Towards Specific Adaptable Housing

Emma Zee

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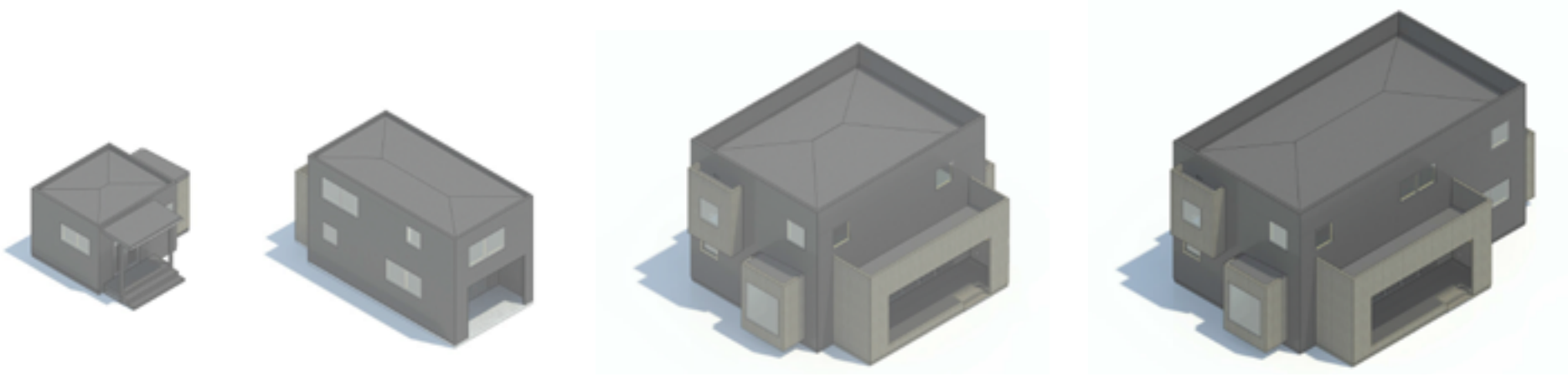

Abstract

The aim of this thesis is to explore specific adaptable design for suburban housing. First an analysis of existing New Zealand mass suburban houses was conducted. It was found that many mass suburban houses are a repetition of generic, low cost, plan generated, hipped roofed houses. This thesis provides evidence that the mass suburban houses are not easily adaptable as they are generally not designed to be altered. Secondly, existing literature on adaptability was explored in which a duality between two design approaches was identified. The very determinate approach to adaptability often results in an overly specialised design, with ideal characteristics but only for a specific brief. The indeterminate approach is to provide a space where no particular use is determined, the theory being that occupants can choose their own use for a space. The literature review for this thesis found that the indeterminate, or multi-use, approach was often used in conjunction with the terms neutral and generic which have a tendency to indicate spaces devoid of character. The thesis aim is to provide adaptable design where the use is not determined but the characteristics of a space are.

It was found that the definitions of adaptability are convoluted and sometimes contradictory. A definition towards specific adaptable housing was developed based on conclusions drawn from a survey asking participants their preferred spatial characteristics for a variety of activities, existing research and design led research conducted in this thesis. The definition went through several revisions to consider where adaptable design allows alterations and removals to be done easily in the future, considers aesthetics and allows a change of use through considering social and utility function through varied spatial qualities. The adaptable definition developed in this thesis is specific and clear about what can be achieved but allows flexibility for the designer as projects will lend themselves to particular outcomes.

A range of adaptable design tactics were identified from the literature review. Each idea was analysed for how it could fulfil the adaptable definition of this thesis. The collection of design tactics is comprehensive and informed by a range of publications, precedents and design led research. Design generation one utilised some of the adaptable tactics from the literature review in conjunction with the survey results. Lessons learnt from design generation one informed the definition of what adaptability means for this thesis in relation to aesthetics and consideration of social and utility function over time.

The specific approach to adaptability is seen in the selection and application of the design tactics in design generation two. The most significant aesthetic and adaptable design tactic being the link which has little impact on built fabric when additional structures are constructed or removed and allows disparate shaped or sized structures to be joined which enables freedom of design and form. Furthermore, the link often becomes the circulation between structures making space planning straight forward when considering how additions will fit in with an existing dwelling. Flat roofs and beam and column construction are notable adaptable design tactics which can allow additional storeys to be added relatively easily to a dwelling in the future. The approach to the ground plane and site are also important considerations as the predominantly two storey design will take up less room on site, allow greater options for additions, more garden/yard area and allows for double height interior space.

Specific adaptable housing is important as it allows occupants to easily adapt their home when their needs change, while providing a unique building which contributes to the occupants' quality of life. As adaptable homes can be built in increments over time it is a clear method for occupants to have the space they want when they need it and can afford it. With housing shortages, the cost of house building and a growing population within New Zealand, the need to look at alternative design approaches is particularly important. Applying the study to terrace housing and a comparative cost analysis of the adaptable design outcome is identified as valuable areas of further research.

Acknowledgments

Thanks to my friends, family and tutors Penny Allan and Mark Southcombe for making this possible.

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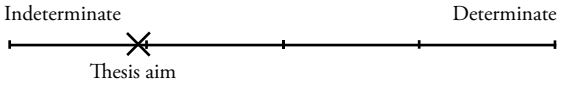
Part 1

1.0 Introduction

"It is equally clear that neither neutrality, which is the inevitable result of flexibility (tolerable for all, just right for no-one), nor specificity which is the consequence of too much expression (just right- but for whom?), can yield an adequate solution" (Hertzberger, 1991, p. 149).

"Flexibility became the catch-word, it was to be the panacea to cure all the ills of architecture. So long as the design of the building was neutral, it was thought, they could be put to different uses, and they could therefore, in theory at least, absorb and accommodate the influences of changing times and situations" (Hertzberger, 1991, p. 146).

Design for use of space



Design approach for character of space

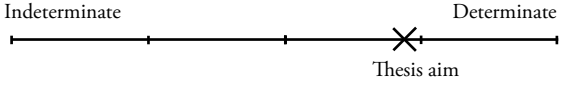


Figure 1: Thesis approach. By author.

1.1 Problem Statement

The aim of this thesis is to explore adaptable design for suburban housing. As the definitions and terminology in adaptability were found to be convoluted and contrasting it became clear that it was important to define, analyse and critique adaptability before it could be applied to suburban housing. To compound the situation, throughout literature on adaptability there exists a duality between two design approaches. This is also acknowledged by Schneider and Till who state "in terms of use it may appear a contradiction that flexibility can be achieved through being either very indeterminate in plan form or else very determinate, but historically both approaches have developed in parallel through the course of the twentieth century" (2007, p. 7). The very determinate approach to adaptability often results in an overly specialised design, with ideal characteristics but only for a determined brief which can result in what Hertzberger states as "just right- but for whom?" (1991, p. 149). The indeterminate approach is to provide a space where no particular use is determined, the theory being that occupants can chose their own use for a space. The literature review for this thesis also found that the indeterminate, or multi-use, approach was often used in conjunction with the terms neutral and generic which have a tendency to indicate spaces devoid of character. As Hertzberger argues, neutrality is "tolerable for all, just right for no-one"(1991, p. 149).

The aim of this thesis is to provide adaptable residential design where the use is not determined but the characteristics of a space are. The proposed alternative approach to adaptable design should be thought of in terms of the ability to design indeterminate space with determinate character; rather than with a generic, characterless space.

It is the hypothesis of this thesis that the aim will lead to an adaptable architecture in which space can be used in different ways while being more specific to site, activities and individual preference.

Thesis title: Towards adaptable residential housing

1.2 Thesis overview

Part 1

1.0 Outlines the motivation of this thesis which is fuelled by the existing and prevalent non-architectural response to providing mass suburban housing. While the motivation of this thesis is in reaction to non-architectural mass housing, this research will be beneficial for anyone wishing to create an adaptable home.

2.0 Explores the existing literature on adaptable design which advocates the indeterminate and determinate design approaches. This is reflected in the definitions of adaptability which were found to be convoluted and contradictory. Further research is conducted as a basis for creating a definition of adaptability for this thesis which will guide the design for a specific yet adaptable suburban residential housing for many different contexts of occupants. As part of this research, a survey was conducted to explore the characteristics of spaces which people prefer for different activities. The trends and implications from the survey and further research are observed and analysed.

3.0 Identifies and analyses different adaptable design tactics through a precedent review. The adaptable design tactics are compared and evaluated against the adaptable definition for this thesis.

4.0 Outlines design generation one which provided a testing ground for the ideas and theories developed in the literature review, survey and subsequent definition of what adaptability means for this thesis. The design however, resulted in some undesirable qualities, which are discussed in the design critique. The lessons learnt from design generation one were used to inform further research and design in the next chapters of the thesis.

Part 2

5.0 Explores a further literature review in which adaptable tactics were conducted via the study of existing dwellings. Each tactic was identified and analysed in relation to the adaptable definition developed in this thesis.

6.0 Demonstrates design generation two which was a culmination of all the research in relation to the adaptable outcomes developed through part one of this thesis. Different adaptable tactics discussed in literature reviews were tested through design to further explore the definition of adaptability for this thesis.

7.0 Concludes with an overview of the thesis process and significant findings, which lead to the final conclusions and the thesis aim being addressed. Consideration of areas of further potential research conclude this chapter.

Figure 2: New suburban housing development in Upper Hutt. Each house is a repetition of the same ideas of low cost, hipped roofs, neutral and generic. Suburban developments like Riverstone Terraces (above) show the scale and number of which the generic suburban houses are being erected. Such houses can only be described as banal, monotonous and soulless. Photo by author.

1.3 Background

The motivation behind this thesis is fuelled by the large numbers of homes cropping up in New Zealand suburbs. The results can be monotonous, plain, banal, repetitive and overall quite generic (Figure 2). The generic approach to residential housing has been identified by many authors. Pollak (2003) and Wigley (1992) describe the typical residential design as having an open plan living with enclosed, private bathrooms and bedrooms. Pollak asserts "this more or less universal model of private living has been incredibly permanent in spite of all changes in style, revolutions and cultural differences and characteristics" (2003, p. 22). The generic residential home designed for the nuclear family was established "immediately after the Second World War builders had little difficulty identifying the demographic makeup of their clients. Breadwinner dad, stay-at-home mom, and their children resided in a limited number of housing prototypes" (Friedman, 2002, p. 5). Since then "the single family house is still geared towards the nuclear family, even though fewer such families exist" (Schittich, 2005, p. 10). Furthermore Friedman states that "statisticians, demographics, sociologists, and other researchers share the agreement that there no longer exists any universal definition of 'family'" (2001, p. 5). The design of homes for nuclear families is the result of generic assumptions about what is required by individuals in their home now and in the future, and yet it remains extremely prevalent for new residential homes despite this change in family dynamics. Assumptions are also made in terms of the style and approach to mass produced suburban housing. This is also noted by Young who perceptively attributes this to a "...need to conform to the same set of desires in order to sell. That is, spaciousness, cleanliness, and neutrality. This is what buyers and tenants want according to agents" (Young, 2006, p. 399).

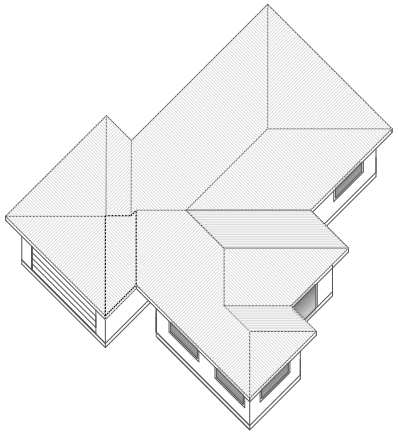


Figure 3: 3D of Golden Homes *Punto* design

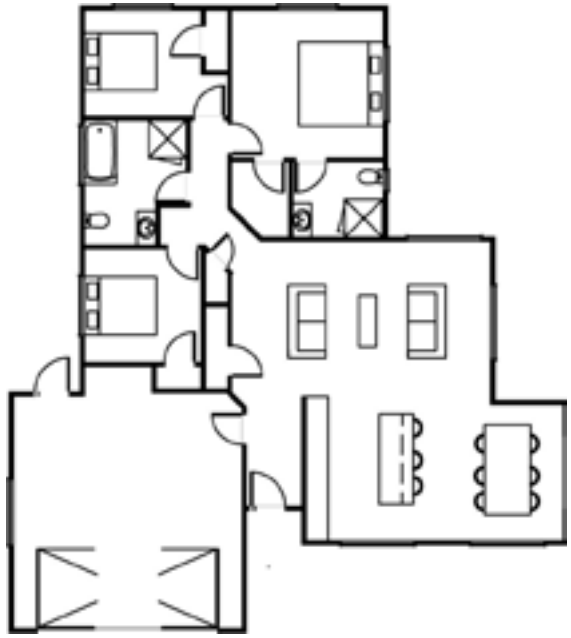


Figure 4: Floor plan of Golden Homes *Punto*

The historic trends and assumptions from the various players such as developers and mass housing contractors, have resulted in many suburban houses providing little expression or character in order to satisfy the widest range of uses and people. The architectural results are often designs that are similar in character to *Punto* from the mass housing company 'Golden Homes'. Each room is a larger or smaller generic version of the next with little variation in the qualities of the spaces. The low studs, even lower eaves, and complicated hipped roofs which are extruded from plan generated designs results in houses in which additions are not easy to construct or design. The problem of mass produced monotonous suburban housing has been commented on by many authors from many countries for example, Canadian Avi Friedman who states,

> *"mass-produced housing represented the culmination of housing innovations from many domains. The houses were designed to be compact and efficient. Materials and construction techniques were chosen to maximize affordability and the rate of production. Marketing strategies, included advertising by developers, were refined to encourage people to believe that mass-produced housing was the optimal housing option. But the downside of uncontrolled and poorly designed mass production of housing was the creation of instant communities made up of virtually identical, low-cost, small houses" (Friedman, p.29, 2001).*

The limitation of this anecdote is that its criticism is applicable for houses generally not designed by architects such as the houses built by design-build spec housing firms where the client can pick and sometimes modify set plans. The argument of this thesis is not against having set plans but against unadaptable, generic designs as a large part of new New Zealand's suburban detached housing stock. There appears to be limited consideration for adaptability in the initial design, therefore inhabitants must either move to a new house which meets their needs or try to adapt their house which was not intended to be altered from the initial build. This thesis proposes that adaptable homes can be built in increments with a higher architectural quality which can accommodate change in the family model over time. While the motivation of this thesis is in reaction to non-architectural mass housing, this thesis will be beneficial for any designers wishing to create an adaptable home.

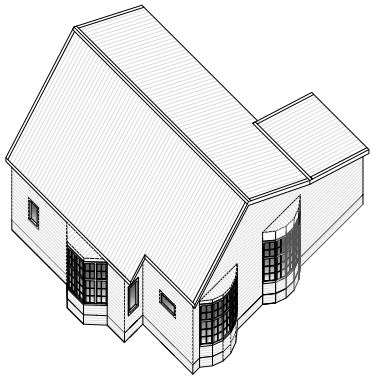


Figure 5: 3D of my parents' house

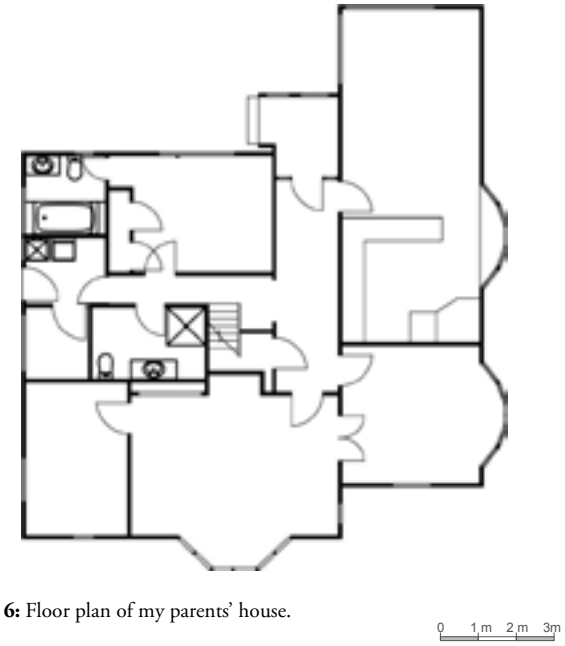


Figure 6: Floor plan of my parents' house.

The mass suburban houses such as *Punto* are a far cry from my parents' house which is an ordinary nineteentwenties 1920s home similar to many homes built of the same period, however, it is superior to the newer homes like *Punto* in terms of adaptability. Table one outlines the things that every person looks for in a house to meet their utilitarian needs, number of bathrooms, bedrooms, living area, total floor plan size etcetera. My parents' house and *Punto* are similar in program as the table below demonstrates.

	My parents' house	***Punto***
	Two storey in part	One storey
Floor Area	160m²	166.6m²
Bedrooms	3 on the ground floor, 2 smaller bedroom/study's upstairs	3 on ground level
Bathroom's	One main family bathroom	One main family bathroom
Master bedroom	Master bedroom with ensuite and built in wardrobe	Master bedroom with ensuite and walk in wardrobe
Living	Combined dining, kitchen and living room with separate lounge.	One combined dining, kitchen and living room.
Garage	No garage	Double garage

Table 1: Program comparisons between my parents' house and *Punto*.

Future additions or alterations to the house would be relatively straight forward because of the high stud and gable roof. For example, previous owners of my parents' house added a lean-to for the dining room which my parents' have since added a small verandah to.

In response to changing social situations, my parents' house was able to absorb changes in use. The house has a variety of specific characters so there was always a space to retreat to that could match mood or need. An example being, sunny areas, quiet areas and social areas. Most of the rooms have served a purpose beyond conventional use. For example; bedrooms and even part of the laundry are frequently used as a study, the living room as a bedroom and the dining room has served as a workshop and group study area. It could be argued that it worked for our family because we were tolerant of each other, but my observation is that the house worked so well because the living spaces and bedrooms were not grouped together. Occupants were able to retreat to another part of the house and avoid disturbance.

Why is an ordinary house built in the 1920's more adaptable than one built today? The element of cost is a factor in new suburban houses. However, the long term costs of trying to adapt new houses can outweigh the cheaper approach. My experiences of my parents' home, as adaptable, responsive and interesting, compared to the bland and sometimes difficult experiences of renting, visiting or drawing up alterations for houses like *Punto* is the motivation for this thesis.

The architectural problem outlined has two elements. The first being specific to mass suburban housing built in a monotonous and unadaptable way. The second problem is the existing literature on adaptability which advocates design approaches which are indeterminate or determinate. This thesis explores both architectural problems through existing literature, precedents and design led research to explore the ideals of my parents' house which is easy to add onto, has specific and enjoyable characteristics in each space while the use of space is easily able to change.

2.0 What is Adaptability?

2.1 Adaptability overview

The aim of this thesis is to explore a design process for creating specific adaptable residential design. Before the aim can be investigated the meaning of adaptability for this thesis is explored. This is not a straight forward process as the terminology used to describe adaptability is varied and vague with the word 'adaptable' often used in conjunction with, or instead of, other terms such as; flexible, multi-functional, multi-use, adjustable, changeable, variable, polyvalent, shell neutrality, layout neutrality, division neutrality and functional neutrality. The terms are used interchangeably so that the intended meaning or differences in meaning is difficult to determine. Friedman has also found that "misconceptions about adaptability are the outcome of the term's many definitions and interpretations" (2002, p. 1).

The aim of this first section is to answer 'what is adaptability and what does it mean for this thesis?'

The method for circumnavigating through the literature on what adaptability means is to discuss adaptable definitions in groups. These groups have been divided into:

-Adaptable design allows alterations to be done easily in the future.

-Adaptable design responds to demographics, economy, lifestyle and technology.

-Adaptable design allows a change of use without making physical changes.

-Adaptable design allows the physical building fabric to be easily altered without the need of a builder: Moving building elements.

A gap in the existing definitions of adaptability is identified and the literature review is expanded. The chapter is concluded with a discussion into what adaptability means for this thesis, why it is significant and what implications it may have on the design section of this thesis.

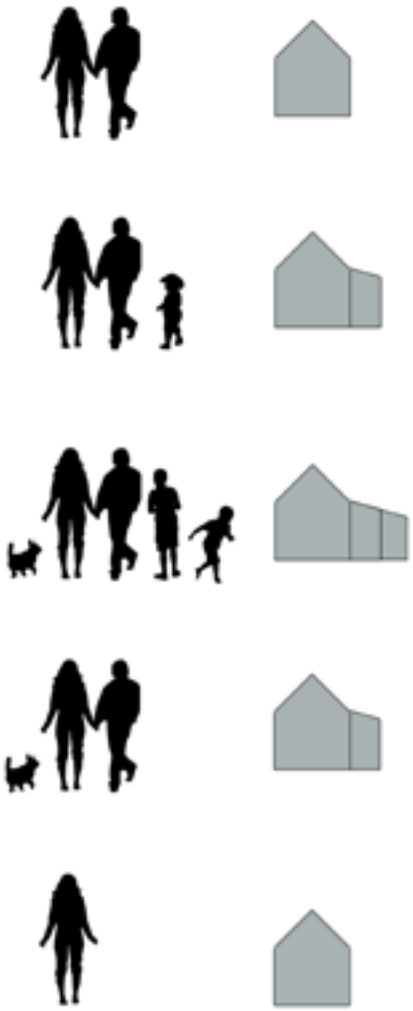


Figure 7: The diagram represents one of many ways in which the family model can expand and contract. An adaptable house can easily grow and shrink in response to changes in the family. Image by author.

Adaptable design allows alterations to be done easily in the future

The ability to add and alter buildings in the future is an important aspect of adaptability as the occupants have different requirements of their home over their lifetime. Most walls can be altered by a builder, however, the ease or difficulty of doing so depends on the design provisions. For example, Van der Voordt & van Wegen state that an adaptable building should be "designed in such a way that later adaption can be done easily and relatively cheaply" (2005, p. 180). This is put into perspective when Brand commented that "almost no buildings adapt well {…}. But all buildings (except monuments) adapt anyway, however poorly, because the usage in and around them are changing constantly" (1994, p. 2).

Design tactics to allow alterations to be done easily in the future could include, but are not limited to; separation of loadbearing and non-loadbearing walls, over designing foundations, construction joints between old and new and so on. This thesis defines this aspect of adaptability as covering anything to do with construction for alterations which would be covered in Friedman's definition of "post occupancy adaptability" (2002, p. 13).

The ease of additions is a common thread throughout the literature on adaptability. Houses often grow in size as a family grows. The additional space however, can become superfluous in time as a family shrinks in size. In order to design a home which considers the entire life cycle, the ease of additions, and ease of removals are considered in this thesis. Specific design detailing to allow ease of additions and removals will be explored further on in the thesis. Friedman highlights this consideration as "growth and division, which refers to design strategies or means that permit the expansion or reduction of volumes or space either during design and construction or later throughout the occupancy" (2002, p. 16).

Adaptable design responds to demographics, economy, lifestyle and technology

Adaptability:

"Providing occupants with forms and means that facilitate a fit between their space needs and the constraints of their homes either before or after occupancy is one interpretation. The search for such fit is the result of accelerated demographic, economic, lifestyle, and technological changes in society that have created a need for designers, builders, and buyers to inquire about adaptable housing forms" (Friedman, 2002, p. 1).

In this theme adaptability is achieved when space responds to changes in family life, demographics, economy, lifestyle and technology. The literature usually does not specify how each design recommendation or intervention responds to each change which is not surprising considering that each intervention could respond to a number of changes at the same time. For example, an attic space could respond to changes in family life as it is turned into a bedroom for an unexpected child. This could also be in response to a families economical situation as the room is rented out or used as an office to save money. The same intervention could also respond to the environment as the attic becomes a safe haven from a flood or technology as internet and phone lines are pre-installed before they are needed. On the other hand the attic may be left unused. In any case the attic has been designed in such a way that any change of use is made simpler and easier.

Friedman states that trying to predict future trends in family life, demographics, economy, lifestyle and technology is a "nearly impossible task" (2002, p. 2). How could you predict the unexpected child, the need for a home office, or a freak flood? This definition highlights the importance of considering adaptable design in order to accommodate unforeseen changes in the home. Therefore, this section acknowledges these drivers of change although they will not be explicitly referred to within this thesis.

Adaptable design allows the physical building fabric to be easily altered in the present without the need of a builder: Moving building elements

Adaptability:

"One design that comes to mind is that of a rotating home with openings that adjust toward the sun. Others might think about movable interior partitions that change position with the push of a button" (Friedman, 2002, p. 1).

Flexibility:

"Flexibility thus applies to both internal and external changes, and to both temporary changes (through the ability to slide a wall or door) and permanent changes (through moving an internal partition or external wall)" (Schneider & Till, 2007, p. 5).

Polyvalent:

"Capable of being adjusted to changed or difference in user preference or needs by changing the relationship between different spaces without the assistance of a builder (e.g. by the use of sliding doors or folding partitions)" (Van der Voordt & van Wegen, 2005, p. 180).

Within the literature there are arguments for and against moving building elements in adaptable space. Moving building elements creates a very specific and determinate design response. Design tactics could include, but are not limited to; sliding doors, moving wall partitions and fold down furniture. This thesis defines this aspect of adaptability as covering anything which can move but is still connected to the building.

In Croft's reference to J.G. Wattjes 1925 description of *Schröder House*, he states that "by rejecting the normal method of subdividing space- with fixed walls- and choosing a system of sliding partitions, an extremely flexible arrangement of the interior is achieved" (Croft, 2006, p. 77). Schneider & Till make a similar claim of extreme flexibility within a traditional Japanese house in which many of the walls are moveable (2007). However, both Croft and Schneider & Till acknowledge that this flexibility is only achieved when the house is used in a specific manner. Croft questions whether "such extreme flexibility in fact proves convenient in the long run" (Croft, 2006, p. 77).

> *The actual flexibility and adaptability of the house is thereby completely dependent upon the active participation of the users {…} by pulling out futons from a storage cupboard, a room that was used as a dining or sitting room can be transformed into a bedroom: the minimal approach to furnishings, and the relative lack of other clutter, demands a discipline to achieve flexibility that may be beyond normal living patterns (Schneider & Till 2007, p. 55).*

Moving building elements are important for adaptable design as the qualities of a space can be manipulated as the inhabitants place the building elements in the desired position. However, they are a design tactic rather than a means to achieve adaptable design. Possible ways in which moving building elements could contribute to adaptable space is explored with the design tactics in the precedent review.

Adaptability:

"Adaptability is achieved through designing rooms of units so that they can be used in a variety of ways, primarily through the way that the rooms are organised, the circulation patterns and the designation of rooms" (Schneider & Till, 2007, p. 5).

Polyvalent:

"Adaptability thus covers 'polyvalency', the term employed by Dutch architects and theorists to describe spaces that can be used in variety of ways, generally without making physical changes" (Schneider & Till, 2007, p. 5).

Multifunctional:

"Suitable or able to be made suitable for different functions without requiring changes to the structure or built in features" (Van der Voordt & van Wegen, Architecture in Use , 2005, p.180).

***Functional neutrality**:*

"The possibility of giving a building a different function" (Van der Voordt & van Wegen, 2005, p. 181).

Neutral:

"Capable of being adjusted to changes without changing the location of various functions and without architectural elements required by those functions needing to be moved, removed or augmented" (Van der Voordt & van Wegen, 2005, p. 180).

Adaptable design allows a change of use without making physical changes

Within the literature on adaptability there are often many definitions for a single term. As demonstrated in the quotes in the left column there are also different terms with the same definition which summarises the idea that adaptable design allows a change of use without making physical changes. Even though the same definition has been reiterated, the definitions are too broad when you consider that individuals usually find a way to use space to their preference regardless of the architect's intentions. This is reinforced by Crabtree (2006) who claims that flexibility and adaptability comes from the ability of individuals to respond and adapt. Furthermore Kent states that "no monofunctional room exists in any Euroamerican home. The 'typical' bedroom is used for many activities. A bed is used for reclining one's body upon but its functions include providing a place to sleep, rest, get well, die, have sex, procreate, watch TV, read, nurse babies, wrap presents, lay coats, and serve as a trampoline" (Kent, 1990, p. 6).

Free standing furniture can allow a change of use without altering the building. Pearson and Richards argue that rooms are strongly determined by the furniture contained (1994), for example a room with a desk and chair could be said to be used for studying or working. Considering furniture placement will not however, give the actual range of use for that space as furniture itself is used in many different ways (Kent, 1990). Free standing furniture is considered a facilitator of activities and will not be considered as an adaptable tactic as individuals move into a space with their own varied furniture. The consideration of furniture placement however, is still an important adaptable exercise as trialling different furniture placement on paper will affect the way fixed building elements are designed. Friedman (2002) claims that placing furniture in drawings restricts inhabitants. However, this thesis argues that providing plans which show how a space could physically accommodate various activities could assist inhabitants in realising the potential of a space and can influence the way the space is designed. An example of this is when the room dimensions and window placement may be altered after trialling different combinations of furniture.

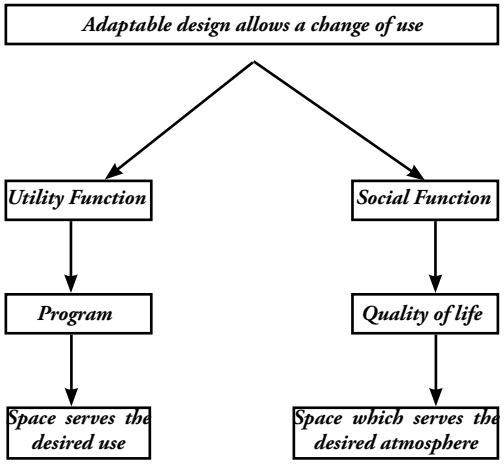


Figure 8: Diagram to understand the outcomes of the adaptable design which allows a change of use without making physical changes. Diagram By author.

While most spaces are able to support a variety of activities almost regardless of the design, the quality of experience for each activity varies. Van der Voordt & van Wegen (2005) state the existing definitions of adaptability are primarily concerned with utility function which is when a space serves the desired potential use. This is compared to social function which is concerned with health, welfare, communication and quality of life (Van der Voordt & van Wegen 2005, p.2). The understanding of adaptable space as providing utility function and social function has implications for adaptability and for adaptable design. It is significant because it shows that it is not enough to just provide space for different uses, but the qualities of those spaces must also be considered. Utility function would be achieved by providing the required square meters for each space. Social function, however, is subjective and less quantifiable.

Norberg-Schulz states "whereas 'space' denotes the three-dimensional organisation of the elements which make up a place, 'character' denotes the general 'atmosphere' which is the most comprehensive property of any place" (1980, p. 11). Van der Voordt and van Wegen's definition of utility function could be compared to what Norberg-Schulz defines as 'space'. Whereas social function could be referred to Norberg-Schulz's term of 'character' or 'atmosphere'.

Similar to Van der Voordt and van Wegen's findings this thesis has found that the current literature on adaptability prioritises utility function. How do you provide quality of life through architecture? And how do you know what atmosphere would be preferable for the inhabitants? Further research will be required into social function which is outside the scope of the literature on adaptability.

Reflection

Two out of the four definition themes are applicable for investigating the meaning of adaptability for this thesis; The first is *Adaptable design allows alterations and removals to be done easily in the future.* A clause, *and removals,* has been added to the definition for this thesis as it takes into consideration the fluctuating number of inhabitants which can occur in a household. The potential uses of a space are also considered in the design of future additions.

Adaptable design allows a change of use without making physical changes is a very broad definition which was often synonymous with the term neutral. The definitions of utility function, due to their generic nature, are applicable to all spaces. It is not, however, applicable when speaking of social function. This is why it is deemed necessary to explore social function further. The aim of further research is to build on the existing definition to a point where both social and utility function can be considered holistically as a part of adaptable architecture.

Two houses could both provide the same utility function with the same number of bedrooms, bathrooms, living room etcetera in the same number of square meters. However, the social function or experience of space, can be radically different in each design which was briefly illustrated in the introduction with *Punto* and my parents' house. Both houses have similar utility function but with completely different interior qualities. My parents' house has varied spaces with different stud heights, varied window sizes where as *Punto* has consistent interior stud height, consistent window treatment with bedroom and living spaces grouped together.

The consideration of social function is inadequate from the literature review for adaptability. The following section explores how social use can be integrated into adaptability and the implications it may have on adaptable design.

2.2 Further Research: Social Function

Social function or the quality and experience of space is affected by many factors for example; mood (Hornik, 1982), the presence of others (Hornik, 1982), (Ardener, 2006), the absence of others (Ardener, 2006), family rules, norms, expectations and habits (Dowling, 2008), "social relations and social etiquette" (Madigan & Munro, 2006, p. 224), **"**stage of life, socioeconomic status, personality and values, hopes for the future, norms for one's peers, and relationships with neighbours" (Gifford, Steg, & Reser, 2011, p. 451) and so on. Those factors are acknowledged, but not included in this thesis as they are out of the control of the architect. The building itself and design of fixed architectural elements are the architect's tools for influencing an individual's experience of space and therefore social function of space.

While fixed architectural elements have a significant impact on the experience of space, there is a multitude of readings, authors and architects who idealise controlling inhabitant's actions through architecture. An example being Hertzberger who describes the failed "social utopias such as 'spaces for social interaction' {…} by architects who believed they could simply predict the behaviour of people" (1991, p. 241). This is further reinforced by Borden who states "architecture has too often been conceived solely as the product of design intention, from which social effects simply follow" (2006, p. 50). While some architects have tried to control the actions of the inhabitants through architecture Madigan & Munro on the other hand state that architecture "constrains but it does not determine the way in which the house is used, or the meanings which the consumers attribute to it. It is the complexity of this interaction between the physical and the intellectual, the objective and the subjective" (2006, p. 226). How individuals may interpret space is an unpredictable factor as Unwin illustrates "a place may have many interpretations, a person might see a wall as a barrier, another see it as a seat, another see it as a path along which to walk; a third might see it as all three at the same time" (2003, p. 82).

While architecture cannot control the actions of the inhabitants it still has an influence. Kent makes an argument that "the built environment may be seen as 'suggestive' in that architecture can suggest new behaviour" (1990, p. 2). This point is reinforced by Hertzberger who claims "whatever you do, wherever and however you organise space, it will inevitably have some degree of influence on the situation of people" (1991, p. 174). The amount of influence architecture has on the inhabitants is more or less restricting depending on the nature of the design.

The design of the space as 'soft' or 'hard' is a contributing factor to the influence architecture has on an inhabitant. Schneider & Till state that "soft refers to tactics which allow a certain indeterminacy, whereas hard refers to elements that more specifically determine the way that the design may be used" (2007, p. 7). Soft space is thought to allow flexible living as the inhabitant is not restricted by fixed elements. This usually results in neutral open plan space with free moving furniture. Hard space is usually created through specific built in furniture which can to restrict inhabitants as they are unable to move the built in fixture other than in some predetermined nature.

Regardless of the design approach to 'hard' or 'soft' space the preference of inhabitants is the dominant factor in the use of space. Attfield refers to a housing study where it was found that "even where an architect had deliberately left no room for eating in the kitchen, people managed to force a table and chairs into it in order to eat some of their meals there" (1999, p. 78). Attfield's example shows that no matter the intention of the architect, the inhabitant will try to use the space in a way which suits them. This reinforces the idea discussed in the definition review that individuals usually find a way to use space to their preference regardless of the architect's intentions.

The problem of providing a space for social use is compounded when you consider that "there is no single solution that is preferable to all others" (Hertzberger 1991, p. 146). When considering all the factors which affect your experience of space it becomes obvious why the indeterminate, neutral approach is preferred as it is seen to be satisfactory to a wide range of people for a wide range of uses. Young perceptively notes that there is "seemingly need to conform to the same set of desires in order to sell. That is, spaciousness, cleanliness, and neutrality. This is what buyers and tenants want according to agents" (Young, 2006, p. 399). The argument for indeterminate spaces is that inhabitants can personalise the space as Hetzberger has noted, "although the bareness of the stark, grey interior is an obvious invitation to the users to put the finishing touches to their space according to their personal tastes, this in itself is no guarantee that they will do so" (1991, p. 24). Furthermore, the social function of space, acoustic privacy, visual privacy, natural light and sense of enclosure are not things which can be easily changed with paint. These factors that are built into the fabric of the building would generally take a lot of effort to change even if it were possible or practical to do so.

Although the indeterminate approach is seen to satisfy the greatest number of people it can result in terribly unexciting architecture which does not address social function. The argument of this thesis is that it is worth the risk of providing more character and expression through specific design at the risk of potentially satisfying less people than the indeterminate approach. Rather than looking to influence inhabitants this thesis is concerned with the impact of architectural decisions on the quality of experience and use for individuals. This thesis aims to provide environments which can be interpreted and experienced in different ways through providing a range of preferable experiences using architectural interventions.

Although the experience of space varies according to a complex matrix of influences, only the factors within the architects control are explored in this thesis. By manipulating the qualities of the built environment you can have an impact on individuals' experience of space. Through further research it was clear that you cannot predict how a space will be viewed or used by inhabitants. A survey is proposed to explore the relationship between qualities of space and the preferred use of that space. The aim of the survey is to help inform how social function may be addressed with utility function by providing some relationships between spatial qualities and use.

The factors which the architect has some control over are investigated and discussed as the architect's toolkit for influencing individuals' experience of space for different uses in the home. The hierarchy of each factor is not investigated as the preference for one spatial quality would likely be subjective to the individual. The qualities of space which can be manipulated through architecture are identified as sense of enclosure, visual privacy, acoustic privacy and natural light. The size of a space or sense of enclosure is the obvious choice as literature on adaptability is already concerned with providing the physical space for different activities. Visual privacy and acoustic privacy are closely linked and are particularly important for a quality of use where inhabitants need a place of privacy and quiet at times. Natural light has the ability to transform spaces and is an important factor in the experience of space.

The consideration of sense of enclosure, visual privacy, acoustic privacy and natural light are regular factors which designers deal with on a day to day basis. While designers may consider social function through good practice the consideration of social function and adaptability appear not to have been studied together in the literature. Furthermore, this thesis has come to the same conclusion as Van der Voordt and van Wegen's findings that the current literature on adaptability prioritises utility function.

The results from the survey are discussed with the literature of each spatial quality. Simplified and comparable diagrams of design tactics for manipulating each spatial quality are included in each section.

2.3 Survey Results and Discussion

This section aims to investigate individual's preference for space through a five point Likert survey. The scale at which the survey is taken is very important as the comparison of living patterns is dependent on the scale at which it is investigated. Rapoport suggests that "generalisations based on too crude a scale may be incorrect or misleading" (1969, p. 13). When you explore the macro scale, it can be found that "people arrange their residential interiors in fairly predictable patterns that are related to lifestyle, social class, and culture" (Gifford, Steg, & Reser, 2011, p. 451). However, the micro scale reveals "everyone has his own needs, his own preferences, his own ways of using space" (Baldwin , 2006, p. 27).

The participants were from a variety of demographics. The participants were required to indicate their age, ethnicity, and occupation. There were several trends towards more popular ambiences. A larger survey would be required in order to ascertain if the preferences represented New Zealand's society as a whole.

The age distribution of the participants showed a bell curve with the peak at the medium age of 40-50 and troughs at the end brackets of 15-20 and 80-100 year olds. The only exception to the bell curve was a greater number of 20-30 year olds which were slightly over represented. Overall, the distribution in age among the participants is broad. The New Zealand European ethnicity group made up the majority of participants. However, there were six other nationalities represented. Eleven out of 34 participants worked in retail followed by six students and three teachers. The remaining participants worked in 11 other various occupations. All of the participants lived in detached homes in suburban areas. While there were some common trends in the participants age and occupation the survey revealed a wide variety of individual preferences.

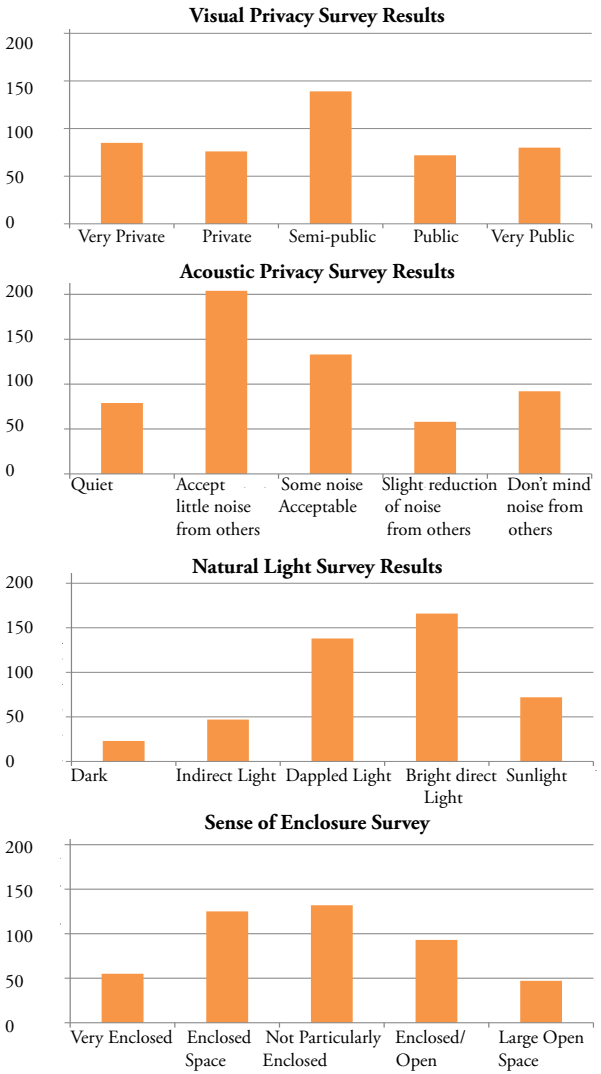


Figure 9: Overall survey results. There has been a trend towards the participants choosing the middle of the Likert scale however, the extremes were not significantly higher. Albaum (1997) identified that the participant's tend to mark the extremes and the middle score more often on a Likert scale. Overall this was not a factor.

The thirty-four New Zealand participants of the survey were asked to indicate their preferred sense of enclosure, natural lighting, visual privacy and acoustic privacy on a five point Likert scale for 14 different activities in the home. The Likert scale was chosen as "Likert scales are one of the most widely used ways to measure attitudes" (Albaum, 1997, p. 331). The activities are resting/snoozing, exercise, relaxing, grooming/preening, socialising with one or two friends, studying/working, watching TV, reading, eating dinner, children playing, circulation space, craft projects, cooking, and entertaining a group of friends. The respondents only indicated their preference for activities which they participate in. For example, exercise in the home received the lowest response rate with 27 responses. The surveys followed Victoria University's ethics guidelines, ethics approval number 18732.

The charts which show the overall preference shows the varied preferences for different spatial qualities though some trends were present. The preference for public or private space was fairly evenly distributed apart from a slight increase in the middle of the Likert scale for semi-public space. The preferences for acoustic privacy tend towards quieter spaces though spaces without sound proofing are accepted in some instances. The greatest trends towards one spatial quality over another was seen in the natural light category with a trend toward bright direct light and dappled light. A greater preference towards medium sized spaces is seen over very small or very large spaces in the sense of enclosure category.

The survey results from visual privacy, acoustic privacy, natural light and acoustics, are investigated individually in the following sections.

Degree of visual privacy	Description
Very private	Careful placement of a privacy barrier prevents any visual access into the space. The space can only be viewed once inside.
Private	The space can be viewed through an open door. Otherwise the space can only be viewed once inside.
Semi-private	Others are able to permanently view part of the space and the remaining space is only able to be viewed by those in the space.
Public	The space can be permanently viewed by others.
Very public	The majority of the space can be seen by multiple areas.

Table 2: Key for gauging degree of visual privacy

Visual privacy is difficult to quantify as it is constantly shifting as people move around space. The table gives an indication of more private and more public spaces however, it is a guide only.

The influence of visual privacy on social use

Visual privacy is sometimes considered with acoustic privacy, as the method to achieve visual and acoustic privacy is often the same. Installing a wall provides absolute visual privacy however the acoustic privacy varies according to the wall construction and execution of installation. While this is the most common tactic to approach visual privacy and acoustic privacy, it does not address situations when an inhabitant may have a preference to see but not hear into a space. Or conversely be able to hear but not see what is going on. The separation of visual privacy and acoustic privacy into two categories enables a wider range of solutions to be investigated. Visual privacy is described as being considered only within the household. This is compared to privacy from people who are outside of the house looking in, for example, privacy from neighbours.

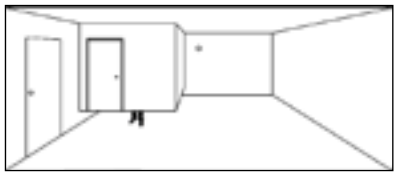
Visual privacy in this study is solely concerned with the ability of inhabitants to place themselves in a home and know the visual privacy which can be afforded by that space. The importance of privacy is outlined by Stewart-Pollack and Menconi who state that "life is composed of many situations and circumstances that cause us to need privacy. We need privacy when we are ill, sad, grieving, angry, tired, and anxious. We need privacy for intellectual, ethical, spiritual, creative, and physical development. We need privacy for emotional release, for self-evaluation, for intimacy, for autonomy, for contemplation, and for rejuvenation" (2005, p. 2). The ability to achieve privacy is very much dependent upon the physical environment.

Visual Privacy Tactics

Visual privacy is a created through the relationship between architectural interventions which restrict or allow visual access. The design intervention can allow full, partial or restricted visual access. The visual privacy categorization depends on the context and application of the intervention.

A full height wall providing full privacy has been omitted.

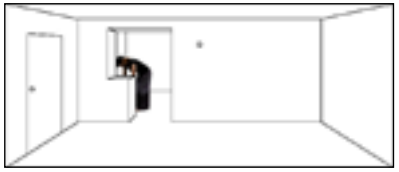
Permanent barrier provides no real visual privacy. Drawn by author.



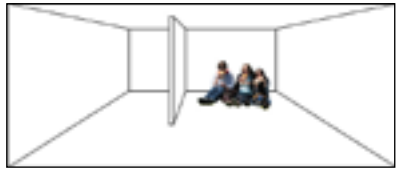
Permanent barrier provides no real visual privacy. Drawn by author.

Cut out in barrier provides partial visual privacy. Drawn by author.

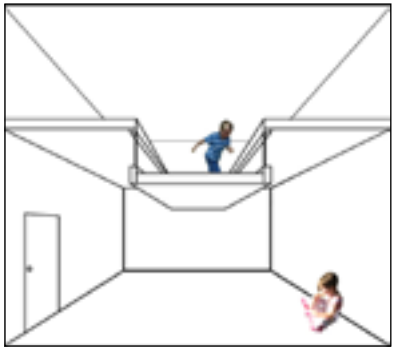
Cut out in barrier provides restricted visual access. Drawn by author.



Cut out in barrier provides partial visual privacy. Drawn by author.

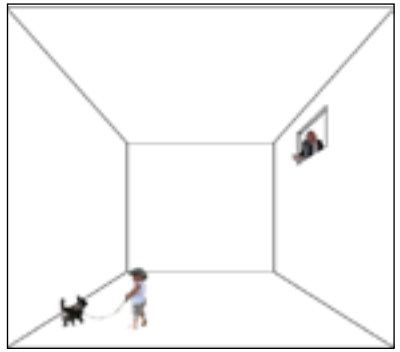


Barrier provides restricted visual access. Drawn by author.



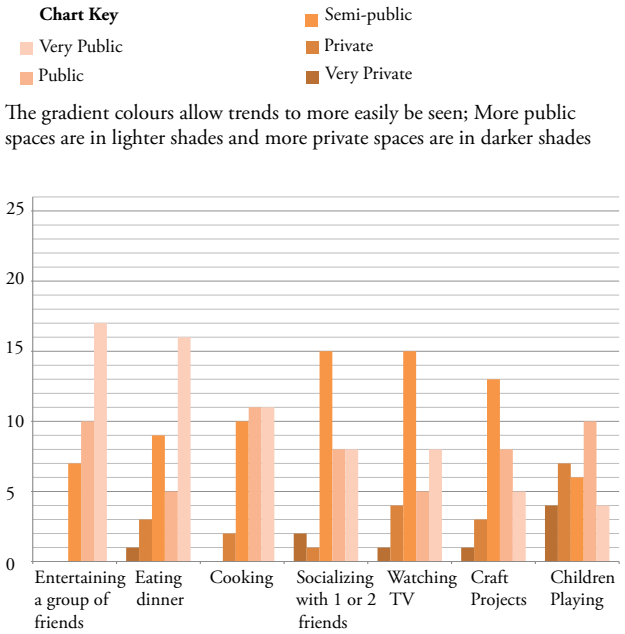
Mezzanine provides partial visual privacy. Drawn by author.

Cut out in barrier provides partial visual privacy. Drawn by author.



Cut outs in the mezzanine floor provides partial visual privacy. Drawn by author

Figure 10: Interventions which allow full, partial and fully restricted visual access



The gradient colours allow trends to more easily be seen; More public spaces are in lighter shades and more private spaces are in darker shades

Figure 11: Activities which survey results show a trend towards a greater preference to public space

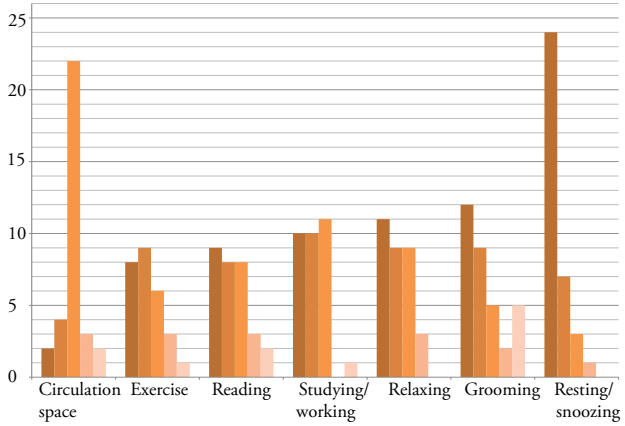


Figure 12: Activities which survey results show a trend towards a greater preference to private space

Survey results for the preferred visual privacy for a variety of activities

Thirty-four New Zealand participants were asked to indicate their preferred degree of privacy on a Likert scale for 14 different activities in the home. Privacy is described as 'the degree in which you see and are seen by other people within the home'. The survey segmented privacy into five distinct categories; very public, public, semi-public, private and very private. The categories were selected in a way that covered a variety of degrees of privacy. It is acknowledged that each individual may have a different idea of 'private' or 'public' space however, the relativity of the scale gives a clear indication of the distribution of preferences.

With the exception of semi-public the results of this survey are fairly well distributed between the different degrees of privacy. For example, 30% of participants preferred a semi-public space while very private was preferred by 19% of participants, very public 18%, private 17% and public 16%. This has repercussions for the project as a variety of architectural interventions are necessary to achieve a variety of private and public spaces. The survey results have a particular implication in open plan areas where Stewart-Pollack and Menconi state "privacy can sometimes become compromised if all members of the family universally claim the space" (2005, p. 68).

In the background section the typical residential design was described as having an open plan living with enclosed, private bathrooms and bedrooms (Pollak 2003) and Wigley (1992) which was "more or less universal" (Pollak, 2003, p. 22). While the survey results show varied preferences for visual privacy for each activity some trends are visible which reinforce Pollak and Wigley's claim. Those activities which could be expected in a public open plan living space such as entertaining a group of friends, eating dinner and cooking have a greater number of responses preferring public space. Similarly those activities which could be expected in private rooms such as sleeping, studying, reading and exercising have a greater number of responses preferring private space. While there are trends the thesis also aims to respond to variety visual privacy preference which is present in the survey results.

The Influence of Acoustic Privacy on the Experience of Space

Soundproofing in the home is important. It affects what you do and where you do it, as you make a conscious effort to keep an ear out for others, or avoid hearing others. While acoustics are usually included in residential design guides, there is an apparent absence of research which outlines the social impact on the lack of acoustic privacy in the home. This is in contrast with the research which investigates the social impact on the lack of acoustic privacy in open plan workplaces. For many researchers acoustics is an essential factor for workplace satisfaction and productivity (Newsham, Veitch, & Charles, 2008, Shepley, Zimmerman, Boggess, & Lee, 2009 and Frontczak, Schiavon, Goins, Arens, Zhang, & Wargocki, 2011) furthermore the lack of acoustic privacy can cause stress (Haynes & Price, 2004).

Reverberations and Reflections

Reverberations and reflections affect the acoustic quality of different sounds in a space. Acoustic tiles are often used to control reverberations and reflections, however Brooks states that "the term 'acoustical' for materials that absorb sound is misleading because all materials have acoustic properties. All materials both absorb and reflect sound to varying degrees" (2003, p. 90). Brook's statement has resonance in this thesis as most rooms in a home, with the exception of the bathroom, have soft furnishings which can control the reverberations and reflections. In addition it is easy for the inhabitant to change the reverberation time by adding or removing couches, carpets or other sound absorbing materials. It is for these reasons that reverberations and reflections will not be considered in this thesis.

Using a table which outlines typical decibel levels of common noises (refer to appendix), each category from the survey is allocated an appropriate STC value.

Degree of soundproofing	Allocated STC value
Don't mind noise from others	no sound proofing
Slight reduction in noise from others	33
Some noise acceptable	40
Accept a little noise from others	50
Quiet	60 +

Table 3: Allocated STC value for each category of soundproofing

Quantifying Acoustic Privacy

Acoustic privacy has been divided into five degrees of soundproofing. This categorization is used throughout the thesis. Different wall construction and detailing determines the soundproofing ability. The effectiveness of a material or composite material wall to provide soundproofing is gauged by the STC number (Sound Transmission Class), the higher the number the better the sound barrier (Levy, 2010). STC is measured in decibels (dB) which is the same measurement used to gauge the intensity of loudness from a source. There are several important things which need to be considered when you are trying to achieve each STC value. The first is that the wall construction must be installed according to the manufacturer's requirement. This often includes requirements for; framing, fixings for the lining, and inclusion of acoustic sealant. To actually achieve each STC value there often needs to be a lot of planning and careful consideration of the construction and installation of the wall. Fortunately, this is well documented. Levy (2010) or Brooks (2003) offer extensive technical information.

Levy warns that even with a high STC rating, any penetration, air-gap, or 'flanking' path can seriously degrade the isolation quality of a wall (2010, p. 321). Flanking paths are the means for sound to transfer from one space to another, other than through the wall. Sound can flank over, under, or around a wall. Sound can also travel through common deskwork, plumbing, or corridors (Levy, 2010, p. 321). When considering flanking, the STC value of windows and doors are important. However, the STC values vary greatly due the different approaches in the type of glass, distance between glazing and installation. Therefore the STC value of glass blocks, doors and windows will be specified on a case by case basis to meet acoustic privacy requirement of each space.

Acoustic Privacy Interventions

The construction of a wall for soundproofing is the most common solution. However other soundproofing methods were considered. These included acoustic curtains, water and glass blocks. Acoustic curtains were ruled out due to the lack of scientific information versus the abundance of advertisement. The soundproofing of water was also considered but ruled out for being impracticable as the acoustic privacy is only achieved while under water.

The construction for the 'don't mind noise from others' category does not have a construction detail as this implies a total lack of soundproofing. The construction of the STC 33 wall which 'slightly reduces noise from others' is an example of how internal walls in New Zealand are typically constructed. The wall construction for each category has been selected from the 2006 Gib Noise Control Systems brochure. While the brochure is not the only document which demonstrates different soundproofing techniques, it reflects the most common construction techniques and products for residential buildings in New Zealand at present.

Figure 13: Water as a soundproofing substance. Image by author.

Figure 14: Glass blocks can provide a range of soundproofing. Image by author

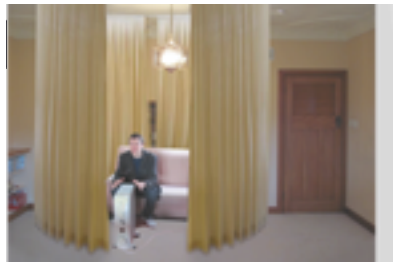
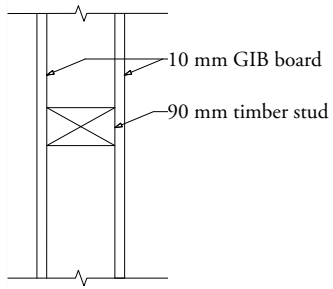
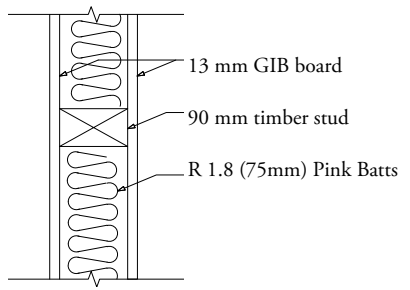


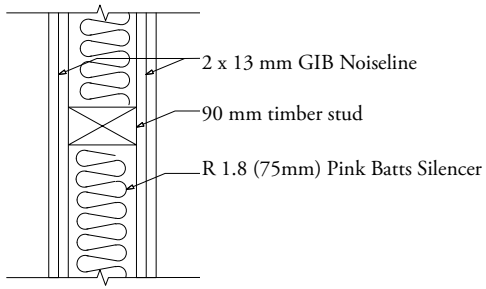
Figure 15: Acoustic curtain provides limited soundproofing. Image by author



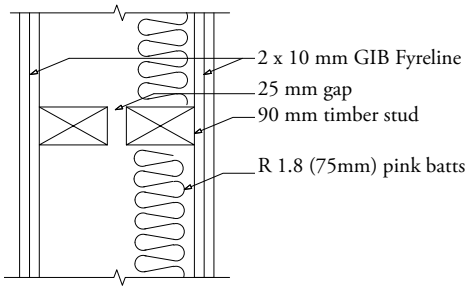
STC 33



STC 40



STC 50



STC 60

Figure 16: Wall construction for different degrees of acoustic privacy.

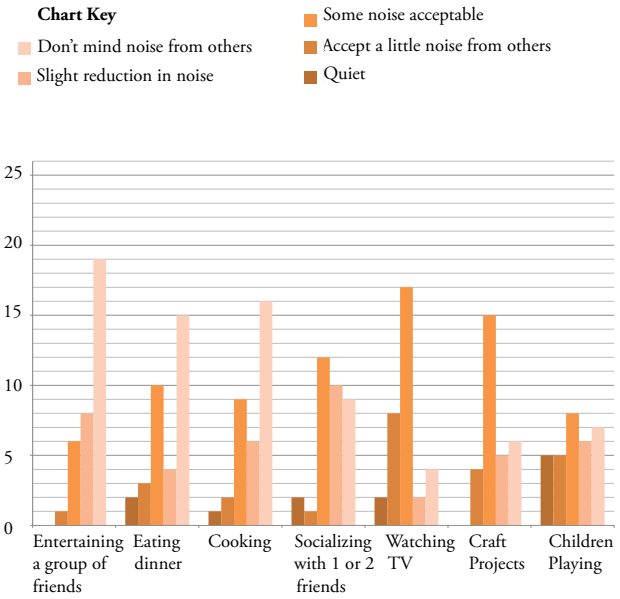


Figure 17: Survey results of preferences of acoustic privacy for household activities.

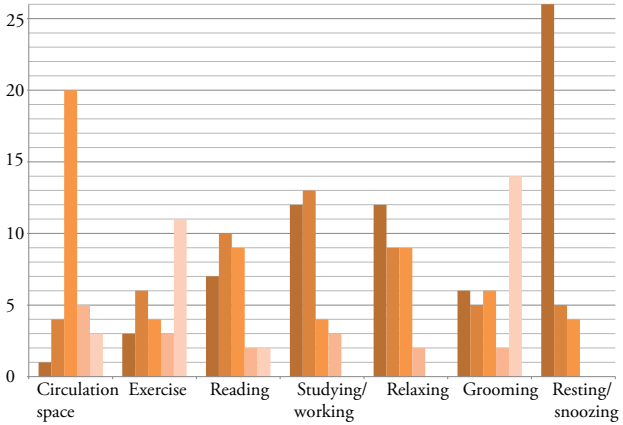


Figure 18: Survey results of preferences of acoustic privacy for household activities.

Acoustic Privacy

Thirty-four New Zealand participants of the survey were asked to indicate their preferred acoustic privacy on a Likert scale for fourteen different activities in the home. The design of the scale is relative and easy to relate to, although it is acknowledged that each individual may have a different idea of what a 'noisy' space is. However, the relativity of the scale gives a clear indication of the distribution of preferences. The survey shows a need for a variety in soundproofing, where different levels of noise can be heard in different spaces.

The 'some noise acceptable' is the most popular acoustic privacy category for all activities with 29.5%, followed by 'don't mind any noise from others' with 23.5%. The category for 'quiet' and 'accept a little noise from others' is preferred by 17.5% and 17% respectively. A 'slight reduction in noise from others' is the least popular with 13%. This has repercussions for the project as a variety of architectural interventions would be required to address the social function. The frequency of each acoustic quality from the survey will be reflected in the design.

The survey has found that individuals prefer a different degree of acoustic privacy to one another for the same activity. Unsurprisingly the most popular acoustic privacy for 'resting/snoozing' is 'quiet', although some tolerance for noise from others was also present. The greatest tolerance of noise from others came from individuals entertaining a group of friends, followed by cooking, eating dinner and grooming. While the most popular acoustic privacy can be identified for almost every activity, this thesis strives to avoid designing for the status quo only. The use of space should be understood through its qualities. Instead of providing a quiet space for 'resting/snoozing', a 'quiet' space should be provided in a way which can be deciphered by the individual and used according to their preference.

Influence of natural light on the experience of space

Natural light is an important factor on an individuals experience of a space. Natural daylight is seen to be therapeutic, provide a view out and show natural light and shadow on objects in continually changing conditions of light quality and colour (Phillips, 2004). In addition to providing suitable light for use, the purpose of daylight design is "to create the desired 'mood' and provide visual focus, to integrate daylighting with the architecture" (Szokolay, 2004, p. 113).

The results of the survey revealed a desire for a variety of natural light qualities in the home. A range of techniques to manipulate daylight is explored in this thesis but excludes the influence of artificial light and internal shading devices such as blinds as occupants can easily install and remove them. Factors which influence the qualities of natural light which are part of the built environment and are difficult for occupants to change are the focus in this section.

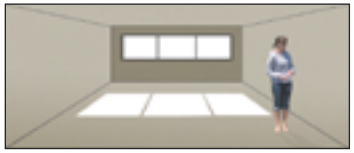
High-tech glazing systems were considered such as "electrochromic and liquid crystal glazings, which can be made to darken on application of an electric current. Photochromic glass, which darkens when sunlight falls on it. Thermochromic glass which alters its transmission value on the introduction of heat" (Philips, 2004, p. 32). High-tech glazing was concluded to be beyond the scope of this thesis due to the highly technological nature and present high cost. A low tech approach of selecting tinted or patterned glass to manipulate natural light was considered. The amount of light can easily be manipulated by varying the intensity of the tint or patten applied to the glass. One drawback of using glass is brought up by Szokolay, "the problem is that they affect diffused light as much as beam light and as their properties are fixed, they have no selectivity in time: perform the same way in winter as in summer, they would reduce daylighting even when it is scarce" (2004, p. 124).

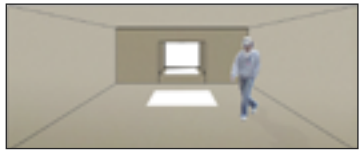
Natural Light Interventions

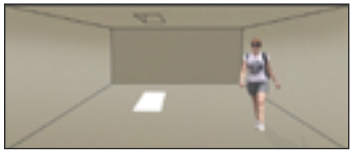
The quality of light is most commonly manipulated through the orientation and size of openings which can affect the amount of sunlight or daylight. While this seems straightforward, an issue with conventional buildings has been brought up by Phillips who states "economies of structure had meant that ceiling heights had been lowered, reducing the penetration of daylight into buildings" (2004, p. 5). Therefore the interior ceiling height will also to be considered in this thesis. The orientation of windows affects the intensity and longevity of the sunlight or daylight. However, the quality of light is not consistent due to the changing weather, time of year and time of day. Without sufficient thought and planning the quality of the natural light may not be suitable for the task at hand. That is why it is important to investigate how to "control, channel, and filter natural light as it enters a space" (Grimley & Love, 2007, p. 214).

The design tactics are used in the design process in order to reflect the desires of individuals as demonstrated in the survey. Preferences towards natural light are addressed if individuals are able to position themselves in the desired natural light for their chosen activity. In this way, adaptability is provided through a choice of spatial qualities.

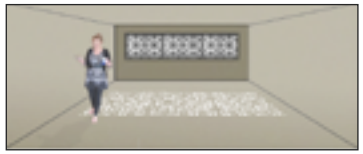
Sunlight and bright direct daylight are considered together. Openings must have a north, east or west orientation with nothing to restrict light entry. For sunlight, north orientation is preferable. For bright direct light east and west orientation is sufficient.


Control window


Sunny window seat


Skylight

Dappled daylight Interventions dappled the entry of light.


Light dappled by decorative lattice work


Light dappled by foliage

Indirect light
Interventions allow indirect light only. South facing windows also allow indirect light.


Window externally shaded by louvre, brise soleil or shutter


Window externally shaded by an awning, overhang or canopy


Light enters indirectly through a hidden skylight or side light

Dark Interventions restrict the access of natural light into the space.


Window allows limited light through small opening


Window allows limited light through dark tinted window facing south

Figure 19: Interventions which allow sunlight, bright direct light, dappled light, indirect daylight and dark natural light. The design tactics should be considered in conjunction with manipulating the size and orientation of openings.

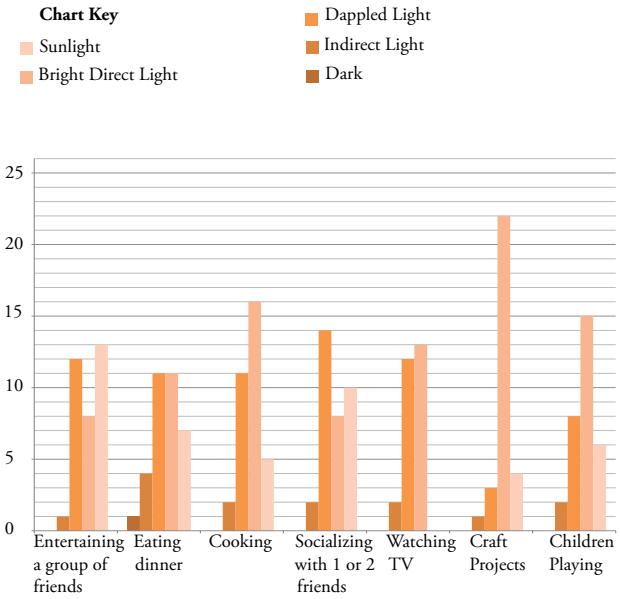


Figure 20: Survey results of preferences of natural light for household activities.

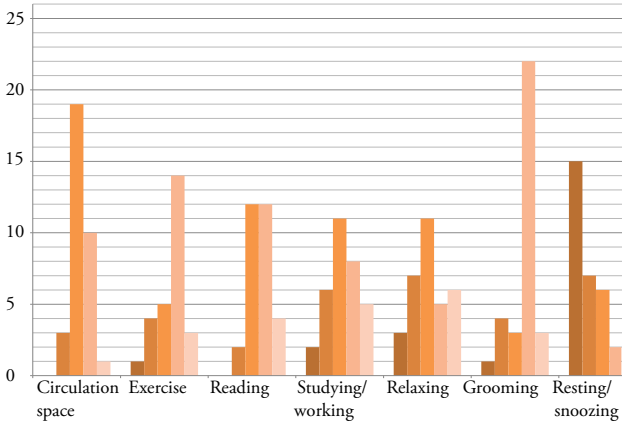


Figure 21: Survey results of preferences of natural light for household activities.

Natural Light

Thirty-four New Zealand participants of the survey were asked to indicate their preferred quality of natural light on a Likert scale for 14 different activities in the home. The survey broke natural light into five distinct categories; sunlight, bright direct daylight, dappled light, indirect daylight and dark. It is acknowledged that each individual may have a different idea of 'indirect light' or 'dappled daylight' however, the relativity of the Likert scale gives a clear indication of the distribution of preferences.

The most popular natural light quality for use is bright direct light with 35% closely followed by dappled daylight with 31%. Indirect light was the second least popular overall with 12.5% followed by 16% of respondents indicating a preference for sunlight. This has repercussions for the thesis as a variety of architectural interventions are necessary to achieve the variety of light qualities. Furthermore, assumptions shouldn't be made as Grimley & Love suggest that rooms with windows facing south are ideal home offices due to the indirect light (2007). The survey however, shows that for 'studying/working' 'indirect light' is preferred by six participants, 'dark' is preferred by two participants, eleven preferred 'dappled light', eight 'bright direct light', and five 'sunlight'.

Dark is the least popular with 5.5% of the respondents indicating a preference for 'dark'. Having 'dark' as a daylight quality may seem irrelevant to some however, Tanizaki demonstrates the relevance of including 'dark' through his description of Japanese housing. He states that "a light room would, no doubt, have been more convenient for use, too, than a dark room. The quality that we call beauty, however, must always grow from the realities of life, and our ancestors, forced to live in dark rooms, presently came to discover beauty in shadow, ultimately to guide shadows towards beauty's ends" (2006, p. 335). The majority of participants indicated a preference for 'dark' for resting and snoozing with a few preferences for exercise, relaxing, grooming, studying/working and watching television. This shows that although the appreciation for dark spaces is not common in New Zealand, it is still present and therefore should be accounted for.

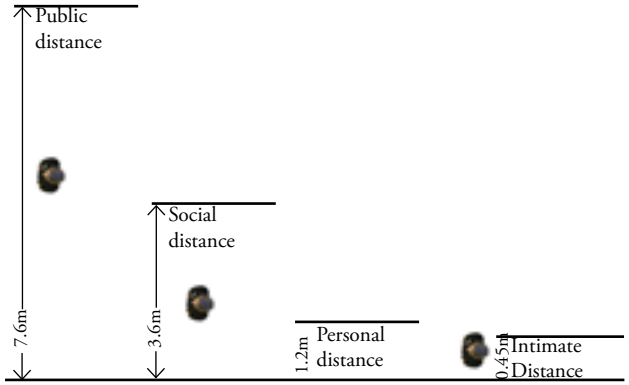


Figure 22: Diagram by author illustrating Edward T Hall's theory of proxemics. The intimate distance is used for activities from wrestling to love-making (0.45m), personal distance for inter familial interactions (1.2m), social distance for friends and business associates (3.6m) and the public distance for informal groups (7.6m) (Watson, 1970).

Influence of sense of enclosure on the social function

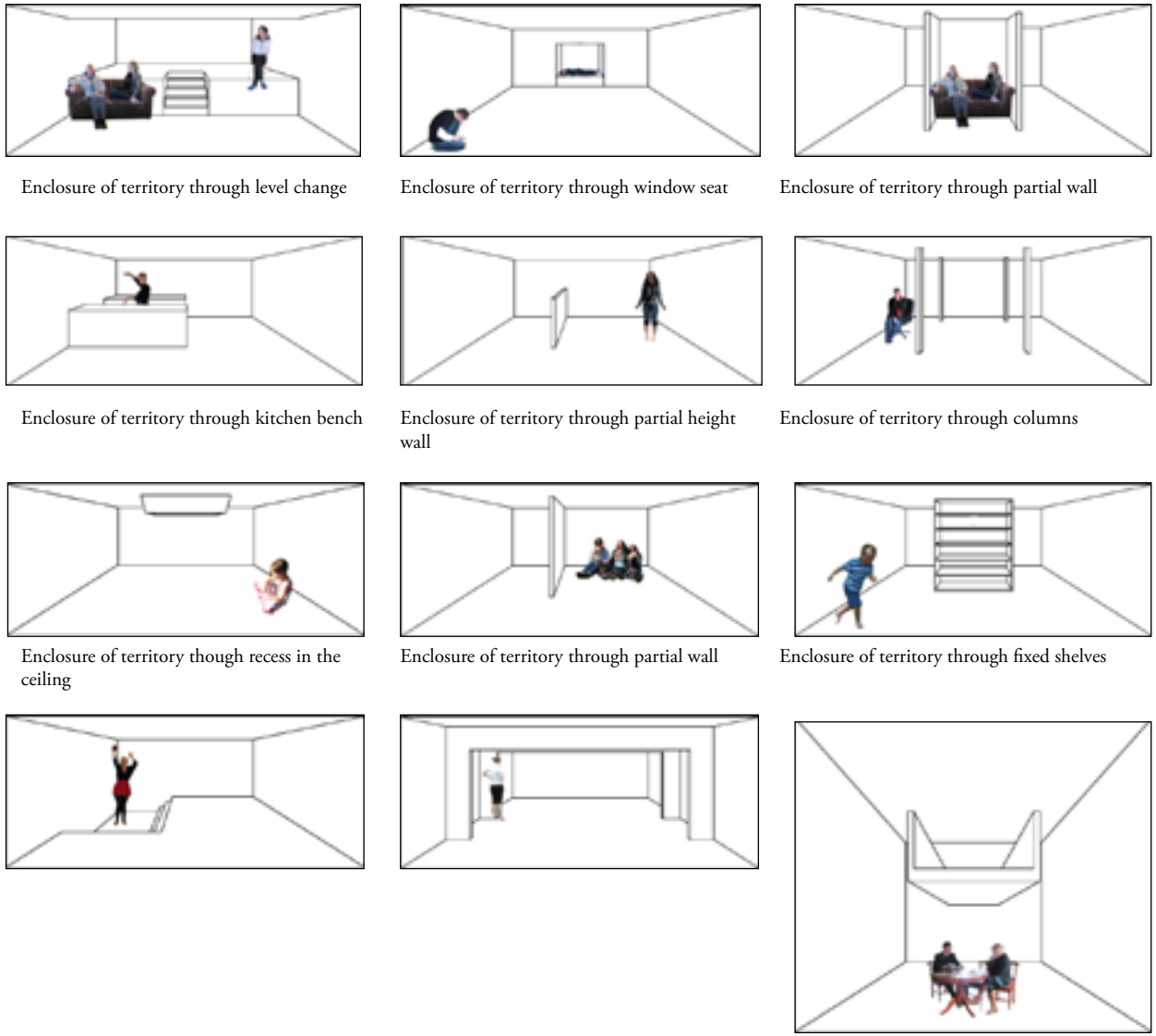
Friedman states that a room's dimensions and proportions are the most important aspects in creating a multi-purpose space (2002) and recommends that a room should be square and that "the larger the space is, the wider the options for adaptability will be" (2002, p. 130). Friedman's comments reinforce Hertzberger's statement that "most architects when they are not restricted by rules and regulation tend to make spaces too large rather than too small" (1991, p. 191). While Hertzberger acknowledges that a larger space can accommodate the greatest number of physical uses he further states that socially a large space can be quite socially restricting (Hertzberger, 1991) as space should be designed so that it is "small enough to be put to use and big enough to offer maximum potential for use" (1991, p. 194). On the other hand there is also an argument for smaller spaces as Borgmann (2010) and Melling (1980) state that the lack of enclosure is the point of failure in contemporary residential design. In Melling's book documenting the work of New Zealand architect Ian Athfield he states "we'd build multi-purpose 'living' rooms where all the diverse activities of domestic life are supposed to happily co-habit without conflict, when they could so easily be separated into smaller, specific space - a nook for reading in, an enclave for music, a cosy introverted space with a fireplace for wild stormy nights" (1980, p. 29).

The survey results show a preference for a variety of sized spaces and resultant sense of enclosure. The study of proxemics which considers the unmarked social distances which people require between one another for different activities is an interesting starting point. The distances however, are based on general activities in the study of Americans. It is important to consider that each culture has different distances at which they feel comfortable with each other (Watson, 1970) and that the proxemic distances are used as a guide only. Alexander proposes that it is likely that the appropriate social distances for individuals also has a vertical component (1977). Furthermore, Alexander states "the absolute ceiling height does not matter as much as one would expect {…} we have been led, finally, to the conclusion that it is the variation itself which matters, not merely the absolute height in any given room" (1977, p.879). Alexander's theory that the relative variation is just important as the room size is applied in the design in response to sense of enclosure.

Sense of Enclosure Interventions

The different approaches could be described as relating to Allsopp's division of enclosure which he categorises into two types; enclosure of space and enclosure of territory. He describes enclosure of space in relation to walls and roof but enclosure of territory as a space which is separated visually by a fence or parapet (Allsopp, 1977). Interventions which create an enclosure of territory are drawn into a control room. The actual sense of enclosure experienced depends on the application of the intervention in design. The common factor in the interventions which manipulate the sense of enclosure through enclosure of territory is that they have no soundproofing ability. Free standing furniture can change the sense of enclosure in a room, however for this thesis only permanent fixtures are considered.

Materials, textures and colours can also change the sense of enclosure in a space. For example Stewart-Pollack and Menconi state that "unadorned ceiling in a light colour such as in an entry hall, it will feel taller {…} If the ceiling treatment is dark, textured {…} it will appear lower and heavier" (Stewart-Pollack & Menconi, 2005, p. 75). However, colour and texture are not considered part of this thesis as occupants can change these factors relatively easily.



Enclosure of territory through level change

Enclosure of territory through window seat

Enclosure of territory through partial wall

Enclosure of territory through kitchen bench

Enclosure of territory through partial height wall

Enclosure of territory through columns

Enclosure of territory though recess in the ceiling

Enclosure of territory through partial wall

Enclosure of territory through fixed shelves

Enclosure of territory though sunken pit

Enclosure of territory through wing walls

Enclosure of territory through mezzanine

Figure 23: Interventions which alter the sense of enclosure through enclosure of territory. Drawn by author.

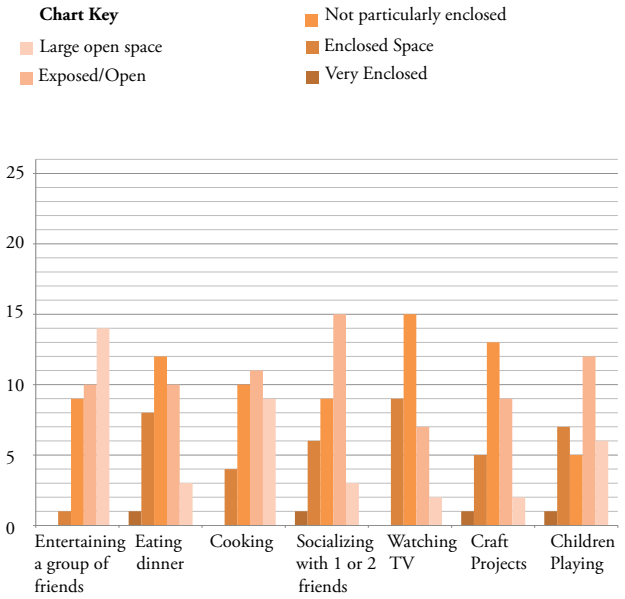


Figure 24: Survey results of preferences of sense of enclosure for household activities.

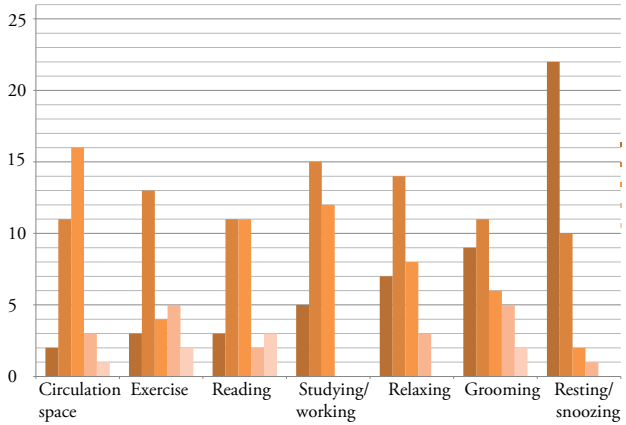


Figure 25: Survey results of preferences of sense of enclosure for household activities.

Survey results for Sense of Enclosure

Thirty-four New Zealand participants were asked to indicate their preferred degree of intimacy or openness on a five point Likert scale for 14 different activities in the home. It is acknowledged that through personal experiences and situational factors each individual may have a different perception of sense of enclosure. For example those who live in high density city apartments may perceive the sense of enclosure differently to those who live in a large sprawling suburban house. Furthermore, openness and enclosure are viewed both positively and negatively by different individuals. Enclosed space has been variously described as protective and threatening (Kingwell, 2006), secure and safe (Nylander, 2002). On the other hand open space can create a feeling of freedom, expansion and opportunity (Nylander, 2002). These considerations will have had an impact on the survey participants as they come from a varied demographic and will have a variety of preferred sense of enclosure.

The results show a need to consider both enclosed and open spaces in the home. The survey showed 'not particularly enclosed or exposed' was the most popular sense of enclosure with 29% closely followed by 'enclosed space' with 27.5% then, 'exposed/open' space receiving 20.5% preference from participants. The least popular was 'very enclosed' and 'large exposed/open' with 12% and 10.5% respectively. Although a range of sense of enclosure was preferred, the majority of preferences lie within the medium range. The sense of enclosure preference reflects what often occurs in homes at present where there is usually only one large space for living areas, one or two very small spaces for storage, bathroom and perhaps a small office with the remainder of spaces being of average size and accommodating bedrooms. While the results show preferences for some spatial qualities over others, it is important to consider even the qualities of less popularity as they might be less common but still an integral part of the spaces which are present in a home.

Conclusion

The aim of this chapter was to explore the meaning of adaptability for this thesis. Grouping definitions helped to navigate the existing meanings of adaptability. *Adaptable design responds to demographics, economy, lifestyle and technology* and *Adaptable design allows the physical building fabric to be easily altered without the need of a builder: Moving building elements* were acknowledged but not used to inform this studies understanding on what adaptability means. The former theme highlighting the need for adaptable design and the latter providing one possible tactic for adaptable design.

Adaptable design allows alterations and removals to be done easily in the future was identified as one aspect of adaptability for this thesis. A clause, *and removals,* was added to takes into consideration the fluctuating number of inhabitants which can occur in households.

Adaptable design allows a change of use without making physical changes was questioned for being too vague and prioritising utility use over social use. The lack of consideration for social use was identified as a gap in the literature on adaptability. The influences on social use which the architect could control were identified as visual privacy, acoustic privacy, natural light and sense of enclosure. Each factor was investigated for how it could affect inhabitants and how it could be manipulated through design. The survey explored the individual's preferences between use of space and the quality of space in regards to the four identified factors. The survey revealed some trends in the preferences in spatial qualities of spaces but overall there was a huge variety of preferences. Considering the survey results it became clear why the indeterminate approach was preferred, where people have diverse tastes it seems easy to provide a neutral space devoid of character to placate all users rather than something with character that not everyone will like. Trying to provide specific social function could be considered taking a risk by creating a space with specific and definite qualities rather than neutral and non-offensive indeterminate space. As a result of the survey and further research the second adaptable outcome was altered to *Adaptable design allows a change of use through considering social and utility function*.

The conclusions from the survey are significant because it shows that social function is likely to be achieved by providing a variety of spatial qualities. Furthermore, it shows that it is extremely unlikely that a indeterminate approach could provide an adequate social function as the indeterminate approach is more likely to produce neutral spaces devoid of character.

While several design tactics have been proposed in this chapter it must be acknowledged that the actual influence of the architect on the physical features is dependent on each project and can vary greatly. Architectural elements could be dictated by other influences, as the form and architectural style may be defined by a district plan, floor area decided by strict client budget and layout of the floor plan by client preference. In every build, the architect has a different degree of influence. Rapoport demonstrates a fairly comprehensive list of factors which can influence the design of a home; "current constraints are those imposed by density and population numbers, and the institutionalisation of controls through codes, regulations, zoning, requirements of banks and other mortgage authorities, insurance companies, and planning bodies" (1969, p. 49). The influence of external factors is acknowledged here, although the maximum possible influence of the architect's design is focused on for the purpose of this thesis.

On conclusion the working definition of adaptability for this thesis is:

Adaptable design allows alterations and removals to be done easily in the future and allows a change of use through considering social and utility function.

*Social use takes into consideration the experience of space through natural light, sense of enclosure, acoustic and visual privacy. Utility function considers the ability to physically use space in different ways.

3.0 Literature and Precedent Review

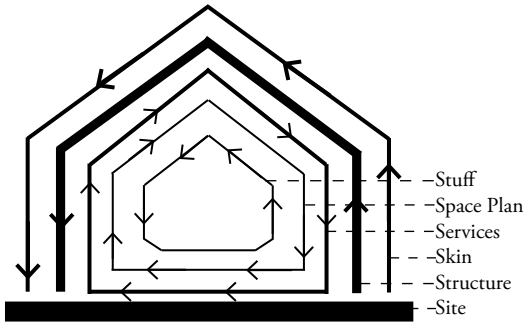


Figure 26: Layers of Change diagram by (Brand , 1994, p. 13) redrawn by author.

Literature and Precedent Review Introduction

This chapter identifies and explores key design tactics in relation to the definition developed in this thesis for adaptable design. This exploration will be used to inform the design section which aims to explore adaptable residential housing.

The medium by which each idea is present is varied as it was found that some ideas were better demonstrated through text, precedents, definitions or combinations thereof. The literature and precedent review explores one idea or design tactic at a time, however, the categories are inevitably interrelated. In each category the effect the idea or design tactic may have on other categories is acknowledged. This consideration is a reflection of Brand's writing on the layers of change who states

> *The lethargic slow parts are in charge, not the dazzling rapid ones. Site dominates the Structure, which dominates the Skin, which dominates the Services, which dominate the Space plan, which dominates the Stuff. How a room is heated depends on how it relates to the heating and cooling Services, which depend on the energy efficiency of the Skin, which depends on the constraints of the Structure (Brand, 1994, p. 17)*

Limitations of the Literature and Precedent Review

Each section describes an adaptable design tactic with precedent examples where possible to give an understanding of each concept. More detailed information should be accessed from its original source. While this may be seen as a limitation of the study the nature of adaptability as a broad concept calls for this type of approach.

Though the content is broad the number of authors in this literature review is comparatively limited. The selection of literature covers the dominant theories of adaptability and don't need to be repeated by referencing multiple publications. Published books were selected as the predominant research medium as books went into enough detail but enabled a one stop shop for a wide range of ideas. The newer publications referenced are Schneider & Till's 2007 book *Flexible Housing*, Avi Friedman's 2002 book *The Adaptable House* and Friedman's 2001 book *The Grow Home.* Schnieder & Till's book *Flexible Housing* was included in the investigation of adaptability as Schneider & Till claim that "the term flexible housing is used to cover issues of both adaptability and flexibility" (2007, p. 5). It is interesting to note that the older publications are referenced in the more recent literature, in particular Brand's 1994 publication *How Buildings Learn: What Happens After They're Built,* Hertzberger's 1991 publication *Lessons for Students in Architecture* and Christopher Alexander's 1977 publication *A Pattern Language.* While Brand's, Hertzberger's and Alexander's publications are not solely focused on adaptable architecture, they provide ample references to adaptable architecture as best practice advice.

Open Plan

Nylander states that, "open and closed space has been valued differently over the course of history" (2002, p. 33). For example the typical bourgeois house of the fourteenth century was a large public hall in which people both worked and lived (Madanipour, 2003). By the seventeenth century "space was subdivided into a larger number of rooms, even though most activities continued to take place in a larger room" (Madanipour, 2003, p. 81). Towards the nineteenth century rooms were given more strict social and physical roles with the inclusion of the corridors, staircases, multiple bedrooms, drawing room, study, parlour and so on (Madanipour, 2003, p. 88).

The twentieth century saw a move to openness again as "enclosed living rooms, principally the parlour, were perceived to be under-used and therefore superfluous to the modern home" (Dowling, 2008, p. 537). In response, the living areas were combined into one open plan space. "Open plan is one of the most fundamental changes in the British domestic interior since World War II. By its radical reversal focus from 'closed' to 'open', it embodied modernization in the form of the house plan, thus incorporating, if only in theory, the notions of adaptability, mobility and change" (Attfield, 1999, p. 73).

Even though "open-planned domestic interiors were largely an invention of mid-20th century modernism" (Dowling, 2008), openness is still valued over enclosed space today. This can be seen with the popularity of open plan in suburban nations like Australia, Canada, and the United States (Dowling, 2008). Open plan's prolific nature could be explained by Dowling who states that "working alongside the efforts of housing agencies and builders were magazines, newspapers, governments, and urban planning policies which coalesced around the importance of open plan in the new suburbs of Australian cities" (2008, p. 537). One could also argue that the open plan interiors are popular because of cost savings over enclosed designs which have more walls. However, Kent outlines an argument where "cultural conventions influence architectural form and use of space more than economic and other factors" (1990, p. 4).

In response to changes in the home, neutral open plan spaces are widely accepted as the best solution for adaptable space. For example Dowling states "open plan is accepted as the natural domestic support for family living" (2008, p. 536). Open plan is often referred to in the literature on adaptability supporting the indeterminate approach to adaptability. Madanipour states the benefits of large, open plans spaces are great in a small house "for a more flexible use of the smaller spaces" (2003, p. 94). Friedman states "open floor plan that allowed the occupants to define the space according to their specific requirements" (Friedman, 2002, p. 26).

There is little formal research on the impact of open plan in the home. The research which is available is usually based on specific cultural groups such as Hadjiyanni's (2009) who recommends separate kitchen and living room in the study on culturally sensitive design for Hmong and Somali refugees.

From the literature review on open plan it can be concluded that open plan is very popular but it appears to be taken for granted. Friedman's advice "the larger the space is, the wider the options for adaptability will be" (2002, p. 130) is correct for utility function as inhabitants can place more furniture in more arrangements in a larger space. However, open plan is questioned regarding whether it can provide sufficient social function. This is illustrated by Hertzberger who states;

> *A space big enough for playing ping pong is not necessarily suitable for a small group of people sitting round a table holding a conversation, for instance. What dimensions to give a space is always a question of sensing the required distance and proximity between people, depending on the situation and the purpose of the space (Hertzberger, 1991, p. 190).*

Although there were some trends towards specific interior qualities for some activities, overall the survey found that people preferred a variety of spatial qualities for different activities. The indeterminate approach to open plan from the literature on adaptable design currently proposes one big space with the same interior quality throughout with no hierarchy and no variety. Open plan space provides a large space with no acoustic privacy and no visual privacy which can cause problems socially within an open plan space. For example, Stewart-Pollack and Menconi state that in large open areas "privacy can sometimes become compromised if all members of the family universally claim the space" (2005, p. 68).

Add-in

Friedman states that add-in "involves the provision of unfinished spaces within the original dwelling which can be finished at a later date as the needs and means arise" (2001, p. 19). Schneider & Till (2007) refer to this technique as creating 'Raw space' though Friedman's (2001) term of add-in is used in this thesis. There are several advantages of considering the add-in approach. Friedman explains "the expanding do-it-yourself industry provides the opportunity for additional savings by allowing homeowners to pay only for finishes within the areas they currently use, and then to pay only the cost of materials for the expansion area by reducing or eliminating private labour expenses" (Friedman, p.19, 2001). The add-in technique is particularly useful in apartment and terrace house examples where small building plots mean the maximum sized dwelling is usually erected ruling out the possibility of adding on upward or outward.

There are several design tactics for implementing the add-in unfinished space approach. Tactics identified from the literature are listed and possible design implications of each are discussed. The effect on the inhabitants needs to be considered when implementing each design tactic. This is illustrated by Friedman who states "the successful implementation of the add-in strategy is directly related to the liveable quality of the space into which the homeowner will eventually move. Unfinished attics or basements can be a challenge in terms of light and ventilation. The unfinished space must also be redundant to the immediate needs of the household so that it does not interfere with overall occupancy while the spaces remains unfinished" (Friedman, p.19, 2001)

Figure 27: Unfinished attic space designed to be completed at a later date. The shell of the future room is made with attic trusses. The windows, while redundant in the present will provide natural light and ventilation. Photo by author.

Figure 28: Redundant services in concrete floor can be added during construction for future use. Photo by author.

Figure 29: A hole can be cut in the flooring between joists for new services at any location. The ability to crawl under a house makes it easy to add or alter services to houses with a timber subfloor. Photo by author.

Provisions for future plumbing

Provisions for future plumbing with concrete subfloors can be made by providing temporary redundant pipe(s) placed in the concrete. This would require careful consideration of locations of future services and consideration of how the pipe for future plumbing would be sealed temporarily. Considering future service locations is important as pipes are difficult to retrofit with a concrete subfloor. Plumbing can be easily added at a later date to single storey houses on a timber sub floor as pipes can be added between floor joists. In a multi-storey house provisions should be made for transferring pipes to ground through lower floors.

Omitting shelving or storage

Shelving is something which inhabitants could organise themselves or a contractor to construct either as built in or free standing at anytime. "A distinct advantage to leaving the exact location of the clothes closets to the homeowner is that storage elements are placed only where required, making space use more efficient. Finally, the deduction of the cost of finished cabinetry from the construction costs of the home- and from the cost of the mortgage- can yield a substantial cash benefit" (Friedman, p.25, 2001). It is still important to design and consider several places where storage could conveniently be installed as this affects the layout of windows, doors, dimensions of rooms and so on.

Providing the minimum of non-loadbearing internal walls

Leaving a large space which can be divided by the inhabitants at a later date is a good way to get the inhabitants involved in the process of adaptability. If they were the ones who put the walls up in the first place, they would hopefully also have the confidence to demolish and rebuild the non-loadbearing walls in the future. For a non-architecturally involved person it may otherwise be difficult to know what is possible with adding and removing walls and how easy it is to achieve.

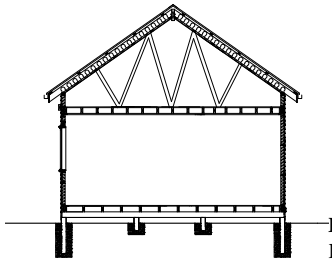


Figure 30: Truss are unhabitable. Drawn by the author.

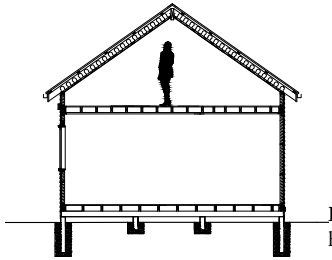


Figure 31: Skillion roof space is habitable. Drawn by the author.

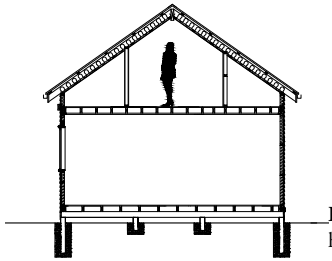


Figure 32: Attic truss roof space is habitable. Drawn by the author.

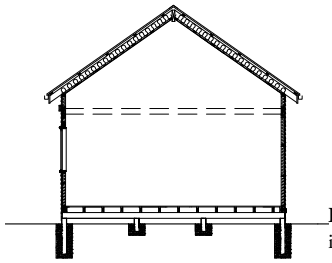


Figure 33: A floor can be added into in the future. Drawn by the author.

Leaving walls unlined

The limitation of leaving walls unlined is that you would have to at least line the external walls with the insulation in. Internal walls can be left unlined though there may be implications for exposed wiring especially when children may inhabit the space.

Unfinished roof space

Schneider & Till (2007) recommend that if the roof space is not inhabited in the present, openings for staircases or skylights should be pre-framed to make the space habitable in the future. Schneider & Till (2007) further suggest implementing a skillion roof or attic truss over a trussed rafter. The access to the roof space should be pre-designed to ensure enough head height up the stairs and in the roof space. The location of future stairs should be designed in the first stage as if it would be built and then omitted from the plans used to build the dwelling.

Add-in second floor in double height space

If there is sufficient stud height it is possible to add a second floor or mezzanine at a later date. Pre-designing will assist in the ease of future construction and access to an additional floor.

Careful consideration of location of windows for present and future use

For the rooms to be reconfigured successfully the detailing of the windows needs to be considered. Schneider & Till state, "for rooms to be divisible, the number and location of windows is crucial {…} a single wide window in a wide room prevents future division, whereas two narrower ones will make it possible" (2007, p. 191). A minimum distance between two windows is necessary for a convenient construction of a new wall. The external aesthetic and window composition should also be considered.

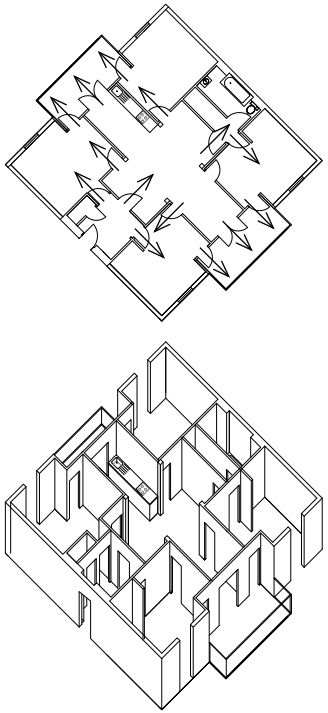


Figure 34: *Wohnhaus* by Anton Schweighofer, 1982, (Study). Drawn by author.

Two entries to a room

Multiple entries into a room are prevalent in Anton Schweighofer's study *Wohnhaus.* The frequency of doors has limited the potential uses in *Wohnhaus* as the wall space for placing furniture against is reduced. The placement of the doors is just as much an issue as the number of doors as Schneider & Till state "an additional door per room can decrease the actual space for activities within it. The position of the door is therefore crucial" (2007, p. 190). While the enclosed rooms are not too detrimentally affected, the central cross area is not convenient for a lot of uses. The frequency of doors, narrow width and necessity to leave areas clear for circulation restrict potential uses of the central area dramatically. The multiple door approach while restricting throughout the plan has some merit in the rooms either side of the entry hall. The choice between the private access from the entrance and the public access from the central cross area allows inhabitants to make a public or private entrance into the apartment depending on their preference. This could be particularly useful for a home office, independent teenagers or in a flat situation with friends or strangers where a separate and private entry to the front two rooms allows the rest of the apartment to be undisturbed.

Wide Corridor

The *Wohnhaus* blurs the definition between wide corridor and room. By seeing corridors as places of possible occupation rather than just as circulation can greater variety in the use of space can be considered.

> *"In most housing circulation space and hallway is reduced to an absolute minimum in the name of efficiency, so that often one is left with corridors that can be used for nothing but moving around. In badly designed housing this can add up to a lot of space that is largely redundant in terms of social occupation. However, by marginally increasing the dimensions of the circulation space, it can accommodate other functions, increasing the ways that the overall unit might be used" (Schneider & Till, 2007, p.187).*

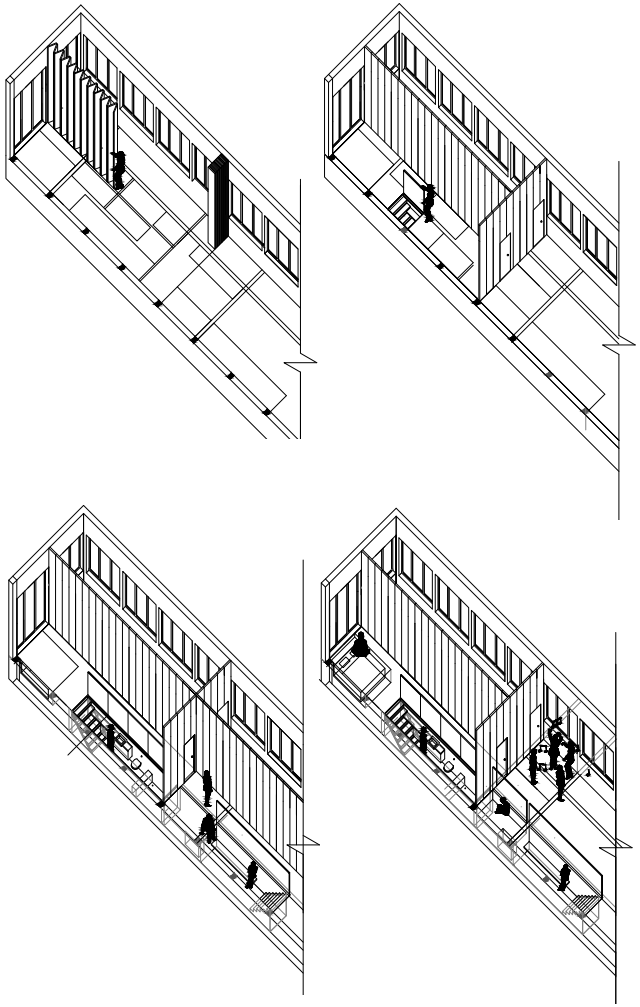


Figure 35: *The Suitcase House* by EDGE (Hong Kong), 2001 (Beijing, China). The moving partitions are folded back to allow a large open space. The position of the moving partitions is predetermined through the rails on which the partitions hang. The privacy afforded by different layouts of the movable partitions allows for a number of uses. Services and storage are below the floor accessed by movable floor hatches. Partitioning space and accessing service areas allows different uses. Drawn by author.

Movable Building Elements

It is fairly common to see movable building elements in the literature on adaptability . The most frequently identified movable elements in the literature were moving partitions, sliding doors, moving walls, and fold-down furniture.

While the precedents are numerous *The Suitcase House* by EDGE (Hong Kong), 2001 (Beijing, China) stands out as the first floor is completely created and recreated through moving building elements as one open space can be transformed into different room combinations including bathrooms, kitchens, bedrooms and living spaces. The movable building elements not only change the use of space but the physical qualities and experience of the space. *The Suitcase House* utilizes moving partition walls and floor hatches.

Within the literature there are arguments for and against moving building elements. In Croft's reference to J.G. Wattjes 1925 description of *Schröder House*, he states that "by rejecting the normal method of subdividing space- with fixed walls- and choosing a system of sliding partitions, an extremely flexible arrangement of the interior is achieved" (Croft, 2006, p. 77). Schneider & Till make a similar claim of extreme flexibility within a traditional Japanese house in which many of the walls are moveable (2007). However, both Croft and Schneider & Till acknowledge that this flexibility is only achieved when the house is used in a specific manner. In this way flexible designs through moving partitions can actually restrict user control. Croft questions whether "such extreme flexibility in fact proves convenient in the long run" (2006, p. 77).

> *The actual flexibility and adaptability of the house is thereby completely dependent upon the active participation of the users {…} by pulling out futons from a storage cupboard, a room that was used as a dining or sitting room can be transformed into a bedroom: the minimal approach to furnishings, and the relative lack of other clutter, demands a discipline to achieve flexibility that may be beyond normal living patterns (Schneider & Till 2007, p. 55).*

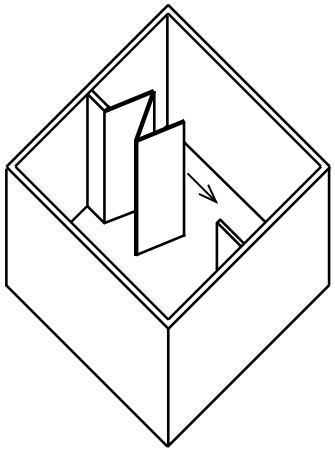


Figure 36: Movable partition

An important idea out of Schneider & Till's quote is that storage is important in an adaptable house. If a space is able to used for multiple activities, the equipment or furniture required for each activity must be able to be put away or put aside at the very least to make room for the equipment for the next activity. In a home the 'equipment' needed for different activities may not be great, and some furniture can be used for many activities, however, there still needs to be storage for the spare bed, board games, art equipment, laptops, computers, printers, DVD's and so on.

In *The Suitcase House* the movable walls are beneficial in response to the constantly changing social situation in the hotel. However, in the context of a residential home the social dynamics are more consistent and the number and location of moving building elements will need to be carefully considered so that they do not become redundant for the inhabitants. For example Alexander states "the modular partition system fails because the partitions become, in effect, ordinary walls; yet they are less useful than real walls for defining territory and for sound insulation" (1977, p. 691). While movable walls can be purchased with STC values which are comparable to permanent walls they might not be worth considering if the inhabitants are unlikely to utilize them to their full potential.

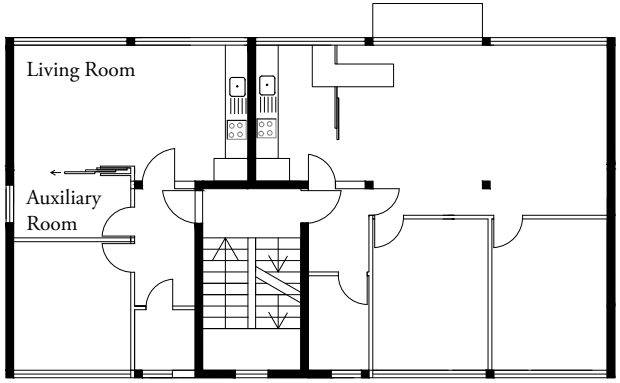


Figure 37: *Wohnzeile* uses careful placement of movable building elements in the home.

Application of movable building elements could be useful between a living area and an auxiliary area. Movable building elements could combine and divide an auxiliary with the living area with ease. The auxiliary area could be transformed into a living space, bedroom, study etcetera, by manipulating the space as enclosed and private or open and public depending on how the inhabitant positions the moving building element. While there is always the chance that the auxiliary room will be only be used for one purpose and the movable partitions left as is, the placement of the auxiliary space adjacent to the living area is sensible as the living room is usually a place of social change accommodating a range of activities for the inhabitants and their visitors. This technique is common and is shown in *Wohnzeile* by Ludwig Mies ven der Rohe, 1927 (Germany).

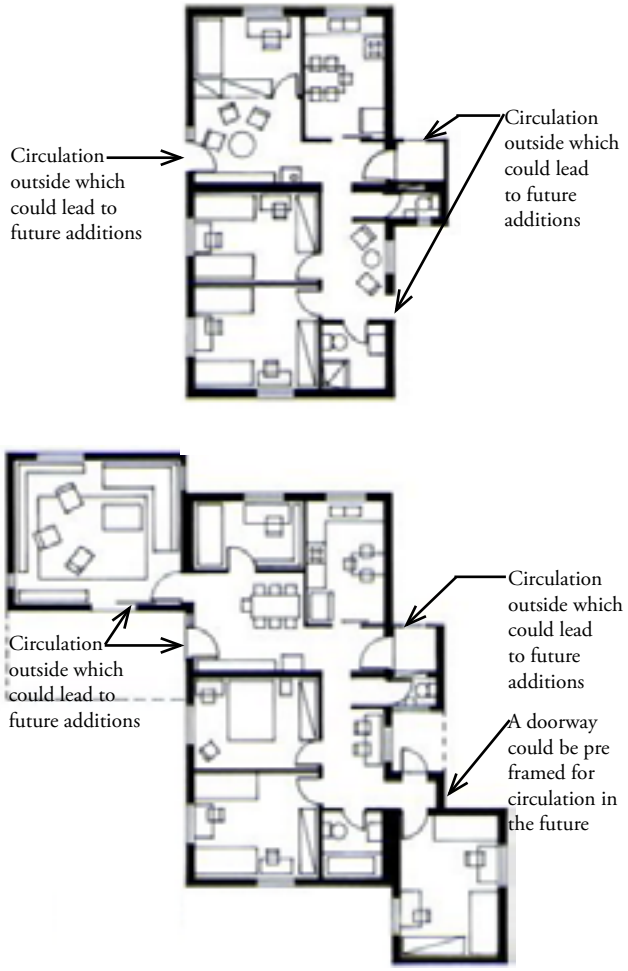


Figure 38: Floor plan from 71m2 to 110m2 (Friedman, 2001, p. 23). The placement of multiple doorways outside could easily lead to future additions without impacting the layout or circulation of the existing spaces. In regards to the design Friedman stated "the planning of the units involved an organic hierarchy of open spaces and circulation which permitted expansion in the form of annexes to the units" (Friedman, 2001, p. 23).

Add-on

The application of the add-on concept varies but includes anything which is added onto the exterior of the original dwelling.

Careful consideration of present dwelling location and future additions on site during initial design process

The design of a building on the site needs to be carefully considered so that the size and nature of the left over space considers present and future outdoor amenity areas, possible extensions or subdivisions. Accessibility to site must also be considered if additions are to be easily added and removed. Council bylaws, potential effect on neighbours, specific present and future site conditions must also be taken into consideration. Friedman describes this design intervention as "growth and division, which refers to design strategies or means that permit the expansion or reduction of volumes or space either during design and construction or later throughout the occupancy" (2002, p. 16).

Consideration of circulation

Crucial to the add-on approach is the design of the space plan. If circulation is not considered the space plan will need to be rearranged when additions are built on, which can be inconvenient to inhabitants. Circulation can be provided through a public space such a living room or through a corridor.

Pre-frame future openings

In Friedman's 2001 example provisions for circulation to additions are provided through existing exterior doors. A doorway can be pre-framed and clad over if a door was not needed in the present.

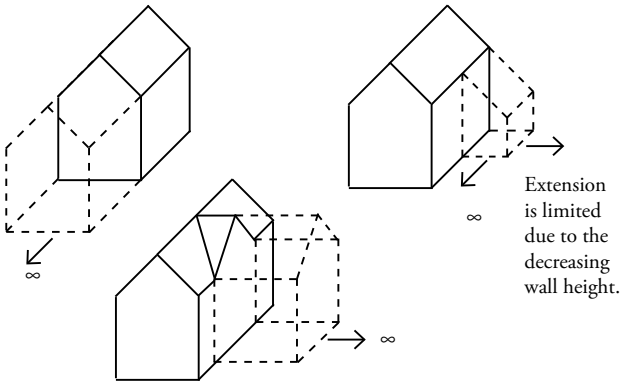


Figure 39: Different gable roof extension options

Add-on through extrusion of gable end

The gable can easily be extended in the direction of the gable as an extrusion of the existing form.

Add-on through lean-to

Additions in the form of a lean-to is often added onto the hip side of the dwelling at the eave or under the eave. The lean-to only has a limited width to which it can extend as stud height is often an issue. Several design tactics are used to mitigate the lower stud. The lean-to extension can be constructed with a lower pitch to achieve maximum stud height in the extension. A higher stud in the existing dwelling can allow a higher starting point on the lean-to extension. A lean-to can also easily be added onto a gable end through extension though it would then restrict the width of the extension. The gable is generally an adaptable form and often used in conjunction with the cottage typology which can also be easily adapted.

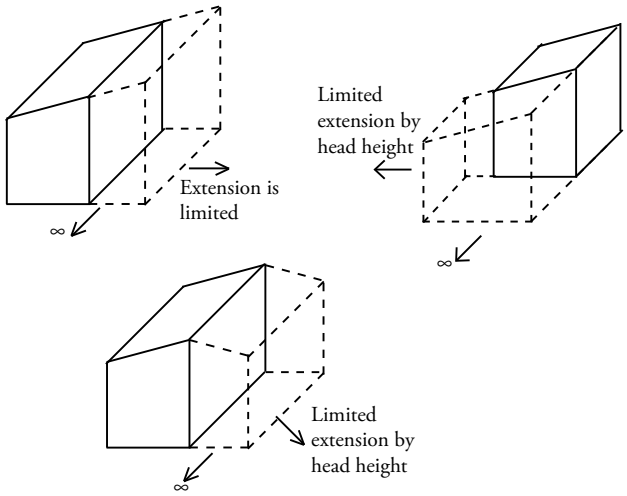


Figure 40: Different mono-pich extension options

Add-on through extrusion of mono pitch

The existing mono pitch roof can easily be extended along the roof axis as an extrusion of the existing form.

Extension of mono pitch

The extension skywards could be limited in a number of ways. For example, the maximum height set by a council, effect on neighbours, maximum desired interior height. Extending skywards could be particularly useful if the addition was two storey. The mono-pitch roof can be added continuing the same pitch or with a change of pitch. Mono-pitch roofs can be added at the side of the existing structure or under the eave. Extensions which result in internal gutters have been omitted as they are not preferable for ease of construction.

Lean-to extension

The lean-to extension is often at a lower pitch to achieve maximum stud height in the extension. A higher stud in the existing dwelling can allow greater flexibility.

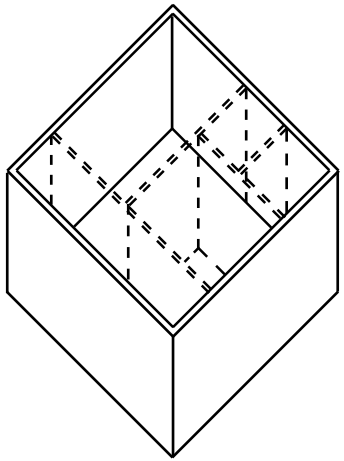


Figure 41: Clear span floor: Only external walls are loadbearing allowing any combination of internal non-loadbearing walls.

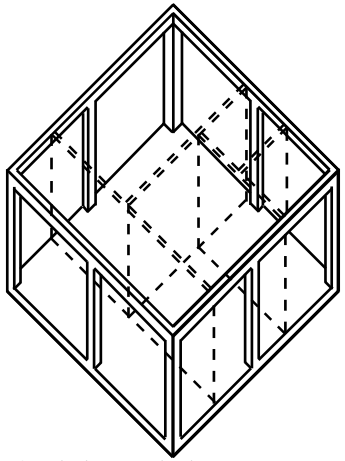


Figure 42: The beam and column construction means that there are no loadbearing walls allowing any combination of internal and external non-loadbearing walls.

Structure

> *"The foundation and load-bearing elements are perilous and expensive to change, so people don't. These are the building. Structural life ranges from 30 to 300 years" (Brand , 1994, p. 13).*

The consideration of structure in adaptable design is one of the most important aspects as Brand illustrates. The consideration and design of the structure to allow adaptations in the future is defined by Friedman as "post occupancy adaptability" (Friedman, 2002, p. 13). This is when a building is physically altered by a builder once occupied.

No internal loadbearing walls through clear span floors

Clear span floors occur when the roof or floor structure spans between external walls. This way all the walls in between are non-loadbearing and can be removed creating a clear span. Schneider & Till state that "there is no reason why all housing should not have clear span floors" (2007, p. 195). Clear span floors can be achieved through several methods. The roof or floor structure can span from one external wall to the other which would allow for only non-loadbearing walls internally. This is only possible if the roof or floor members are able to reasonably span between external walls. If the members are unable to span the distance then a structural intermediate beam can be designed to reduce the span.

Beam and column construction

A column and beam construction would eliminate the need for external loadbearing walls all together. Schneider & Till suggest that "constructionally and conceptually the frame should be separate from the infill of partitions, services and fittings, and preferably also the exterior walls (so that can be changed at a later date as well)" (2007, p. 192).

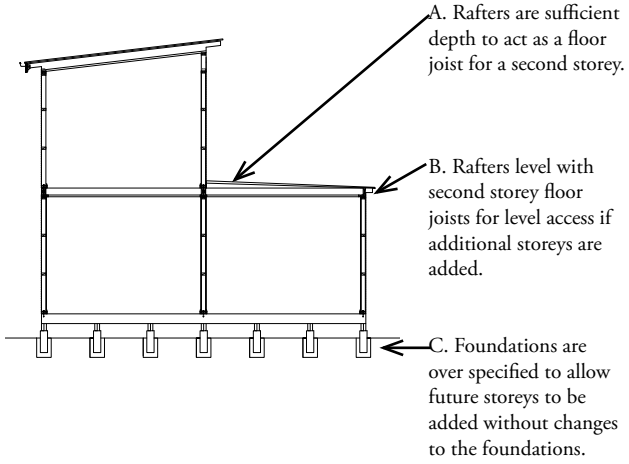


Figure 43: Design tactics for structural provisions for an additional storey

Separation of facade from the loadbearing structure

The separation of the façade from the loadbearing structure is the one way to make changes in the façade easy in the future. "Exterior surfaces now change every 20 years or so, to keep up with fashion or technology, or for wholesale repair. Recent focus on energy costs has led to reengineered skins that are air-tight and better insulated" (Brand , 1994, p. 13).

Differentiating between non-loadbearing and loadbearing walls

The differentiation between loadbearing and non-loadbearing walls should be made clear so that "simplicity and legibility in construction means that future changes can be made without forensic examination and specialist input {…} Built examples of flexible dwellings have often failed for the simple reason of technical over complication, leading for difficulties amongst new generation of users to distinguish between what could or could not be altered" (Schneider & Till, 2007, p. 194). One way to indicate a wall is non-loadbearing is suggested by Schneider & Till who recommend "the continuation of wall and floor finishes past or under any removable partitions" (2007, p. 196). Ballard-Bell & Rand suggest indicating non-loadbearing walls with "no interior partitions contact the perimeter walls, confirming that they are non-structural" (2006, p. 168). Another solution could be indicating the wall type through framing thickness: 90mm framing for non-loadbearing and 140mm framing for loadbearing walls.

Structural provisions for an additional storey

Schneider & Till (2007) recommend building sufficient foundations which allow additional storeys to be added in the future if desired. Friedman (2002) recommends horizontal rafters to be level with the second storey floor joist for level access if additional storeys are added. Rafters create a flat roof which allows ease of construction if the roof is removed and second storey added. These interventions are aligned with Friedman's (2001) add-on method where provisions are made so that a home can be easily added onto in the future.

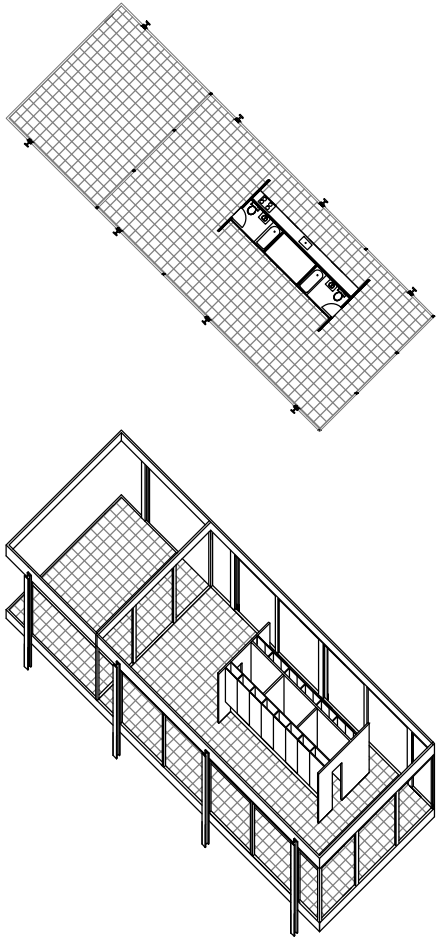


Figure 44: *Farnsworth House* by Ludwig Mies van der Rohe, 1945-1954, (Plano, Illinois). Drawn by author. *Farmsworth House* has the services in a central service core allowing flexibility in the layout.

Services

"These are the working guts of a building: communications wiring, electrical wiring, plumbing, sprinkler system, HVAC (Heating, ventilating, and air conditioning), and moving parts like elevators and escalators. They wear out or obsolesce every 7 to 15 years. Many buildings are demolished early if their out-dated systems are too deeply embedded to replace easily" (Brand, 1994, p. 13).

Careful consideration of services location(s)

The design and location of services is related to the space plan as the services have an effect on the placement of interior walls. For example Schneider & Till state "the position of the service core is critical in determining flexibility of a unit, since it often defines the most permanent elements in plan, the kitchen and bathroom" (2007, p. 189). Furthermore Schneider & Till state that refurbishment costs can be "greatly reduced if the initial design of the services take into account future flexibility" (2007, p. 197). Different service core and entrance layouts should be trialled and the potential add-in scenarios for each layout should be evaluated for a successful add-in concept.

Easy access to services

With concrete subfloors you are unable to access and maintain services buried in the concrete (Brand, 1994, p. 20). Therefore Brand strongly recommends timber subfloors in which services can be accessed, maintained and altered (1994). Grouping services into one location will also make it simpler and easier to maintain services. Placing access hatches near plumbing fixtures is a simple tactic so that access is made easier. If services are in different locations access hatches should be placed as close as possible to each service hub. One drawback for a wooden subfloor however, is the increased height from ground level.

Figure 45: Pendant light with long flex. Photo by author

Figure 46: Extension cord built into the wall.

Absence of electrical wires or services in non-loadbearing walls

The absence of electrical wires or services in non-loadbearing walls is a recommendation from Schneider & Till (2007) to simplify the process of removing or altering interior partitions.

Pendant lights with long flex

Lights with a long flex allows lights to be low over a task which may require more intense lighting and the flex could be hung on simple and discrete hooks for wider spread light. Installing a long flex for lights avoids what Friedman describes as function-related fixtures such as "lighting and socket outlets that are located according to the planned function of the room, for example, lighting related to bed position" (Friedman, 2002, p. 14).

Provide plenty of storage

Regardless if storage is built in, free standing or built post-occupancy, it is imperative that storage is considered. An adaptable house allows different activities and one activity can often not be started until the previous one has been cleared from the area and relevant items placed into storage.

Extension cords built into the wall

An extension cord can easily be plugged in to extend the reach of electronics. Extension cords built into the wall create a tidy and convenient alternative to the plug in extension cord.

Overview of adaptable design tactics

Adaptable tactics add-in: unfinished space
-Provisions for future plumbing
-Omitting shelving or storage
-Providing the minimum of non-loadbearing internal walls
-Leaving walls unlined
-Unfinished roof space
-Add-in second floor in double height space
-Careful consideration of location of windows for present and future use
-Two entries to a room
-Wide Corridor

Moveable Building Elements
- Bi-fold, sliders or moving wall elements

Adaptable tactics for add-on
- Careful consideration of present dwelling location and future additions on site during initial design process
- Consideration of circulation
- Pre-frame future openings
- Add-on through extrusion of gable end
- Add-on through lean-to extension
- Extrusion or extension of mono pitch

Adaptable tactics for Structure
-No internal loadbearing walls through clear span floors
-Beam and column construction
-Separation of facade from the loadbearing structure
-Differentiating between non-loadbearing and loadbearing walls
-Structural provisions for an additional storey

Adaptable tactics for Services
- Careful consideration of services location(s)
- Easy access to services
- Absence of electrical wires or services in non-loadbearing walls
-Pendant lights with long flex
-Provide plenty of storage
-Extension cords built into the wall

Conclusion

There are many different adaptable design tactics within the literature on adaptability. When deciding which tactics to utilize Friedman suggests "to improve the chances of success, all strategies must be carefully considered to ensure that they include provisions for future growth within the original design" (Friedman, p.19, 2001). While the list of suggestions is relatively long, the specific requirements of each dwelling and site will make it easier to consider which tactics to use. The list could be considered a checklist of adaptable design tactics. Schneider & Till make an important suggestion that "potentials for additions should be tested at design stage, so that the initial plan can anticipate future extensions rather than limit them" (2007, p. 183). All the future add-ins and add-ons should be designed with the present stage so that there is less likelihood of missing something or making a mistake and greater likelihood of the future add-in fitting like it was always there rather than an afterthought. In regards to creating adaptable design all strategies must be considered at design stage.

> *"add in involves the provision of unfinished spaces within the original dwelling which can be finished at a later date as the need and means arise. In comparison with add on procedures, this process requires a somewhat higher initial investment in space and in structure- compensated, in return, by a considerably smaller investment at the time of expansion" (Friedman, p.19, 2001)*

Figure 47: My parents' house was easily able to accommodate a new covered verandah underneath the eave because of the high stud height of the existing house. Image by author.

Figure 48: Cottage for Jeanne Zee built 2011. Designed by author.

Overview: Cottage typology verses new suburban house

Cottage typology

Friedman states that cottage typology is inherently adaptable in its layout as "cottages have always been rudimentary, compact volumes with little irregularity of contour or variation in shape (Friedman, 2001). The following points outline common items which are adaptable and unadaptable about the cottage typology through evaluating my parents' house.

High stud: The high stud allows lean-to additions to be added on and easily have sufficient head height in extensions.

Often gable roof line: Gables roof lines are easy to add-onto either with a lean-to or by extruding the gable.

Internal loadbearing walls: The older construction techniques mean that there are a greater number of internal loadbearing walls. The second floor also increases the number of loadbearing walls. A beam would be required in place of many of the interior walls.

Aesthetic beauty: Traditional aesthetic, bay windows, decorative timber facings, colonial glazing bars.

Present adaptable use through consideration of social and utility function:

In my parents' house each room has a specific character with varied stud heights, floor areas, sun qualities, views.

Acoustic privacy

In terms of acoustics, my parents' house misses the mark. In the upstairs rooms and laundry/study you cannot hear if someone is at the front door or if dinner is ready. On the other hand any movements made in the upstairs rooms are heard by the rooms immediately below. Each room is separated by a plasterboard lined timber framed wall with solid timber doors. With the exception of the bathroom, every room has a computer, stereo or television which could be blaring out sound at any given time. The lack of acoustic privacy has been a source of conflict in my parents' house.

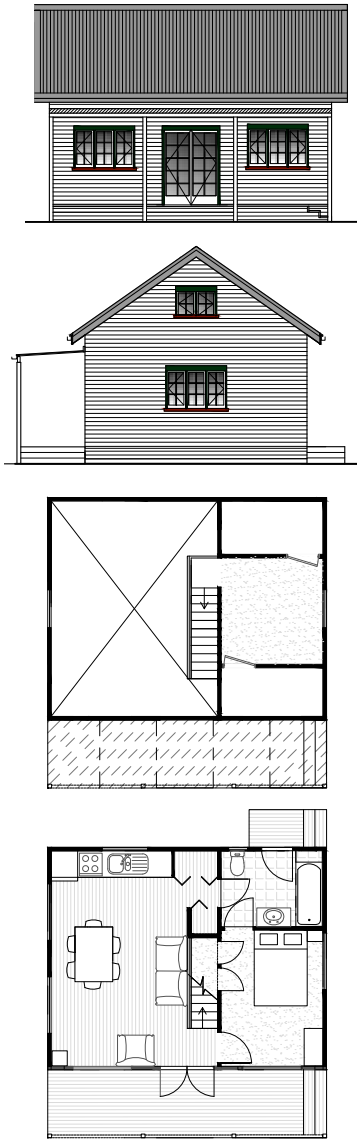


Figure 49: Cottage typology; inherently adaptable. Image drawn by author.

Visual privacy

In my parents' house every room has a different level of privacy. The large south facing room has functioned as a bedroom and an auxiliary living space due to the glass French doors leading into the living room. The room is sandwiched between the kitchen/dining room and living room. It was decided that the child with the tidiest disposition could use it as a bedroom as it was on the most visible route between the two living spaces. Conversely the child with the messiest disposition got one of the smallest rooms upstairs out of the public eye. In addition to the two small rooms upstairs there was a small semi-public landing which was eventually used to store clothes, shoes and make-up. The semi-public space became a social hub for my sisters and me so that we were not invading each other's personal space or being intruded on by anyone who wasn't part of our beautification process. Having two public areas, a living room and a dining/kitchen was immensely valuable to my family. If a conflict in use arose in a public living area, family members could retreat to the remaining living space rather than having to retreat to their bedroom.

Sense of enclosure

Almost every room has a different stud height; 1.5m, 2.4m, 2.7m, 3.0m, 3.3m.

Natural light

In the Southern Hemisphere, houses are usually oriented so that the prioritised living areas face north for maximum sun, and the low priority bathroom faces south and receives little sun. My parents' house however, was orientated the opposite way with the large bay windows in the living rooms facing south, and bathrooms facing north. While we'd prefer to have the living room receive more sun my parents' ensuite is a beautiful light filled and social space. It is not the allocation of the space which has dictated use, but the preference of our family for a sunny space. As the house was relocated from another site it can be assumed that the large windows were originally intended to face north and the bathrooms to face south.

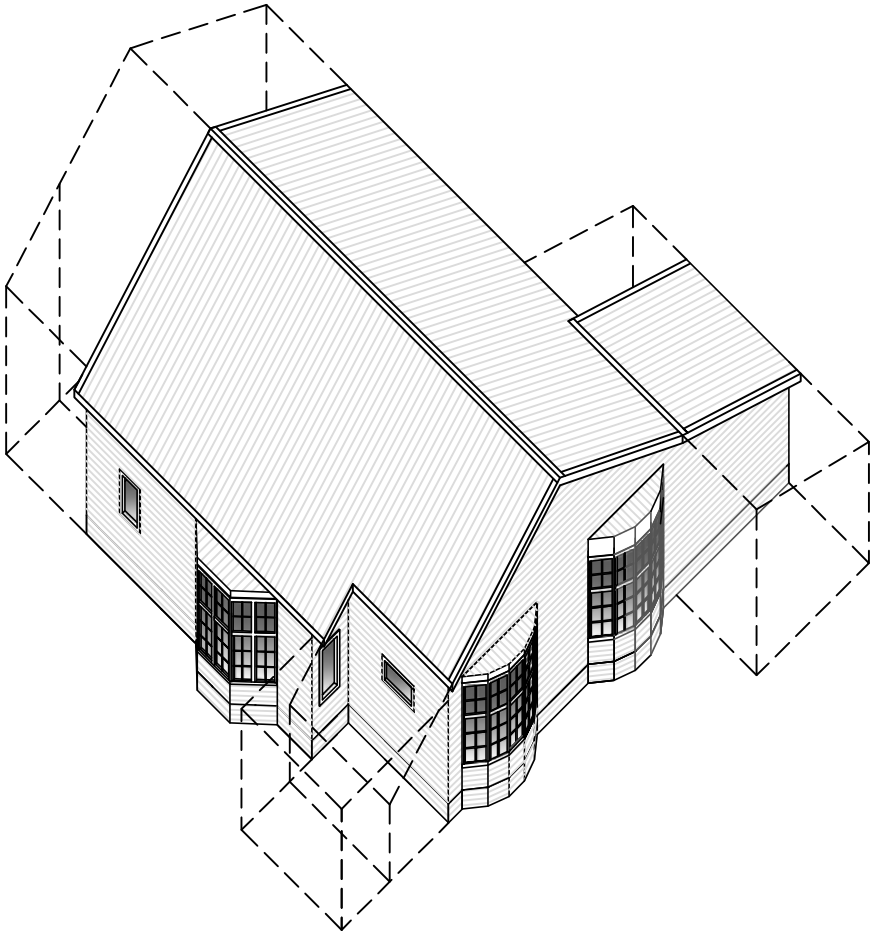


Figure 50: Left: Grey shaded area indicates different floor plan options for additions to my parents' house through lean-to, extrusion of gable and extrusion of lean-to.

Figure 51: Above: Dashed area indicates different 3D options for additions to my parents' house through lean-to, extrusion of gable and extrusion of lean-to.

Figure 52: Although the extension of this home will be easy to add-onto with a high stud and gable roof, the connection between the extension and existing gable roof is very poor. Extending onto hipped roofs can result in very messy junctions and internal gutters. Photo by author.

Modern mass suburban home

The following points outline common items which are adaptable and unadaptable about the mass suburban home through evaluating *Punto*.

Low stud: The low stud is difficult to add onto as a 2.4m interior stud height often results in 2.1m between floor level and soffit which leaves little head height for additions. Even adding a verandah can be quiet challenging with alternative or overly complicated solutions required to increase the head height or offset it in some way.

Hip roof: The roof line is often extruded from a plan generated design which often does not consider the implications of the roof. The resultant roof is often complicated with many hips and valleys.

Concrete subfloor: Many of the modern mass suburban houses are on concrete subfloors which makes it difficult to access services.

Clear span floors: New mass suburban houses are usually constructed with trussed roofs which are able to span the typical widths found in the new mass suburban houses.

Aesthetic beauty

Windows are uniform in terms of style, proportion and in most cases size. The hip roof is consistent. The dwelling has one cladding.

Present adaptable use through consideration of social and utility function:

Punto like many of the mass suburban houses are generic in character with consistent spatial qualities throughout.

Acoustic Privacy: The open plan space provides no acoustic privacy. The bedrooms are grouped together leaving only one standard wall between bedrooms.

Natural light

Generally five types of windows are repeated; Small frosted bathroom windows, medium sized bedroom windows, small and high garage window(s), medium sized kitchen window, and large living room window(s). The same five types are generally repeated to varying degrees between each house. There are less options and less room to play with in terms of window composition with the low stud. As a result there is generally little sense of window composition.

Figure 53: Aerial view of new suburban development of Riverstone terraces. Every house is designed in the same way with hip roof, low stud, single storey on a concrete subfloor. Image from Google maps.

Sense of enclosure

The bedrooms have the same spatial quality with the exception of the master bedroom being slightly larger. Large open plan living.

Visual privacy

In the adaptable design precedents the approach to visual privacy is usually made through a clear cut division between the public living area and the private bathrooms and bedrooms. You are either totally exposed in the public space or completely private in the bedroom or bathroom.

Figure 54: Street view of Riverstone terraces. Image from Google maps.

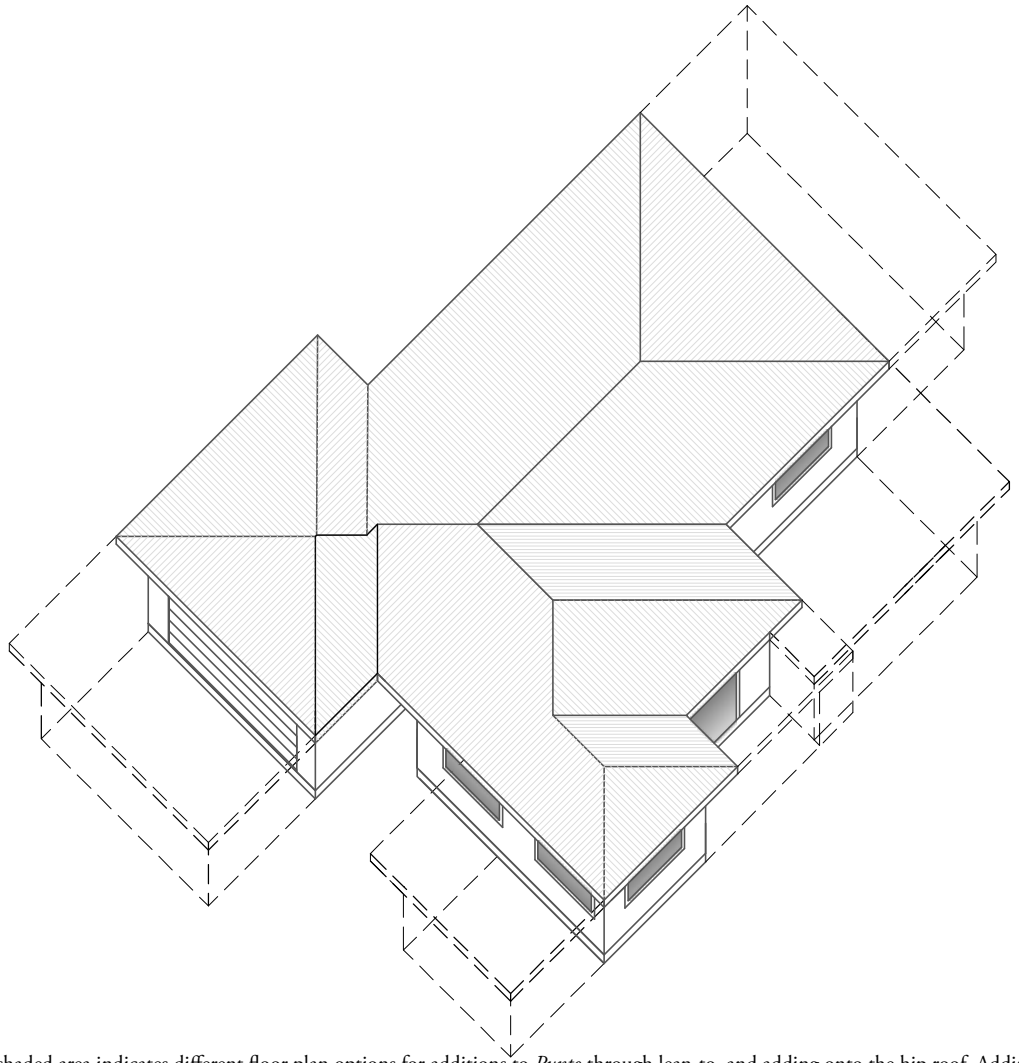


Figure 55: Left: Grey shaded area indicates different floor plan options for additions to *Punto* through lean-to, and adding onto the hip roof. Adding a lean-to is trailed on *Punto* though the low stud height renders it impracticable. The only option then is to construct the new extension over the existing hip roof as shown. The extensions have been shown as a hipped roof to keep with existing style though a gable would be more suitable if future additions were possible.

Figure 56: Above: Dashed area indicates different 3D options for additions to *Punto* through lean-to, and adding over the existing hip roof.

4.0 Design Generation One

Figure 57: Design Generation One in its suburban context. For all its draw backs it is very interesting and different to the run of the mill suburban neighbours.

4.0 Design: Generation One

Design generation one provided a testing ground for the ideas and theories developed in the literature review, survey and subsequent definition of what adaptability means for this thesis. The design however, resulted in some undesirable qualities which are discussed in this critique and used to inform subsequent design processes further in this thesis. This chapter concludes with lessons learnt from design generation one, primarily considering aesthetics in adaptability, considering an approach to social function which is specific but not overly prescriptive, considering moving building elements and changes in spatial qualities over time.

Background behind design generation one

In the introduction a critique was made against the indeterminate approach which is prevalent within adaptability and new suburban housing. While the spaces would meet occupants requirements for utility function, the ability to address social function is questioned. The aim of design generation one was to create a dwelling which was more specific and satisfied the utility and social requirements for many by providing adaptability through choice of a variety of spaces.

A survey was conducted to ascertain what qualities would be desirable for different activities in the home. Results showed a great variety of preferences for different interior qualities which are unlikely to be achieved by the indeterminate approach with its non-specific spaces. The survey results were complex with some trends visible within the varied results. Design generation one utilised the most popular interior qualities in the design of a home in the theory that it would have a wide variety of specific qualities which inhabitants could choose from. In this way you could find a space which suited a particular use or spatial preference. Design interventions from the precedent review were used in an iterative process of designing, testing and evaluating, which continued until the interior qualities reflected the survey results. The aim of providing the most popular spatial qualities as identified from the survey was achieved.

Figure 58: Design generation one section

Figure 59: Design generation one section

Approach to social function was too specific

The prioritisation of the social function meant that the utility function was never fully resolved as the specific interior attributes of space did not always lend itself to practical spaces. For example, a specific set of interior qualities from the survey results were; very private, quiet, enclosed space with indirect light. The space was created so that it could only have those qualities. As each room adhered to one set of specific spatial qualities many spaces were created. If the interior qualities of each room were able to change, fewer rooms would be needed. While the spatial qualities used in design generation one were popular in the survey each space should be able to have multiple spatial qualities rather than one specific set to appeal to a greater number of occupants and activities.

The limitation of the survey which informed the design was that the preferred spatial qualities was determined by the opinion of the thirty-four survey participants. While the participants were made up of a variety of demographics a larger survey would be required in order to ascertain if the preferences represented New Zealand's society as a whole. If the survey tells us anything it is that individuals have varied spatial preferences. Rather than using specific interior qualities from the survey, the survey should be used as a reminder that social function is achieved through a variety of spatial qualities. The presence of variation is more important than the specific requirements which the survey identified.

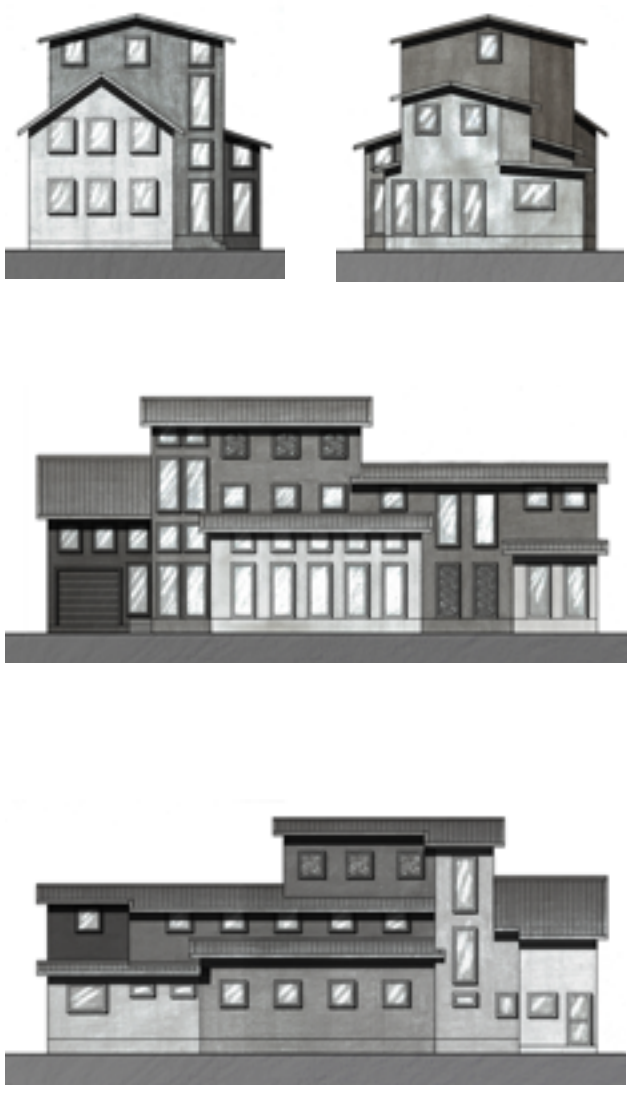


Figure 60: Elevations for design generation one by author. The focus on creating varied interior qualities, in particular sense of enclosure and natural light results in a random and non-cohesive aesthetic

Need to consider moving building elements

The interaction between the inhabitants and the building was lost as the design was too rigid about what qualities each space should have. Moving blinds or curtains for example can change a space from sunny to dark and back again. Moving building elements are an important aspect of adaptability as they allow a change in the spatial qualities with minimal effort.

Aesthetics in Adaptability

As the design process was focused on creating a variety of interior qualities little consideration was made to the exterior as a whole. This was most prevalent in the placement, location and size of the windows which were made larger or smaller depending on the light qualities without any overall relationship between the windows. In order to allow the subdivision of space many smaller windows were used which created a disjointed facade.

In an effort to provide various senses of enclosure the roof has no continuity and sticks up in several different places at different roof pitches with no consideration of the building composition as a whole. Overall the look of the design is reflective of the process of which it was created, from the inside out. A holistic process of designing the exterior and interior simultaneously needs to be implemented in the following design process.

An additional outcome of adaptability is required: *Adaptable design which considers the design as a whole and its aesthetic beauty.* Further research is required into techtonics, geometry, proportion and scale to inform the design process for this thesis.

Figure 61: The exploration of the individual spaces through section and interior perspectives.

Design Generation One Comments

While trying to achieve the varied interior qualities, especially that of the varied sense of enclosure, many roof lines were created. This meant that there was an increase in the number of internal loadbearing walls, making it more difficult to make any future interior alterations. Alternative interior configurations should have been trialled and the design and resultant loadbearing walls should have been re-evaluated. Furthermore there was no differentiation between walls which were loadbearing and walls which were non-loadbearing. Legibility between loadbearing and non-loadbearing walls would make alterations easier. With the exception of the large central space downstairs there is no hierarchy between each space and little consideration of the left over exterior space.

The literature and precedent review was conducted by exploring adaptable design tactics in isolation to architectural examples. As a result the way in which each tactic could be implemented and the effect it could have was not considered. In addition, the design is presented without sufficient comparison between each tactic. Further exploration into the adaptable design tactics will be conducted in the following chapter in order to explore and compare each tactic within a built example.

Upon reflection of design generation one, the definition of adaptability for this thesis has been revised:

Adaptable design allows alterations and removals to be done easily in the future

Adaptable design allows a change of use through considering social and utility function*

Adaptable design which considers the design as a whole and its aesthetic beauty

*Social use takes into consideration the experience of space over time through natural light, sense of enclosure, acoustic and visual privacy. Specific spatial qualities are just as important as variable spatial qualities. Utility function considers the ability to physically use space in different ways.

Part 2

5.0 Precedent Review

Precedent Review Introduction

The literature and precedent review conducted in Chapter three was criticised in the review of design generation one. Adaptable design tactics were considered in isolation without the context of how they could be implemented and the effect they could have. This literature review explores adaptable design tactics within built examples. This literature review also has a design component as the tactics are described and analysed through drawing as a means to explore and understand the precedents and their potential adaptability.

Open Plan

The idea behind open plan is simple. The living areas, primarily kitchen, living room and dining room are combined into one large space. While this tactic is beneficial for smaller dwellings where space is at a premium (Madanipour, 2003, p. 94), open plan can be applied without any consideration of the actual use or the interior qualities of the space. The resultant indeterminate space is intended to accommodate a wide range of activities with little specific design provisions for various activities.

Open Plan in *Single Family House in Sapporo*

The *Single Family House in Sapporo* combines the living room, kitchen, dining room and study into one connected area. However, it has areas within an open space with distinct spatial qualities so that inhabitants can have the choice of space for their desired activity. *Single Family House in Sapporo* is examined to inform a design approach aiming to create adaptable residential design where the use is not determined but the characteristics of a space are.

Single Family House in Sapporo uses several techniques to create a variety of interior spaces within the one open plan space. Moreover the qualities are specific in terms of the light and sense of enclosure but also specific for a particular uses such as having a nap or breakfast.

Provide varied spatial qualities within an open plan space

Providing one open plan space can sometimes result in one interior quality. *Single Family House in Sapporo* demonstrates how varied spatial qualities can be successfully created within one open plan space.

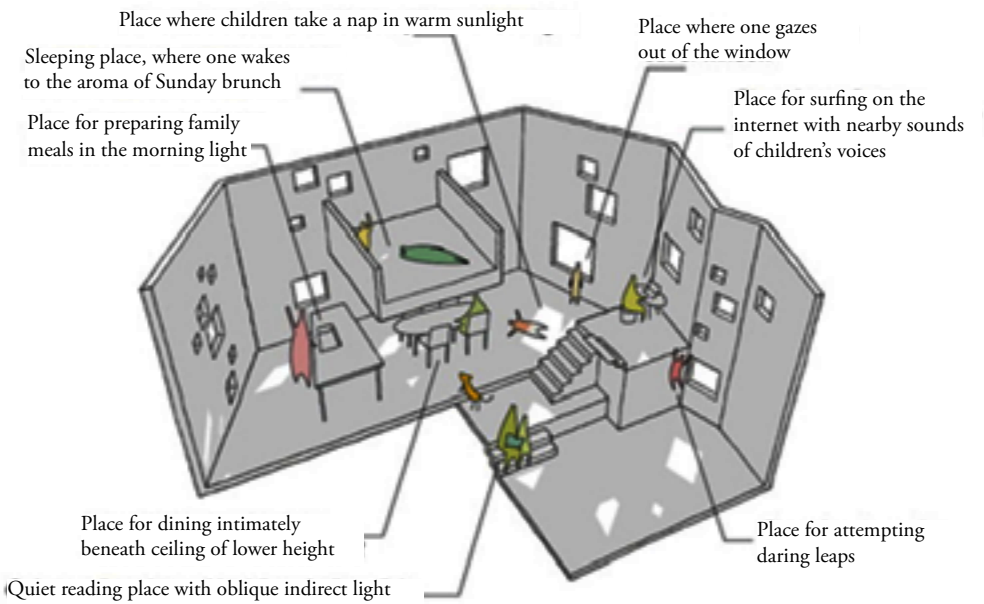


Figure 62: *Single Family House in Sapporo* uses several techniques to create a variety of interior spaces within the open plan. *Single Family House in Sapporo* by Akaska Shinichiro Atelier, 2007, (Sapporo, Japan)

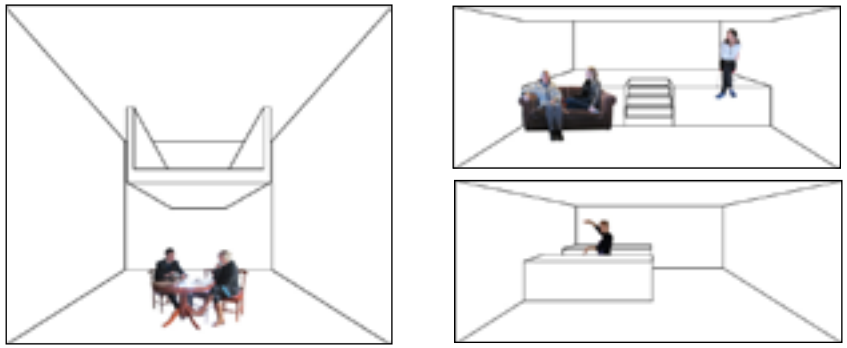


Figure 63: Design tactics utilized in House in Sapporo to create different areas within the same open plan volume. Left; Lowered ceiling under mezzanine floor. Right above; raised floor. Right below; kitchen bench

If open plan space is included, ensure that quiet and private spaces are provided else where in the house

By designing for multiple specific qualities and multiple specific activities, interesting and varied open plan spaces can be created. The lack of visual and acoustic privacy in the open plan space should be offset with providing quiet and private spaces elsewhere in the house.

Single Family House in Sapporo

As the windows of *Single Family House in Sapporo* have been designed for specific views and light conditions the resulting facade appears to be random. The windows appear distorted as the walls are angled. The window heights vary as the house has several split levels. Although the windows are different sizes and have no correlation in the placement on the elevation, the windows are the same 1:1 proportion in different scales. This creates continuity and order within a 'random' composition. The double doors do not keep the same 1:1 proportions as the rest of the windows however, the practice of having a set of doors as tall as they are wide may have been too impractical or restricting.

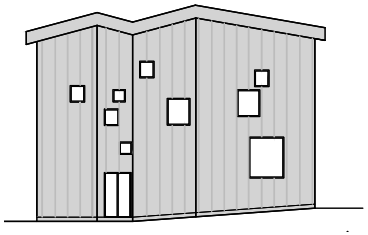
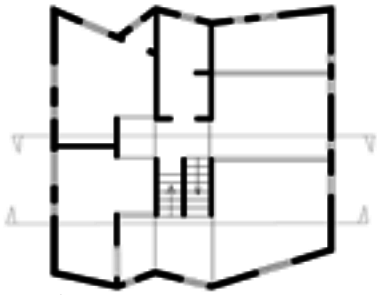


Figure 64: *Single Family House in Sapporo* by Akaska Shinichiro Atelier, 2007 (Sapporo, Japan). Elevation drawn by author.

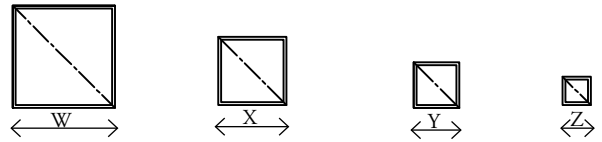


First Floor

Ground Floor

Figure 65: *Single Family House in Sapporo* by Akaska Shinichiro Atelier, 2007 (Sapporo, Japan).Plan drawn by author.

Figure 66: *Single Family House in Sapporo* by Akaska Shinichiro Atelier, 2007 (Sapporo, Japan). 3D drawn by author.



W=1.5xX X=1.5xY Y=1.5x Z

Figure 67: Window proportions of *Single Family House in Sapporo* Drawn by author

Approach to Ground Plane

Different approaches to ground plane can have implications on future extensions. The different approaches to ground plane are summarised by Ching who states "The building can merge with the ground plane, rest firmly on it, or be elevated above it. The ground plane itself can be manipulated as well to establish a podium for building form. {…} carved or terraced to provide a suitable platform on which to build; or stepped to allow changes in elevation to be easily traversed" (2007, p. 20).

Rest firmly on the ground

Dwellings which rest firmly on the ground allow extensions outward or upward. Dwellings on a terraced ground plane are equally easy to accommodate if the floor level has adjusted with the ground level.

The ground plane creates a platform

Additions can easily be made upwards and outwards. Provisions will have to be made for extensions out side the platform with an extension of the platform or elevating the extension.

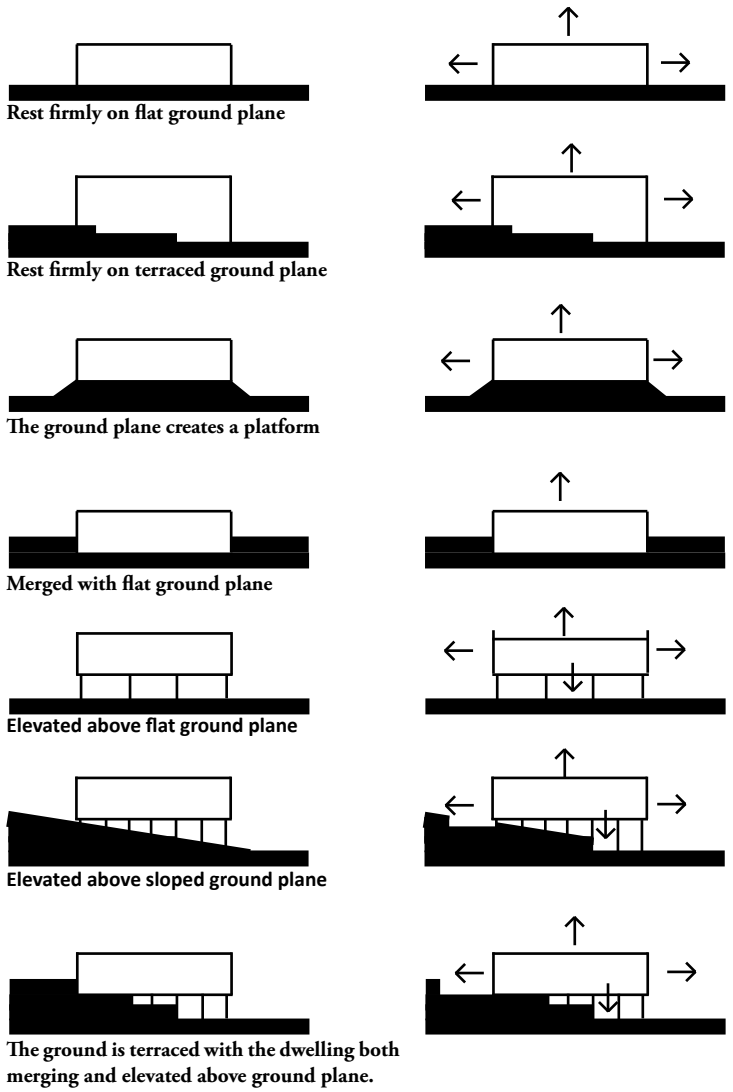


Figure 68: Illustration of Ching's approaches to site. Drawn by author.

Merged with the ground plane

All of the approaches to the ground plane allow for expansion upward as long as the foundation is designed or altered to carry the extra load. If the dwelling is merged with the ground plane then an additional storey would have less impact on neighbours daylight or the appearance of mass than dwellings which are above or level with the ground. Expansion outwards however, would be more difficult as excavation would be required.

Elevated from the ground plane

Elevated structures allow the space below floor level to be an easy extension below the original structure. Some minor excavation may still be required depending on the slope and stud height of the extension. In the meanwhile the void could also be used for storage or a covered play area.

All approaches to ground plane allow expansion upwards (providing the structure allows) and outwards unless the structure is merged with the ground plane. Elevating a dwelling off the ground plane is adaptable as it allows expansion downwards without requiring construction of additional roof.

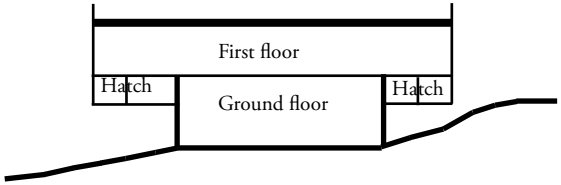


Figure 69: Section schematic of *The Suitcase House by EDGE Design, 2001, (Beijing, China).*

Figure 70: *The Suitcase House* both sits on the ground plane (ground floor) and is elevated from it (first floor). The elevation above the ground in the first floor allows for several subfloor hatches. The hatches allows bedrooms, kitchens, bathrooms, storage, meditation room, media room and so on to be put away by closing a hatch.

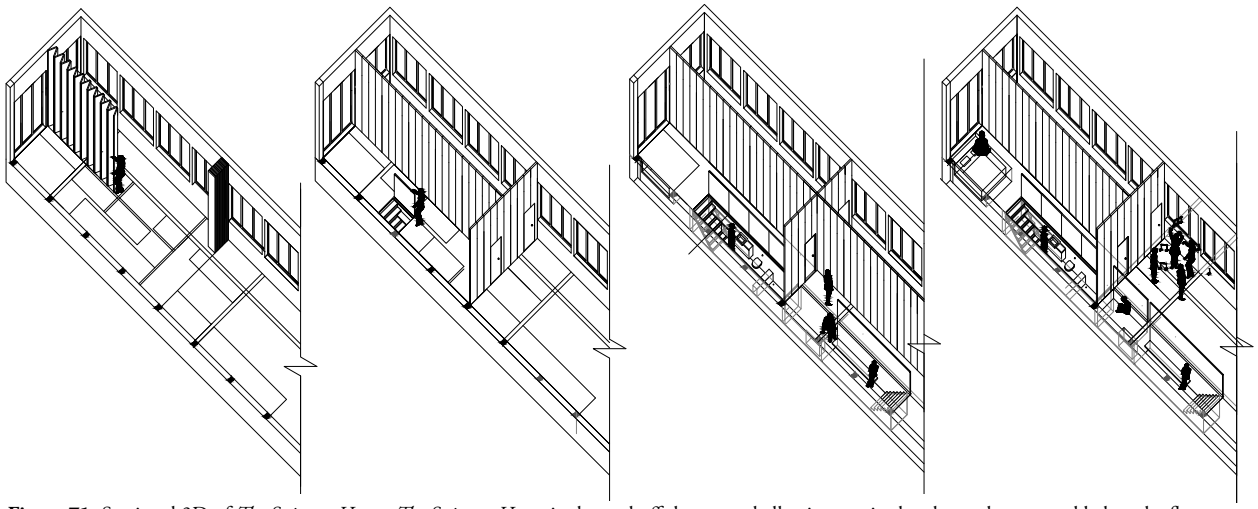


Figure 71: Sectional 3D of *The Suitcase House. The Suitcase House* is elevated off the ground allowing service hatches to be accessed below the floor level.

Add-on

Houses should be designed with specific add-on locations in mind which have a specific intent.

While the *Y House* by Steven Holl, 1999, (New York) was completed in one stage, it could easily be added onto. If the *Y House* was completed in sections the ideal place for extension would be along the prongs of the Y. Firstly, the extension would reinforce the original concept of the house where one prong captures the morning sun and the other the evening sun. Secondly, the folded roof would be relatively easy to construct and suit with the dwellings aesthetic with any number of extensions. Specifying the locations of potential extensions in the original design has several benefits as it allows greater flexibility as the impact on the aesthetic exterior and interior impact of extensions can be more realistically considered. Importantly any extensions can be designed with a specific intension.

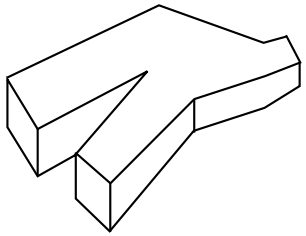


Figure 72: Parti diagram of the *Y-House* as built drawn by author.

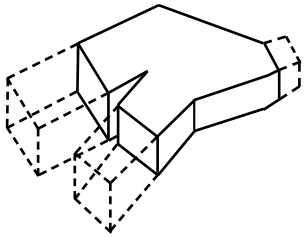


Figure 73: Conceptual diagram of the *Y-house* if it was built in stages with the dashed lines representing future extensions. The extensions would extend and emphasise the original concept of the Y shape and are purposefully placed with one extension to gain morning sun and the other for afternoon. The existing folded roof design would be excellent for additions as alterations in the roof are artfully concealed in a fold in the roof.

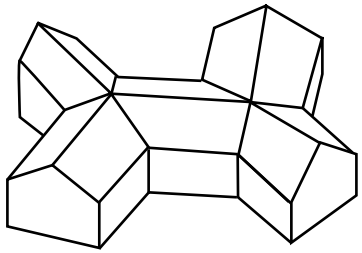
Figure 74: *Y House*

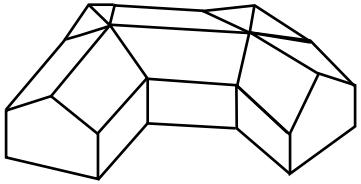
Figure 75: *Y House*

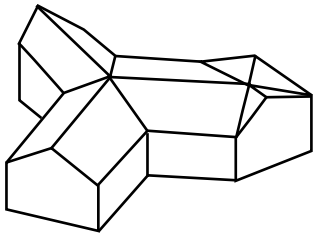
Add-on through the extension of the gable end is explored in Chapter three. It is highlighted again in this chapter through *Branch House* by Kino Architects, 2010 (Fukushima, Japan). Similarly to *Y House*, *The Branch House* creates a number of specific locations which could be potentially extended.

The number and location of the gables in a 'branch' like fashion is possible with the three way hips and an uninterrupted ridge line. The branches are all different widths however, the building still looks regular and ordered as the angle on each roof is different. The slight change in roof angle is not very noticeable as not to impact the geometry of the building.

The Branch House is explored through working backwards from the original design. By starting with the finished product, the building can be carefully designed in increments in order to ensure all design provisions for future additions are catered for. This will include, but is not limited to, circulation, geometry, ease of construction, overall aesthetics and so on.



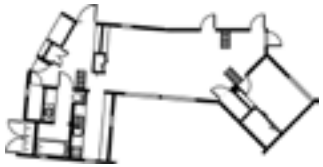




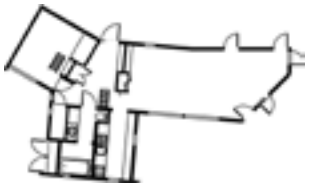
Different options for the first iteration are proposed with the service branch, living and at least one bedroom. The area of extension is limited to the extrusion of the non-loadbearing gable end walls.

Figure 76: 3D options of *Branch House.* Drawn by author.

Original floor plan of *Branch House*



Proposed first stage with design provisions for future additions. For example, access to potential future additions and gable ends which can easily be extruded.



Proposed first stage with design provisions for future additions. For example, access to potential future additions and gable ends which can easily be extruded.

Figure 77: Floor plan options of *Branch House.* Drawn by author.

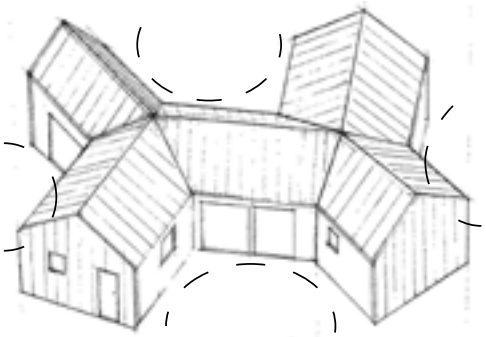


Figure 78: Creation of negative space: The branches create several partly enclosed exterior spaces

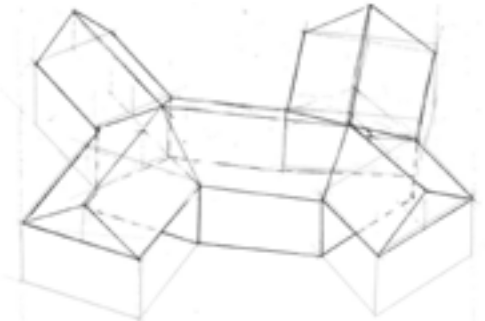


Figure 79: The private or semi-private spaces all branch off the centralized living space. The Branches are visually and acoustically separated from one another.

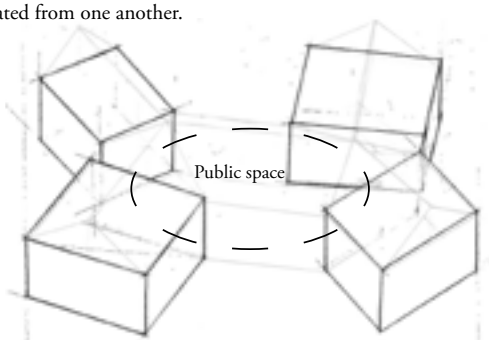
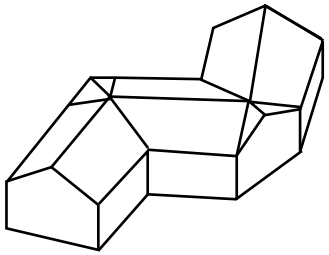


Figure 80: Public space is the ideal space to extend off as it can be used for circulation to new additions. The public space in *Branch House* is centralized allowing private or other public spaces to be easily accessed.



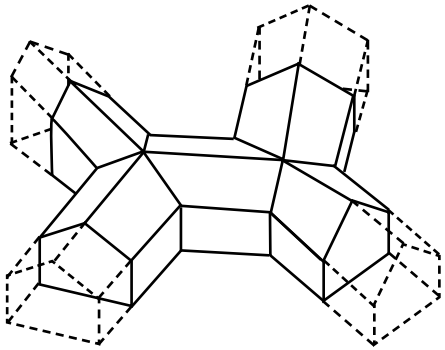
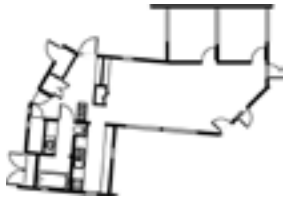
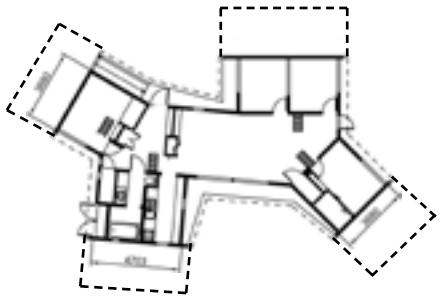


Figure 81: 3D options of *Branch House*. Drawn by author.



Branch House can create several different and interesting forms fully or partially built.



More specific branches can be created off the existing or future branches. The branch concept can expand indefinitely; or as great as budget, client, council regulations and site will allow.

Figure 82: Floor plan options of *Branch House*. Drawn by author.

Legibility of an add-on

Branch House demonstrates an interesting tactic in legibility. The internal walls are not touching the roof so they are clearly non-loadbearing.

At the gable, the end wall continues from the exterior envelope to the soffit. This creates a monolithic wall at the gable end. The extension could be added on with the extended wall remaining. This would allow for the existing and new cladding to join in an internal corner which would be a tidy detail. Also, any changes in material, slight change in colour and so on may not be a noticeable with a visual break.

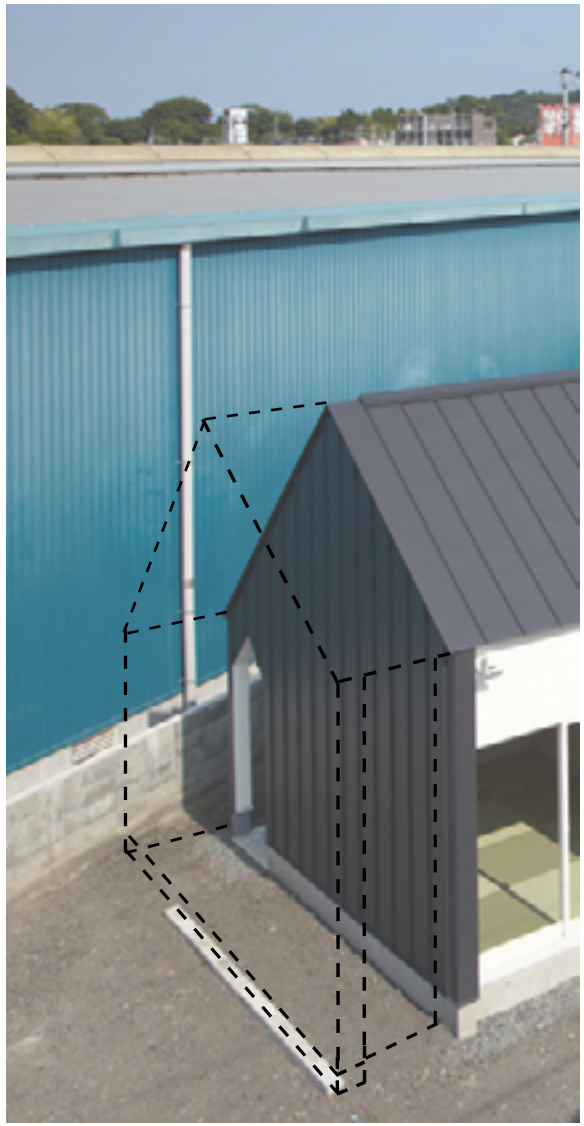


Figure 83: Extensions can be differentiated from one another with the gable wall extending to the eaves. When an addition is added, the extended wall creates a visible junction between old and new.

Figure 84: *Branch House* demonstrates an interesting tactic in legibility. The internal walls are not even touching the roof so they are clearly non-loadbearing.

Branch House

The floor plan of *Branch House* by Kino Architects, 2010 (Fukushima, Japan) is created through a central rectangular area with two branches at each end at different angles.

The gable end is clad in metal trim rib type cladding which is also used on the roof. The roof and elevation merge seamlessly without an overhang on the gable end. The roof and gable end have been painted dark black and three of the four gable ends have no windows. The window on the fourth gable is small for the bathroom.

The elevations with a hip always includes an overhang which visually and constructionally separates the roof/gable wall material from the light coloured cladding. The size and placement of the windows along with the hip elevations vary according to the room placement and use.

The gable extends out to the edge of the roof creating a wing wall under the eave on the hip elevation. The change of cladding then occurs at an internal corner which creates a tidy and easy to construct junction. The wing walls also create definition and enclosure to the left over space under the eave.

Figure 85: *Branch House*

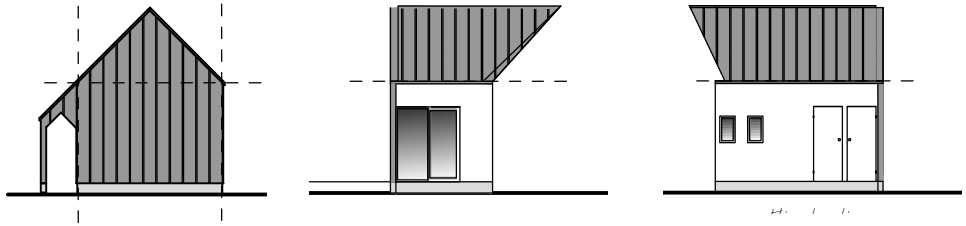


Figure 86: *Branch House* elevations drawn by author. The angles distort the elevation so only sections of the elevation have been shown.

Add-on with an Insert

The idea of adding in through inserting a addition into the existing is inspired through analysing *HAZP House* by Frederico Zanelato, 2011, (São Paulo, Brazil). While the insert may not have been constructed retrospectively, it appears as though it could have been. The dark masonry room sits above the floor bisected by a glass façade as the external façade penetrates the interior. The idea of inserting an addition into an existing space is an interesting concept. An addition which is inserted into a space should be as easy to remove again and gives the appearance of the temporary and adaptable.

The insert creates an area which is still connected to the main area but defined as a separate space. This is done through the change of material, step up from the main area and the way that it sticks into the space like it was inserted there rather than concealing the join. The main façade is light glass with black aluminium joinery whereas the insertion looks like a concrete or rough stone material. The insertion still relates to the main structure which also has a monolithic cladding.

Figure 87: *HAZP House* with the space which appears to have been inserted.

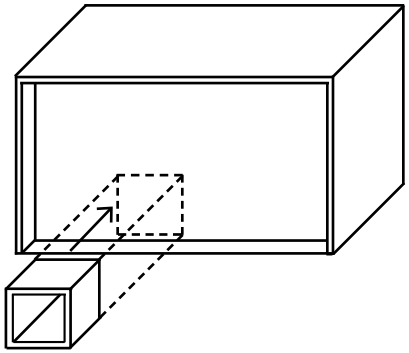


Figure 88: Schematic of the inserted space in *HAZP House*. By author

Figure 89: Interior view of *HAZP House* with the space which appears as it could have been inserted.

Add-on Design Experiment

A 90m2 design was created to investigate the possibility of inserting additions into existing purpose made. Wide bi-fold doors were proposed as the doors could be removed leaving the perfect opening for an addition. The design was proposed with a false and decorative timber cladding in which flashings and connections between the existing and inserted space could be hidden.

The design incorporated several adaptable design tactics:

Non-loadbearing walls are 90mm thick and loadbearing and are 140mm thick for legibility. The services were centralized for efficient and easy to access plumbing. A wide corridor was added with the intention of having it used for storage, or with a desk for a study space though it was not practical with the full length glazing.

The design aimed to have a number of opportunities to insert new additions however, this was not ideal as it was difficult to arrange the interior around the preface of extending everywhere. This limited wall space for furniture and there were difficulties getting enough head height in the extension while fitting floor and roof structure into an existing space.

Figure 90: Add-in design experiment renders

Figure 91: Add-in design experiment interior view.

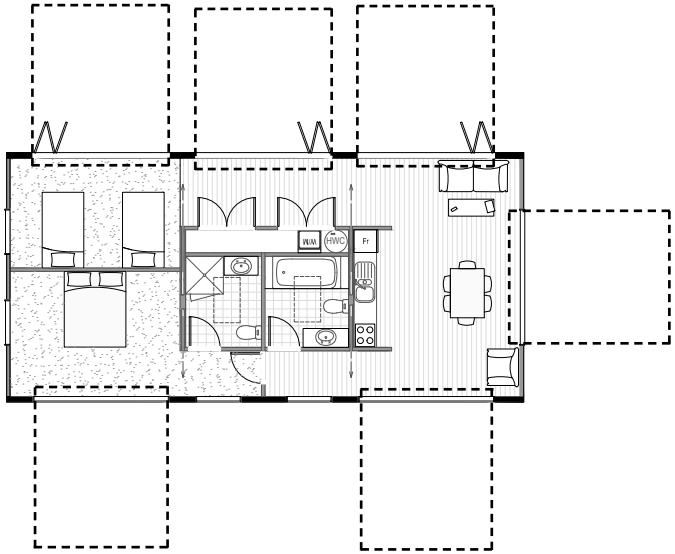


Figure 92: Add-in design experiment plan.

Add-on Using The Link

The link is an important adaptable design tactic as it has several advantages over the other add on tactics.

The link can join up disparate shaped or sized structures

Structures can be independent of each other as the link only contacts a small section of a dwelling.

The link minimises change to built fabric

The link only intersects each joining structure with a small amount of area. This means that when the link or extension is added or removed only a small portion of the building fabric is affected.

Consideration of circulation

The width of the link can be the size of a room or a hallway. In any case the link allows circulation when it physically connects two structures.

Pre-frame future openings

The ends of the link should always have a lintel allowing full sized openings as the link often becomes the circulation

End Elevation

Cross Section

Side Elevation

Figure 93: *IBS* by Ivan Juriss, 1972, (New Zealand).

Stage One
The Young Couple

Stage Two
With Children

Stage Three
With teenagers

Figure 94: *IBS* floor plans

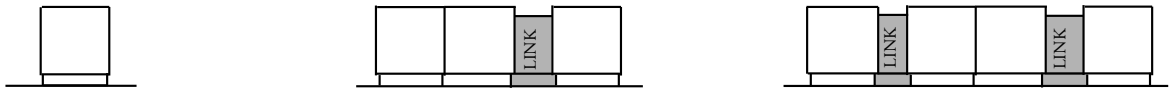


Figure 95: *IBS* schematics

The Aesthetic of the link

While *Park Terrace* and *Mascara House* are completely different in appearance, they have some similarities in the treatment of the link and end sections. In both cases the link is the main living space. As a result the link has similar traits which are: light with maximum floor to ceiling glazing, direct access to a covered outdoor area and flat roof over a single storey creating a long horizontal joining element. The two end sections contain bathroom(s), laundry, kitchen, bedrooms. To varying degrees the end section in *Park Terrace* and Mascara House are tall and emphasise the vertical. Without so many windows compared to the link the ends will be darker. In the link the doors slide away blurring the boundaries between inside and outside compared to the end sections which have definite edges and frames to the view outside. The end sections of *Mascara House* are made up of similar volumes with the left hand section being a taller and more narrow than the shorter and more wide right hand section. In the Park Terrace the end sections are the same width and height but with different lengths. Realistically each end section and link will have different requirements which will result in slightly different sizes and window combinations. In both precedents the link and end sections are contrasting in both aesthetics and experience.

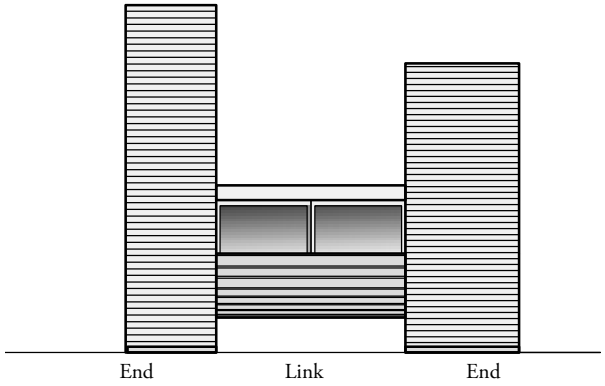


Figure 96: *Mascara House by* mA style Architects, 2011 (Hamamatu-City, Japan). Drawn by author.

Figure 99: *Mascara House*

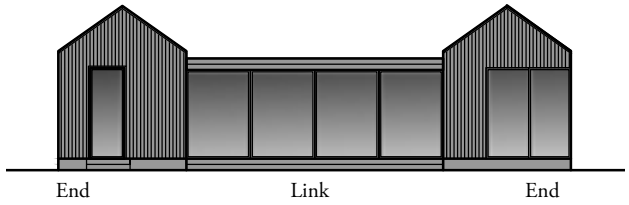


Figure 97: *Park Terrace* by Andre Hodgskin of Architex, 2012 (Christchurch). Drawn by author.

Figure 100: *Park Terrace* by Andre Hodgskin of Architex, 2012 (Christchurch).

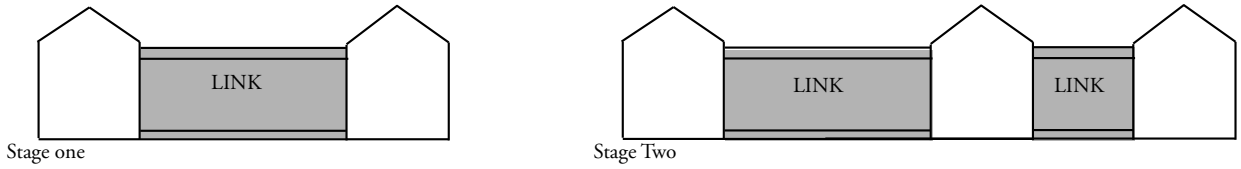


Figure 98: *Park terrace* has been designed in stages, where additions repeat the existing aesthetic. As the link only connects to the existing and new additions for a small section, the impact on the interior layout is minimal. Drawn by author

Seaview House

The cantilevered extension on *Seaview House* was designed as a window seat. The cantilevered extension however, would make an ideal link. It is a generous width for a corridor with a low stud for minimal impact on existing and new extensions.

In the *IBS* example and *Park Terrace* the link was added on with an extension at a later date. There are advantages of including in link in the initial design. Having the link in the initial design means even less impact on the existing built fabric when the addition is built. The end of the link will form the circulation to the new addition and can easily be pre-framed. In the present the link creates a contrasting and interesting space adding to the interior spatial variety. If the link is included in the initial design it will be easy to consider with the circulation and layout of the house. The link could become the starting point of extensions to come.

Figure 101: *Seaview House* by Jackson Clements Burrows Architects, 2009, (Australia).

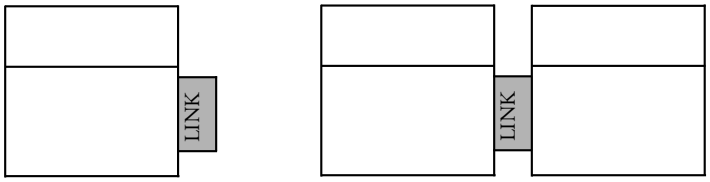


Figure 102: Schematic of *Seaview House*. Drawn by author.

Link Design Experiments

Different approaches to materials, window placement and layout were trialled in the link design experiments. Similar to *Park Terrace* and *Mascara House* the design experiments had contrasting links to the rest of the dwelling.

Different options for corner windows and highlight windows were trialled so that the link could be added conveniently on the elevation.

Figure 103: Link design experiments.

Adding onto Irregular shapes

Curved or organic shapes are generally more difficult to construct and add onto than square or rectangular forms. While curved or irregular shapes should be approached with caution, they can be incorporated into adaptable design via extrusion or through utilising a link element. *Cloud House* demonstrates the freedom the link offers in terms of form as it connects the existing, ordinary house to the organic shaped cloud. The end sections of the cloud are linear allowing the link to easily connect the new to the existing.

The cloud would be difficult to alter transversely along the curves, however the long and tight site would not allow any extensions on the side in this case. Extruding the cloud longitudinally could be a possible avenue for extension though not without complications through the organic form.

Approach to irregular shapes

Nonlinear walls to be located where extensions are not convenient or desirable. Furthermore, areas where extensions are possible or probable, should be linear for ease of construction between existing and new utilising the link element.

Figure 104: *Cloud House* by McBride Charles Ryan, 2012, (Victorian, Australia).

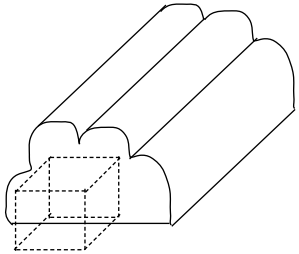


Figure 105: Schematic of a link connecting to *Cloud House.*

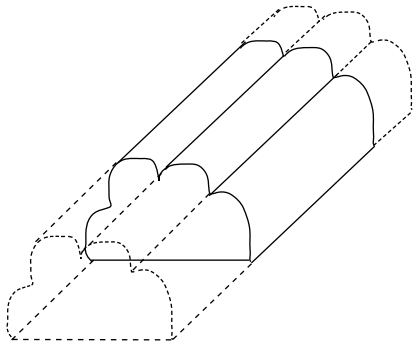


Figure 106: Schematic of an extrusion to *Cloud House.*

Add-on through repetition of module elements

iPAD by Architex, 2011 (Porkapa Beach, Taranaki) can be reincarnated into many different sized and shaped designs to suit different budgets and sites. Different modules can also be connected together using a link, which allows an undercover connection, or a deck, where you must walk out in the open from one module to another.

The "winglike walls that extend to brace the house and conceal the opened sliding doors" (Bell, 2012, p.89) which means less walls are required for structural bracing. This means more freedom for the layout of the interior which has clearly taken advantage of that with minimal use of walls and maximum glazing.

Grouped service location

The services are grouped into one clip on space. The services can be easily accessed for alterations or maintenance.

iPAD is modular with the design based on an underlying grid which allows the *iPAD* to be easily altered and added onto.

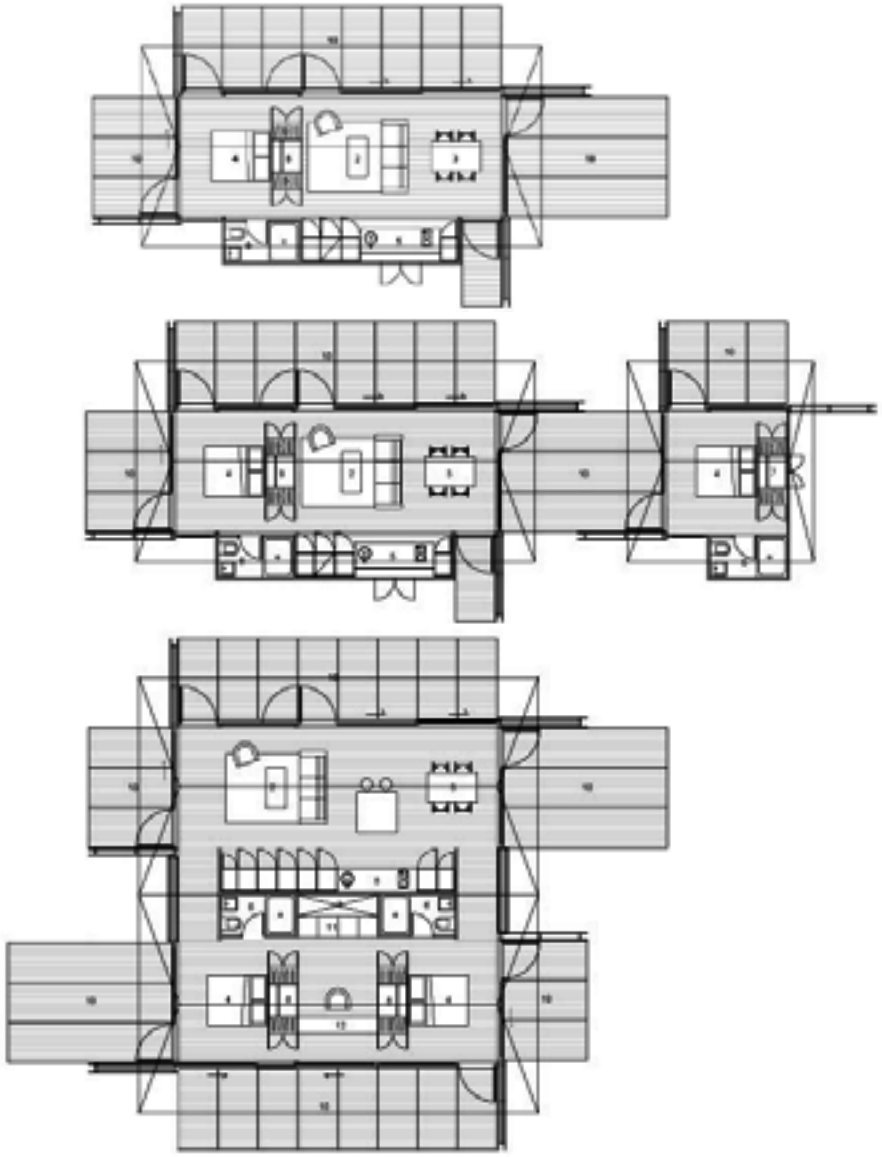


Figure 107: A sample of the different floor plan options for *iPAD*.

Figure 108: *iPAD* at Porkapa Beach, Taranaki.

Figure 109: *iPAD* at Porkapa Beach, Taranaki.

Add-on to a Flat Roof Structure

The flat roof can extrude in any direction. The flat roof structure is extremely adaptable as extensions are easily made in any direction. The flat roof is superior to the pitched roof as there is no issue of running out of head height or creating too much head height. The extension of the flat roof continues the head height in the existing dwelling infinitely or until funds or land is spent. If the parameters of possible extensions are known and the pitched roof can extend within those parameters then the pitch roof is a perfectly acceptable solution. If the parameters of possible extensions are not known and the potential extensions could have long spans, then the flat roof is the more suitable option.

Add-On top of a Flat Roof Structure

The flat roof can be designed to take floor loads if an additional storey is added. The flat roof members can easily be converted to floor joists with a little forward planning.

A lean-to could be easily added to the flat roof structure though the extension of the lean-to may be limited.

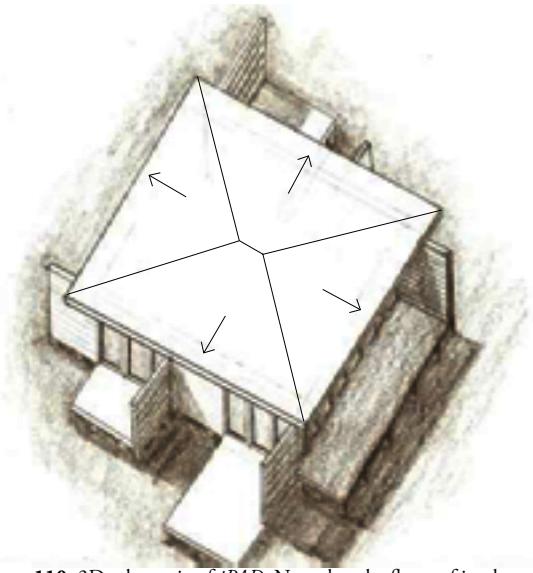


Figure 110: 3D schematic of *iPAD*. Note that the flat roof is a low pitch hip roof.

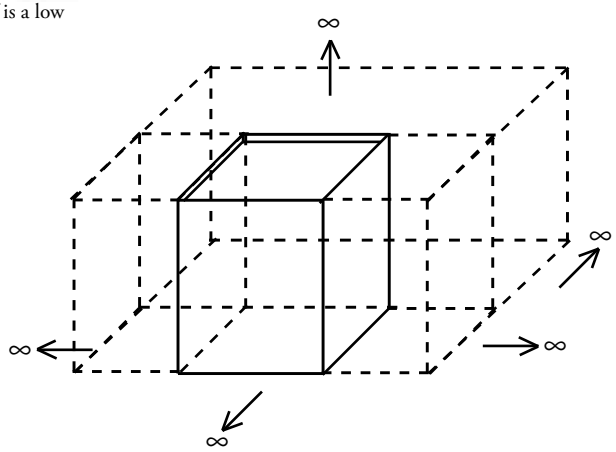


Figure 111: Different flat roof extension options

Add-in

The adaptable tactic of add-in was established in the literature review in Chapter three. The authors described the add-in process as leaving space unfinished so that additions could be made at a later date when the need arises or when it is affordable. In chapter three the add-in's were all dependent on the existing structure. This section proposes a design tactic where the additions are independent of existing. The benefit of having the new additions separate from the existing is that the new can be easily removed without altering the existing.

Ant House by mA-style Architects, 2012, (Shizuoka Prefecture, Japan) was built in one stage, however, its form is suggestive towards the add-in design tactic. A second skin is clear demarcated from the exterior envelope. *Ant House* provides an insightful solution for providing light into the second skin; a skylight in the roof below the skylight of the space within a space. The resultant space however, has no acoustic or visual privacy from the surrounding spaces.

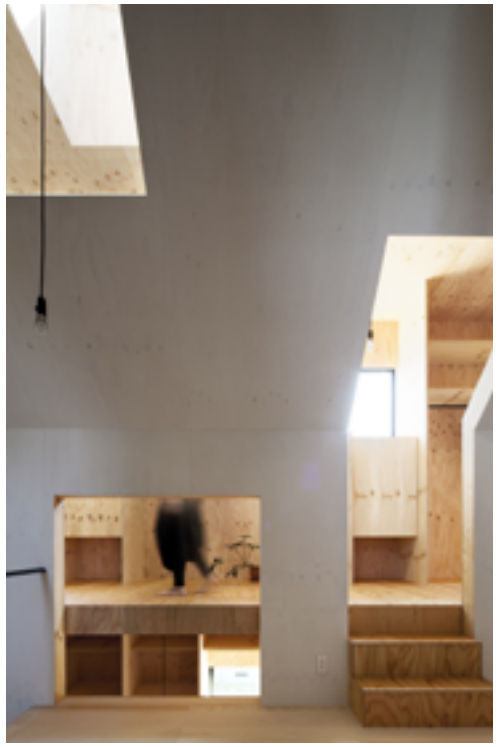


Figure 112: *Ant House* interior view.

Figure 113: *Ant House* interior view.

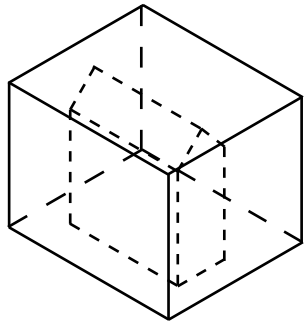


Figure 114: *Ant House* schematic. Drawn by author.

First Floor

Ground Floor

Figure 115: *Ant House* floor plans. Drawn by author.

The number and size of windows are generally small on the *Ant House* as it is located in a dense residential area. The small windows and dark metal clad elevation creates a contrasting approach to the light and timber clad interior. Skylights light the interior. The greatest contrast is between the interior and exterior is the windowless elevation which contains the entrance door and faces the street.

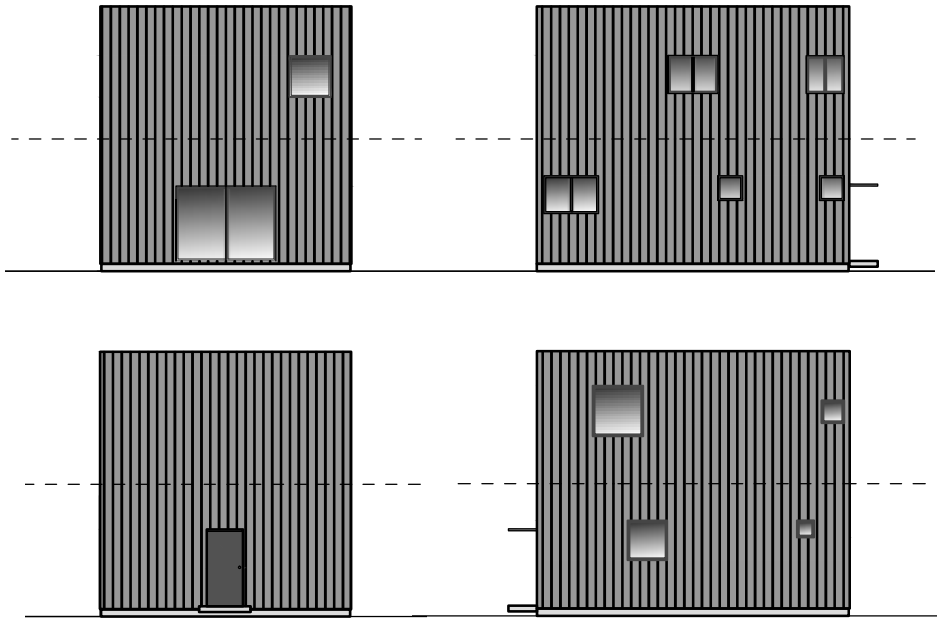


Figure 116: *Ant-house* elevations. Drawn by author

Figure 117: *Ant-house*

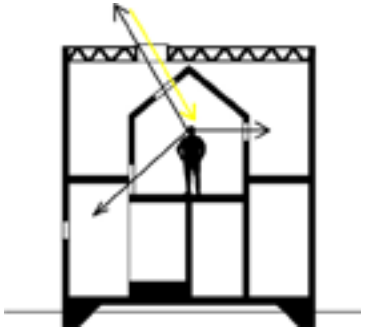


Figure 118: *Ant-house.* Section drawn by author

Adding volumes into a large space allows the external structure to be physically and visually separate from the add-ins. This gives the appearance and the reality of having an adaptable construction where the additions can be added, removed or modified easily.

Interiors can be created by stacking volumes or creating space on posts for example. For the volumes to be easily added and removed either large openings should be included on the exterior so that it can be removed in one piece or the volumes should be able to be easily disassembled and reassembled elsewhere.

The interior fit out of a volume can be done over time to suit the financial and social situation of occupants. With this approach the overall space is quite large and there will be issues with heating and acoustic privacy. The placement of windows will have to be carefully considered for future additions. The add-in approach where the internal and external structure is separate has a draw back where it requires some generous volumes that anticipate potential future changes to add-in a 'space within a space'.

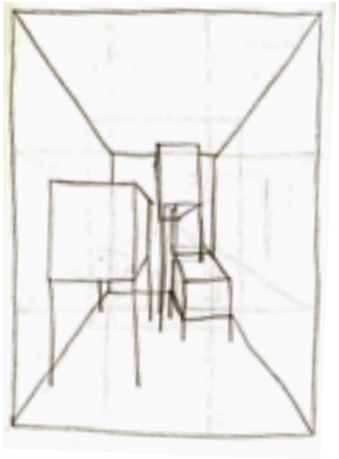


Figure 119: Volumes could be added into a large volume and places on posts.

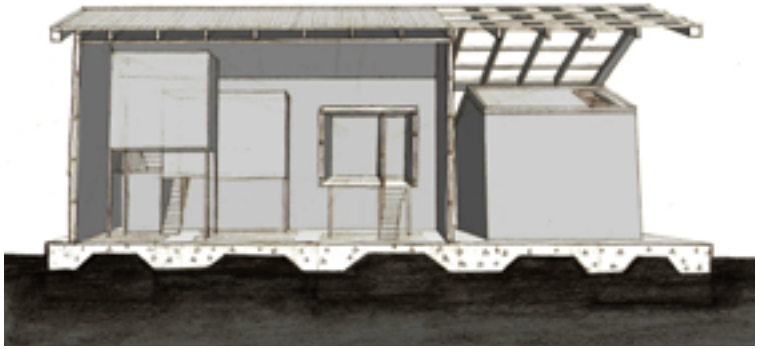


Figure 120: Trial design of add-in tactics where volumes are added into a large open volume. On the left the volumes are added into an enclosed volume. On the right a volume is added under a structure which is open to the elements.

Figure 121: Space within a space. *Country House in Tarusa* by Alexander Brodsky (Tarusa, Russia)

Overview of Adaptable Design Tactics

Open Plan
Provide varied spatial qualities within an open plan space.
If open plan space is included, ensure that quiet and private spaces are provided else where in the house.

Add-on
Houses should be designed with specific add-on locations in mind which have a specific intent.

Add-on with a link
The link can join up disparate shaped or sized structures which allows freedom of design and form. The link has little impact on each structure and minimises change to built fabric when both adding or removing structures. The link allows circulation from one structure to another which allows consideration of present dwelling location and future additions on site during initial design process

Add-on to a flat roof
The flat roof can be extruded horizontally but also leans itself to an easy conversion if an additional floor is added and the flat roof members become floor members.

Approach to site
All approaches to ground plane allow expansion upwards (providing the structure allows) and outwards unless the structure is merged with the ground plane. Elevating a dwelling off the ground plane is adaptable as it allows expansion downwards without requiring construction of additional roof.

Adaptable tactics for Structure:
Beam and column construction is preferable which creates:
- Clear span floors
-Clear legibility between the loadbearing beam and column structure and the non-loadbearing walls.
- Separation of facade from the loadbearing structure
- Differentiating between non-loadbearing and loadbearing walls:
- Structural provisions for an additional storey

Overview of Adaptable Design Tactics

Open plan

Open plan space is a common design tactic in modern houses (Dowling, 2008). Literature on adaptable architecture often advocates neutral and indeterminate open plan space devoid of specific character. To look towards specific adaptable housing this thesis recommends that if open plan space is included that spatial variety be provided both within the open plan space and through the rest of the dwelling. A space can still be open plan with different stud heights or natural light conditions for example. Open plan can be included in adaptable design if varied spatial qualities are included within an open plan space. As open plan creates a very public space without acoustic privacy it must be ensured that quiet and private spaces are provided else where in the house

Structure

Chapter three outlined different approaches to structure; clear span floors, beam and column construction, separation of facade from the loadbearing structure, differentiating between non-loadbearing and loadbearing walls, structural provisions for an additional storey, and providing the minimum of non-loadbearing internal walls. This summery outlines a hierarchy in the tactics for structural adaptability. Beam and column construction is superior as it means that there are no loadbearing walls, external or internal, on loadbearing column and beams. This means that the facade is automatically separated from the loadbearing structure and creates clear span floors. The column and beam structure can also be designed to support an additional storey. The column and beam structure however, comes at a price as it will need to be engineered and have additional constructions costs. The column and beam structure can be combined with conventionally residential construction methods to have a few specific columns and beams to take the load off internal or external walls. The loadbearing column and beam structure is also easily differentiable from the rest of the non-loadbearing structure. If a column and beam structure is not implemented, at the very least the structure should have a clear span floor. This is often easy to achieve with trusses which have a long span range.

Add-in

Different add-in tactics were explored in this chapter where the internal structure is separate from the external structure. It was concluded that the tactic requires some generous volumes that anticipate potential future changes to create a 'space within a space'.

Add-on

Different add-on tactics were discussed in Chapter three through extension of the gable, mono pitch roof, flat roof and lean to. It was found that the pitched roofs could only extend a certain distance before the head height became to small or too great (in the case of the high side of a mono pitch roof). Add-on's through a lean to were also limited through the head height especially if the soffit and stud height is low on the original structure. "A pitched roof freezes a plan into one limited form" (Hay, 2012, p. 33). Flat roofs however, presents the most opportunities for additions as a flat roof can be extended until space or money runs out.

Extrusion or extension of pitched, flat or mono pitch roof required the new structure to be connected to and integrated with the existing structure. The link however is a key tool which can separate the existing structure from the new structure. There is usually only a small area where the link connects the structures which means that sections can be added and removed without much hassle and alteration to building fabric. The link is often small with a reduced stud height so it can fit under the eaves (if any) of two structures. The link allows freedom of form as disparate sized or shaped structures can easily be connected. The link often becomes the circulation between structures which is easy to accommodate into existing and future schemes.

Discussion: Add-On Versus Add-In

The add-in process has some advantages and disadvantages from add-on tactics. With add-in you get the final volume of the building in the first stage. This approach would be particularly useful with sites where the building envelope is restricted and it is better to have the maximum building envelope and site coverage in the first stage. The add-in process has advantages for construction as additions will always be constructed undercover and waterproofing is not an issue as there is no change to the building envelope in additions.

The main challenges with the add-in process are designing the first stage to accommodate future additions while providing a building which is still adaptable and liveable in the present. Consideration of services, natural light and ventilation are also a concern where the additions are not adjacent to the external envelope. Access between the existing space and additions will also need to be considered.

Considerations for the add-in tactic is how can you provide infrastructure to support future rooms within the empty space? This is particularly important for services. Timber subfloors can allow services to be connected at any location from the ground floor however, services to a second or third storey would need to go through a false wall or duct, the location of which would need to be predetermined. Structurally there would be concerns with providing sufficient support for future add-in's through the foundation floor and external walls. With the add-in method the starting point is always an empty space or part thereof.

For one reason or another the add-on might be preferred over the add-in approach or both could be used together. It is the consideration of these tactics to site and client which will influence how and why each tactic may be used or omitted.

Aesthetic of the Add-on

This thesis argues that more new houses should be designed with the consideration of potential additions and alterations. The layout and junctions between old and new will be an issue related to the existing building. Juxtaposition or integration between the aesthetic of the old and new will always need to be considered.

There are many options to approach the aesthetic of the add-on. A select few are explored here to inform the design process in the following chapter. These are contrast, complement, extension or extrusion of existing, merger of original design and hybrid.

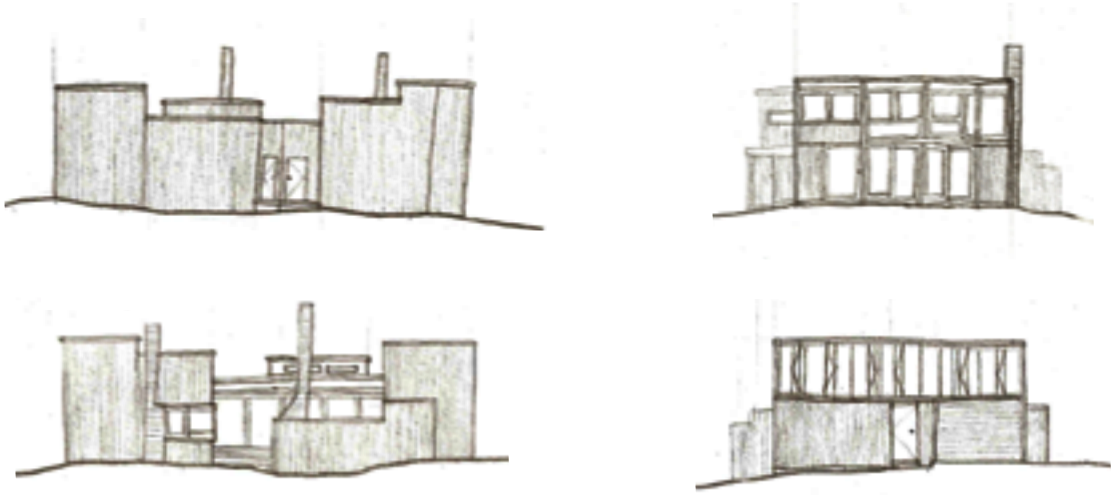


Figure 122: *Walker House* by Mitchell and Stout Architects, 2005 (Coromandel Peninsula). Elevations drawn by author.

Walker House

Walker House has a combination of various sized wings around a central courtyard. Although constructed in one stage, *Walker House* is interesting to study for its different approaches to areas and elevations while retaining a cohesive aesthetic through the consistent use of vertical timber cladding.

Figure 123: *Walker House.*

Figure 124: *Walker House.* Perspective drawn by author.

Hybrid Approach

Gehry House by Frank Gehry, 1977-1978, (California, USA) is an example of a hybrid approach to the aesthetic of the add-on. Some parts of the building mimic the existing with a repeat of a pitched roof with central rectangle window in the roof space, albeit on an angle.

Other parts of the building are totally contrasting to the existing with completely different materials and windows. The interior is quite interesting where the exterior walls have been built around becoming interior walls.

Figure 125: *Gehry House.*

Contrast

The Trojan house takes a completely different approach of the addition to the existing. Because of the narrow site the existing and addition cannot be viewed together so the vastly different approach in style cannot be viewed at once.

The new modern extension of *Shift Top House* was built on top of the existing traditional house.

The extension of *Park House* is contrasting to and dominates the existing in size and scale.

Integrate

In the *Folded Corten House* it is obvious that the traditional plaster and steep pitched roof was existing and the modern flat roof structure with clad corten is the new addition. The addition however, seems to integrate itself with the existing. It does this by wrapping itself around the existing. Furthermore the new structure allows the existing to be visible through the corten extension. This is particularly effective at the entrance. The corten follows the line of the existing house soffit revealing the existing wall cladding above and below the addition.

Figure 126: Top row left; Addition to *The Trojan House* by Jackson Clements Burrows Architects, 2009, (Melbourne, Australia).
Figure 127: Top row right; *The Trojan House* Existing and road frontage.

Figure 128: Middle row left: *Shift Top House* whereby the extension was built ontop of the existing first floor. *Shift Top House* by Meridian 105 Architecture, 2012, (Colorado, USA).
Figure 129: Middle row right: *Park House* by PLY Architecture, 2007, (Michigan, USA).

Figure 130: Bottom row left: *Folded Corten House* by x Architekten, 2004-2007, (Austria).

6.0 Design Generation Two

What adaptability means for this study

Adaptable design allows alterations and removals to be done easily in the future

&

Adaptable design allows a change of use through considering social and utility function*

&

Adaptable design which considers the design as a whole and its aesthetic beauty

*Social use takes into consideration the experience of space over time through natural light, sense of enclosure, acoustic and visual privacy. Specific spatial qualities are just as important as variable spatial qualities. Utility function considers the ability to physically use space in different ways.

Introduction to Design Generation Two

In chapter two it was discussed that any space can be used for any activity as people are adaptable. As long as you provide a physical space, and sometimes even when you do not, people tend to make a space work for them. While the utility function can be satisfied with generic, indeterminate spaces the social function of space can only be satisfied by considering the quality or character of each space. This includes, but is not limited to, considering natural light, sense of enclosure, visual privacy and acoustic privacy. These factors influence how enjoyable or suitable a space is for social use. The survey conducted for this thesis asked participants their preferred spatial characteristics for a variety of activities. The results showed that individuals preferred varied interior qualities. It was concluded that the indeterminate approach could satisfy utility function, as inhabitants could live and use the space. Social function however, is unlikely to be satisfied by the indeterminate approach as the experience of space is often not considered beyond the utility requirements.

Design generation one provided a testing ground for the ideas and theories developed in the literature review, survey and subsequent definition of what adaptability means for this thesis. The design however, resulted in many undesirable qualities which are discussed in this critique. Lessons learnt from design generation one are addressed in design generation two. These were the holistic consideration of aesthetics, approach to social function which is not too specific, including moving building elements and considering changes in spatial qualities over time.

The definition of adaptability is a reflection on the research throughout this thesis, which is used to guide the application of the adaptable design tactics in design generation two. Not every adaptable tactic was explored in the design process, nor was there an intention to. The design aims to address a few key tactics, activities and site conditions in order to demonstrate an exemplar of adaptable design.

Terminology

Figure 131: Concept for design generation two. A valuable adaptable design tactic, the link, is the centre point of the design both aesthetically and for adaptability.

One technique recommended by Friedman (2002), Schneider & Till (2007) is to encourage adaptable use by eliminating room labels and furniture on architectural drawings. Schneider & Till even go as far as to state that "the naming of the room goes hand-in-hand with the controlling of the activities in that room" (2007, p. 147). This statement questions the role of architectural drawings in the relationship between space and use. However, Turner states that "in the case of categorisation, what we designate a 'space' itself is loaded with our cultural interpretation of space, so that even labelling a 'space' as a 'room' or a 'street' depends on what our understanding of a room or a street is" (2003, p. 663). As Turner states individuals have preconceived ideas of what room labels mean and will have different ideas of what each space will be used for depending on their individual preferences. For example, the term living room is pretty arbitrary, which may include specific activities such as watching TV, socialising with friends, eating, drinking, doing homework and so on. Room labels have been omitted in this thesis, with furniture in plan and sectional perspectives used to indicate possible uses and give an indication of scale to assist occupants in envisioning and arranging furniture to their preference.

Design Generation Two Concept

Mass suburban houses are often single storey, with maximum site coverage which means little or no room to expand. The hip roof is often a complicated extrusion of a plan generated design. These types of houses often have low studs and even lower soffits which are difficult to add onto. Design generation two is in reaction to the critique of mass suburban houses. The main adaptable design tactics used are outlined.

Two storey dwelling

The exemplar of adaptable design in this chapter is two storeys which will take up less room on site and allow greater options for additions with more garden/yard area. The two storey design also allows for double height interior space.

Open Plan

Open plan can also be considered an add-in tactic as non-loadbearing partition walls can easily be installed if required or desired. Conclusions throughout this thesis acknowledge the merit of open plan especially in smaller dwellings but also acknowledges that open plan can sometimes be neutral and devoid of specific character. In each design version, specific spatial variety in the open plan space has been provided through varied stud heights and varied natural light qualities. The link which features in each version is particularly useful for providing this. As open plan creates a very public space without acoustic privacy other visually private and acoustically private spaces have been provided elsewhere.

Structure

Beam and column construction creates a superior adaptable structure as there are no loadbearing walls, external or internal. This means that the facade is automatically separated from the loadbearing structure and creates clear span floors. The column and beam structure can also be designed to support an additional story. However, it comes at a price as it will need to be engineered and have additional constructions costs. Furthermore, the steel loadbearing column and beam structure is easily differentiable from the rest of the timber non-loadbearing structure.

Add-on through the extension of a flat roof structure

Extrusion or extension of pitched, flat or mono pitch roof lines are limited in their possible extensions. A flat roof has been utilised as it creates greater opportunities for extensions and also allows the roof to become a floor if additional storeys are added.

Add-on using the link

The link is a key tool which can separate the existing structure from the new. There is usually only a small area where the link connects the structures which means that sections can be added and removed without much hassle and alteration to building fabric. The link is often small with a reduced stud height so it can fit under the eaves (if any) of two structures. The link allows freedom of form as disparate sized or shaped structures can easily be connected. The link often becomes the connection between structures which is easy to accommodate circulation into existing and future plans.

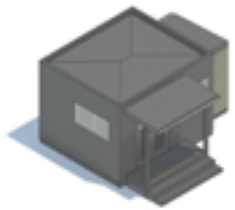
General adaptable design tactics implemented into the design:

- Including unfinished space with provisions for future plumbing, omitting shelving or storage and leaving walls unlined
- Careful consideration of the entrance and services location
- Add-in second floor in double height space
- Careful consideration of location of windows for present and future use
- Careful consideration of present dwelling location and future additions on site during initial design process
- Consideration of circulation
- Easy access to services
- Absence of electrical wires or services in non-loadbearing walls
- Provide plenty of storage
- Moving building elements
- Two entries to a room
- Pendant lights with long flex

Design: XS, S, M & L

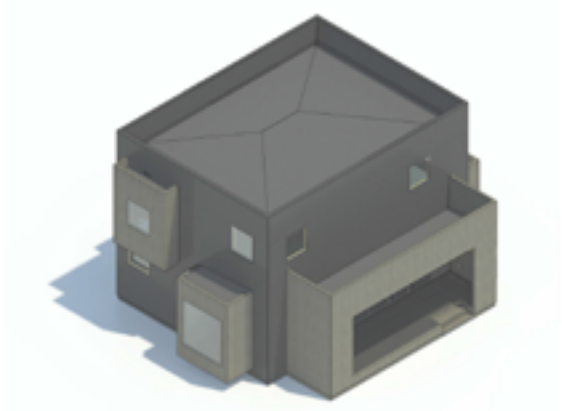
The focus of this thesis is to investigate alternative and adaptable mass suburban housing. This thesis proposes several different sized designs which can be easily altered for occupants to suit their lifestyle, budget and site. This design approach is divided into several versions, extra small, small, medium and large. The way of differentiating the same design ideas into smaller or larger versions is a common technique which can be found in *iPAD* by Architex NZ Ltd or *Eunoia Baches* by Harriet Piklington, (NZ) among others.

The design tactics which, are the same in all versions are demonstrated in the large design. Anything specific to a particular sized design will be explored individually. These tactics are explored through the definition of adaptability developed in this thesis to create adaptable homes. The definition is concerned with the holistic approach to ease of additions and removals, consideration of social and utility function and overall aesthetics. Different materials and roof types are trialled further demonstrating the diversity and adaptability possible with this design. Areas of further research are highlighted at the end of the chapter.

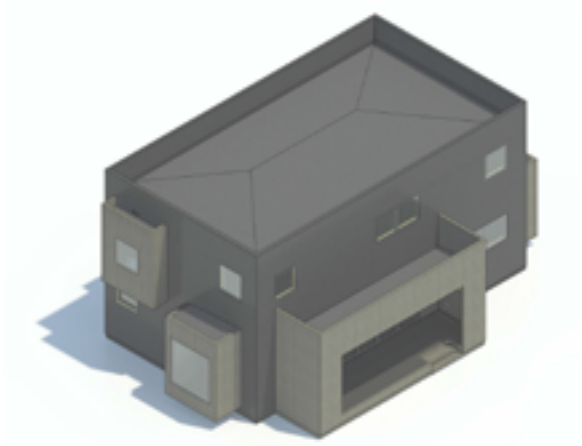


Extra Small
Floor Area
Indoor Space: 20 m²
Covered Outdoor Space: 3 m²
The easiest to add or remove and the cheapest being the smallest version

Small
Floor Area
Indoor Space: 29 m²
Covered Outdoor Space: 6 m²
The small version is designed with a concrete foundation so that it can function as a garage at some time in its life. The foundation can easily be changed to a timber subfloor if its unlikely it will used as a garage



Medium
Ground Floor
Indoor Space: 75 m²
Covered Outdoor Space: 22 m²
First Floor:
Indoor Space: 35 m ²-75m ²
Possible Deck Space: 17 m ²



Large
Ground Floor
Indoor Space: 100 m²
Covered Outdoor Space: 22 m²
First Floor:
Indoor Space: 40 m² -100 m²
Possible Deck terrace Space: 17 m²

Figure 132: The design versions are all in keeping with the same aesthetic using the same materials, window sizes and proportions, though the design can be easily adapted to other styles.

Large Design

Beam and column construction

A column and beam structure can be engineered to specific site conditions. The engineered structure can increase costs but it is the most adaptable structural solution. Every single wall including exterior walls are non-loadbearing and can be easily removed. The structural provisions for additional storeys can be included in the design of the frame. The steel beam and columns are easily identifiable as the loadbearing structure compared to the non-loadbearing timber structure.

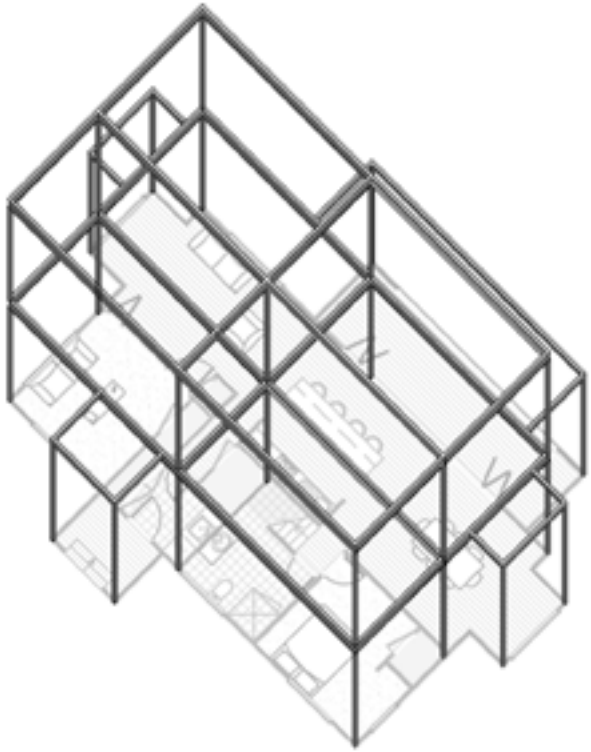


Figure 133: The Large design version with structural beam and column frame. The frame can be designed to take additional storeys and allows all walls to be non-loadbearing.

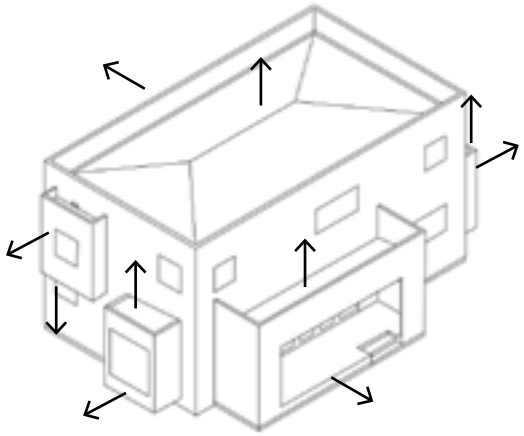


Figure 134: The flat roof and beam and column construction allows expansion in any direction outwards and upwards. The design can also be extended downward where the first floor links overhang.

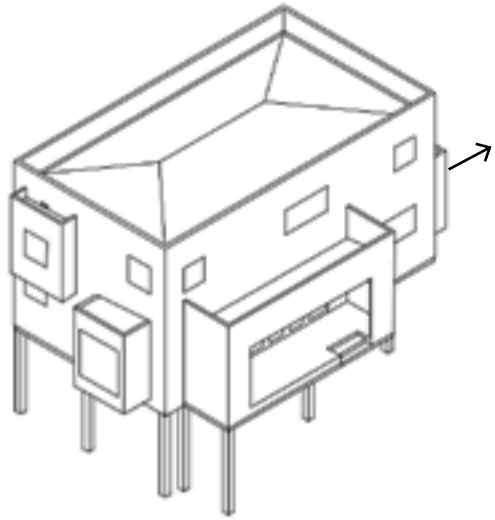


Figure 135: Elevating the design above the ground on piles allows for further possible expansion downwards. This could be particularly useful on sloped sites.

Site

Where the house is placed on a flat site it should rest firmly on the ground to allow expansion in multiple directions. Accessibility and room for future extensions should be considered when placing the house on a site.

The link from the first floor hangs above the ground. The floor of the link could eliminate the need for an additional roof if walls and a floor are constructed underneath the link to expand the ground floor area.

If the house is on a slope the house should be raised above the ground if possible for ease of future extensions below the ground floor.

Provisions for future plumbing

The large, medium and extra small designs are all on a timber subfloor allowing services to be easily altered. The small design however, is on a concrete subfloor as one of the proposed uses is a garage. Providing ease of access, timber subfloors allows ease of alteration to services on the ground floor. Services on subsequent floors however, need to be carefully considered. Transferring service pipes from the first floor can occur outside the building envelope although it can be very unattractive. Several specific locations for transferring service pipes from first to ground floor have been identified. The ground floor may need to be slightly altered depending on possible plumbing layouts on the first floor, though they will be minor: moving around shelves in the wardrobe, relocating the washing machine or laundry sink or moving the shower forward and creating a false wall behind it.

Timber subfloor and centralisation of services

The services are easily accessible through an access hatch in the timber subfloor. Grouping the services together also increases the ease of accessibility to services.

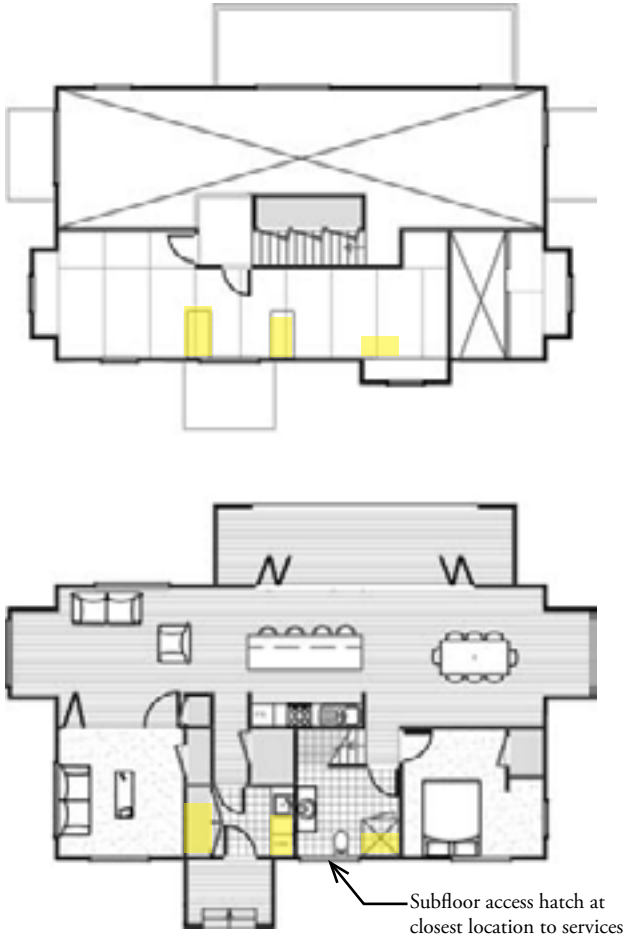


Figure 136: Large Version Ground Floor Plan. Possible locations to bring services down from first to ground floor are shown in yellow.

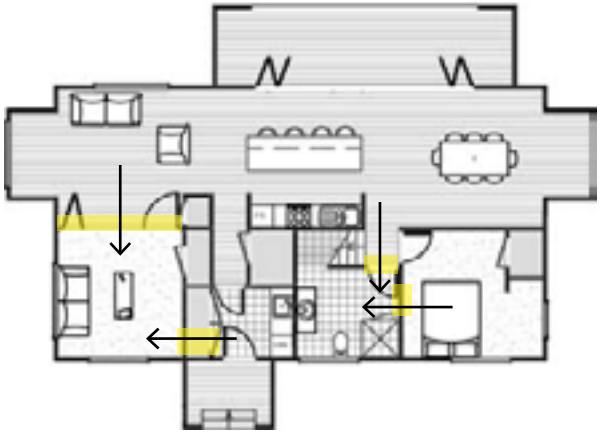


Figure 137: Large Version Ground Floor Plan. The yellow shading indicates the rooms which can easily be adapted for dual access.

Two entries to a room

Two entries to a room is a useful tactic as it gives options. It is particularly useful when it gives the option between entering a room from a public space or a private space. Although the bedroom is close to the bathroom already, it is possible to easily add a cavity slider for dual access from the living space and bedroom. The access from the bedroom to bathroom gives greater convenience and privacy than the access from the public open plan living space.

Two entries could be particularly useful for a home office, for boarders, independent teenagers or a flat situation where a separate and private entry allows the rest of the dwelling to be undisturbed. If the room was used for an office the two entries allows clients to enter the dwelling without going through any private residential space. Bi-folds can be placed in front of the laundry so that the entrance looks tidy and professional. Non-loadbearing internal walls allow the interior to be easily rearranged and a section of wall removed to allow for a second entry point.

Figure 138: Large Version: Ground Floor Plan. The yellow shading indicates built in cupboards. The green shading indicates possible future locations of storage either built in or free standing.

Provide Ample Storage

In the literature review the importance of storage was discussed. For space to be convenient and adaptable, inhabitants must be able to put away equipment from one activity and take out equipment for another. Some furniture may be permanent such as a desk but the ability of the desk to be used for an office, sewing room, art table and so on depends on having the storage space to put away unwanted bulky equipment such as a printer, paints, scanner or sewing machine etcetera. While there are several built in cupboards there is opportunity to install more built in or free standing cupboards. The shelving in the storage cupboards could be omitted on the initial build for the occupant to construct themselves.

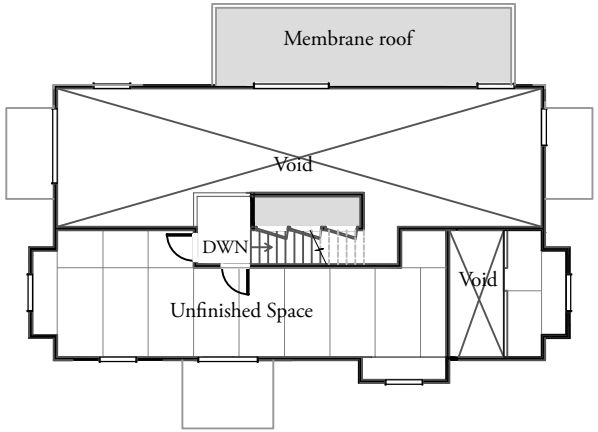
Add-in: Unfinished Space

In the literature review it was discussed that the add-in tactic is best used when inhabitants can still use the dwelling without being significantly affected by the unfinished space. The ground floor is completely finished. In the case of elderly inhabitants, there is no need to go upstairs with the exception of storage. The upstairs area, whether unfinished or finished can be used by more able visitors or inhabitants.

The first floor is proposed as being entirely unfinished. Over time when the need arises or finances are available the first floor can be developed. Several alternative layouts for the first floor are demonstrated though many more configurations are possible with the absence of loadbearing walls. If suitable the walls in the unfinished space can be left unlined. Ply flooring can be left unfinished, varnished or carpeted at the inhabitants leisure.

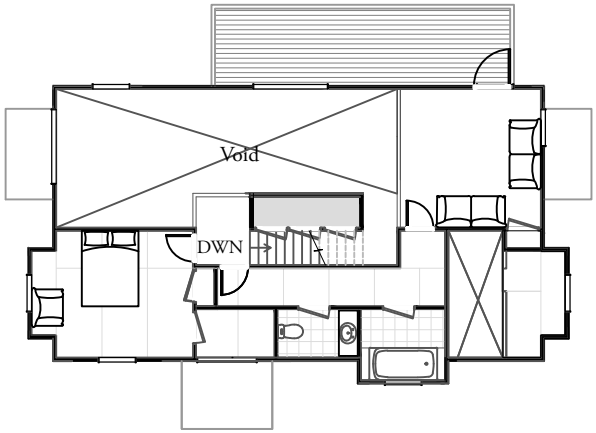
The roof of the covered first floor section is constructed with membrane roofing on rafters which are sized as floor joists. If the first floor is extended and it is possible to access the roof as a terrace, timber decking on supports can be added to create an attractive and perfectly even surface. The parapets of the roof terrace are extended to create balustrades.

Large Version: Proposed unfinished space on the first floor
42m2



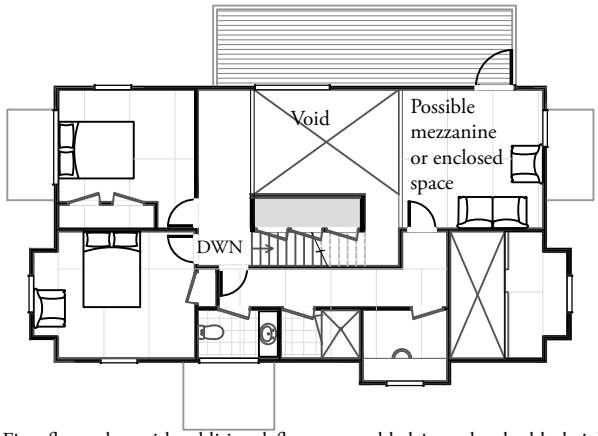
The first floor is proposed as entirely unfinished. Interior walls including storage and a possible bathroom can be added at a later date.

Option One
55.4m2



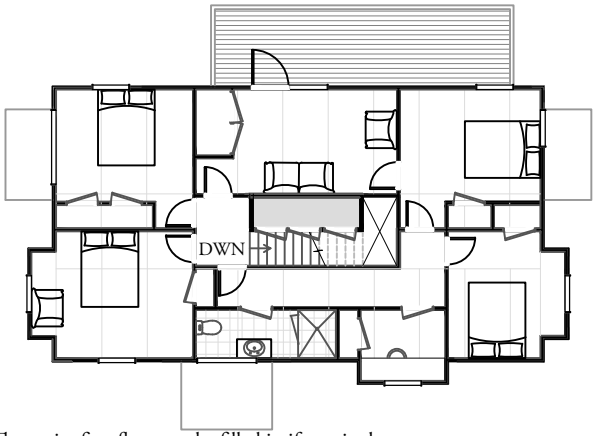
First floor plan_with additional floor area added into the double height space. The floor plan is divided into a possible combination of bathrooms, storage, bedroom and living room. The bathroom fixtures are proposed near the places identified for transferring services from first to ground floor.

Option Two
72m2



First floor plan with additional floor area added into the double height space. The walls adjacent to the void (if any) can be half height and create a mezzanine floor or full height and create an enclosed room.

Option Three
93 m2



The entire first floor can be filled in if required.

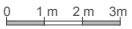


Figure 139: Different first floor plans and roof terrace options

Double Height Interior

The double height space has sufficient height to extend the first floor and create two single height spaces if required. The stairs are centralised providing convenient circulation to the existing first floor and any future extensions of the first floor.

The windows along the void create a pleasant and light filled space in the double height space and can provide light, ventilation and view if the first floor is extended. The height and location of the windows in the void have been considered for head height, composition and window placement which allow the space to be easily divided into different layouts.

The double height space adds to the variety of spaces within the house. This also creates contrast to the single height studs found throughout the rest of the design.

Figure 140: Section through the double height space of the large design where the first floor is unfinished.

Figure 141: Section through the double height space of the large design. A floor has been added into part of the double height space at a later date.

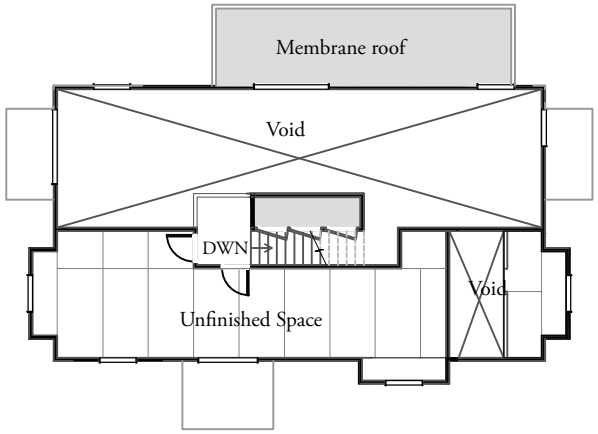
Provisions for access to the roof

A storage space has been included parallel to the stairs from the ground to first floor. The storage area can be converted to stairs connecting the first floor to roof terrace if required, as the length and width has been pre-desinged for this. If roof access is not required, and the stairs not installed, the space will continue to functions as useful storage.

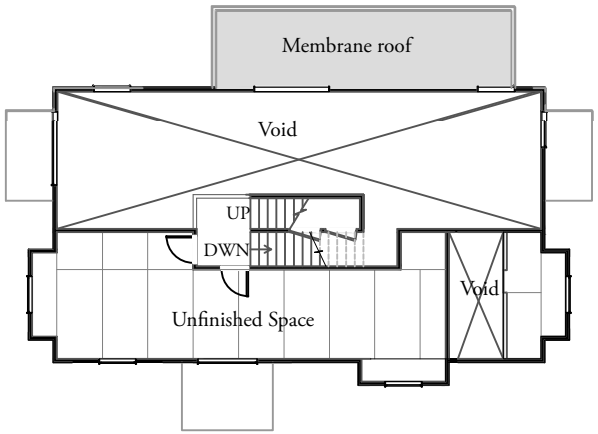
The roof space above the proposed stairs is to be framed out for possible future access.

Structural and design provisions allow a straight forward process for adding access to the roof. A small structure to provide covered access to the roof terrace can be added at a later date. Larger extensions on the roof terrace are possible and can be added if extra interior space is required.

Large Version: Provisions for stairs to a possible roof terrace from the first floor

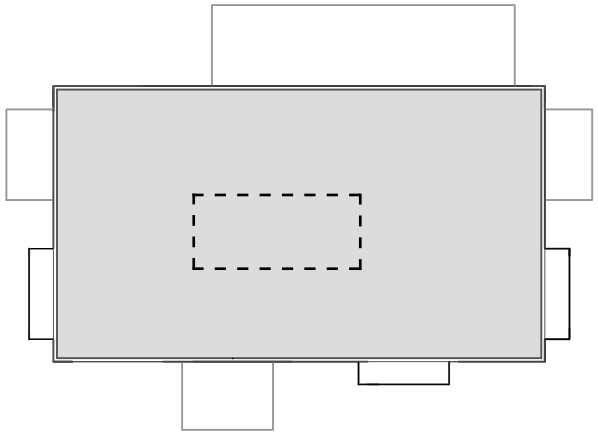


First floor plan with provision for stairs to a possible roof terrace. The area intended for the stairs in the future, functions as storage in the present. The space could be used for long term storage for Christmas decorations and holiday suitcases etcetera.

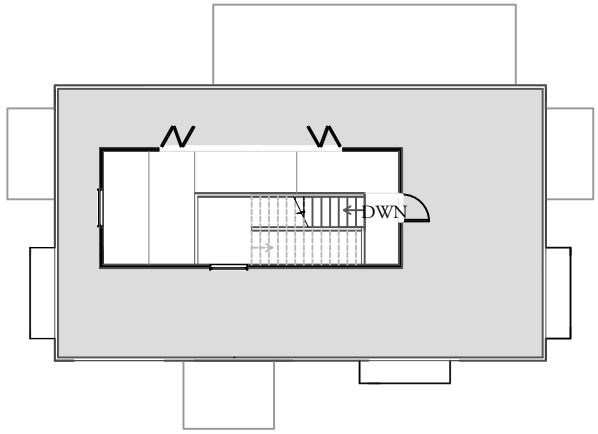


First floor plan with stairs installed between the first floor and roof terrace. Some storage under the stairs can still be retained.

Figure 142: First floor plan options



Roof terrace without access. The dashed line indicates the area to be framed out for the stairway void. The void can be narrowed but is shown as a void over the stairs from first floor to roof terrace as well as ground to first floor to allow light into the stairwell.



Roof terrace with access and small interior area. A partial height wall can form a barrier and will allow natural light down the stairwell.

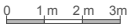
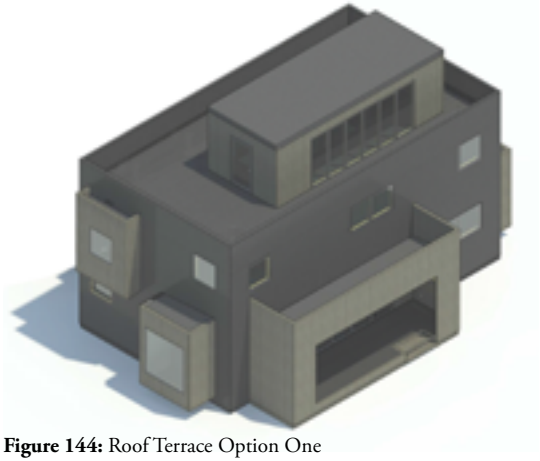


Figure 143: Roof plan options

Different Options for the Roof Terrace

Several alternative layouts for the roof terrace are demonstrated though many more configurations are possible. The layout of the roof terrace is a trade off between the amount of interior versus exterior space.

The roof terrace is constructed with a membrane roof on plywood and rafters which are sized as floor joists. The rafters are flat with additional members creating a slight fall in four directions from a central ridge line. The fall in the roof is slight allowing the roofing to be walked on. However, if the roof terrace is accessible and used frequently, timber decking on specific supports can be used to create an attractive and perfectly level surface. The parapets of the roof are extended to create a safety barrier.



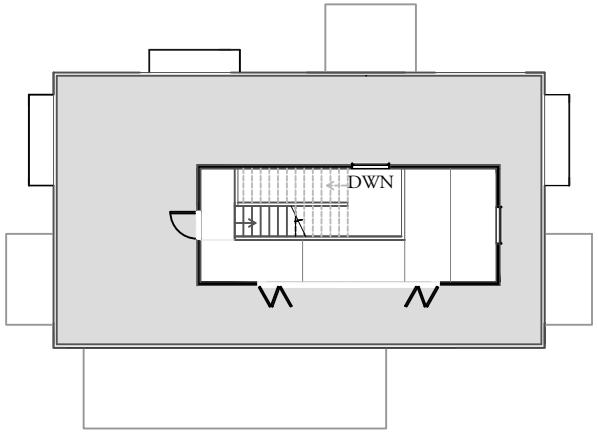
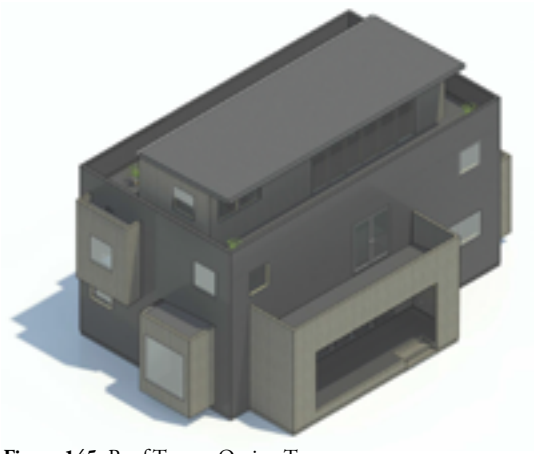


Figure 144: Roof Terrace Option One
Interior Space: 15m2
Exterior Space: 65m2



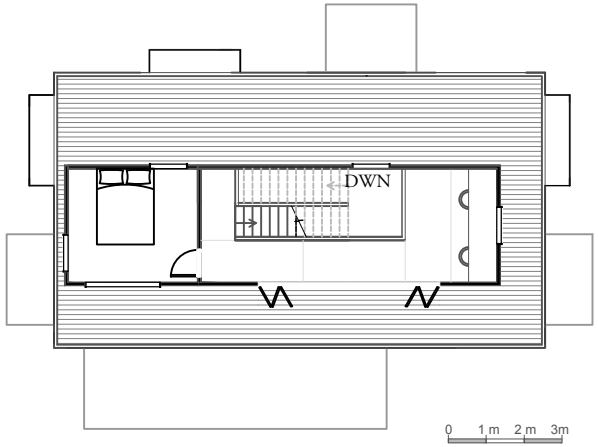
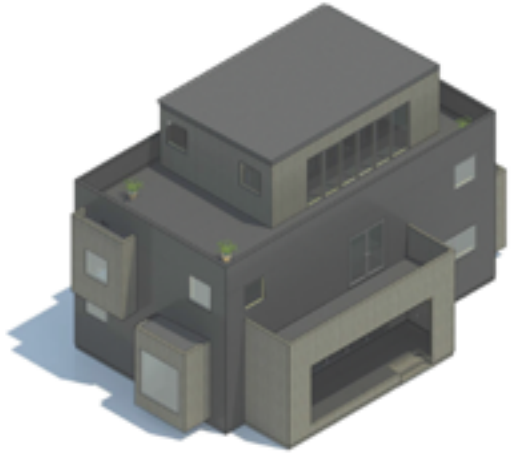


Figure 145: Roof Terrace Option Two
Interior Space: 25m2
Exterior Space: 55m2



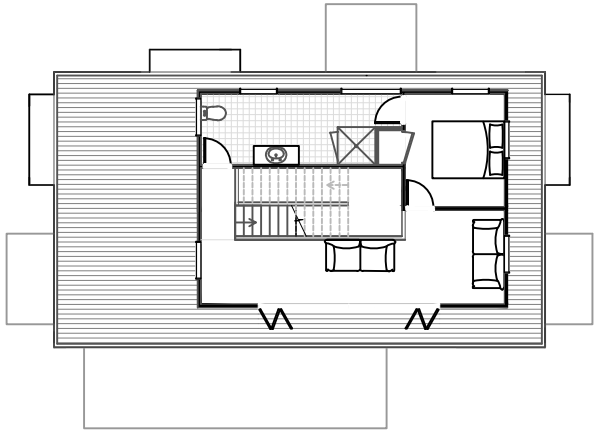
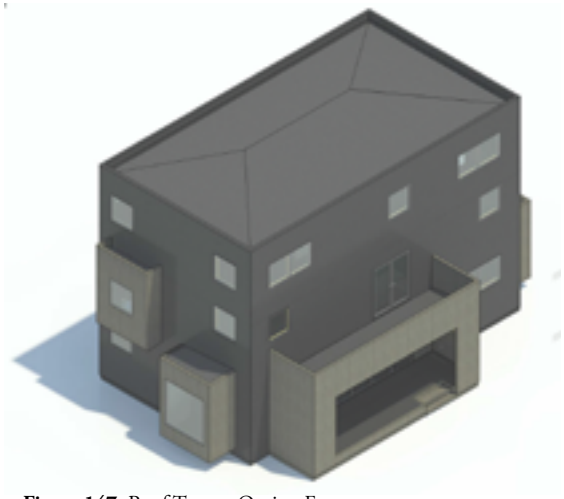


Figure 146: Roof Terrace Option Three
Interior Space:40m2
Exterior Space: 40m2



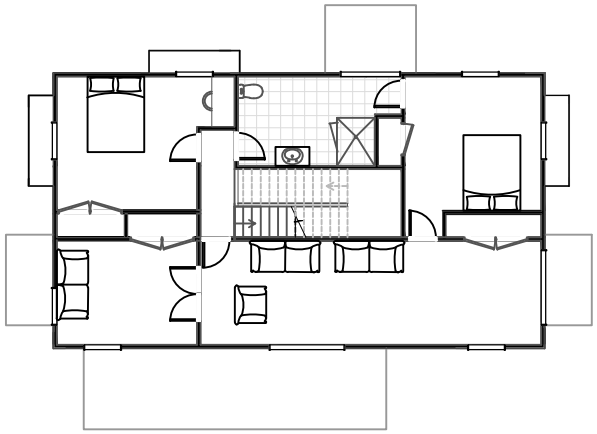


Figure 147: Roof Terrace Option Four
Interior Space: 80m2
Exterior Space: 0m2

The Link

Figure 148: The link could easily accommodate an office or study. The link could be left open so the inhabitant could be a part of the action in the main living space or younger family members could be supervised.

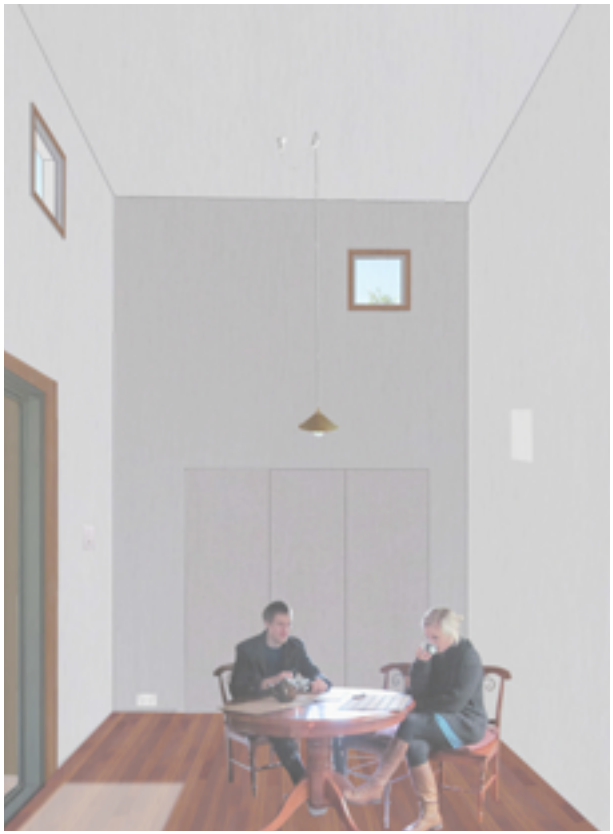


Figure 149: The link could be shut off from the main space with large bi-fold doors. The bi-fold doors could have an STC rating for acoustic privacy.

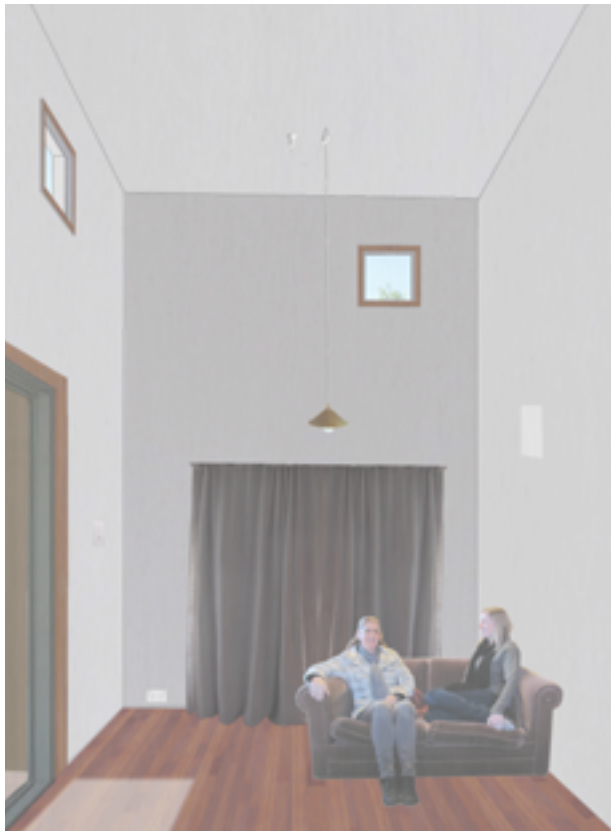


Figure 150: The link could be closed off from the main space with curtains.

The link is the corner stone of the design, both aesthetically and in terms of adaptability. The link has several unique properties which make it ideal for different uses. The link can be small as its attached to a larger space. This means that the link can physically be small but feel large when opened to another space. The ability to easily close the link off or combine it with a larger space is valuable. It can be open or can easily be closed off providing visual and possibly acoustic privacy. The link creates a specific space to put things which might otherwise be in the way or awkward in one open space.

Figure 151: A window seat could easily be installed in the link. The window seat could have many uses, a stage for children, a temporary place to sleep, a sunny spot to chat and have a hot drink and so on. In addition storage could be held under the seat.

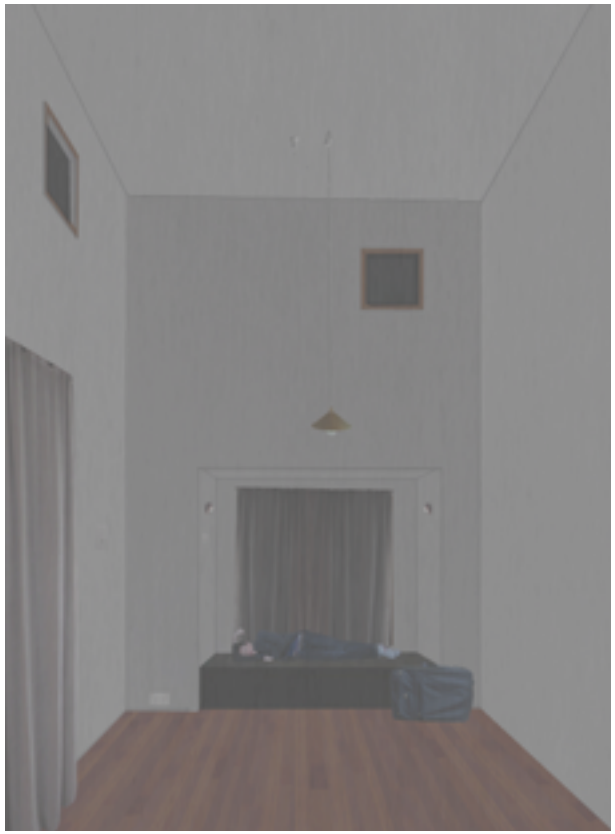


Figure 152: The link with a window seat could double as temporary accommodation. The window seat can be in place all the time compared to other temporary solutions where mattresses must be brought out and stored again after use.

Figure 153: As the link can be easily closed off, using the link for temporary accommodation is less intrusive than housing extras in the living room. Visitors baggage and bedding can be closed away and forgotten about.

Figure 154: Exercise equipment can be quite intrusive in a room. The link is big enough to accommodate even large home exercise machines but it is out of the way yet accessible and can be put out of sight with bi-fold doors or curtains in front of the link.

Figure 155: One temporary gate could be easily installed to create the perfect play pen for children. Blinds could be added over the window to control excess light.

Figure 156: The link could easily accommodate a couch and bookshelf for a sunny reading spot.

Figure 157: The link could be walled off in line with the internal wall and the link could become covered exterior space.

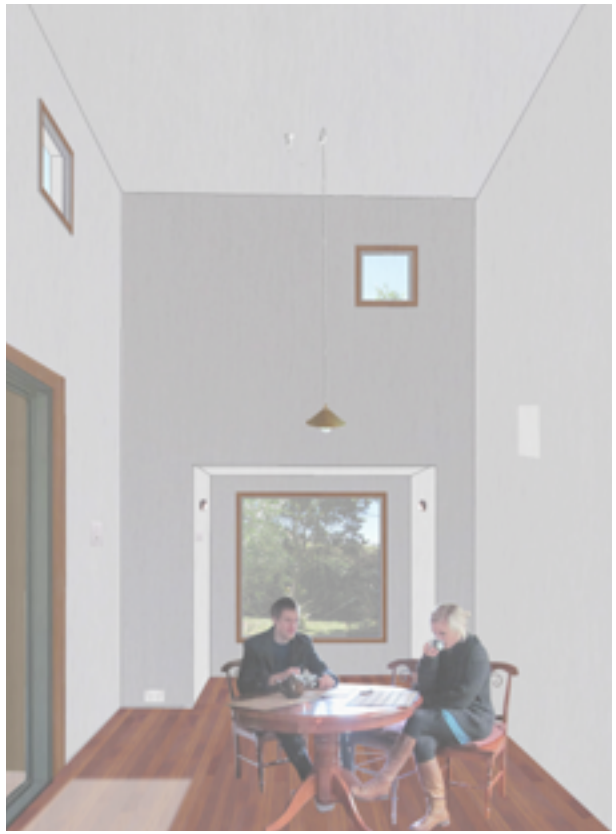


Figure 158: Even if the link isn't immediately utilised it provides an interesting and varied space.

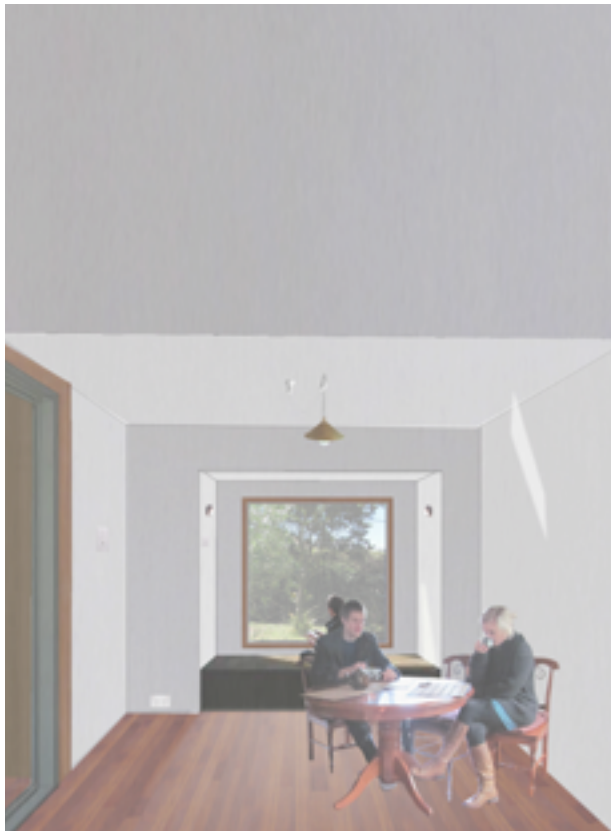


Figure 159: Even if a floor is added in the double height space, the link adds to the variety of space as the link has a reduced stud height.

The link responds to both utility and social function. Physically the link can accommodate different activities. Socially the link provides a space which can be either public or private. Movable partitions can be selected with sound proofing if required. The natural light can be controlled with blinds or curtains though the large window which can let in ample natural light. The link is a small space but as it is connected to a larger space, it becomes cosy without being claustrophobic. Even if a floor is added in the double height space, the link adds to the variety of space as the stud height is reduced.

Provide places with acoustic privacy

Acoustic privacy is provided in the ground floor bedroom. It will be up to the occupants to provide sound proofing on the first floor as its proposed as an unfinished space without interior walls.

Over time if another structure is added the link provides acoustic privacy.

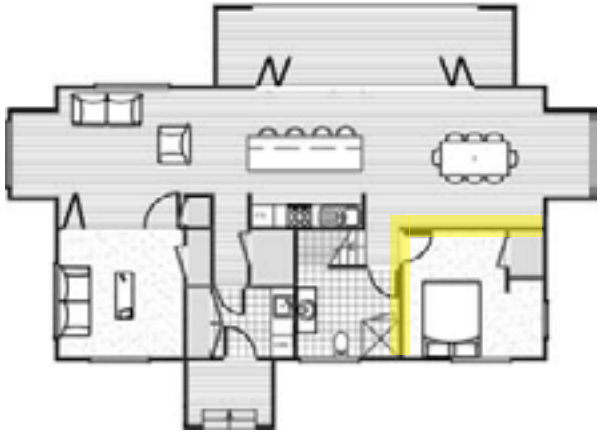


Figure 160: Large Version Ground Floor Plan. The yellow shaded walls indicate soundproofing. Note sound proofing will also be provided in any adjacent floors/ceiling/walls to other spaces on the first floor.

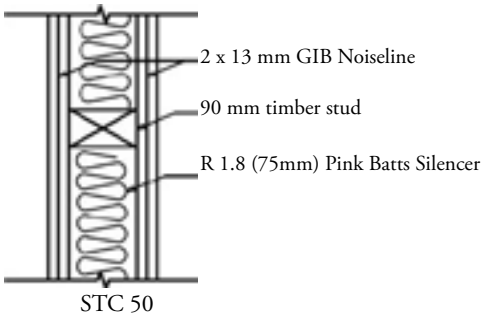


Figure 162: Wall construction for wall with a STC rating of 50

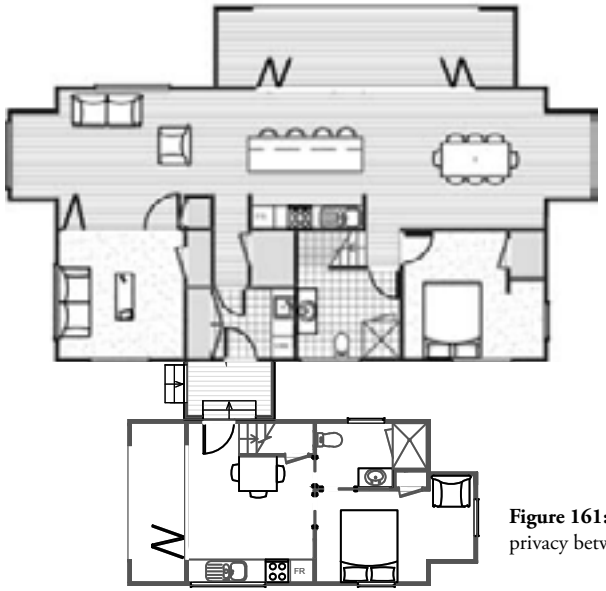


Figure 161: The separation of the link provides acoustic privacy between each structure

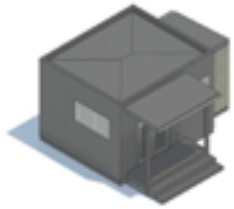
Extra Small Design

The 'extra small' design is the easiest version to add to or remove from a site and is the cheapest to construct. The interior is 20m2 with a 3.6m2 covered outdoor porch.

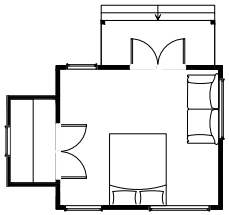
In order to have minimal site coverage and maximum options for expansion in the future, buildings which are two storeys or greater should be considered for adaptable design. In some circumstances however, a single story may be more appropriate. In any case, structural provisions should be made if adding an additional storey is a possibility.

Add-In Options

The rectangular layout with a link space can have many different interior layouts. The small option may start off as a large bedroom. The timber subfloor allows easy connections of new services if an ensuite or kitchenette is added to a bedroom or office.

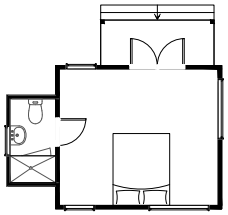


Option One



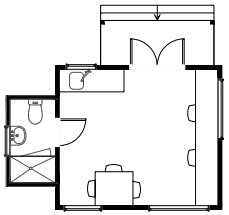
The extra small design as large bedroom with small office, or storage room

Option Two



The extra small design as large bedroom with ensuite

Option Three:



The extra small design as an office with bathroom and kitchenette

Figure 163: 3D image of the extra small design with three floor plan options.

0 1m 2m 3m

Add-On Options

Option One

The extra small design can be added on at the side for any length as long as finances and site allow. The wide windows can be replaced with a single or double door into the new extension.

Option Two

Being single storey, the verandah at the front is unlikely to become a roof garden. Therefore the simple construction of the lean to roof was applied to the verandah. The high stud of the small design allowed a high roof height in the verandah and enables the verandah to be extended if required.

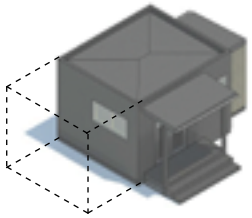
Option Three

If there is a possibility of having an additional storey added onto the small design, the structure should be over specified and location of future stairs identified for a simplified conversion to two storeys. In any case the flat roof members can easily become floor joists.

Option Four

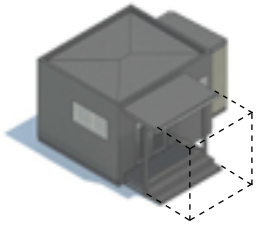
The link provides a low impact connection between the small design and any future additions. Additional links can be added connecting the small design to one or multiple parts of other structures.

Option One



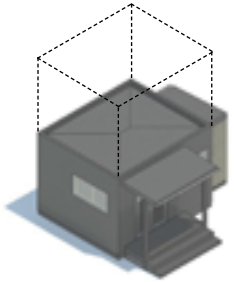
Extend flat roof section of design.

Option Two



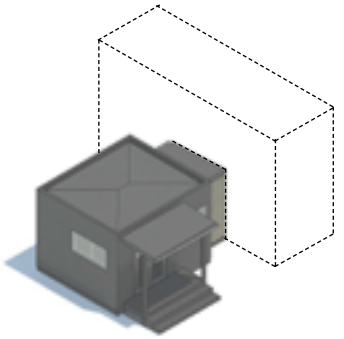
Extend mono pitch verandah. The verandah space could be enclosed.

Option Three



Add an additional story

Option Four



Use Link to join the design to a new structure

Figure 164: Four options for adding onto the extra small design.

Small Design

The small design is unique as it is the only version which has been designed to be able to be a garage. There are two versions of the small design, the single garage version and the double garage version. The design of a garage is usually not prioritised which inhibits its ability to accommodate other functions. While the size of the small design is specific to a garage, the design has utilized many design tactics to enable a variety of uses and spatial qualities. The small design includes a link, double height ceiling, column and beam structure and so on. The following pages demonstrate possible solutions for the add-on as a garage, studio, office or independent living quarters.

The small design can start as an empty shell, being partly or fully fitted out. It can be constructed as a stand alone dwelling or connected to other structures in the present or future. The small design can be connected to other structures with a link.

Figure 165: Small design at single garage size.
Shown on a concrete subfloor so that it can function as a garage at some time in its life. The design can easily be altered for a timber subfloor if its unlikely it will used as a garage

29m2 indoor space ground floor.
6m2 covered exterior space

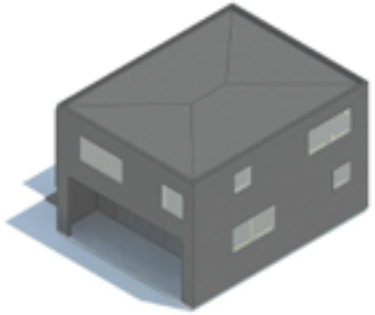


Figure 166: Small design at double garage size.
The small design can be used as a two car garage, office, independent living or extension of an attached house.

60m2 indoor space ground floor.
12m2 covered exterior space

Sample combinations of the large and small design

Each design may be an independent and detached dwelling, although they may also be attached to another structure. The link element allows an easy connection between different versions of the design, or any structure for that matter. The link can join multiple structures built at the same time or over time. The size and location of the link can be adjusted to suit site and client preferences.

The following images demonstrate ways in which the small design can be joined to the large design. The placement of the small design will be very dependent on access if it is to be used as a garage. The number of links of the large design allows the small design to be attached in many different locations. The link of the large design is always through a public space so that it can provide access to additions.

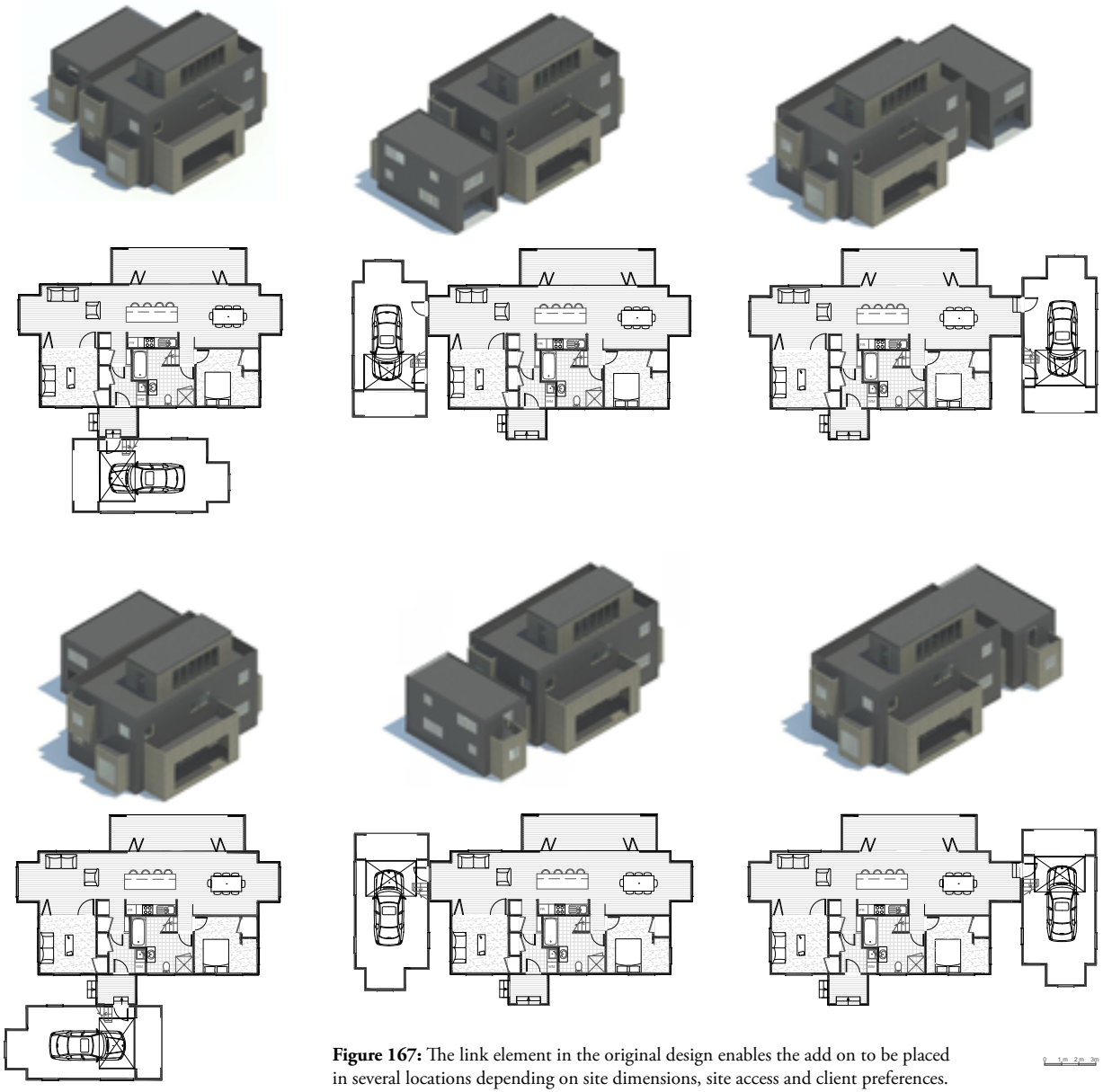


Figure 167: The link element in the original design enables the add on to be placed in several locations depending on site dimensions, site access and client preferences.

Small design as a Garage

The specific adaptable design features are demonstrated through the small design. The small x2 has the same capabilities. The small design is shown as a garage in the first instance as it is in its cheapest form to construct with no interior fit out required.

The modern garage is used for many different activities. Primarily the garage is used to store a car, but it often doubles as a workshop, general storage area, laundry, teenage haunt, games room, gym and so on. The garage is generally for activities where a large space with minimal fittings and minimal natural light is sufficient for activities which are considered too messy for in the house.

Driving through new suburban developments almost every house has a large double garage attached which has one or two small windows. The double garage, which can be over six and a half meters square is generally one of the bigger spaces you find a in home. The large size and minimal natural light can inhibit the possibility for different uses. Schneider & Till found that attached garages are designed to their structural limits and unable to accommodate built changes (2007, p.164). Therefore the space understood as a 'garage' needs to be carefully considered so that the space can be adapted for other uses.

Figure 168: Sectional perspective and plan. In the front of the add on, an overhang provides a covered area which can be particularly useful for a workshop where maximum natural light or ventilation may be required with cover from rain. The overhang also provides a pleasant space for outdoor living if the garage space was adapted into a habitable space.

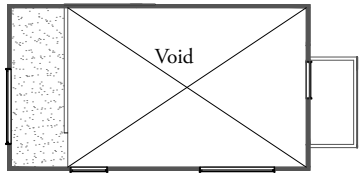
Figure 169: Sectional perspective and plan. Even though the small design may function as a garage in some time during its life, the number and placement of windows are carefully considered to future proof the design for other uses.

Different options for the double height space

The small design has a double height ceiling so that an intermediate floor can be added. Whether the space is used as a garage, independent dwelling or office, different areas on the first floor are possible. Full or part sections of the first floor can be constructed depending on the client's preference for single or double height space on the ground floor and required floor area. The first floor can be a mezzanine with partial height walls, enclosed rooms with full height walls or combination thereof depending on user preference. The floor and walls can be installed, removed or reinstated without complications.

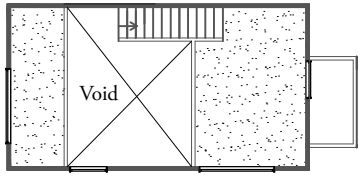
On the first floor the window behind the link can be replaced by a door and the link below can become a small balcony. The link has a slightly lower stud allowing a step down from the first floor to the balcony.

Option one



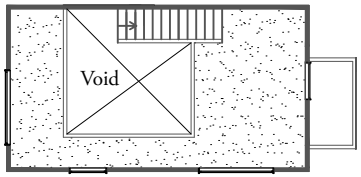
6 m2 of Mezzanine above the overhang

Option two



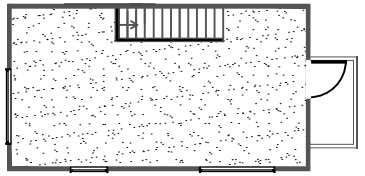
12m2 of floor area used plus 6.3m2 of the mezzanine above the overhang. The small balcony could be utilized at a later date by replacing the window with a door.

Option three



20m2 of floor area. The mezzanine above the overhang is easily accessible while still allowing a spacious void.

Option four



Utilizing the entire 30m2 floor area plus the 1.2x2.4 outdoor balcony.

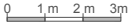


Figure 170: Four options for the double height space for the small design.

Small design as an independent dwelling

The conversion of the add-on into a habitable space can be done so that someone living there can be totally independent of the main dwelling. All the basic requirements are accessible on the ground floor with bathroom, kitchen, bedroom and small living. Additional living and/or a spare bedroom can be added with a mezzanine or second floor if desired. The conversion of the add-on to an independent dwelling could accommodate elderly relative(s), an older child at home, a boarder, a renter, a couple or single with a dependant and so on.

The potential use for the mezzanine area at the front of the add-on is limited as it is accessed with a ladder. The mezzanine space however, is out of the way and out of sight which is useful for storage or temporary accommodation for the fit and able.

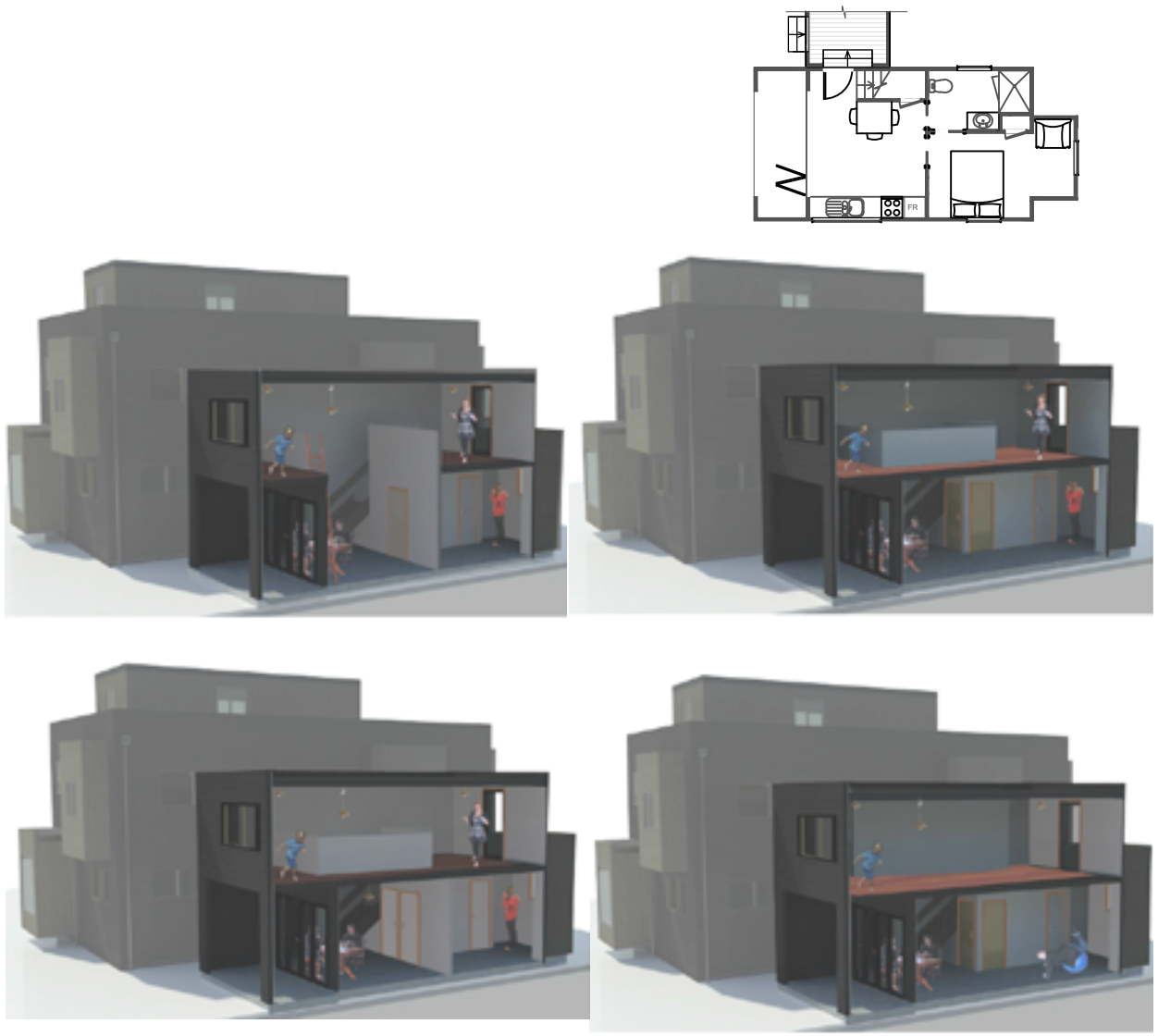


Figure 171: Plan and sectional perspective options of different configurations for the small design as an independent dwelling.

Small design as office

The small design could be used as an office for one or a number of people depending on the occupation. The ground floor could include a small kitchenette for staff and coffee making for clients, a small bathroom and working areas.

Movable Building Element: The ground floor could be one open plan space or divided into two. A private meeting could occur in any space and when its finished the large slider separating the spaces can be opened creating the open plan office again.

Two entries to a room: The dual access into the bathroom is extremely useful as you do not need to disturb the occupants of the other office space to access the bathroom.

The Link: The link provides a covered entrance to the dwelling and the add-on either as a primary or secondary entrance depending on how the inhabitants prefer to use it. The open link means that the inhabitants of each space, the main house or the add-on, do not need to go through each others space. This is particularly useful when the add-on is an office space connected to someone's home.

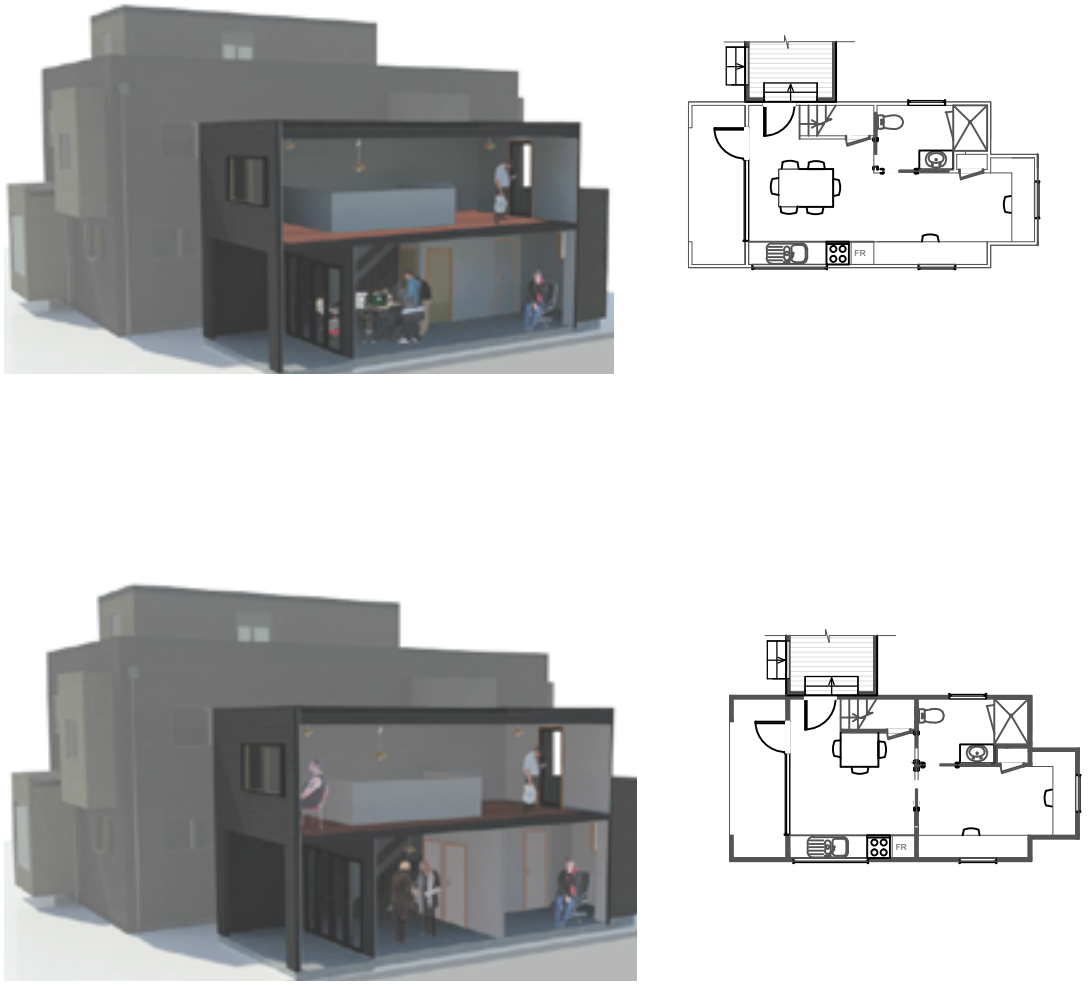


Figure 172: Plan and sectional perspective options of different configurations for the small design as an office. The small design is shown connected to the large design via the link though it could be independent.

Medium Design

The medium design is the large design with a portion omitted. Although the medium design has a small ground floor it includes one bedroom, bathroom, laundry and open plan living. Similarly to the large design the first floor is proposed as unfinished space.

Possible indoor and covered or roof terrace outdoor space

	Indoor space shown	Outdoor space shown	Maximum indoor space	Maximum outdoor space
Ground Floor	75 m ²	22 m ²	75 m ²	22 m ²
First Floor	35 m ²	0 m ²	75 m ²	17 m ²
Roof Top	15 m ²	55 m ²	60 m ²	0 m ²

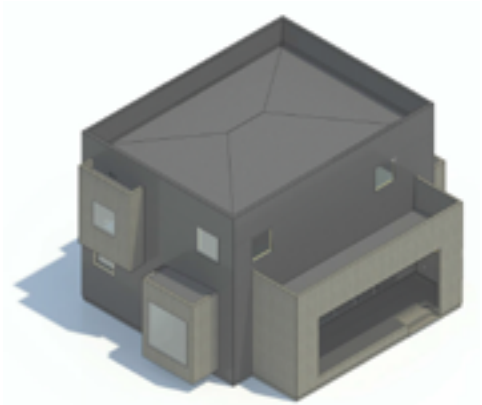


Figure 173: Medium design without roof terrace. The parapet shown is high enough to form a barrier if roof top access is added. The parapet height can be reduced if roof top access is unlikely.

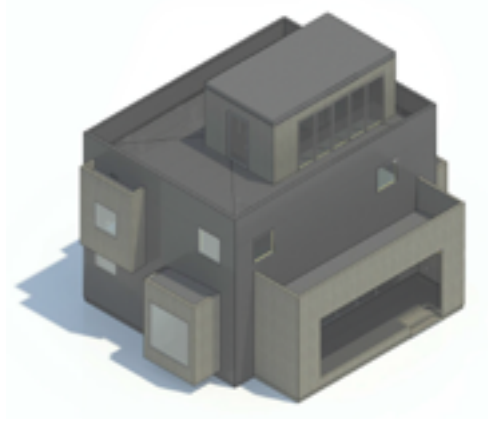


Figure 174: Similar to the large design a roof top access can be included in the initial build or added at a later date.

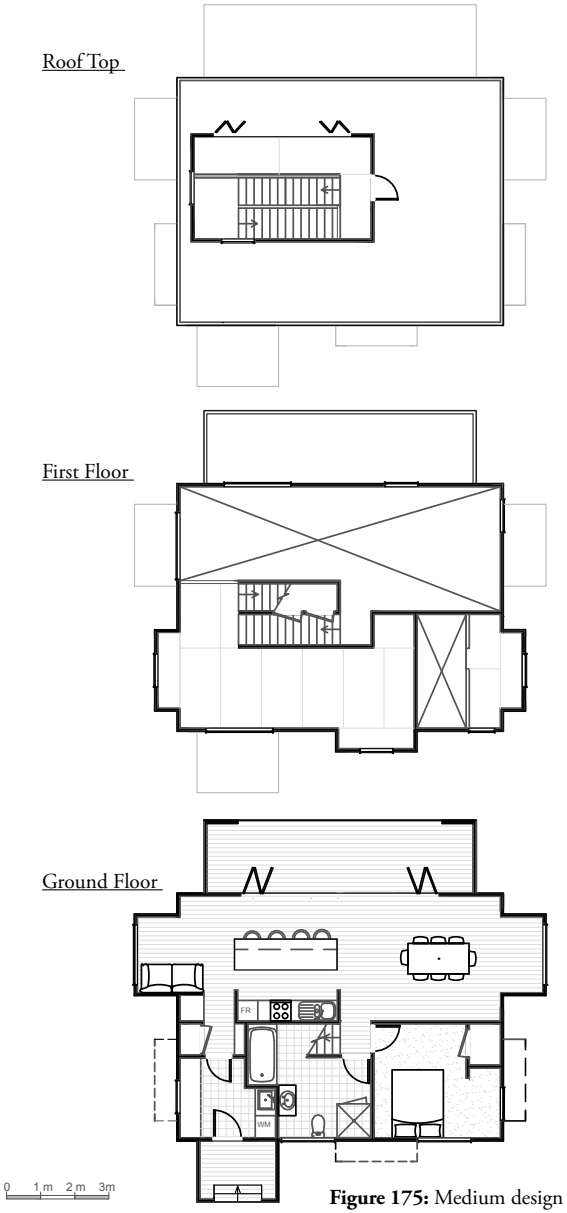
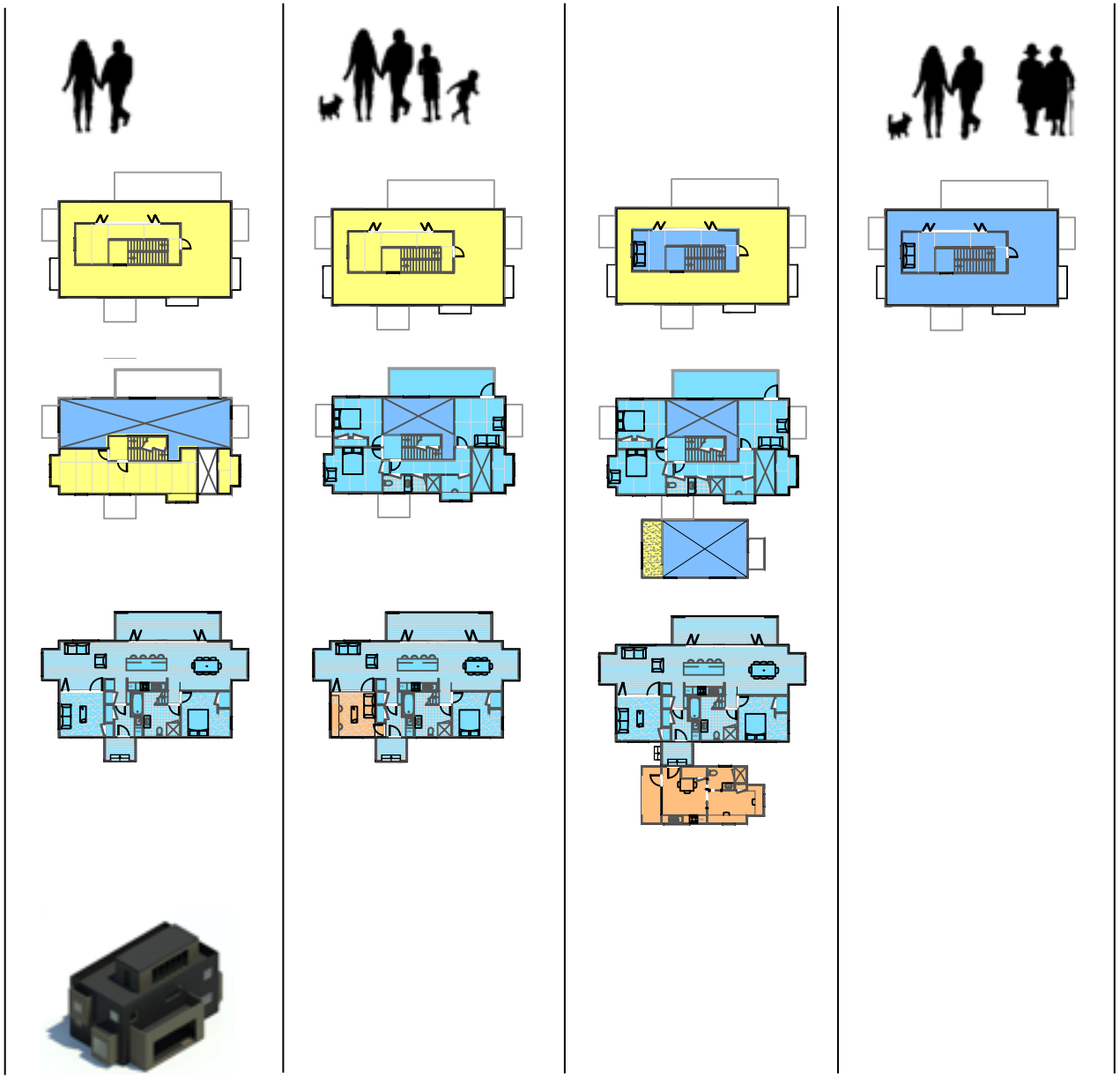


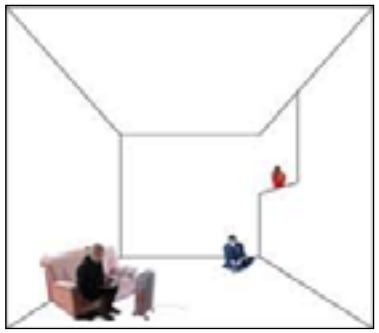
Figure 175: Medium design floor plans



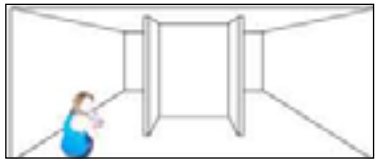
Visual Privacy

The approach to visual privacy in the design was in some ways conventional. The bedroom, laundry and bathroom were designed as private spaces with the open plan living room as a public space. While the bedroom, laundry and bathroom are accessed from the living room, the wing walls around the kitchen create a partial corridor for privacy and reduce possible views into the private spaces.

The double height space is an add-in adaptable tactic. The height can be filled with an intermediate floor or remain an architectural feature. Naturally, visual privacy tactics which work within a double height space are used. For example, mezzanine floor and cut outs, which create a view shaft from the first floor overlooking the ground floor.



Cut out in the first floor overlooking the ground floor



Full height partition wall with side wing walls

Partial visual privacy from a mezzanine floor

Figure 177: Visual privacy tactics used in the design.

Figure 178: Cut out in the first floor overlooking the ground floor & full height partition wall with side wing walls

Figure 179: Partial visual privacy from a mezzanine floor and full height partition wall with side wing walls

Visual privacy can be manipulated over time through many different tactics. Bi-fold doors or curtains for example, can be used to easily change the visual privacy of a space on a daily basis. Long term measures can also be utilised such as full height walls to constructed view shafts and full or part height walls.

The second bedroom/lounge can transform its potential use by manipulating the space as a public space, with bi-folds open or private space, with bi-folds closed. While bi-folds could have been added to the bedroom, the approach was to create specific space where one enclosed room will have bi-folds and the other a conventional bedroom. This enabled the bedroom to have notable soundproofing.

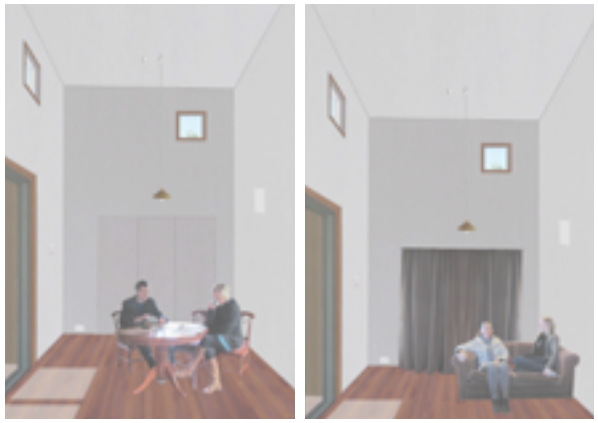
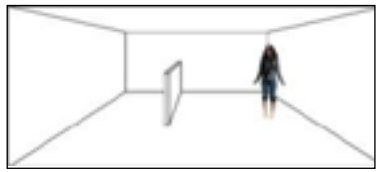
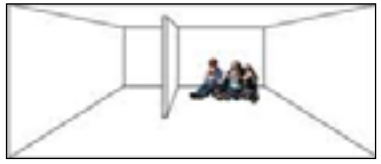


Figure 180: Bi-fold doors or curtains can be easily installed to change the visual privacy of a space on a daily basis.



Partial height wall



Full height wall

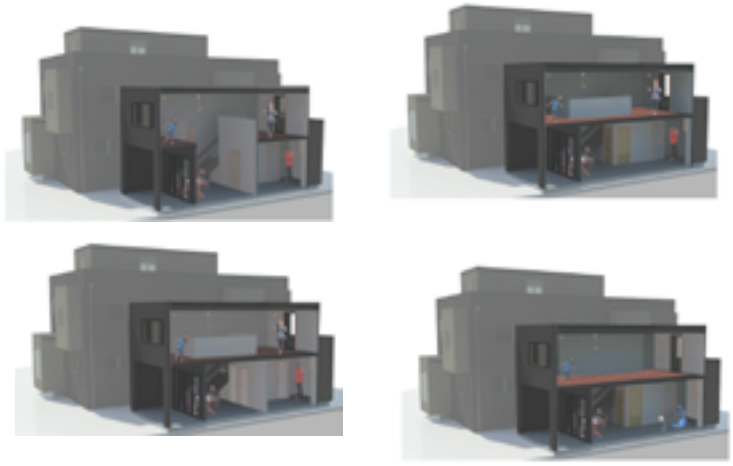


Figure 181: The visual privacy within the design versions can easily be manipulated with any combination of full or partial height walls.

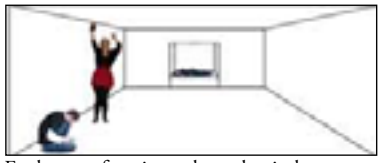
Sense of enclosure

The sense of enclosure was considered in conjunction with the adaptable design tactics.

The link creates a small space which feels larger as its open to the living room. As the link is only open on one side it is very easy to enclose the space through bi-folds or curtains such as in the visual privacy example.

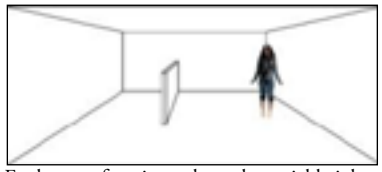
The partial wall with wing walls was utilised in the design in the kitchen. It defines the kitchen as a separate space while retaining the combined living space open plan. A partial height wall is also used in the mezzanine to create a semi private space.

The kitchen bench further articulates the kitchen as a separate space albeit one which is connected visually.

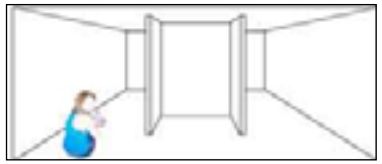


Enclosure of territory through window seat

Enclosure of territory through mezzanine



Enclosure of territory through partial height wall



Enclosure of territory through partial wall

Enclosure of territory through kitchen bench

Figure 182: Design tactics used in the design to manipulate the sense of enclosure.

Figure 183: Sense of enclosure manipulated with a window seat and reduced stud height.

Figure 184: Sense of enclosure manipulated with a mezzanine floor, partial height wall, partial width wall and kitchen bench.

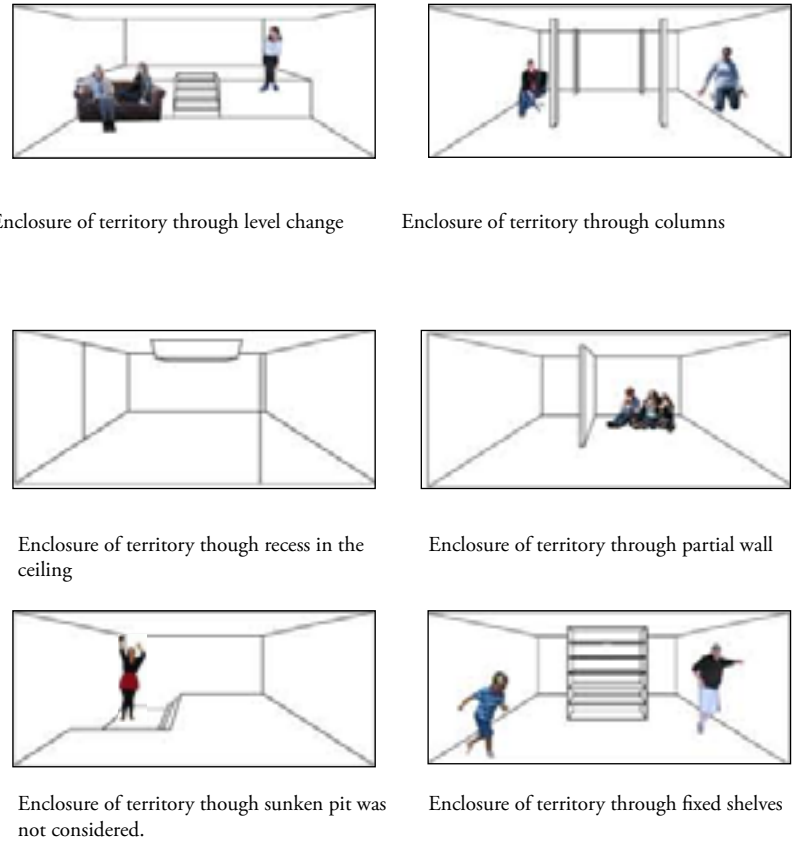
The level change was utilised on a large scale with different floors and openings between each floor.

While there is a column and beam structure in the design it is generally discrete placed within or close to walls. Placing columns to create definition of space is not adaptable without the columns having another purpose.

A recess in the ceiling was not used in the design. The mezzanine created a reduced stud in the open plan space, further differentiating areas within the open plan space.

Shelves was not considered in the design as it is left unfinished as something occupants can do themselves.

While a few design tactics were used in the design, any number could be utilised as the design allows for ease of construction with non-loadbearing walls from the engineered frame. However, when manipulating sense of enclosure, the potential future and current use must always be considered.



Enclosure of territory through level change

Enclosure of territory through columns

Enclosure of territory though recess in the ceiling

Enclosure of territory through partial wall

Enclosure of territory though sunken pit was not considered.

Enclosure of territory through fixed shelves

Figure 185: Interventions which alter the sense of enclosure through enclosure of territory. Drawn by author.

Natural Light

While this thesis investigated tactics for creating all different light conditions, only one or two were generally utilised. Creating a space where the daylight is specifically manipulated to be indirect, dappled or restricted, limits the possible light qualities in a space. It is not beyond occupants capabilities to install blinds, louvres or plant trees to manipulate the natural light to their preference. Occupants can only reduce or filter natural light easily which is why large openings for sunlight and bright direct light were provided throughout the design.

There were many windows included in the design to make dividing space easier. There was no manipulation to the smaller windows. The only manipulation of the light was providing a covered roof over the large bi-fold doors to reduce excess solar gains in the summer. Similarly, the light from the large windows in the link can be controlled by creating a secondary wall or partition with an opening.

Control window | Sunny window seat | Skylight

Figure 186: Tactics used to for natural light.

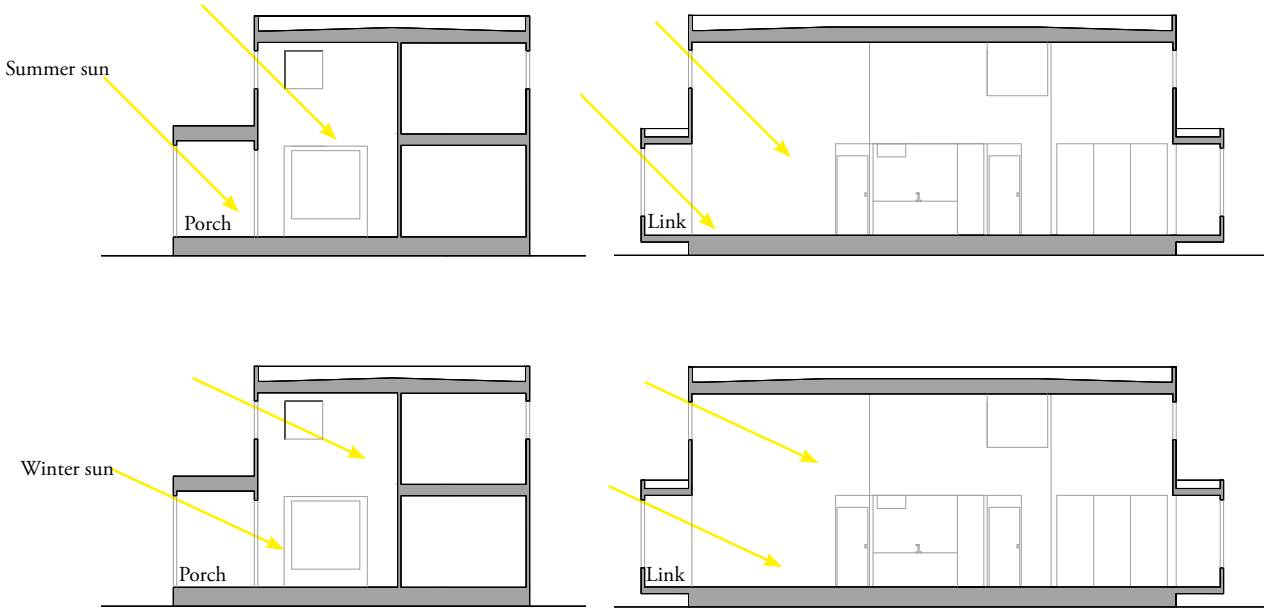


Figure 187: Summer and winter light study

Overview

Summing up design generation two the following points outlines how the aim of creating specific adaptable housing was achieved.

Adaptable design allows alterations and removals to be done easily in the future.

This was achieved predominantly through use of the link which has minimal impact on both the existing and any additions. The link also allows disparate shaped and sized forms to be interconnected. Additions are also made easier with a double height open plan interior allowing intermediate floors to be added and removed. Engineered frames allows for non-loadbearing walls and provisions for additional floors. The flat roof is also an important feature which is easy to add-on to.

Adaptable design allows a change of use through considering social and utility function.

The experience of space over time was explored through consideration of natural light, sense of enclosure, acoustic and visual privacy. Specific spatial qualities are just as important as variable spatial qualities. A few key interventions which had an affect on several variables were selected to manipulate the qualities of space.

Utility function considers the ability to physically use space in different ways. Functional tactics such as providing two entries to a room, bi-fold doors, easy access to services and consideration of circulation physically empowers spaces to take different uses.

Adaptable design which considers the design as a whole and its aesthetic beauty

The aesthetics of the design has been considered in the initial design and in possible future iterations. The window sizes and relationships between windows has been considered. Each window or window module is of the same proportions albeit on various scales. The link is an important aesthetic feature. The link breaks up the large volume with a change of cladding. The flat roof set a modern aesthetic. The protrusion of the link creates interest and variety where the negative space becomes a defined space of character.

Figure 188: Elevations for the Large design.

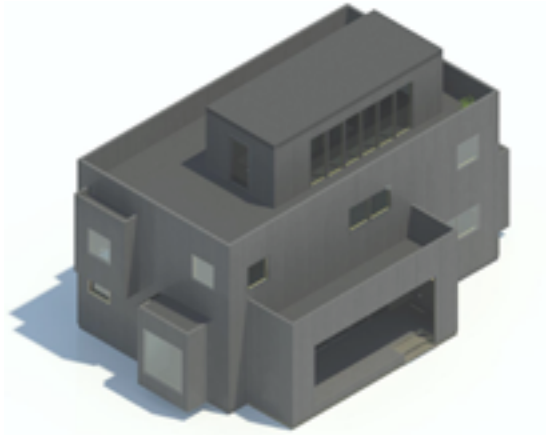
Material Options

There are many different options for materials and colours which can be chosen to suit an individuals' taste and budget. Changes in the cladding are proposed in internal corners only for a tidy transition between materials. Claddings which are typically used in New Zealand are trialled on the design. For a vertical cladding grooved ply (less expensive) or vertical shiplap timber weatherboard (more expensive) are proposed. For horizontal cladding fibre cement weatherboard (less expensive) or timber weatherboard (more expensive) are also proposed. Each cladding type is made up of panels or boards of which sections can be removed or cut without affecting the rest of the cladding. Details in joining each cladding to another are common and fairly easy to achieve.

Rendered plaster cladding systems have not been considered in the material options as it can be difficult to alter with plaster forming a continuous surface which can be awkward to join to dissimilar materials. Similarly, brick and metal cladding systems were not considered.

The colours which could be applied are numerous. Possible light and dark colour combinations have been proposed on the design.

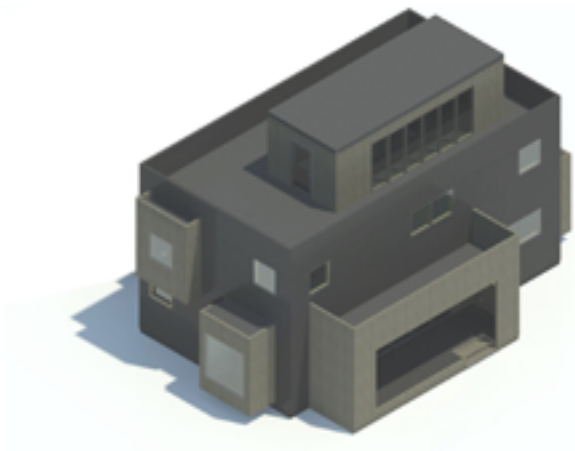
Continuous material and colour throughout



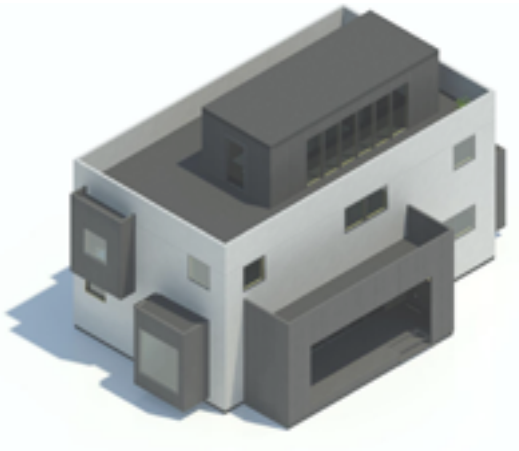
Vertical cladding: Grooved ply or vertical shiplap timber weatherboard

Horizontal cladding: Timber or fibre cement weatherboards

Contrasting material and colour



Vertical cladding: Grooved ply or vertical shiplap timber weatherboard
Horizontal cladding: Timber or fibre cement weatherboards



Vertical cladding: Grooved ply or vertical shiplap timber weatherboard
Horizontal cladding: Timber or fibre cement weatherboards

Figure 189: Different material options on the large design.

6.1 Design Discussion

In the background section of this thesis the existing indeterminate and determinate approaches to adaptable designed were criticised. In response the thesis aim looked towards specific adaptable residential housing. The design proposed in this chapter is an exemplar specific adaptable design as a culmination of the research conducted throughout this thesis.

The specific approach to adaptability is seen in the selection and application of the design elements and tactics in design generation two. The most significant design tactic being the link which has little impact on built fabric when additional structures are constructed or removed. It also allows disparate shaped or sized structures to be joined which gives designers freedom of design and form in additions. The link also becomes the circulation between related structures making space planning straight forward when considering how additions will fit in with the existing. Flat roofs, which can be easily extended when adding on, and loadbearing beam and column construction, which eliminates loadbearing walls, were also key adaptable design tactics utilised in design generation two. The approach to the ground plane and site are also important considerations as the predominantly two storey design will take up less room on site, create more volume for less external wall area, allow greater options for additions, more garden/yard area and allow for double height interior space.

Particular attention was given to showing the myriad of ways that space could potentially be used in this design. A range of activities were trialled in each space catering to both the utility and social function for occupants. Spatial variety was provided throughout the design, especially in the open plan space through varied stud heights and varied natural light qualities. The link which features in each version provides smaller niche spaces that break down the scale of the associated main space and give a range of opportunities for small scale uses.

The proposed adaptable design is unapologetically different from the existing mass suburban approach. Whether it is developer or buyer influenced, it is clear that the traditional hip roof spec house is extremely prolific and individuals may take some convincing to adopt a more modern flat roof design. For those who prefer the more traditional aesthetic the design can be adapted to suit without losing too many of its adaptable features. Link elements can easily be added and removed in the future where the flat roofed link would be less conspicuous, dwarfed between the existing and any additions.

The proposition to build in increments over time is a clear method for families to have the space they want when they need it, and can afford it. The increments also allow for the removal and relocation or reuse of unused sections of the house allowing for a simple process for the elderly to down size their home. This is an important idea to contribute to the possible ways to address the housing shortage in New Zealand. In justifying the need to consider greater prefabrication in New Zealand construction and design, Bell and Southcombe illustrate the housing shortage in New Zealand. This is also relevant in promoting adaptability.

> *"15-17,000 homes needed to be replaced for the Cantebury Rebuilt in the wake of the earthquakes since late 2010. A further 110,00 homes have been identified for repair {...} Over 27,000 houses are needed to fill Auckland's shortfall. On an ongoing basis, the region needs 10,000 houses every year for the next two decades" (Bell & Southcomb, 2012, p.133).*

Investigating prefabrication and adaptability may be a valuable area of further research investigating the overlaps and differences and how they might be able to work together.

Figure 190: Aerial view of new suburban development of Riverstone terraces. Every house is designed in the same way with hip roof, low stud, single storey on a concrete subfloor. Image from Google maps. The large design has been added to the new suburban development.

Figure 191: Perspective of the aerial with the large design added into the suburban development.

The design is contrasting and unusual in the context of a typical mass suburban housing street. It is clear from the aerial with the large design superimposed onto a typical site, that although the house looks large in perspective being three storey in one section, it actually takes up less room on the site than its neighbours which will allow options for adding on if required. The large design is placed in the centre of the site leaving space for extensions and outdoor living and minimising the impact the house may have on the daylight for neighbours.

Figure 192: Pitched roof design example in suburbia

A pitched roof is trialled on the large design to reflect the pitched roof in the rest of the suburb. The pitch roof would mean that it would be more difficult to add-on additional storeys than with a flat roof, though its unlikely that additional storeys could be added without blocking sunlight on the neighbouring properties. The links require a flat roof for ease of connecting additions. The flat roofs of the link contrast with the pitched roof of the main structure.

Figure 193: Pitched roof design.

Further research

The adaptable home could be easily applied to terraced or high density housing. The ability to adapt the home means that the terrace housing can be varied and interesting yet cohesive with repetitive use of the same architectural elements, primarily the link which is both the aesthetic centre piece and incredibly useful adaptable tactic.

Figure 194: Design as terrace housing

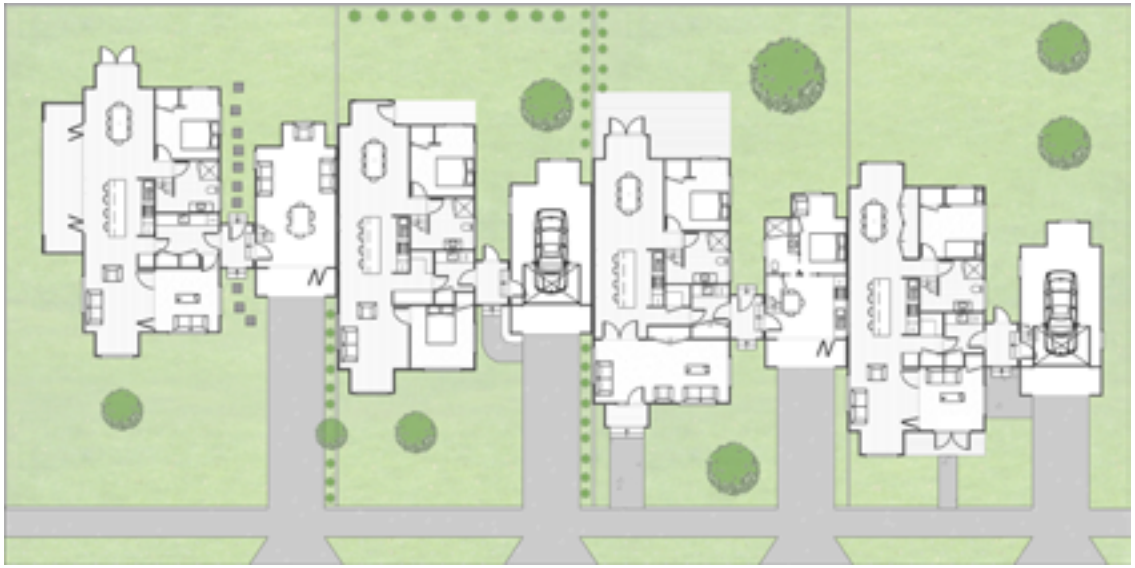


Figure 195: Location plan of design as terrace housing

7.0 Conclusion

Conclusion

This chapter outlines an overview of this thesis, significant findings and final conclusions. Furthermore, the thesis aim is addressed and areas of further research are identified.

The motivation for this thesis was fuelled by the prevalent indeterminate response to providing mass suburban housing. These have a tendency to be generic, low cost, plan generated and hipped roofed. This thesis provided evidence that the mass suburban houses are not easily adaptable as they are generally not designed to be altered. If adaptability is not considered in the initial design, inhabitants must either move to a new house which meet their needs or attempt to adapt a house which was not designed to be altered. The need for homes to be adaptable and respond to changes in the family dynamic is paramount and continuously relevant, as requirements for families inevitably fluctuate over time.

With housing shortages, cost of house building and the growing population in New Zealand, the need to look at alternative design approaches is particularly important. The mass suburban house often consists of one storey on a small plot which usually fills most of the site. The proposition to build in increments over time is a method for families to have the space they want when they need it, and can afford it. Building in increments also allows for the removal of unused sections of the house allowing for a simple process for the elderly to downsize their home.

Through the literature review it was found that existing definitions of adaptability are convoluted and sometimes contradictory. Further research was conducted with the aim of creating a clear understanding of what adaptability means for this thesis. The following definition was the catalyst for identifying a framework on which to develop the understanding of adaptability for this thesis; *Adaptable design allows alterations and removals to be done easily in the future* and *adaptable design allows a change of use without making physical changes.*

Adaptable design allows a change of use without making physical changes was considered too broad and was divided into two sub categories of utility function and social function. It was found that the indeterminate approach prioritises the use of space through utility function over social function. This lack of consideration of social function was considered to be a gap in the adaptability literature.

Further research was conducted with the aim of building on the existing definition to a point where both social and utility function could be considered holistically as a part of adaptable architecture. Visual privacy, acoustic privacy, natural light, and sense of enclosure were identified as factors which can be manipulated in a design to influence social function. The way in which design tactics could effect each of these factors was explored. A survey was conducted to explore the relationship between use of space and the preferred quality of space in regards to the four identified factors. The survey revealed some trends in the preferences of spatial qualities but over all there was a huge variety of preferences. Considering the survey results it became clear why indeterminate designs are favoured, as it is easier to provide a neutral space devoid of character to placate all users rather than providing a more specific design that not everyone will like. This thesis acknowledges the indeterminate approach to adaptability but aims to explore an alternative specific design approach. As a result of the survey and further research the adaptable definition was revised to read *adaptable design allows a change of use through considering social and utility function*.

Design generation one provided a testing ground for the ideas and theories developed in the literature review, survey and subsequent definition of what adaptability means for this thesis. The most popular spatial qualities from the survey were applied to design generation one by manipulating the four factors; natural light, sense of enclosure, visual privacy and acoustic privacy. As a result of designing from the inside the exterior aesthetics were not significantly developed. While aiming to reflect the survey and respond to social function each space was designed to conform to the spatial qualities from the survey. This approach was found to be too specific and did not consider spatial qualities over time.

Reflecting on design generation one, it was considered pertinent to add aesthetics and social and utility function over time to the developing definition of adaptability for this thesis. The principle that *Specific spatial qualities are just as important as variable spatial qualities* was added to the adaptable definition so that design variation is able to be provided without becoming too specific.

In reaction to the critique on the existing literature review in chapter three a second literature review of adaptable tactics was conducted via the study of existing dwellings. Each tactic was identified and analysed in relation to the adaptable outcomes of aesthetics, ease of adding on or removing and adaptable use through social and utility function. There were several standout tactics, in particular the link. The link has little impact on built fabric when additional structures are constructed or removed and allows disparate shaped or sized structures to be joined which enables freedom of design and form. Furthermore, the link often becomes the circulation between structures making space planning straight forward when considering how additions will fit in with existing structures. Flat roofs which can be easily extended when adding on and loadbearing beam and column construction which in turn eliminates loadbearing walls were also notable adaptable design tactics.

Design generation two is an exemplar of an adaptable house to demonstrate the adaptable definition through application of design tactics. Design generation two was predominantly influenced by the link which became the main adaptable and aesthetic feature of the design. Aesthetics were addressed through considering proportion, geometry and composition. The social and utility function was addressed in the design through testing different activities in the same space over time. Furthermore, the characteristics of the spaces throughout the design were varied and could be manipulated by occupants to an extent. Overall design generation two met the aims of this thesis to explore specific adaptable housing. In particular the design provided spaces with varied character which could be used for a range of activities preferable to the occupants.

Further research

Adaptable designs have the ability to allow for future change embedded in the design. In some cases the adaptable tactic may have no effect, increase or decrease the initial or future build cost. For example, providing unfinished space where walls may be unlined or omitting shelving would have an obvious decrease on the initial cost. Building a frame for a future opening may increase initial build costs but may save construction costs in the future. A cost analysis over time comparing the typical mass suburban house to a design of similar scope with adaptable features could also be a useful path for further research. The cost of altering the mass suburban house which was not designed to change should be considered against the adaptable home. The cost of selling and relocating to a home more suited to the inhabitants needs is another cost factor that should be included against the mass suburban house when it is unable to accommodate changes where the adaptable home can. The specific monetary calculations will likely hold much weight with government agencies, developers, investors and individuals. It is important to assess it over time as many of the adaptable tactics have an upfront cost which will be beneficial in the future. A comparative cost analysis of the design outcome would be a valuable area of further research.

What adaptability means for this study

Adaptable design allows alterations and removals to be done easily in the future

&

Adaptable design allows a change of use through considering social and utility function*

&

Adaptable design which considers the design as a whole and its aesthetic beauty

*Social use takes into consideration the experience of space over time through natural light, sense of enclosure, acoustic and visual privacy. Specific spatial qualities are just as important as variable spatial qualities. Utility function considers the ability to physically use space in different ways.

There are many different adaptable design tactics within the literature on adaptability. When deciding which tactics to utilize Friedman suggests, "To improve the chances of success, all strategies must be carefully considered to ensure that they include provisions for future growth within the original design" (2001, p.19). While the list of adaptable tactics within the literature review is relatively long, the specific requirements of each dwelling and site will make it easier to decide which tactics to use. A matrix for assessing the likelihood of an adaptable tactic being utilised in the future would be a useful topic of further research. The assessment criteria for including the design provision for adding on another storey for example, would include analysing the current and future character of the surrounding area and investigating the planning requirements. Critical consideration of the application of each tactic would reduce the likelihood of redundant adaptable tactics and unnecessary additional costs.

Key Contribution

The aim of this thesis was to explore specific adaptable residential housing. This was addressed by creating an adaptable definition for this thesis and a range of adaptable design tactics to achieve the adaptable definition. The research was trialled in design generation one and finalised in design generation two. The collection of design tactics is comprehensive and informed by a range of publications and precedent studies. The application of the range of tactics employed through the adaptable outcomes is unique. The collection and evaluation of adaptable design tactics in combination with the adaptable definition developed in this thesis are the key contributions made. The adaptable definition is specific and clear about what can be achieved but allows flexibility for the designer as projects will lend themselves to particular outcomes. This thesis research is important and relevant as it could influence a new generation of housing stock which is unique but can be constructed on mass, and is able to respond to changes in both the present and future.

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6.0 Design Generation Two

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11 Appendix

2006 Gib Noise Control Systems brochure available for free on the Gib website.

http://www.gib.co.nz/assets/Uploads/3-0-128955-Noise-Control-Bro.pdf

Typical Decibel Levels of Common Noises (Levy, 2010, p. 321)

0 dB	Threshold of hearing
20 dB	Buzzing insect at 1 metre
30 dB	Public library, whispering
40 dB	Household living room
50 dB	Light traffic, refrigerator
60 dB	Normal conversation, air conditioner
70 dB	Heavy traffic, busy restaurant
80 dB	Subway, noisy factory
90 dB	Lawnmower, large truck
100 dB	Chainsaw, jack hammer
120 dB	Rock concert
140 dB	artillery fire, jet engine
180 dB	Rocket take-off

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

Phone 0-4-463 5676

Fax 0-4-463 5209

MEMORANDUM

TO Emma Zee

COPY TO Penny Allan

FROM Dr Allison Kirkman, Convener, Human Ethics Committee

DATE 25 August 2011

PAGES 1

SUBJECT **Ethics Approval: 18732 - Creating loose space through hard and soft architecture**

Thank you for your application for ethical approval, which has now been considered by the Standing Committee of the Human Ethics Committee.

Your application has been approved from the above date and this approval continues until 30 September 2011. If your data collection is not completed by this date you should apply to the Human Ethics Committee for an extension to this approval.

Best wishes with the research.

Allison Kirkman

Human Ethics Committee