quality

82
Prefab precedents

Siting

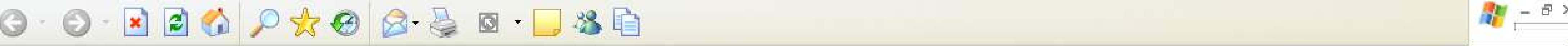
Location: Swan hill
Property size: 530sqm
Number of occupants:4
Surrounding buildings
Scan plan and submit

Embedded Software for:
Check with local planning regulations
Recommended rainwater tank size: 10 000l
Recommended hot water system size: 15sqm
Recommended solar panel size: 20sqm

3 D Model

Number of bedrooms:3
Size: 137 sqm
Price: \$ 137000
Energy Demand H/C:
3 kwh/m²/a
Construction time: h

"Confirm with us" means that after the first test run, the architect will be contacted and can access the clients design. Recommendations can then be given online or in person. Changes could be made immediately so they can be evaluated and demonstrated to the client.



Self configure your house

3 D Model

- 1. Shape/ Rooms
- 2. Exterior Materials
- 3. Interior Materials
- 4. Furniture
- 5. Siting
- 6. Confirm with us
- 7. Myhouse

- Professional Library
- Self-Design Library

- Design principles
- Sustainability
- Affordability
- Design Quality

- Prefab precedents



Share your experience

The price for the house incl. an architectural consultant service.

- intoduction to the system
- checkup throughout the process
- final checkup and siting

We provide also:

- Detail plans
- Executive plans
- Building application
- List of components

Lifelong maintenance

We will go through the whole process with you

after consultant service sign the contract

Current Price:	\$ 137000???
Morgage: interest free	200 x \$503
Montly payments:	\$ 503

Size: 137 sqm

Price: \$ 137000 ???

Energy Demand H/C:
3 kwh/m²/a ???

★ ★ ★ ★ ★ ★ ★ ★

Construction time: h???

"Myhouse": The client would leave feedback, upload some pictures and the whole experience of buying the house could be shared. This is a marketing strategy but could also be used to collect data that could help to continually improve the system in the future.

Self design your house

Share your experience

Photos Upload your best photos

Write about your experience

Upgrade Update Recycle house

Maintenance: next inspection 10.12.2008
Size: 137 sqm
Price paid: \$ 137000
Measured Energy Demand: 3 kwh/m²/a
Construction time was: h

84

Fertig Arbeitsplatz

- 1. Shape/ Rooms
- 2. Exterior Materials
- 3. Interior Materials
- 4. Furniture
- 5. Siting
- 6. Confirm with us
- 7. Myhouse

Professional Library
Self-Design Library

Design principles
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Prefab precedents

Affordability

1. Shape/ Rooms
2. Exterior Materials
3. Interior Materials
4. Furniture
5. Siting
6. Confirm with us
7. Myhouse

Professional Library
Self-Design Library

Design principles
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Affordability
Design Quality
Prefab precedents

Customisation ▶ arrange a house with optimised orientation
> house performs better
> lower running costs

reflect what you really need and arrange a house that fits your needs
> smaller house
> lower construction and running costs

The design and production process is streamlined

Design-system
Customisation
Embedded programs
Concultyancy
Design process is cheaper + Production process is cheaper
Pre-fabricated

Prefab as a way of production

Production in a controlled environment
Optimised production process
Better quality control
Less waste
Less transportation
Better working conditions
Less Time needed
Cheaper product
Better quality
Less energy used

How do we operate

Architect
Design of:
- system/ program/ interface
- range of pre designed houses
- range of pre designed components

Client
User and designer

1. Manufacturer
Development+
Production of components(wall panel)

2. Manufacturer
Development+
Production of components(windows)

...Manufacturer
Development+
Production of components(.....)

Engineer/ Scientist
design embedded software/ interface
Development of components/ materials

Web site
Built to order
Database and info hub

Local Builder
Assembly on site

Fertig Arbeitsplatz

There is an educational section of the web site concerned with sustainability, affordability and design quality.

Architectural consultancy service:

The architect's knowledge is especially helpful for complicated processes like siting and further customisation options. For example, placing of additional windows could form part of the architect consultancy service, the cost of which will be included in the price of the house.

The interface would have a mandatory architectural service integrated.

The website is where the architect and the customer come together. The module and the components make communication easier because the dialogue is more specific, options can quickly be tested and evaluated.

The Steps for the use of the site can be summarised as follows;

1. Self design by customer
2. Architect consultancy service (3 hours)
3. Refinement
4. Customer purchase

Design Quality

The architectural knowledge and values are embedded in the design system and in the interface.
You customise your house within the system for your needs. Customisation allows individuality and adaptability.

1. Shape/ Rooms
2. Exterior Materials
3. Interior Materials
4. Furniture
5. Siting
6. Confirm with us
7. Myhouse

Professional Library
Self-Design Library

Design principles
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Affordability
Design Quality
Prefab precedents

The interface allows different levels of pre-design and customisation

Customisation with a design system would allow houses to be adaptable to particular sites in terms of orientation and topography. The flexibility of the design system offers great potential for consideration of passive solar design.

The design system also offers adaptability to individual clients needs such as size and layout of the house.

Involving the client in the design process provides for streamlining the procedure while also allowing for the inclusion of the clients individual personality. Most importantly, it allows for the client to create a house that fits his or her needs, while also taking into consideration architectural issues such as building form, material and spatial relationships.

The module as the "language" of the system is open for discussion and is expected to evolve further when more designs are arranged. New modules could be constantly developed and tested.

Involvement of other architects could widen the offered styles from the more decorated though to the more minimalist. But the main intention is to offer an alternative to the repeated designs of past styles offered by the volume builder.

Sustainability

1. Shape/ Rooms

2. Exterior Materials

3. Interior Materials

4. Furniture

5. Siting

6. Confirm with us

7. Myhouse

Professional Library

Self-Design Library

Design principles

Sustainability

Affordability

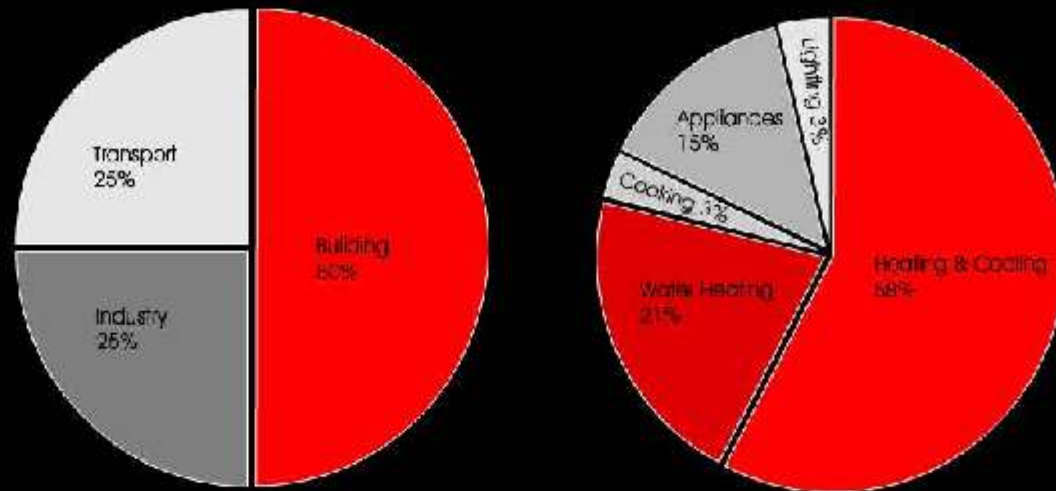
Design Quality

Prefab precedents

Why should your new house be sustainable?

The relationship between energy consumption and climate change is well documented. Buildings are responsible for 50% of all CO₂ emissions. Design and materials are playing a key roll in energy consumption.

Also you can save money for running costs



World Energy Consumption

Energy use in Victorian homes

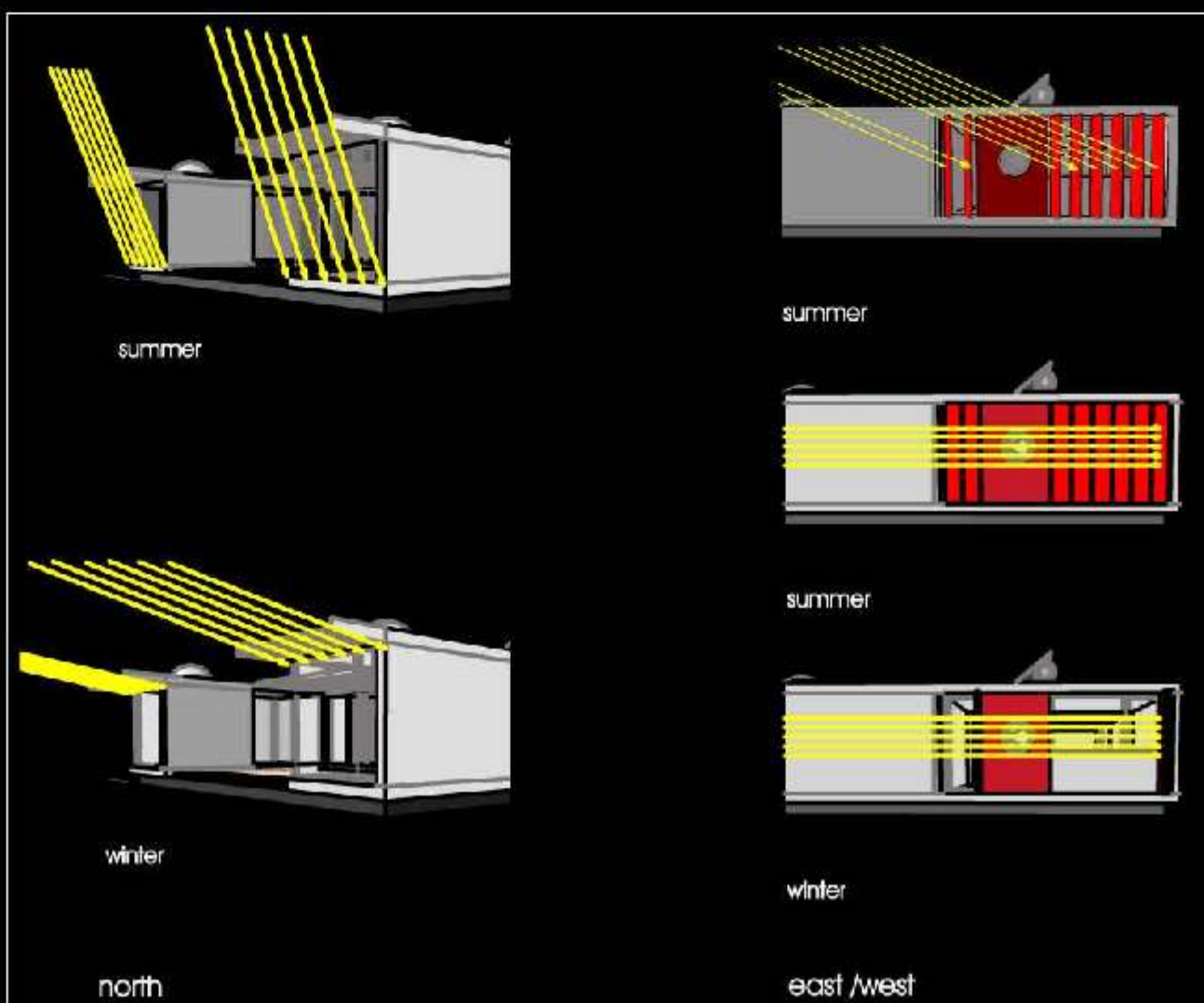
Rules for Orientation / Passive solar design

Applying passive solar design (PSD) features to a building means to take advantage of the free natural flows to maintain and support thermal climate and lighting comfort. The aim is to adapt the house so that it serves its purpose with minimal impact to the environment it is sitting in.



The buildings orientation will influence the heating and cooling load and the opportunities for passive solar heating and passive cooling. The dwelling's main facade should face north and have a high window area to wall area ratio.

Rules for Shading elements



In the "Sustainability" section of the website

The client can access information regarding orientation, shading elements, siting, and house size.

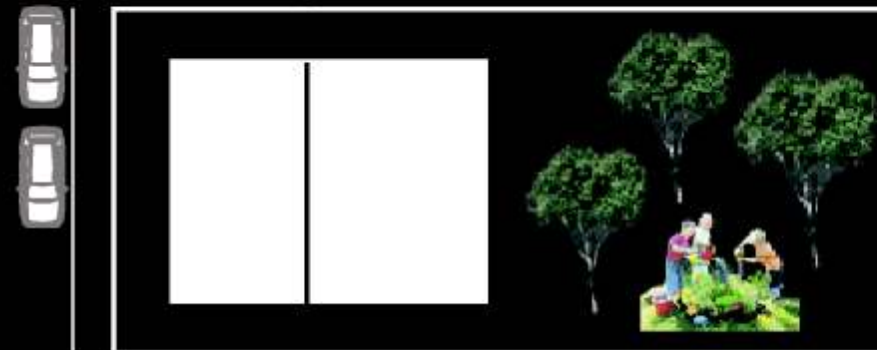
The materials used and the construction system applied will be described and energy related services that will be supplied as part of the system are explained. There will be links provided to the websites of the producers for access to more detail.

The educational section of the website would be extended over time and could become a large collection of knowledge concerned with all aspects of "designing" a house.

This opens up the possibility to educate people about good design for housing.

Size of the house and its flexibility matters

A smaller house uses less energy, has less embodied energy and also consume less land and you have more space left for a garden



Do you need a garage or can you park the car on the street or in your frontyard?
 efficient planning can mean a smaller house can provide space for the same number of occupants
 the houses in the library are per average 110 sqm (3 bedroom)
 Flexibility and adaptability / think about sharing your house / how will the house be use during time
 >>>look at floor plan variations in the processional library

Materials+ construction system

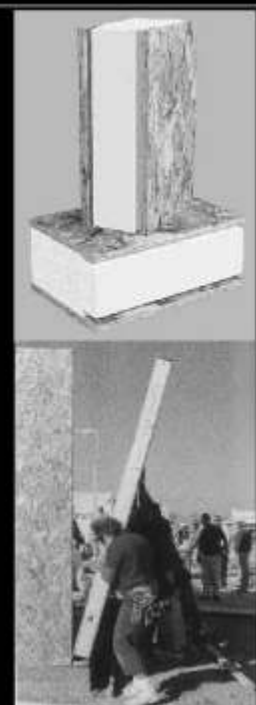
Highly insulated external walls ceilings and floors, less thermal bridging +double glazed windows,

structural insulated panels->high R value
 agriboard wall panels with straw core

Low embodied energy (example broadmeadows)



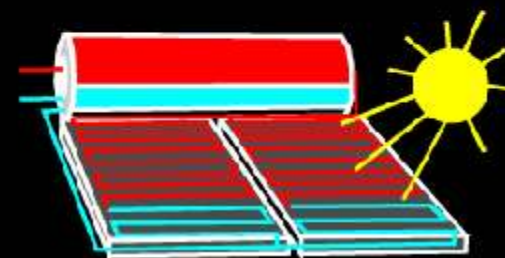
Straw as main material->Easy to recycle /biodegradable
 Straw/timber natural material without toxins



Energy/ water related services to be supplied as part of the system

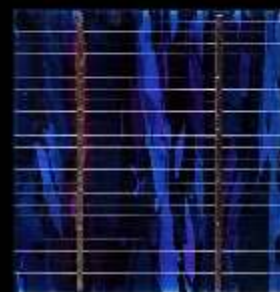
Solar hot water system

Solar hot water systems are an easy and well established way to provide a building's hot water needs. Solar water heaters are consisting of a box, insulation, an absorber plate attached to glass and glazing as described in Figure 67. The incoming irradiance heats up the water running through the pipes. The insulation at the back minimises heat losses due to conduction while the glazing reduces convection and radiation losses. Furthermore the glazing prevents losses due to wind passing over the absorber plate.



Photovoltaic electricity

In order to supply a reliable source of electricity for household appliances, a Photovoltaic system seems to be ideal. This system has been deemed most appropriate given its reliability, the abundant supply of radiation in Australia and the limited impact the system will have on aesthetics and urban noise. The major drawbacks from the system are relatively high capital costs (compared to gridconnection for residential house) and the potential for changes in the urban environment to affect access to solar radiation. We believe that the capital cost of the photovoltaic system are not so significant that they can't be offset against savings made from reduced labour and material cost inherent in the modular building system.



Integration of solar cells into the shading elements

Rainwater tank

Integration of a rainwater + grey water tank+pumps... into the system could reduce water usage by up to 90%



Embedded programs

The Interface includes embedded programs which immediately show you the estimated energy demand for heating and cooling, while you are designing. Optimised orientation is therefore easier to achieve

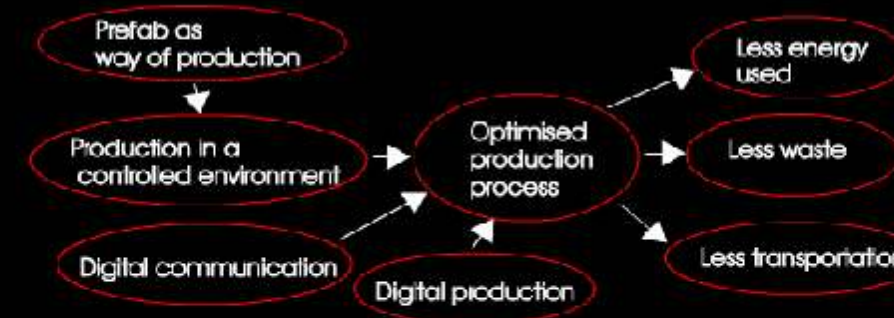


Recommendation of the right size solar hot water system

Recommendation of the solar panel size

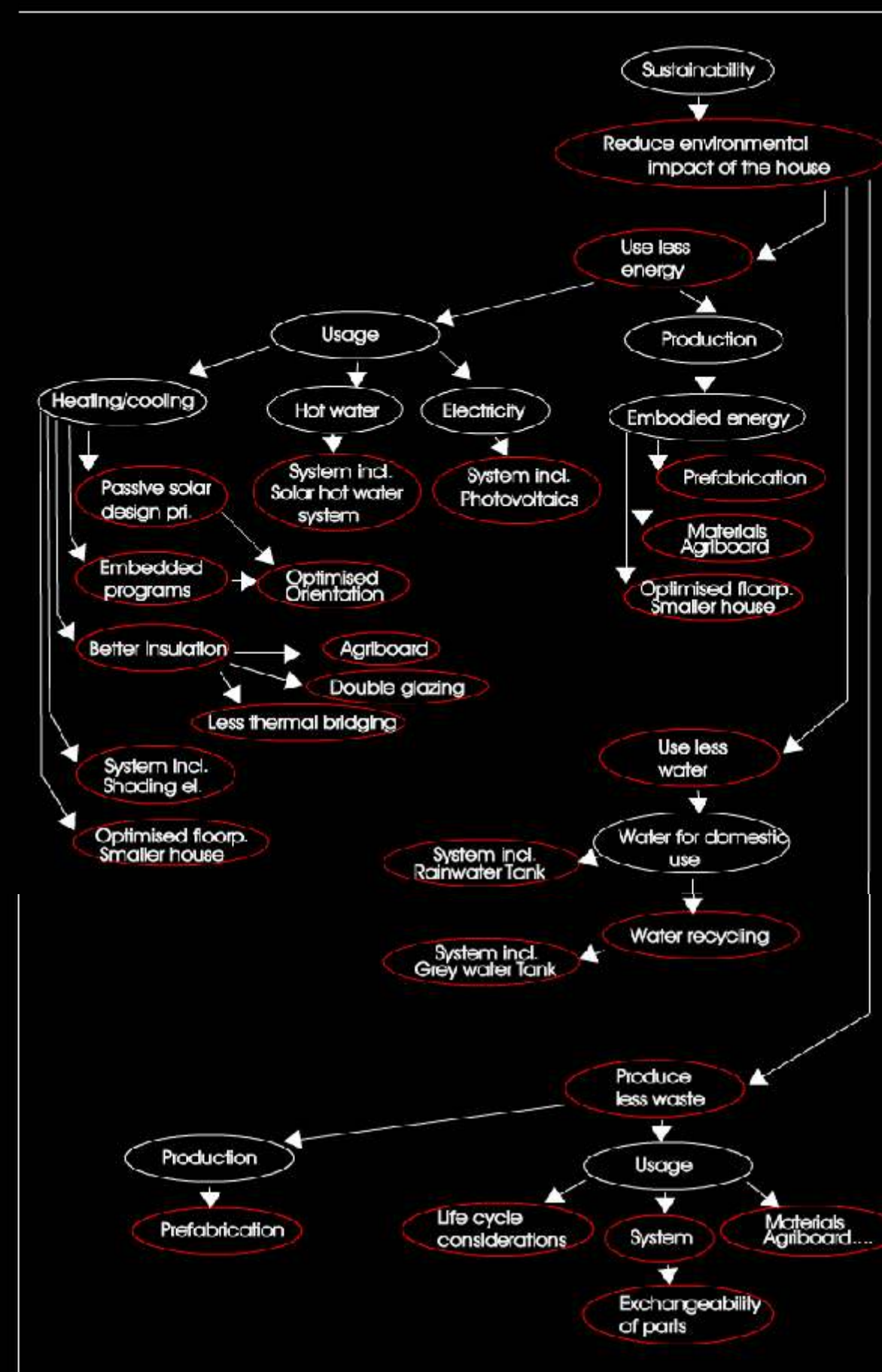
Recommendation of the rainwater tank size

Reduction of energy use and waste during production and transport



Recycling / Life cycle

40 % of all waste in Australia is building waste
 The system idea allows Re- use of components for other projects
 Recycling is easy due to the main materials straw and chipboard



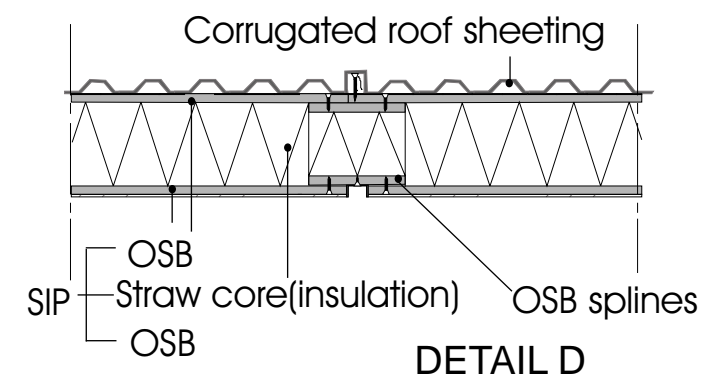
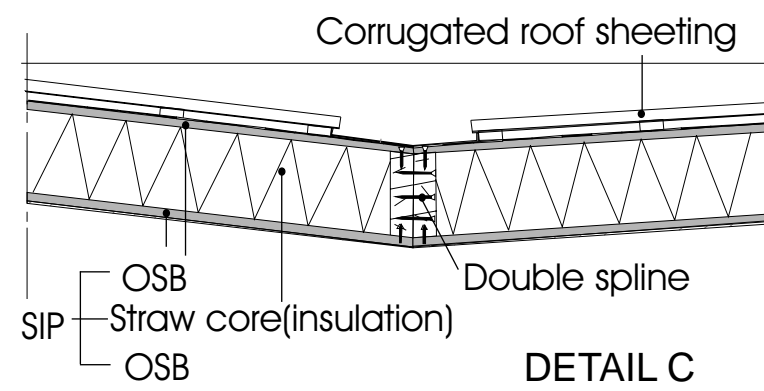
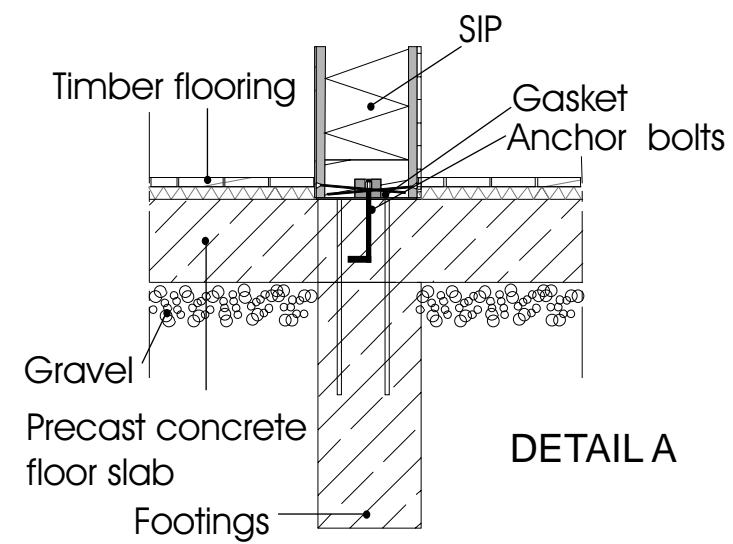
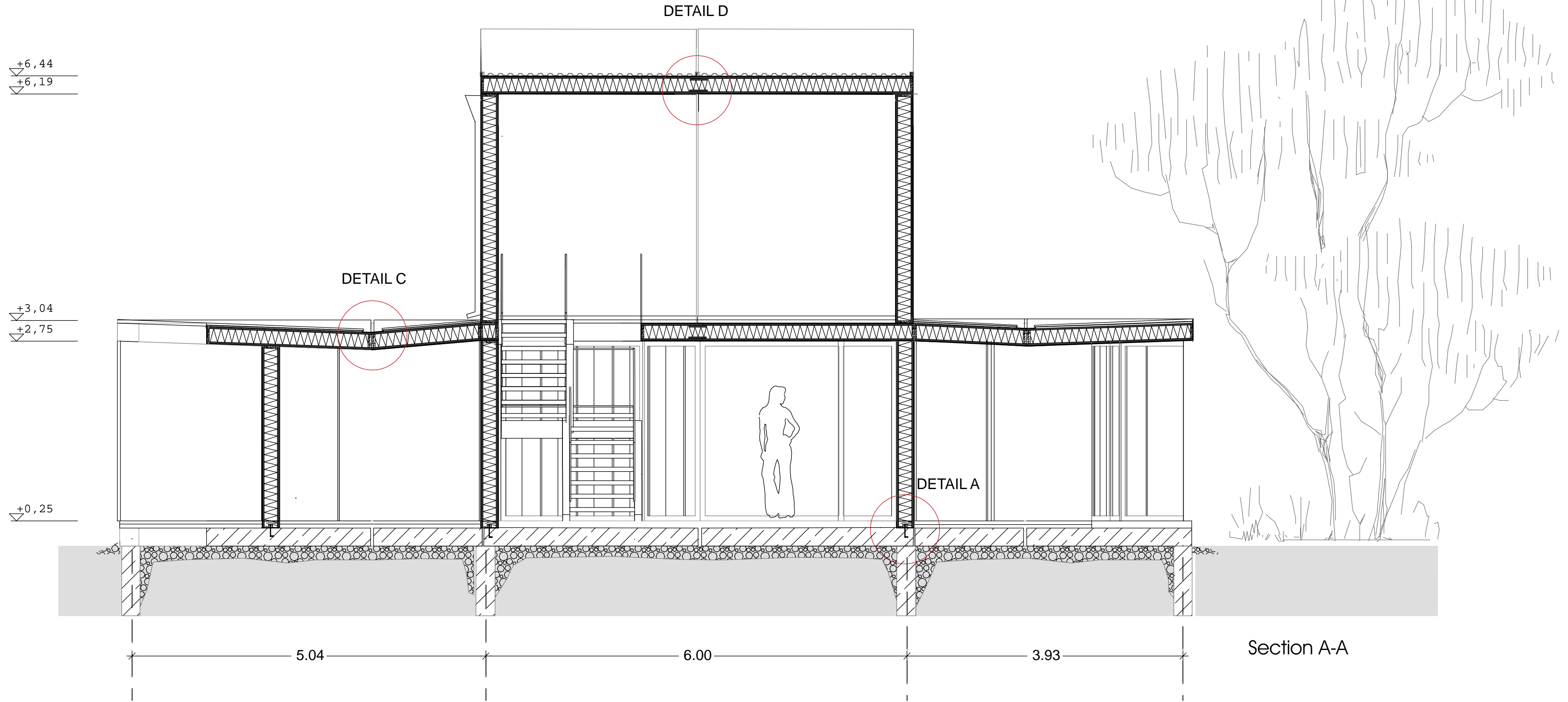
1. Shape/ Rooms
2. Exterior Materials
3. Interior Materials
4. Furniture
5. Siting
6. Submit
7. Myhouse

Professional Library
 Self-Design Library

Design principles
 Sustainability
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 Design Quality

Prefab precedents

An example of plans that the interface/ service would provide (Executive plans, details)



Mynewhome.com.au	
Sarah`s house Swan Hill	Section A-A

An example of plans that the interface/ service would provide (Executive plans, details)



Elevation East



Elevation North



Elevation West



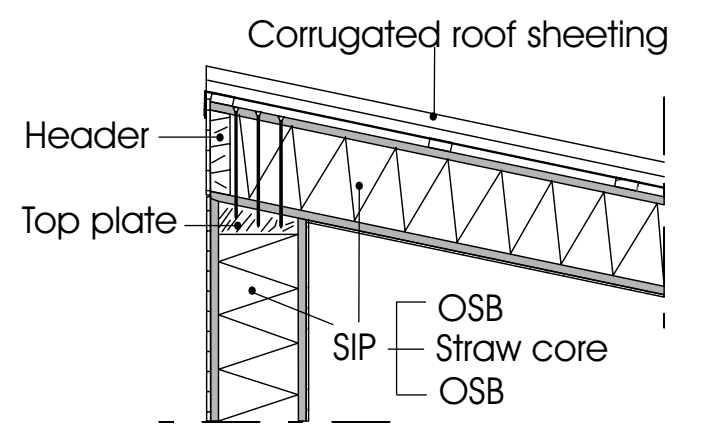
Elevation South

Mynewhome.com.au

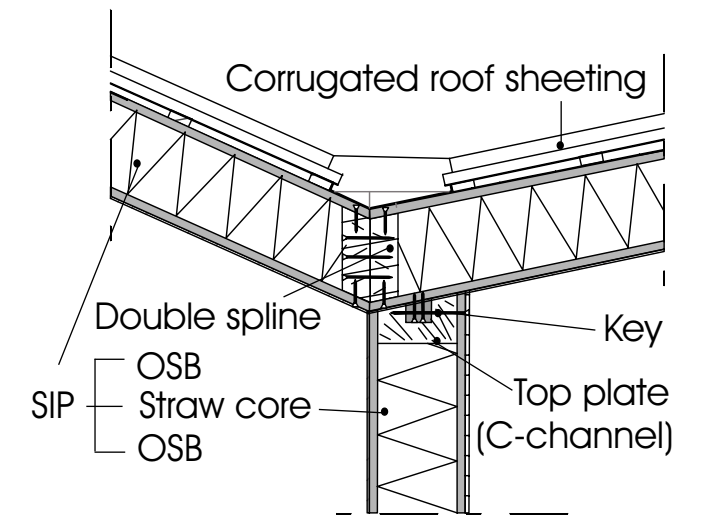
Sarah`s house
Swan Hill

Elevations

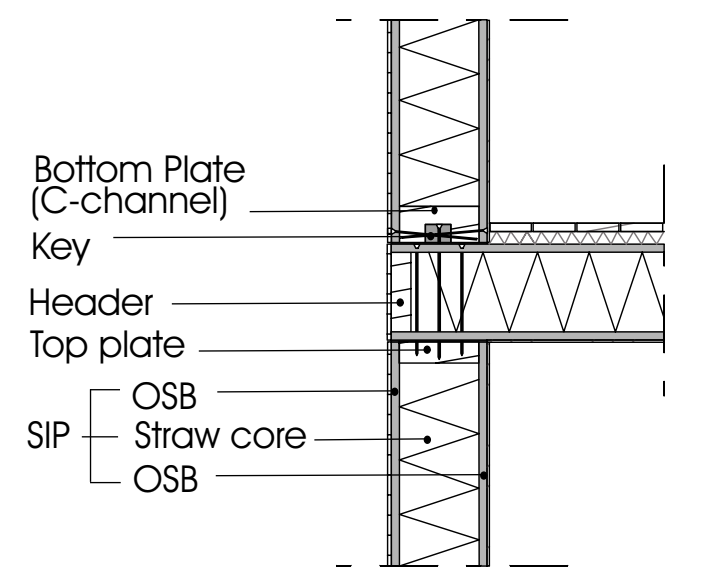
An example of plans that the interface/ service would provide (Executive plans, details)



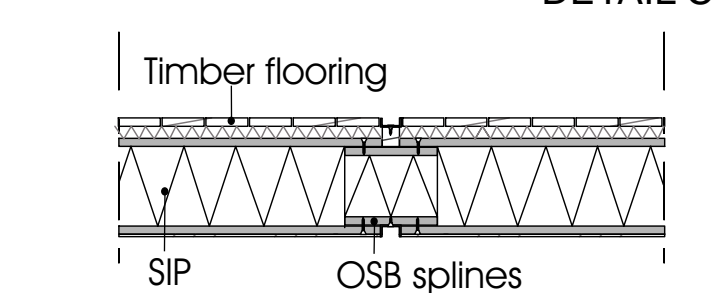
DETAIL A



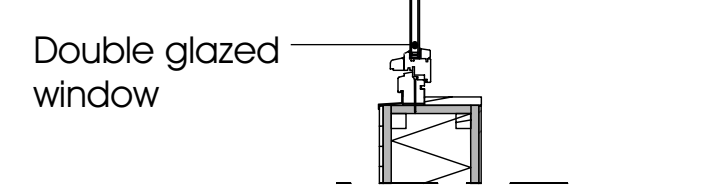
DETAIL B



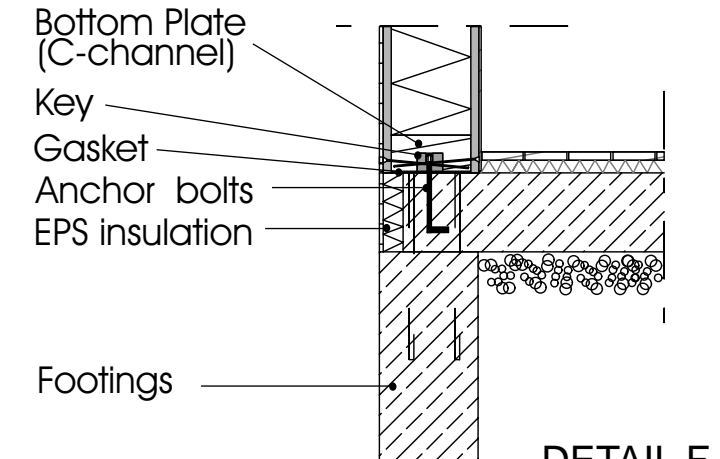
DETAIL C



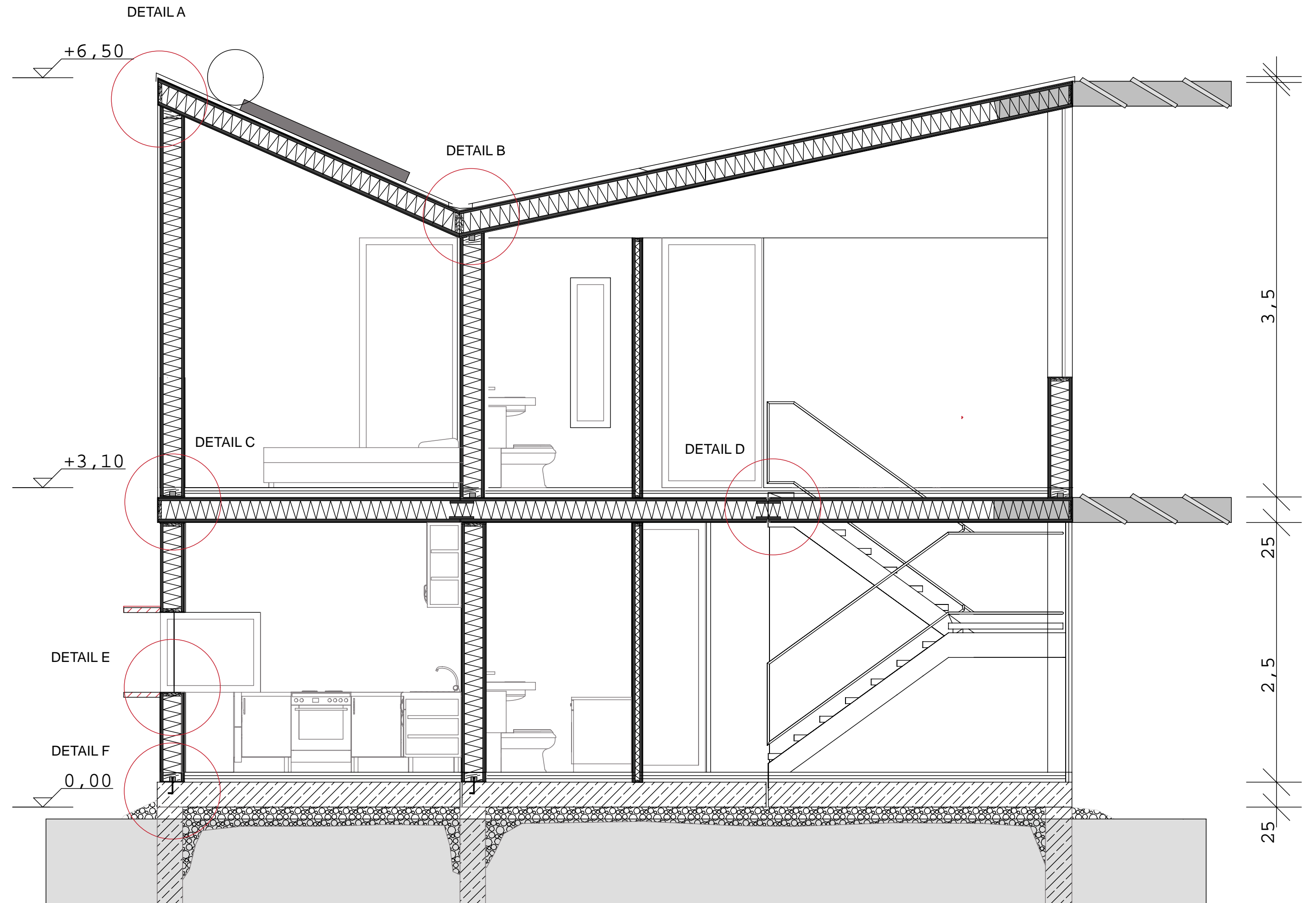
DETAIL D



DETAIL E



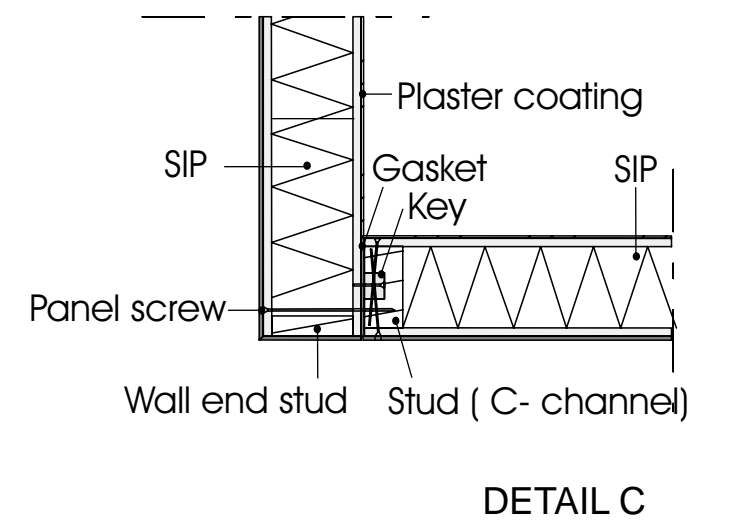
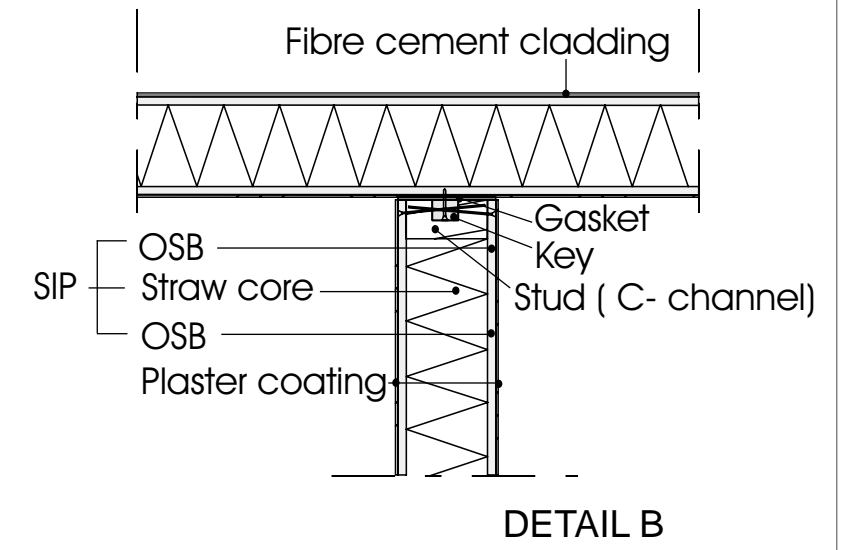
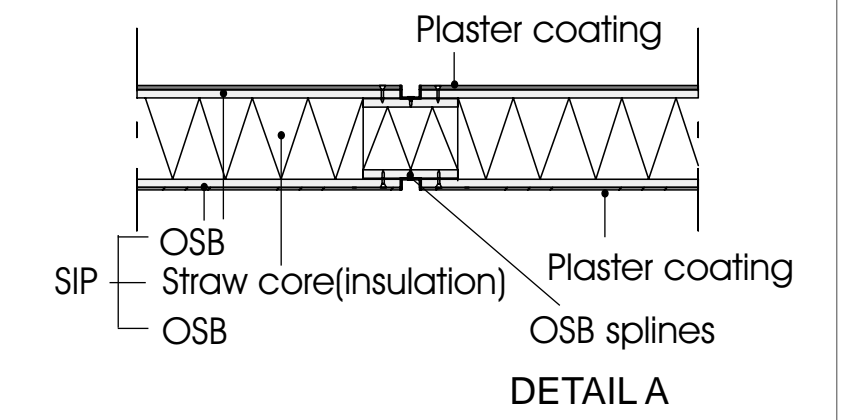
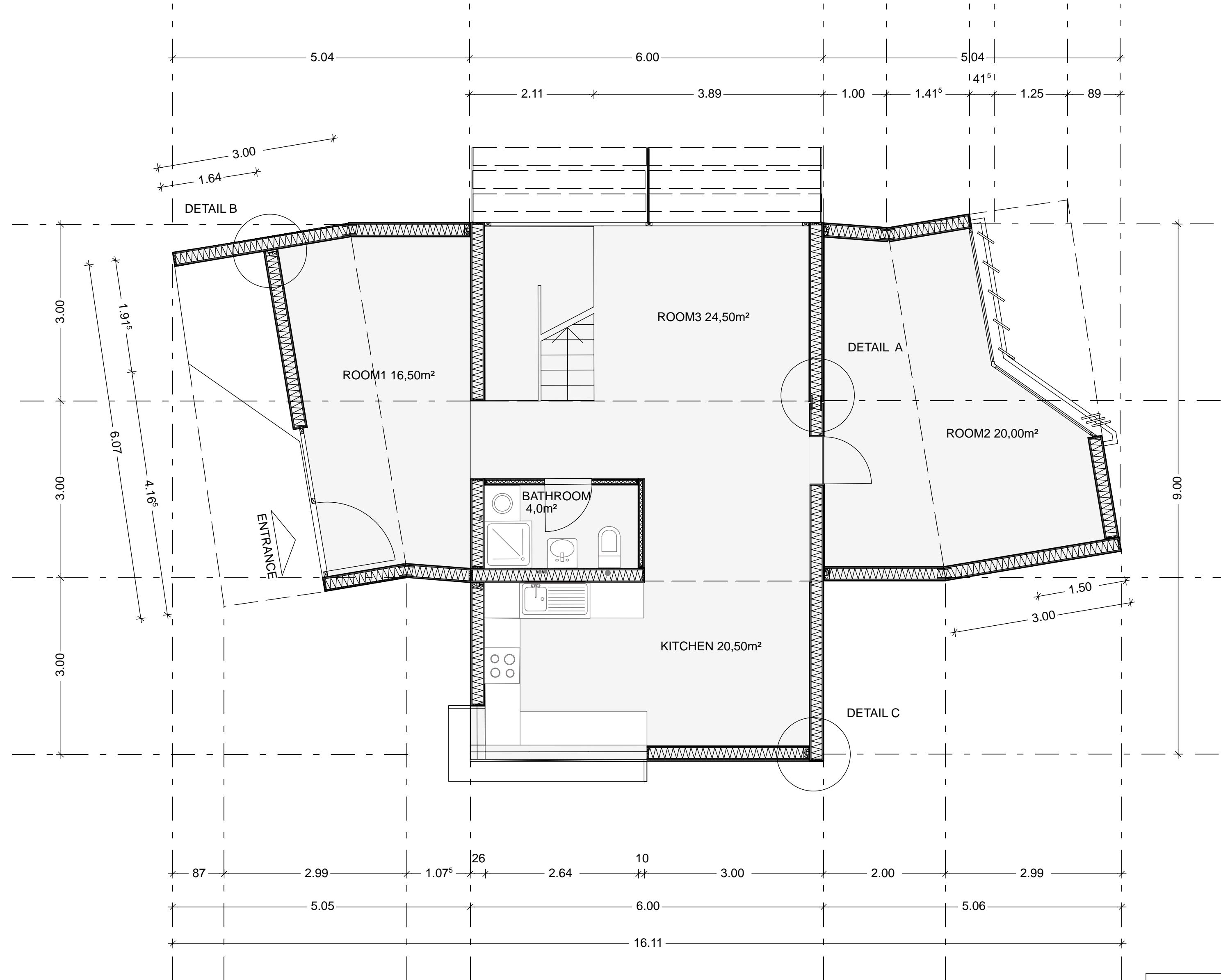
DETAIL F



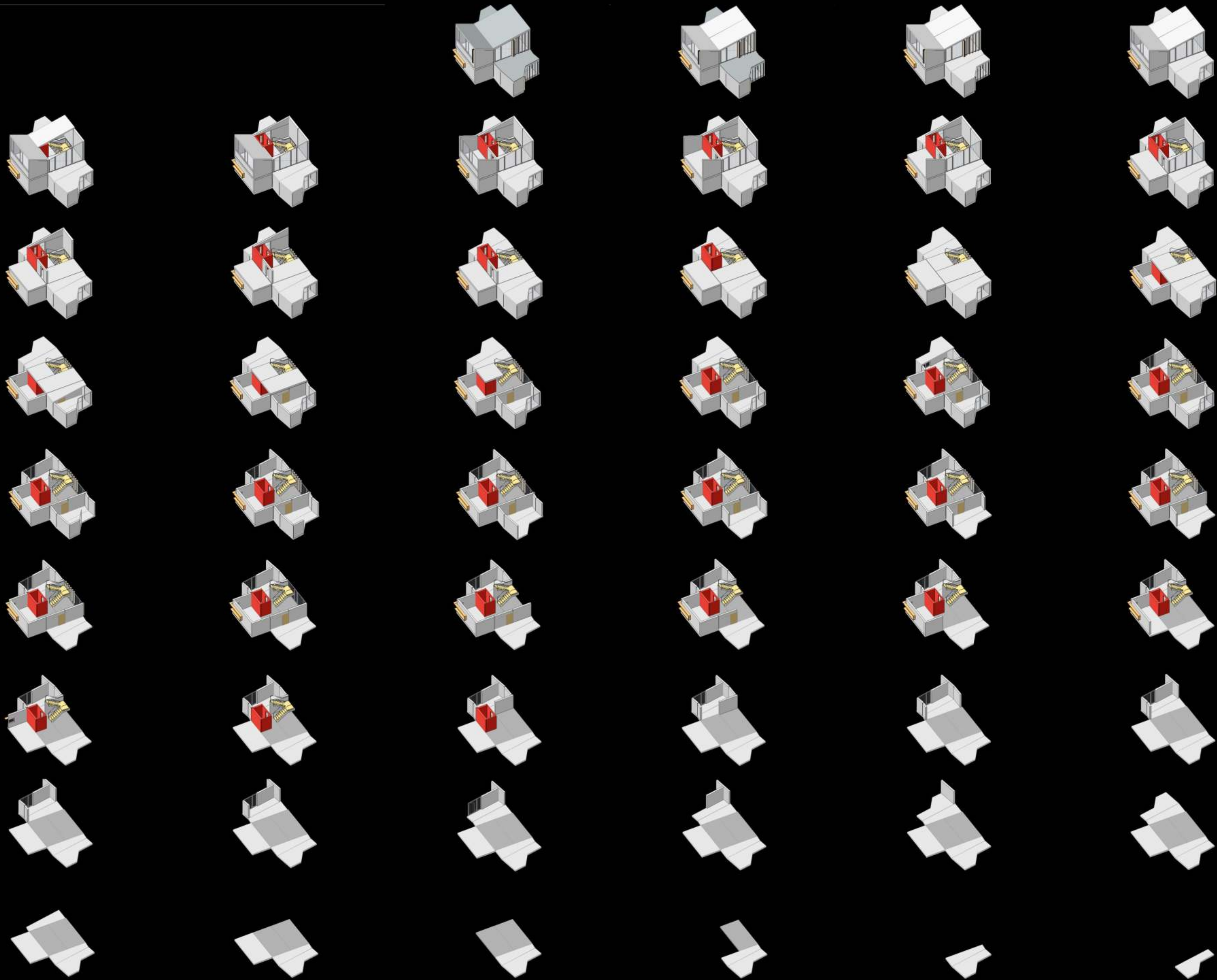
Section B-B

Mynewhome.com.au	
Sarah`s house Swan Hill	Section B-B

An example of plans that the interface/ service would provide (Executive plans, details)



Mynewhome.com.au	
Sarah`s house Swan Hill	Floorplan



Conclusion

Involving architecture in general housing can be achieved by the digital delivery of design, through the proposed design interface.

The design system and interface can provide a solution to the current challenges facing the Australian suburban housing market – affordability and sustainability.

It can provide an alternative to the “super sized” house of the volume builder, currently the most popular type of housing in the country.

This type of design alternative needs to be provided as volume built homes are generally of low quality in that, as discussed they do not consider orientation, are poorly insulated and have buried internal spaces lacking access to direct natural light and air. Consequently these homes use high amounts of energy for air conditioning and heating.

Arguably volume built homes are too big, typically using up all the space on a property, leading to over consumption, an increase in running costs and higher mortgage repayments. As they do not allow customisation, these houses are not adaptable to sites or peoples needs, resulting in homogenous houses that lack diversity in terms of size, plan layout and design.

In contrast, the design system and interface that has been proposed will allow for houses that are architecturally designed, sustainable and affordable in price.

The design interface was developed in response to the need for finding alternate ways of delivering architecture. It was developed to show how the knowledge of the architect could be applied to ordinary housing, without the huge financial cost of the one off, architect designed house.

The aim was to combine as much of the quality and advantages of a one off architecturally designed house, in particular, the consideration of user and site needs with the affordability and predictability of a completely pre-designed volume builder house.

The proposed design system.

A design system was developed in different testing modes: speculative designs and site specific designs (as demonstrated in the Broadmeadows and Richmond examples).

The system consists of modules and components that would have the embedded knowledge of the architect. They are intended to allow non professionals to self-arrange their homes.

The proposed design system would allow adaptability to a particular site in terms of orientation.

The flexibility of a design system offers great potential for passive solar design which would dramatically reduce energy demand for heating and cooling.

The design system allows putting a price tag on each component and makes the design process more predictable.

Customisation

Including the client in the design process, opens up the possibility of educating them so informed decisions could be made, meaning the houses are optimised for their user's needs and finances. The promotion of smaller houses which leaves more space for a garden would result in more sustainable homes that could still be affordable in price.

The customer could self arrange his or her house with the help of an additional architectural consultancy service.

The approach would be more about the client thinking about what they really need versus merely buying what they get offered.

It is argued that customisation would result in more diverse types of houses in comparison to the one size fits all approach of the volume builder.

Construction system

The proposed SIP panel system is a highly insulating, low embodied energy, composite material available at a competitive price.

The use of these panels could lead to better environmental performance without a significant cost increase.

Additional costs for eco features such as double glazing, solar hot water, and photovoltaic cells, can be offset by reducing the size of the house and possibly through the optimisation of the production process.

Modern prefabrication and digital production technologies allow greater flexibility than ever before.

By using prefabrication it might become easier for the architect to control the building process for the house and achieve the desired outcome without supervising the construction process. With this, better quality could be achieved.

Prefabrication also has the potential for waste minimisation during production.

Better environmental performance of the house would guaranty long-term affordability.

The Interface

A web based interface can be an ideal tool for customisation as seen in other industries. It functions as a database, includes embedded programs which allow simulation and visualisation, and enables communication between all participants.

The embedded programs allow the user to see costs and energy demands while they are designing. This might create more awareness of environmental issues.

The customer could self arrange their house with an additional architectural consultancy service, or modify a house from a library which would mean the costs for the architect are split among more people.

The process in general is more predictable in comparison to a one off architect designed house. Costs can be calculated simultaneously and can be considered immediately.

The digital delivery of design with a design interface to create more sustainable, affordable housing is possible but it needs further development by architects, IT experts and the construction industry. It needs to be tested with real people to become a viable alternative. This is a very complex issue in which different experts would have to work together.

The limitations of this research are that no industry testing (construction prototyping, marketing or costing) was carried out. The focus was on the custom architectural service in a digital mass production context.

As I found out during my research the clients Interaction with the design system through the interface is more important than the design system itself.

The real challenge for affordable, sustainable housing lies not only in building technologies, as the necessary technology exists already, it is more important to make the right choices and to educate the client. This is seen as the tasks for the architect and can be made possible by the user interaction in the user interface.

Due to this interaction the prefab house can also be customised and can overcome its tendency of being to rigid.

As a consequence the main focus of the research was on the delivery of design and client engagement and not on the technicalities, or the realisation of a prefab system.

This could realistically only be done by testing and prototyping the prefab system, to sort out application problems.

However, there is a real possibility for a design interface to open up a dialogue between the architect and the general public.

The potential role of the architect in this process would be the creation of a design system, a user interface and the provision of a consultancy service for the client.

Initially, most customers will presumably be younger, with a familiarity with not only using computers but also buying products over the internet.

In the long run, it is assumed that the market would widen to other demographics.

While this research project was primarily about improving affordability, sustainability and quality of the single house, improvements on the master plan level also need to be made to create sustainable, high quality new suburban neighbourhoods.

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