# HUMANISING HOUSING

*Exploring the relationship between the human mind, body, and architectural space*

By Oscar Lovelock

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*Master of Architecture*

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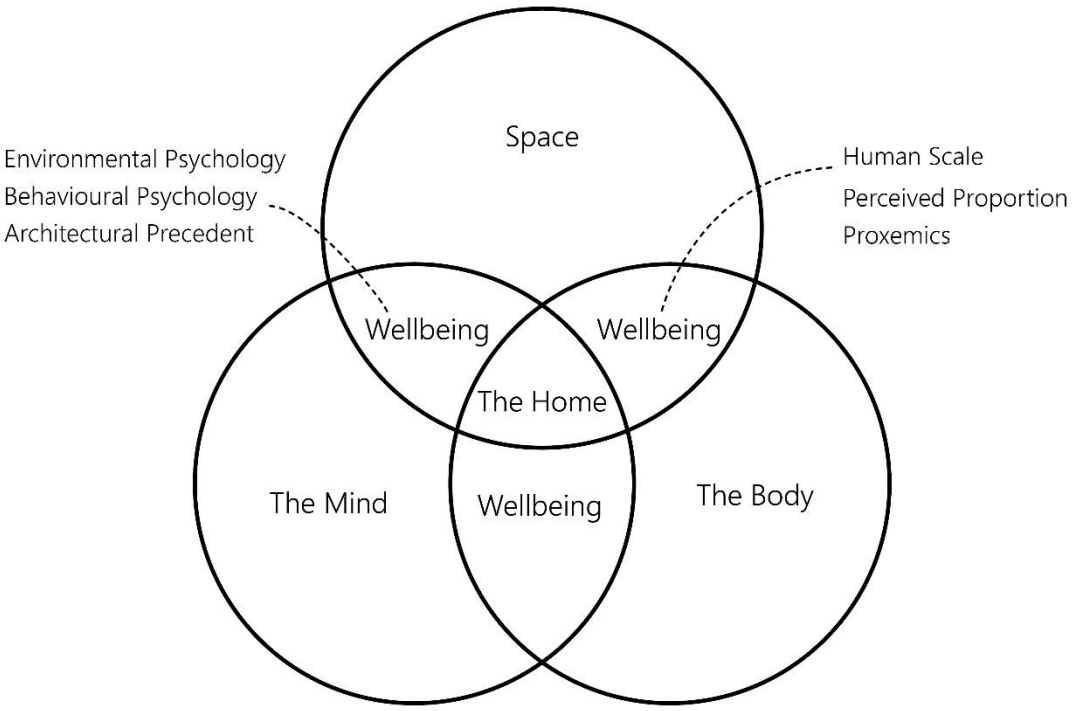

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*This project is dedicated to Binky Lovelock.*

## Abstract

Through the research and analysis of historical and architectural precedent, human proxemic, behavioural, and psychological research, this thesis explores the potential of implementing evidence from these research areas in the architects' design process for creating residences. The aim of this evidence inclusion is to engage and enhance the wellbeing of occupants through design and the manipulation of space. The evidence is in the form of designable/iterative parameters known to influence the mind and/or body through a users' experience of space. The parameters include, **proxemics, ceiling height**, **materiality,** and **connection to nature and natural light**. Reimagining the essential elements of a home separately, according to their function and use from a human-centric perspective, resulted in a modular design approach. As well as an outline of how these parameters can be explored in design, an evaluative testing method utilising **virtual reality** (**VR**) and questionnaires has been developed and employed. The testing method attempts to measure the impact of these parameters and their iteration on the user's experience of the space. The testing process revolves around the user experiencing a simulation of the designed spaces across iterations and answering relevant questions and ultimately scoring the spaces in terms of **Comfort**, **Stimulation**, **Privacy**, **Social Connection** and **Spatial Balance**. Scoring highly in these areas and providing a successful balance of each factor is the main design goal of this thesis. Achieving this goal in space is what this thesis defines as **spatial wellbeing**. The main value of this design led research however comes through the development and findings from the testing and design processes. The aim was to create a system that allows a more personally (user) responsive residential architecture to be developed, and to overcome the abyss that sometimes exists between an architect's design on paper, and the built home of a client. This design-based research addresses the role design plays in domestic architecture's ability to improve peoples' wellbeing.

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# 1.0 Introduction

The body and mind are known to interact with space and it is this interaction that impacts our wellbeing. Humans experience the world and their surroundings, through perception and physical setting. Architecture is one field where practitioners have an influence over how certain environments can be used and to some extent experienced – and this in turn has an influence on users' moods, behaviours, and health. The physical setting of the home is one constant in the motion of humans' lives that we have power to design and control. This thesis proposes that with the improving accessibility and quality of virtual technology, and the wealth of knowledge available within the realms of environmental psychology and other fields related to the effects of space on human experience, a more responsive type of architectural design for housing can be developed. A type of architectural design that caters to the human experience and therefore can improve the wellbeing of occupants. People in materially developed cultures spend over 90% of their lives in buildings (Evans & McCoy, 1998), with most peoples' everyday life taking place in and around architecture, and a significant proportion of that time being within their homes, the link between wellbeing and residential design is clear. As Ellard (2017) observes *"Every day, the architecture we inhabit envelopes our mind and body and influences how we feel and behave"* (cited in Cockburn & Vartanian 2020: 4).

This thesis explores the idea that by catering the design of a home to the human experience through considering and measuring the effects of certain design decisions pre-construction, spaces can achieve a balance of user comfort, stimulation, privacy, social connection, and an improved perception of spatial balance. Achieving this balance is this thesis's definition of wellbeing within the home, and primary design outcome goal. The power of architecture to address wellbeing is significant as Coburn and others observe "the design of our built environment can modulate how comfortable (Baker & Standeven, 1995; Brager, Paliaga, & De Dear, 2004) or focused (Mehta & Zhu, 2009) we feel in a given moment and can influence hormonal patterns (Fich et al., 2014; Küller & Lindsten, 1992) (Coburn et al. 2020: 218).

Without a method for evaluating the outcomes of wellbeing parameter iteration, the most responsive design outcome for users cannot be determined. Furthermore, the findings from this thesis would be difficult to justify or quantify. The method employed in this thesis involves applying the parameters shown to influence the mind/body in virtual reality (VR) as it allows a truer experience of the design pre-construction than the typically provided renders, plans or sections offer, and therefore provides the opportunity to create more responsive designs. The increased field of vision provided,

the quality of the live rendering, and ability to move through the space in real time offers an opportunity to respond to individual clients' subtle preferences among parameters and ultimately offer them a house that is better suited to them and their wellbeing. Additionally, with the use of questions and the rating of different qualities discovered from psychological precedent in testing, the knowledge gained from tests becomes quantitative as well as qualitative, providing a potential resource to inform future design decisions. This key aim of this thesis is addressed through the following objectives:

## 1.1 Objective 1

To determine the key **themes of wellbeing** in residential architecture through a review of research literature. From these themes extract key **designable parameters** that have been shown to influence the wellbeing of users in their experience of architectural space through their body and/or mind. Following this, to integrate these parameters in the design process and explore and iterate them according to research and theory – across each module of the home.

## 1.2 Objective 2

To develop an **evaluative method** for analysing the outcomes of this design process in terms of the effects of parameter inclusion on the user's wellbeing and experience of the space. To evaluate the experience of the designed spaces, wellbeing in space will be defined. The evaluation will include testing involving the use of virtual reality which should offer an accurate reflection of the user's experience of the space pre-construction - and therefore an opportunity to improve its responsivity to users' wellbeing through design.

## 1.3 Objective 3

To **evaluate** and summarise the value of the testing and design methods used and their ability to improve responsiveness to wellbeing in the design process, and to provide users with a truer spatial experience of the home and its parameter iterations than is typical in architectural practice.

# 2.0 Context

The housing crisis in New Zealand has been one of the most significant political and societal issues of the last decade, with it being one of the last several election's main discussion points and featuring in countless news articles. The core of the crisis is the high cost and/or low-quality of the housing stock on offer for first homebuyers and renters alike in this country.

With home ownership rates at a 60-year low, an average house costing approximately six to eight times household income (Alan Johnson, 2018) (NZIER, 2014), and 665,300 people moving residences between March 2005-2007 (within their region) who attribute 'economics' and 'housing factors' as the largest influence on their decision (Statistics NZ, 2008) - finding a high-quality but low-cost housing solution is in New Zealand's best interest as a society. As our population grows, low quality homes house an estimated 300,000 (Ministry of Social Development, 2010), and New Zealand has the highest homelessness rates out of 36 countries in the OECD (OECD - Social Policy Division, 2019). With building initiatives taking place to increase housing stock, and New Zealanders gradually moving out of their older or run-down housing and moving into newly constructed homes, an opportunity is presented for domiciliary architecture - to leave its low-quality past and reinvent itself. This thesis proposes that while the issue of the cost of housing should be continually addressed, that architects also contemplate the quality of their designs in terms of their potential effects on the mental and physical wellbeing of future occupants, as this 'cost' can be just as damaging.

With people typically spending such a significant portion of their time within the home; resting, socialising, bathing, eating, working – the influence it has on a person's physical and psychological comfort is undeniable. This thesis proposes that through adding considerations of the body and mind into the design process, and iterating these considerations and measuring the effects, more responsive housing can be created for occupants in terms of their wellbeing. It is well established that exposure to particular objects can prime concepts that are related to them (e.g., Aarts and Dijksterhuis 2003; Garcia et al. 2002) and that the heightened accessibility of such primed concepts can spill over and affect people's perceptions or even their overt behaviours (Bargh, Chen, and Burrows 1996; Mandel 2003 Meyers-Levy, Zhu, and article. 2007).

This thesis proposes that by learning how to expose and design these objects that have the power to prime concepts in users; that a higher level of 'human' responsivity can be produced in housing. By catering the building to the body and mind rather than vice versa, wellbeing at home can be enhanced through design.

# 3.0 Methodology

## 3.1 Stage 1: Research and Design Process Development

Stage 1 involves reviewing research in the fields of environmental and behavioural psychology, architectural/historical precedent, and proxemics. From this review, key themes of wellbeing are extracted, and design outcome goals are established that define wellbeing in residential architecture for the means of this thesis. From categorisation and analysis of the themes and goals, as well as specific literature review, designable parameters shown to have an influence on user experience are selected to be explored iteratively through design.

## 3.2 Stage 2: Baseline Design

From key architectural theory, precedent and certain contextual factors relating to New Zealand's housing; a baseline two-bedroom home design is created to serve as a starting point for further iterative development informed by the findings of the literature review. The baseline design responds to research and theory, but its design execution is largely influenced by the personal decisions of the author/designer, and the quality and form of the outcome is not the key subject of analysis in this thesis. This is not considered a limitation as the baseline design's purpose is only to provide a canvas for the specific iteration and testing of the Wellbeing Iterative Parameters. The iterative and testing processes have been developed to be capable of application to any concept design of a home; in the context of this thesis, that concept is the product of the author and has been informed by theory and research relating to perceived spatial balance, human scale, use of the golden ratio, modularity, footprint reduction and sustainability. A hypothetical site in New Zealand has been digitally modelled with accurate topography and orientation according to sun that serves as the site for this theoretical design throughout all iterations.

## 3.3 Stage 3: Development of Testing

In order to determine an appropriate response to users' wellbeing through design, wellbeing in the experience of space must be defined. Furthermore, to be able to measure a design against this definition, a procedure for testing the experience of users' needs to be implemented. That is what this stage of the thesis sets out to do; to collate the

information from the initial research and literature review to create a user-experience based evaluative method. In addition, other resources are engaged that revolve around the potential of virtual reality to provide an experience of designed but unbuilt spaces. The result of this stage of the thesis is the development of research-based questionnaires/instructions for users engaged in the testing of parameters, as well as a method for utilising VR to provide feedback on how the designed space will be experienced by the end user. This process is to be developed to be used alongside design iterations, to monitor progress during design and allow enhanced responses to the client's needs as they present themselves through question responses and spatial ratings.

## 3.4 Stage 4: Iteration of Parameters on Baseline Design

Following the completion of the baseline design for a two-bedroom home with a compact footprint, and the development of an appropriate evaluative/testing method, the iteration of the selected parameters will begin. This follows the testing process simultaneously. The iterations will address all modules of the house that are deemed most influential to the everyday life of the occupant. These modules include: The Workspace, the Dining Space, the Living Space, the Kitchen Space, the Bathroom, and the Bedroom (1). The process for iterative design follows the wellbeing parameters selected in Stage 1; Proxemics, Ceiling Height, Materiality and Connection to Nature and Natural Light. Each parameter comprises of three iterations, including the unmodified baseline model that is tested for comparison of the effects of design changes made in the following two iterations. After each iteration (including the baselines) testing is to be conducted to measure the impact of design changes made in terms of user experience – and to implement these findings in the next design iteration.

## 3.5 Stage 5: Testing

The testing involves the selection of three iterations of the two-bedroom home design from each wellbeing parameter explored. Each parameter's iterations are tested using virtual reality alongside a relevant questionnaire inspired by the literature review and based on the themes of wellbeing being explored. Instructions were also given for the user experiencing the iterations (in this situation; the author) to try and bring the parameter to their attention or to guide them to relevant spaces. Four different types of test were run (Proxemic, Ceiling Height, Materiality and Connection to Nature & Lighting)

with one test per iteration, and three iterations per parameter (see Appendix A). 12 tests were conducted in total and their results are referenced in Appendix A, as well as referenced throughout the Testing and Design chapter. This process is to be conducted alongside the Iterative Design Process.

## 3.6 Stage 6: Evaluation and Conclusions

The final stage of this thesis is the evaluation of the findings of the testing and consideration of the potential of the testing and design process itself. This is done in terms of its ability to address or improve responsivity of common design elements to users' wellbeing in the experience of residential space, and in terms of its validity or value of implementation in general design practice.

# 4.0 Themes, Parameters and Design Outcome Goals

The review of literature focussing on the impact of specific objects in architectural space on a user's wellbeing/experience (such as ceiling height or window design) found there were thematic commonalities. Commonalities were also found amongst more general resources relating to historical precedent and theory and the goal of creating a 'sense of home' in spaces. These commonalities of themes are an outcome of engaging with the idea of enhancing the experience of the user of space. The links between architectural theory and psychology, and the motivations of the research in these fields – to improve or analyse human experience of space – are an inspiration for this thesis.

To understand and be able to apply these thematic commonalities in a design context, the key findings from the literature review have been categorised and are outlined below. This categorisation is for the purpose of making theoretical and psychology-based knowledge more accessible and understandable from the perspective of a designer/architect. To divide the findings from the literature review into themes, parameters and goals sets the basis for a process to be developed to incorporate and measure the effects of the findings in a residential context. Furthermore, scorable criteria to measure the impact of the parameters on occupants' experience of the space have the potential to be developed, bridging the gap between theory and reality in the architectural design process. Seeing an improvement in the achievement of these experiential goals in design or across iterations is what this thesis defines as success in terms of creating a more responsive housing design process for enhancing users' wellbeing.

This thesis aims to make theoretical and researched-based concepts/ideas relating to wellbeing in space more accessible and quantifiable for the use of designers of residential spaces.

*Wellbeing in the context of this thesis will be defined as the enhancement and successful balance of the following properties in users' experience of residential space: Comfort, Stimulation, Social Connection, Privacy and Spatial Balance.*

There is an overlap in terminology between some of the themes, goals and parameters described, as there is also an overlap in human experience between the mind, body and space, therefore multiple perspectives are presented for each Design Outcome Goal (DOG), Theme of Wellbeing in Space (TOWS) and/or Wellbeing Iterative Parameter (WIP). These perspectives include the spatial/designable perspective, the social and the personal. Take the term 'privacy' for example – it is a designable parameter as physical intervention such as a frosted window or door can provide it, but it is also a spatial quality as it can be used to describe a space or room. Finally, privacy is also a personal/social

factor, as it is a feeling that relates to the individual experience of each user of a space. If a user feels as if their privacy has been violated (through design and/or social factors) there is an obvious implication on their mental comfort and wellbeing. In a design context, the perceived privacy of a space defines how suitable it is for certain uses or social environments (e.g. an orgy in a glasshouse). For this reason, privacy can be considered as a goal for design, a theme associated with wellbeing as well as a physical/designable element.

The **Wellbeing Iterative Parameters (WIPs)** are all designable features, shown in research and precedent to influence the experience of space in terms of users' senses of comfort, stimulation, privacy, social connection and/or perceived proportion (DOGs). They do so through their engagement with the Themes of Wellbeing in Space (TOWS). The selected WIPs are as follows:

**Proxemics, Ceiling Height, Materiality, and Connection to Nature and Natural Light**

It is through the successful iteration and design of these parameters that the themes of wellbeing are engaged.

The **Themes of Wellbeing in Space (TOWS)** are the ideas that the WIPs engage through their iteration. They are the themes extracted from the literature review that explain how certain design features (such as the WIPS) seen in our built environment and residential architecture can influence our wellbeing. They include the following themes:

**Sense of Privacy, Connection to Nature, Feeling of Belonging, Sense of Harmony, Notions of Freedom, Notions of Confinement, Sense of Balance, Sense of Social Connection, Reduction of Stress and Physically Healthy Environment.**

It is through the successful experience of these themes in space that the Design Outcome Goals (DOGs) are obtained, and wellbeing is therefore responded to.

The **Design Outcome Goals (DOGs)** are the defining qualities of wellbeing in residential architecture in the context of this thesis. They are the qualities that the TOWS are working to achieve (and therefore the WIPs). They are the scorable criteria for measuring the

success of designing according to wellbeing parameters (WIPs). The successful implementation of the WIPs should present an improvement in the relevant Design Outcome Goal(s). They are as follows:

**Comfort, Stimulation, Privacy, Social Connection and Spatial Balance**

It is through the achievement and successful balance of the above goals that wellbeing within residential space is obtained (in the context of this thesis).

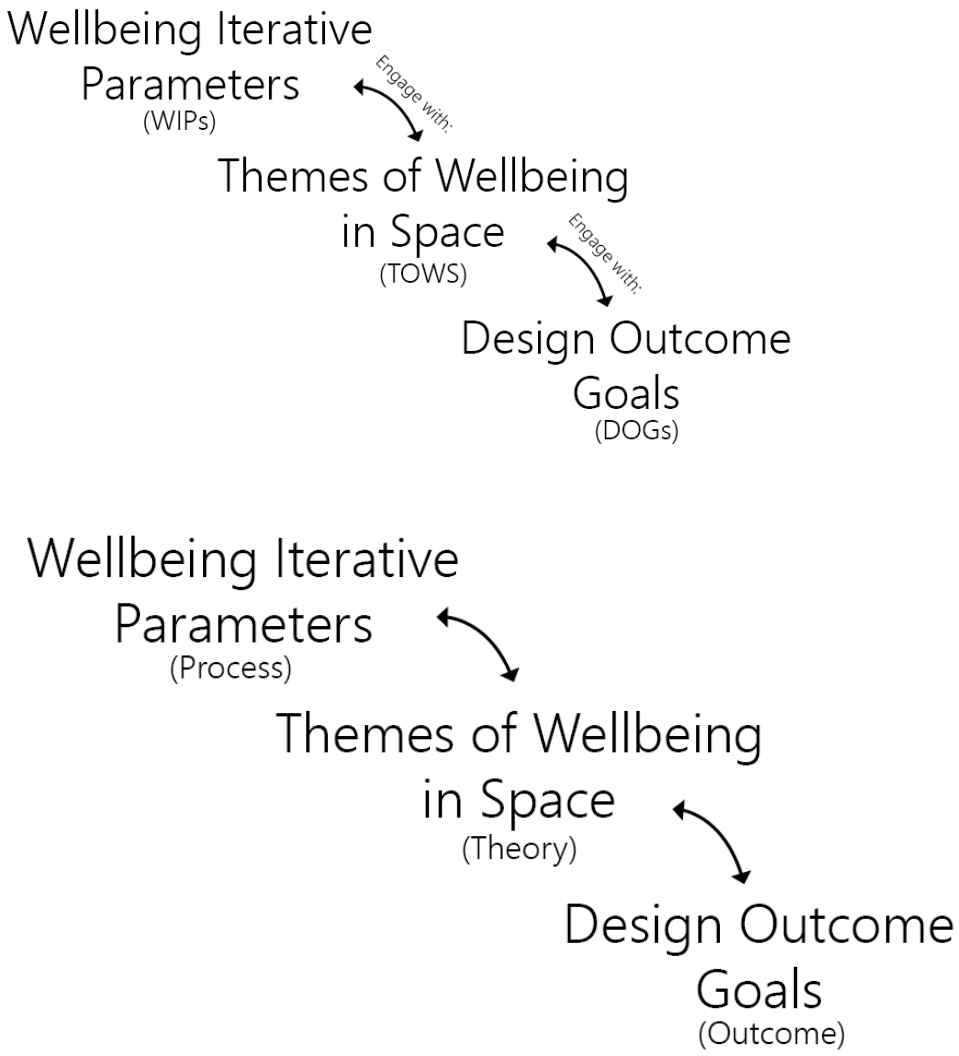



*Figure 1 - Theory & Design Relationships*
*Source: Author, 2020*

# 5.0 Baseline Design

## 5.1 Introduction

In order to provide a context for parameters to be tested and iterated within, a baseline design for a two-bedroom home has been developed. This baseline design is a product of the design decisions of the author, influenced by both the context of housing in New Zealand, and by the precedent of key architectural theory. It does not engage with all the wellbeing iterative parameters that are explored as the main subject of this thesis but serves as a canvas for them to be applied and tested against. It still engages with wellbeing - primarily through themes relating to the spatial balance and human scale, but this is not a key area of investigation.

The scope of this thesis is not to dictate an entire design process, but to simply outline and assess the validity and/or benefits of the application and testing of additional wellbeing related factors within the process. For this reason, the overall formal and aesthetic design decisions remain in the hands of the architect/designer - how/if they choose to manipulate their design to incorporate the elements explored in this thesis would theoretically remain at their discretion. This thesis ignores architectural style and trend, it revolves entirely around the experience of users in a given designed space (the home).
This perspective is summarised well by Peter Smith (1979:5)

> *"The last thirty years have witnessed a steady progression of buildings in which human comfort and mechanical efficiency have been sacrificed to an aesthetic attitude... this is what is regarded as 'aestheticism', the search for aesthetic goals which are esoteric to the profession, and which disregard essential performance requirements".*

This thesis focuses purely on designing for the 'human dimension'.

The contextual factors have been selected because of their relationship to the housing crisis in New Zealand and the international climate crisis. These factors are cost and sustainability. As they are not the key focus of this thesis, they have been explored in the generation of the baseline only. Further design and iteration in the following stages of this thesis relate only to the themes of wellbeing in space (TOWS) and relevant iterative parameters (WIPs) that work towards obtaining the design outcome goals (DOGs). The factors in concept generation that originate from precedent and architectural theory are

the incorporation of human scale, the golden section and spiral, and an understanding of human perception of proportion through an understanding of balance and harmony. The final significant design influence for the baseline home was the decision to approach it from a modular perspective – splitting key areas of the home apart, to be designed separately in detail and then together as one.

The elements of human scale and the golden ratio, as well as space reduction and other baseline design influences have not been tested directly as they are only to act as a background for the other WIPs. The process for their involvement in the baseline design is outlined visually and annotated at the conclusion of the thesis, alongside iteration of the other WIPs.

## 5.2 Cost, Tiny Homes and Sustainability

Cost and sustainability have only been addressed in the baseline design through the objective of reducing the physical footprint/area of the home to its bare minimum, an architectural trend often referred to as 'small home living', or 'tiny houses'. The outcome of this approach is less material use than a typical two-bedroom home due to reduced scale, a smaller amount of green space covered by structure, and encouraged 'minimalist' living to reduce the personal carbon footprint of the home's users/occupants. As Michael Sell (2019: 3) observes "the tiny house movement offers a case study for a more efficient, less polluting world. When constrained to a few hundred square feet, tiny house dwellers must be more selective in their use of resources".

In recent times, tiny homes have been growing in popularity in New Zealand - with the high cost of existing housing and building new, they can offer a cheaper and more sustainable alternative. While downsizing is not for everybody, it is the perspective of this thesis that it can play a vital role for the future of sustainability in the housing sector. Additionally, reducing the scale of the home somewhat forces the home's designer to address spatial quality in greater detail, as there is less laxity in the use of space. It could also be suggested that the effects of the WIPs is greater when the scale of the space the occupy is decreased; as the likelihood of users' attention being drawn to them is increased.

The process for reducing the area of the home began with the setting out of the essential modules of the home, iterating their arrangement, and then using a human scale grid in plan, alongside a scaled golden spiral derived from the golden section to present areas

that could be ‘shaved’ off the floor plan. This process is outlined (visually) in more detail at the conclusion of the thesis.

## 5.3 Modularity

The modular approach undertaken for the baseline design involves addressing the key domiciliary spaces as focussed areas, to be designed separately with attention to the key aims of this thesis, and then merged. The modules will be tested separately and as a whole to evaluate their experiential qualities. The modules developed in the baseline design, to be later iterated and tested according to the wellbeing parameters and design outcome goals include the: Workspace, Dining Space, Living Space, Kitchen Space, and Bedroom Space (One). Another basis for the modular approach utilised is the ability to increase the level of detail in the design of the separate building areas, and the subsequent necessary consideration of the connection of the areas as a whole. This design approach is informed by ‘Gestalt theory’ in architecture which is “concerned with the interdependence of things, and with the whole that is greater than the sum of the parts” (Smith 1979: 21). Following this theory, this thesis takes the stance that by designing the components of a home separately and in relation to one another in detail, rather than as one singular space, an ultimately greater design outcome (whole) can be created. Rather than subtracting necessary rooms from a box or given space, a whole is created through a process of addition.

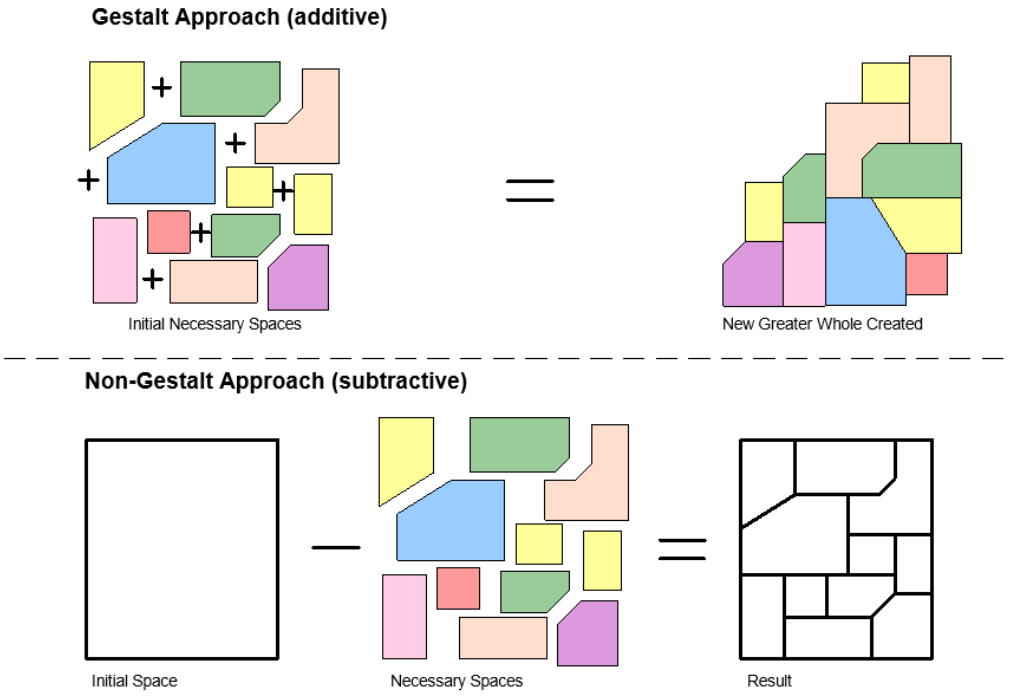



*Figure 2 - Gestalt and Modular Approach Diagrams*
*Source: Author, 2021*

This method of design also allows for prefabrication to be considered in the early stages of a project. As construction is not a key focus of this thesis it has largely been ignored in the text, although buildability and cost were considered throughout initial concept development. The benefits of prefabrication for sustainability, quality of build and cost are notable, and therefore another potential benefit of a taking modular approach worth mentioning. A report by Bernstein (2011: 1) found that over three-quarters of respondents to the SmartMarket survey "indicate[d] that prefabrication/modularization construction reduces site waste – with 44% indicating that it reduced site waste by 5% or more. In addition, 62% of respondents believe that these processes reduce the number of materials used – with 27% indicating prefabrication/modularization reduced materials used by 5% or more". In agreement with this, Monahan and Powell (2011: 180) suggest that prefabricated systems can offer waste reduction of between 20 and 40%. There is no reason the final design outcome could not be prefabricated for clients; this process however will not be outlined due to its lack of relation to themes of wellbeing.

## 5.4 Site and Client

A vacant site located at coordinates (-41.23008, 174.82683) in Wellington, New Zealand has been selected for the baseline design in order to provide consistency in context/setting across the iterations and throughout the design process. This primarily effects the 'Connection to Nature' iterations, as the other parameters are heavily focussed on interior experience. The site was selected simply to provide a more representative setting for the home during digital modelling, so sunlight could be simulated accurately and meaningfully in the virtual reality testing. Apart from discussion and design work in the Connection to Nature testing, iteration and analysis, the site will not be engaged with or considered as a large design element in this thesis. It is the architects' responsibility and skill to respond to specific site considerations in their concept designs, and it is not within the scope of this thesis to outline that process.

The selected site has been accurately topographically modelled (digitally), and the baseline positioned accordingly by the author. For site plans please refer to the Connection to Nature & Light Design Sheets at the conclusion of the thesis. While addressing design parameters that do not directly relate to site, it has been excluded from diagrams, it however is present in all virtual reality testing. (-41.23008, 174.82683) offers a combination of urban elements and greenery in its setting, which is common in New Zealand cities/towns, as well as views of Wellington harbour and some interesting terrain to respond to in design. The author has no affiliation with the site and it is being

used purely hypothetically. The site offers relevant scenarios for Connection to Nature testing and design opportunities; as it provides a combination of views to be avoided (neighbours' homes, sharp inclines) and more pleasing views to be engaged with (i.e. of nature) by the user.

## 5.5 Perceived Proportion, Harmony and Balance

Proportion in relation to the geometry of objects, the human body and space has been a consistent area of research and exploration throughout architectural history. Starting with the studies of the Golden Ratio and the Fibonacci Sequence by mathematicians such as Euclid in centuries BC, proportion and its relevance in how we experience the world has been explored by the likes of Marcus Vitruvius Pollio in his 'De architectura' (Ten Books on Architecture) in the first century BC, Leonardo Da Vinci through his works and 'Vitruvian Man' in the late 15thC and Andrea Palladio in his '*I quattro libri dell'architettura'* (*The Four Books of Architecture*) in the 16thC. In the context of this thesis, this information is valuable for an understanding of the origins of certain themes relating to architectural manipulation of space, and the intertwined psychological fields of study relating to proportion, aesthetics, and human perception of space.

Reviewing literature related to architecture and psychology and the overlap in human perception of space resulted in the discovery of key themes relating to what is considered a comforting or pleasing arrangement of space for users. These themes are harmony and balance. Smith (1979: 11) describes comfort in perception of space through the idea of the recognition of elegance. He says: *"Psychologists are coming to accept that there are good grounds for believing that the mind has an innate capacity to recognise and respond to elegance".*

This is one overlap between aesthetics and human spatial experience; people can recognise, either consciously or subconsciously, the qualities and formal arrangement of their environment. This is not new knowledge; Sommerhoff (1974: 73) made similar observations "*advanced organisms have become responsive to the information profile of the sensory inflow, and… this may be the biological basis of Man's aesthetic sensibilities".* Despite the subjectivity of aesthetic preference, Smith (1979) identifies balance and harmony or proportion as key facets of aesthetic sensibility and as common themes in the perception of elegance and that these two qualities are often incorrectly regarded as synonymous. Looking back to the 16th Century, Palladio's writings on proportion within '*I quattro libri dell'architettura'*, describe his hopes of manifesting the notion of 'harmony'

within architecture. Furthermore, he *"utilised a series of mathematical proportions and ratios that represented ideal relations among the width, length, and height of rooms"* (Vartanian et al. 2015: 11). In short, this essentially means that Palladio's approach to creating preferable architectural space revolved primarily around the concepts of perceived proportion and resulting harmony (Vartanian et al. 2015).

The baseline design of this thesis explores these architectural theories and 'balance' and 'harmony' are defined as themes of wellbeing in space (TOWs) to be engaged with throughout design. Ultimately, their manipulation through design and research has the goal of creating a comfortable residential space – thereby engaging with the design outcome goal (DOG) of comfort.

## 5.6 Balance

The idea of attaining balance in the design of spaces dates to the origins of architecture and the works of Vitruvius. In '*De re aedificatoria'* (1443-1452AD), Leon Battista Alberti paraphrases his interpretation of Vitruvius's ideals of aesthetic balance and beauty in architecture, claiming that every part of a building/design has a specific size and shape, and thus that nothing could be added or subtracted from these areas without destroying the harmony of the whole. This relates to the Gestalt and modular approach taken in this thesis – not only through the sum of the components being greater than the whole, but also through the aim of an equilibrium being established between components, resulting in a dependence on one another – which in turn provides a 'balanced' spatial experience. Many centuries later, psychological research reaffirms this architectural theory; and users' ability to recognise balance (or a lack of balance) in space is an experience with effect (Smith 1979). In the same way that siblings in a large family have the ability to recognise the largest portion of food amongst an array of very similar plates on a kitchen bench, or we have the ability to slice a cake into equal portions by eye – the human brain seeks to detect equilibrium.

Smith goes on to explain how balance as an idea can be understood (in experience or design) *"through the energising of components of a visual 'gestalt' so that they are regarded as forces acting within a system"* (Smith 1979: 13). Conceptually, these ideas are still prevalent in practice, and this can be seen through the language used to describe designed components within spaces by architects. Considering these components or elements as physical forces within a system (which to some extent they are) serves as an analogy for the mind to comprehend proportional balance. Often in architectural discourse we hear the opposing terms "heavy/light, weak/strong or moving/static" used

to describe elements within a building – always with the goal of creating or explaining a visually appealing space. This is a result of the innate human appreciation of proportional balance and the resulting visual comfort it can create in spaces. While these terms are still frequently mentioned and undoubtedly considered to varying extents within practice, the depth and understanding of their engagement can be taken further than it was centuries ago; through the knowledge more recent psychological research and studies provide. Balance as an aesthetic preference has been shown to relate to its ability to foster a sense of comfort in peoples' experience of spaces, which is a theme of wellbeing and design outcome goal of this thesis.

Architects have explored balance in countless ways throughout history. The iteration and design of this thesis's baseline considers this theme of wellbeing through the modularity of the design and the Gestalt elements of its arrangement and formulation. Drawing on the attribution of physics related qualities to design features, and the visual breakdown of spaces in terms of Smith's planes of reality, particularly: lines and edges, textures and symbolism (Smith 1979).

## 5.7 Harmony

Harmony is not synonymous with balance, but rather a result of a successful consideration of balance and the achievement of equilibrium within design. Defined by Smith as a relationship between disparate elements, he states:

> *"it is a condition of harmony that there be at least two entities which are not identical and between which there is sufficient difference to dispel uncertainty, but not so much as to cause excessive dominance"* (Smith 1979: 20).

This idea differs to that of balance – which seeks equilibrium between elements through attributing physical qualities to their visual influence such as weight or strength. It instead seeks to provide a comforting visual arrangement of components which are not identical, by either emphasising their contrasting qualities or designing differences to have minimal visual impact within space. Rudolf Arnheim, a Gestalt psychologist explains that proportions that are based around small differences leave the eye uncertain as to what it is observing, whether they are dealing with an equality or an inequality; a square or a rectangle. When this uncertainty exists, he claims, we cannot understand what the pattern is trying to say (Arnheim 1955).

It is these slight differences between objects that cause uncertainty and discomfort in spatial experience, and therefore these disparate elements within the home (which cannot be identical) must be designed with special attention. While nobody would claim that a beam and a column are identical - with one engaging the horizontal plane and the other the vertical; harmony can be established between these necessary structural elements through careful design. For example, one could match the sizing and length of the structural members, to not provide a displeasing contrast between their scale and connection – or when this is not possible, hide one of the members as to avoid creating a dissonance. Special consideration must be paid when creating harmony between elements or within a space in general, as an inharmonious space fosters an inharmonious experience for users and can potentially cause discomfort. As summarised by Smith (1979: 21) *"Harmonic relationships are, in some way, sympathetic and supportive to the system, whilst dissonance is out of phase with the system and thus heightens arousal and generates stress".*

This concept of harmony is explored through the baseline design and iteration. In order to understand how architects have explored harmony in design precedent has been taken from historical theory as well as well-known architectural works of the last century. These include the use of human scale, as well as the incorporation of the golden section/ratio in concept design. The baseline design is represented visually in the Design Sheets at the conclusion of the thesis.

## 5.8 Golden Ratio and Human Scale

Another consideration of proportional perception that overlaps with the ideas of balance and harmony that has not been mentioned thus far is that of scale. The arrangements of elements within a space are well covered under the aforementioned headings; however, to resolve a design fully with these ideas one must consider the scale of these elements. Having an equation for a comforting spatial design is one thing, but without the values to insert into the equation a definable outcome is unobtainable.

Overlapping between the themes of harmony and scale is the use of human scale and the golden ratio. Although there are numerous examples of their use in architectural history, this thesis focuses on the works of pioneering modernist Le Corbusier, his interpretation of the golden ratio and anthropometrics, and how they can be incorporated within the design of habitable spaces. The goal is creating comfort through harmonious or balanced proportional experience.

Also referred to as the golden mean, golden section or divine section, the golden ratio in mathematical terms is when the ratio of two quantities is the same as the ratio of their sum to the larger of the two quantities. Key equations and diagrams of the golden ratio are shown below. From an aesthetic perspective, the golden ratio is widely utilised in all areas of design as a basis for proportional balance.

The connection between the golden ratio, human scale, and one of the key architectural precedents of this thesis is explained by Smith (1979: 27), under the context of fostering harmony. He says:

> *"The harmonic principle was clothed in a twentieth century guise by Le Corbusier with his 'Modular'. This was a complex system of ratios derived from the golden section. He demonstrated that this ratio is fundamental to human proportions: thus it brought to architecture the law of nature"* (P. F. Smith 1979).

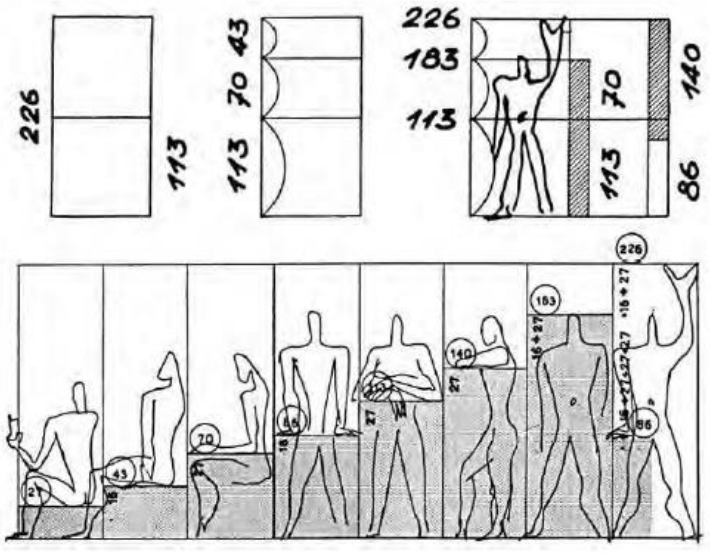



*Figure 3 - Le Corbusier's Modulor Man*
*Source: (Le Corbusier 1954: 66, 67)*

Le Corbusier (1948) is perhaps the most well-known modern theorist to engage with these concepts, he however was far from the first. Le Corbusier's theories (1948) included ideas of earlier theorists, such as Vitruvius and Da Vinci and developed new methods and interpretations for design using 'human-scale' in the modern context. Le Corbusier (1954) believed all architecture is but a container or an extension of man and the use of any method of measurement that was not based on human form would lead to a sense of "*dislocation*". This is fundamentally tied to Palladio's 'harmony through perceived proportion', but with the additional notion that the geometry of the human body must be

in proportion with the geometry of space to create a sense of belonging for occupants. This sense of belonging achieved through human scale and the attainment of harmony and balance in space presents another theme of wellbeing for this thesis.

Perhaps Le Corbusier's (1954) most recognised piece of architectural anthropometric design is the Cité Radieuse in Marseille, which is one of several housing developments he designed according to his anthropometric principles for residential housing called 'Unité d'habitation'. He utilised anthropometric data in all aspects of design at the Marseilles Unité d'habitation, including all exterior planes, interior areas, the floor, ceiling and wall surfaces, and the key divisions in all parts of the building, with the goal of providing a sense of harmony throughout the design. Speaking of his use of human scale (in coordination with the golden ratio) he said: "*It is the task of our modern world to dispose of arbitrary metric measurements in construction and replace them with the remarkable resources of numbers*" (Corbusier, 1948: 490)

As Smith (1979) observes, this harmonic system is not solely a convenient harmonic system for Le Corbusier it was a system of ultimate truth. Le Corbusier, however, was not the only pioneering modernist to utilise human scale to inform proportion in his architecture, Frank Lloyd Wright also saw its potential for creating a positive spatial experience for occupants. Employed in his design of the Robie House (1909), Wright claimed:

> *"through innate sense of comfort came the idea that the size of the human figure should fix every portion of a dwelling or of anything in it. Human scale was true building scale… What other scale could I use?"* (Wright 2010: 320).

Thus, we can see that harmony, proportional balance and the use of human scale, are capable of fostering human comfort.

In the context of the baseline design of this thesis, the golden ratio and human scale have been integrated into the iterative and concept development process as shown at the conclusion of the thesis. The processes used by Corbusier and Wright for the incorporation of these ideas has not been analysed in depth, as newer fields such as proxemics offer more value for testing in the context of this thesis. Data used for the involvement of human scale has been based off the anthropometrics of the author, as in this theoretical situation the author represents the client.

*Figure 4 - Corbusier's Cité radieuse de Marseille*
*Source: Unité d'habitation Marseille © FLC / ADAGP - Paul Kozlowski*
*retrieved from: https://www.lescouleurs.ch/en/journal/posts/the-modulor-human-closeness-as-a-basic-value/*

*Figure 5 - Wright's Robie House Section with Consideration of Human Form*
*Source: Adelyn Perez. "AD Classics: Frederick C. Robie House / Frank Lloyd Wright" 16 May 2010. ArchDaily. Accessed 23 Feb 2021. <https://www.archdaily.com/60246/ad-classics-frederick-c-robie-house-frank-lloyd-wright>*
*ISSN 0719-8884*

## 5.9 Conclusion

From this historical investigation and review of the literature ideas relating to the perception of proportion in architecture have been identified as an area of focus and investigation for centuries. The link between the body, mind and space as a proportional relationship that can either be in or out of balance is presented, and harmony and the use of proportional or human-scale design are key precedents. It has established the connection between the physical and mental effects of space on users, and 'spatial balance', 'harmony' and 'human-scale' as parameters that are key elements of a type of architectural design that aims to produce comfort and its associated wellbeing. The outcome of the baseline design that considered these areas is shown below, and in more detail in the design sheets at the conclusion of the thesis.

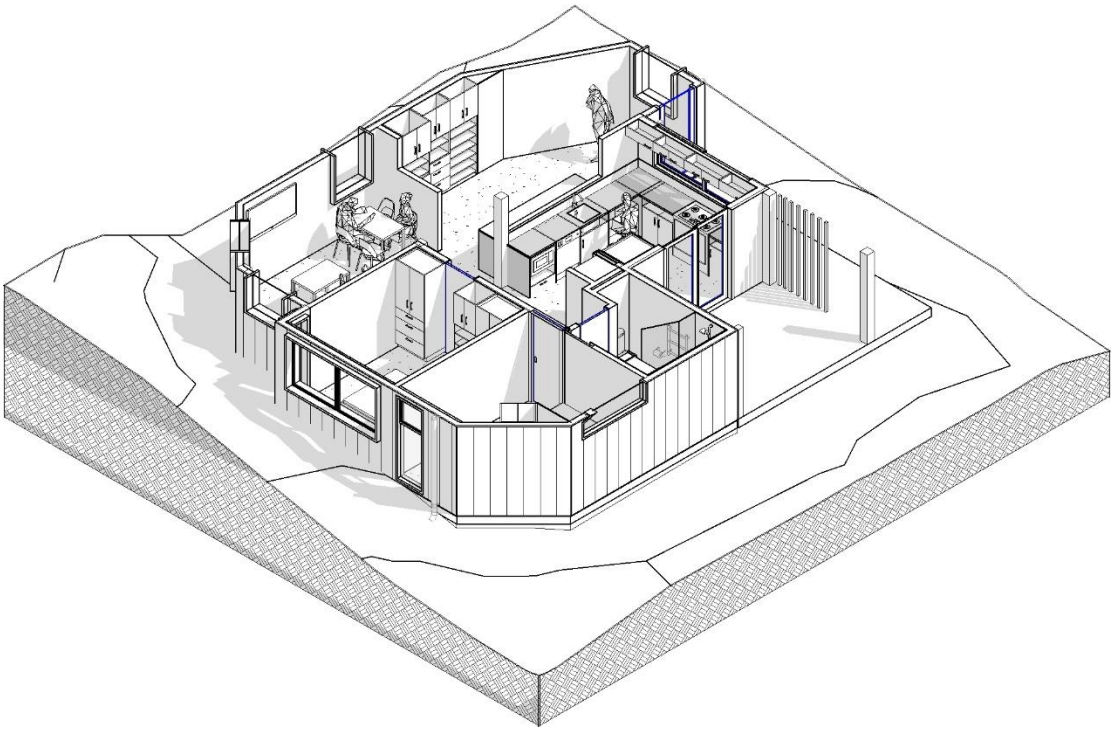


*Figure 6 - Completed Baseline Concept Design*
*Source: Author, 2021*

# 6.0 Literature Review - Perspective

## 6.1 Introduction

The review of research literature into the relationship between the mind, body and space was conducted to inform the baseline design. Focussing on human perceptions of space, and the visual elements within that perception which have a profound influence on experience; the review highlighted the importance of balance, harmony, and human scale. The spatial arrangement and 'shell' for the detailed design is informed by these influential design parameters. There are overlaps in the research focussing on mind, body and/or space and several additional themes emerged. Themes of Wellbeing in Space (TOWS), design outcome goals (DOGs) and parameters (WIPs) which are described at the beginning of this thesis.

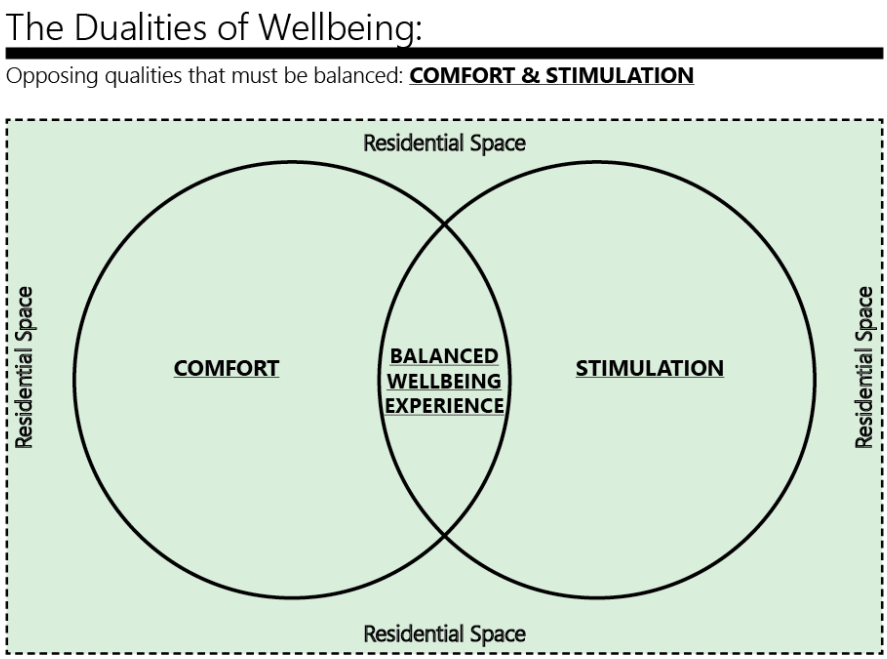
The research and review's key purpose is to provide a better understanding of the relationship between mind, body, and space in the context of housing. It also has the additional intention of justifying the WIPs' relationship with the TOWS and engagement with the DOGs; and therefore, showing the potential for enhancing responsivity to wellbeing in the design of residential spaces through the iteration of particular elements. The result of the literature review is a summary and list of design elements that have been shown through research to impact human experience and wellbeing. These elements are carried through to the detailed design phase to be iterated and practically tested in relation to the occupant's experience.

## 6.2 Wellbeing/Happiness Definition:

As there are innumerable factors affecting a person's mental and physical state and therefore wellbeing, it is important that that the term 'wellbeing' is defined in the context of this thesis. Wellbeing is sometimes used interchangeably with the notion of 'happiness' (Toy & Guite 2008). There are two different philosophies that have emerged from defining happiness: the hedonic and eudaimonic traditions. The hedonic tradition defines happiness as seeking pleasure and avoiding pain, which provides subjective wellbeing; from an architectural perspective this would cover aesthetics. The eudaimonic tradition is concerned with psychological and social wellbeing, in architecture this is form and function (Toy and Guite 2008). Wellbeing in this thesis is defined through a combination of the hedonic and eudiamonic perspectives and addresses the effects of aesthetic and functional design decisions in housing.

Wellbeing has been defined as a *measurable outcome* of the relationship between the user of residential space and their subjective experience of *comfort/stimulation*, *privacy/social connection*, and *perceived proportions* – an outcome of the relationship between the mind, body, and space. This definition is based on the Design Outcome Goals of this thesis and following the review of literature into the effects of architectural elements (WIPs) within space on the mind and body of users. Wellbeing within residential space, or 'wellbeing design' has been successfully achieved or completed when there has been sufficient effort made to respond through iteration and specific design to the spatial qualities of comfort, stimulation, privacy, social connection and spatial balance. This effort will be made through designing architectural parameters that have been shown through the literature review to have an impact on the DOGs and user wellbeing, and then measuring the impact (using virtual reality and testing procedures later described) and working to enhance user experience. Seeing an improvement in user responses/experience that is related to the Design Outcome Goals or Themes of Wellbeing in Space after iteration and testing is what this thesis defines as enhancing wellbeing in residential space through design.

This 'measurable' aspect of this definition is discussed in further depth in the testing chapter of this thesis. The other four DOGS consist of two dualities rather than independent factors. There is a distinct relationship between Privacy and Social Connection, as there is between Comfort and Stimulation, they are opposing ends of the same spectrums. While these qualities can be described and experienced separately, in terms of the design of residential space they must be considered as interrelated. This is because spaces within the home can be put in the position of having to provide both privacy and connection, or comfort as well as stimulation – depending on the specific space in use and its function, and the situational context of the environment. For this reason, though they are separate DOGs, their relationship is acknowledged and a relevant balance between the qualities is sought throughout the home (dependent on each module's social function and requirements). Wellbeing in residential space is not defined by complete privacy as it is not defined by complete stimulation – it is the relevant balance of these factors/qualities within the home that provides a positive environment and user experience that therefore responds to wellbeing. The diagrams below summarise the notion of the dualities and their balancing qualities within space.



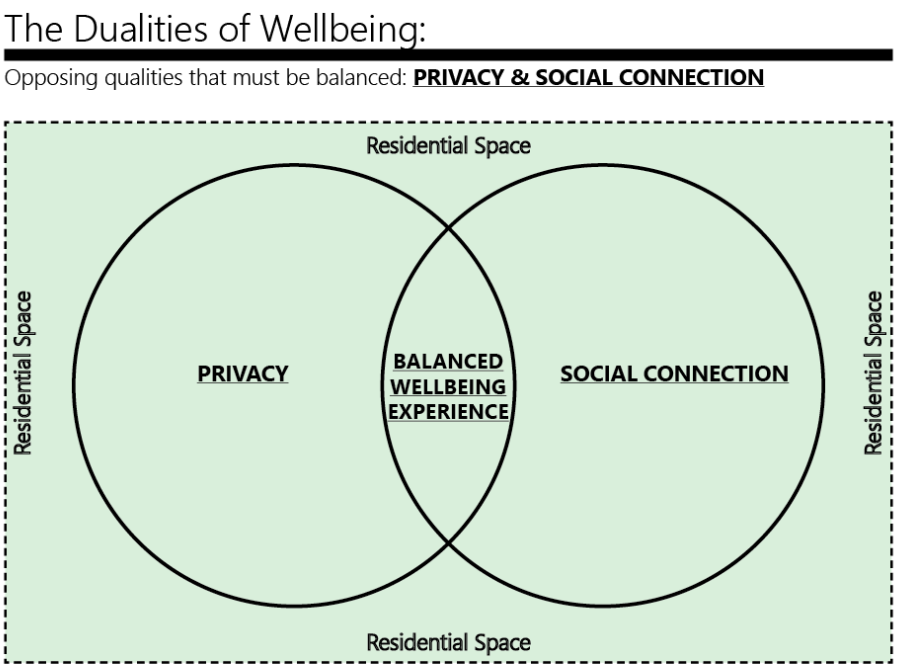




*Figure 7 : Dualities of Wellbeing to be Balanced within Space*

*Source: Author, 2020*

## 6.3 The Perceptual Lens

> *"It has been said that buildings act as a "third skin" right after clothing, and that they function as a selectively permeable boundary between people and their environment"* (Fischl 2006: 1).

But how do we interact with this permeable skin? And what environmental effects can make it through this 'permeable barrier' and impact our experience most? This relates back to the initial research question of this thesis: '*How can an improved understanding of the relationship between the mind, body and space enhance wellbeing in residential architecture?'.* The simple, although ambiguous answer to this is that it is all to do with individual perception – just as we choose to dress differently to one another due to differing tastes that have be born from a myriad of personal and social factors, we experience architecture differently due to our individual subconscious preferences and past experiences. The question is: how do we understand individual perceptions of space, and the relevance of the psychological processes that occur and inform perception and experience from a design perspective? From a scientific perspective this relationship is very complex, and there are several fields of study dedicated to understanding it. Géza Fischl (2006) describes this relationship in an architectural context explaining that people are affected by the built environment through *sensation*, *perception* and *cognition*. With sensation being the initial and physical response to your environment (based on your sensory systems), and perception following that and relating to your "conscious experience of objects and their relationships". Finally, cognition refers to the "process of knowing" and relates to both perception and learning (Fischl 2006: 3).

A useful analogy for understanding this psychological process is the Brunswick's model, which compares it to a lens. Referring to this processing of information (from the body, to the mind, to experience) as a process of looking through a lens allows us to understand the relationship between objects in space and people in simpler terms. Fischl (2006) describes the Brunswick model as

> *"a perceptual process as analogous to a lens, wherein stimuli from the environment become focused and perceived through the perceptual efforts. The actual lens in Brunswick's model represents the mental processes that search for relevant cues (distal) and consider those cues that experience has demonstrated to be the most important in drawing perceptual conclusions (proximal)"* (Fischl 2006: 4).

This has become the basis for understanding the relationship between the architectural objects composing the residential environment (distal cues) and the effects they have on

users through their perception of them (proximal cues). These distal cues are the Wellbeing Iterative Parameters (designable objects), while the proximal cues are the Themes of Wellbeing in Space (experience of objects). Referring to the processing of space as a lens allows designers to address this relationship between humans and architecture without an in-depth knowledge of psychology or other related fields – while still engaging with key knowledge from them.

The need for understanding this perceptual process relates to the approach the designer will take for designing a residence. To enhance responsivity to wellbeing through design the architect must relate to the people the space is being designed for. Fischl (2006) describes this approach as "psychosocial", and this parallels the key aims of this thesis; to use an understanding of the relationship between the mind, body, and space to improve design outcomes for people. Simply put, the importance of this approach to residential architecture is that it can decrease the environments negative effects of users; and in turn, improve their overall experience of their home. Or, as put by Fischl: *"the importance of a psychosocial approach to environmental design can be characterized by the individual's increased mental resources to cope with a stressful situation"* (Fischl 2006: 2).

## 6.31 Comfort – Perceptual Lens Diagram

Comfort and how it is affected by each parameter will be discussed in detail in each parameter chapter. The tangibility of comfort and comfortable spaces is well established in architecture. An individual's personal experience of comfort is impacted by a myriad of factors and past experiences that have shaped their perception – however, this thesis focuses on the relationship between an individual's experience of comfort and specific distal cues/architectural parameters.

The relationship between the physical setting of the home and a person's comfort within it depends on their perception of factors or distal cues within the environment; and the proximal cues associated with each parameter or distal iteration. Summarised in simple terms by Max Fordham:

> *"We experience our surroundings through our senses. The feedback we get from our senses give us the information to confirm that we are vibrant and alive. Our sensory responses let us know if we are comfortable, and thus affect our happiness"* (Fordham 2008: 56)

Thus, comfort is a vital design outcome goal for this thesis, for the role it plays in the relationship between the body and mind and the experience of space. The relationship between comfort and the wellbeing iterative parameters (WIPs), as well as the themes of wellbeing in space (TOWS) is illustrated diagrammatically below; with an emphasis on understanding the role of human perception in the relationship between spaces and humans' experience of said spaces.

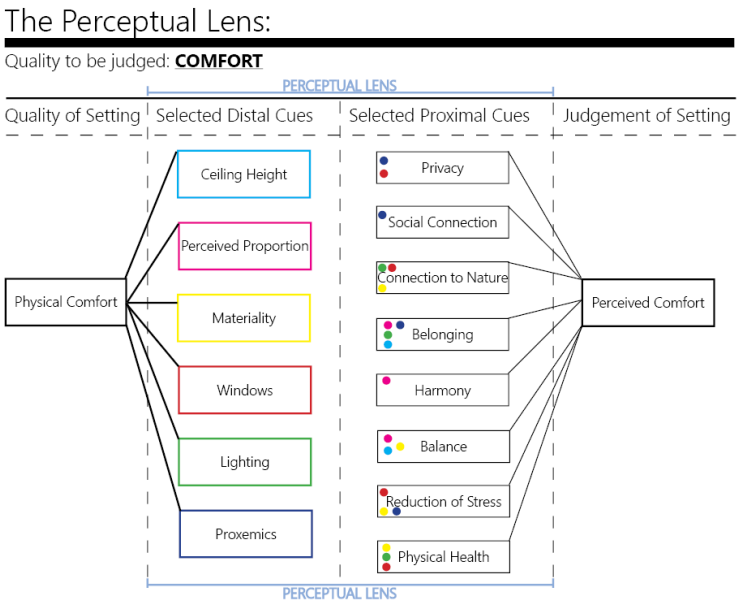



*Figure 8 - Comfort Perceptual Lens Diagram*
*Source: Author, 2020*

## 6.32 Stimulation – Perceptual Lens Diagram

As a part of the definition of wellbeing in space for this thesis, the term stimulation also requires a brief explanation. Stimulation in the context of this thesis does not necessarily mean that of a directly conscious or physical nature, but rather as a contrasting quality to that of comfort. If comfort is an inactive sensuous experience, then stimulation is the active sense to counterbalance it and provide a mental and physical balance within space. Stimulation is an alternative quality of wellbeing, that is still achieved by priming relevant concepts within users through distal cues. It relates to common proximal cues of wellbeing through these distal factors and relates to the body and mind in space in the same way that comfort does.

The relationship between stimulation and experience is shown through the perceptual lens diagram below, and stimulation and how it relates to each WIP (wellbeing iterative parameter) is discussed throughout the following chapters.

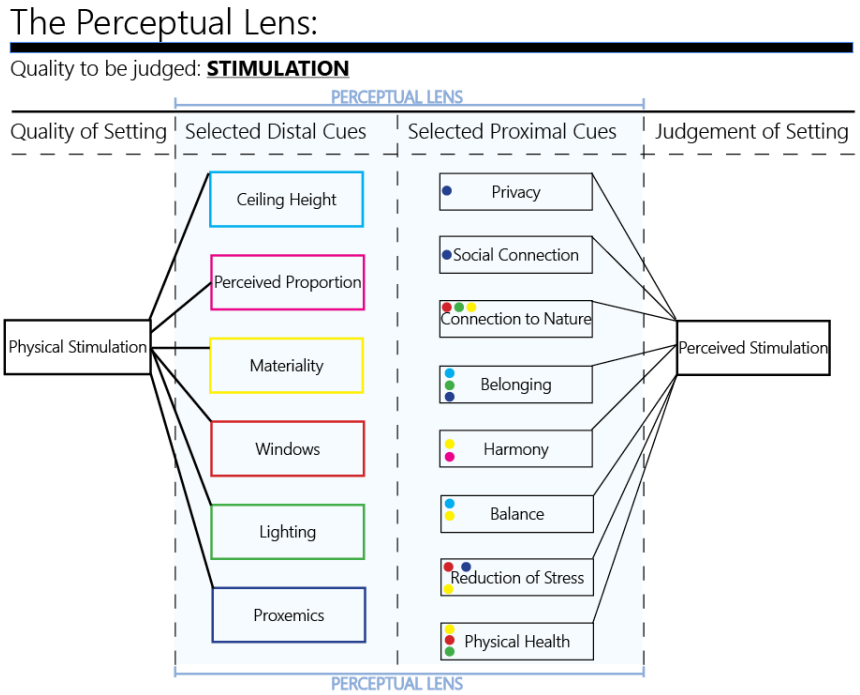



*Figure 9 - Stimulation Perceptual Lens Diagram*
*Source: Author, 2020*

## 6.33 Privacy – Perceptual Lens Diagram

Relating to the personal and social experience of space, and therefore user wellbeing is the notion of privacy. Humans can experience spaces as an individual, or part of a group – and in the home their wellbeing relates to the need for privacy as well as social connection. As Halpern (2008) observes

> "*the physical environment has a big impact on how we interact with others – whether we experience other people as a nuisance or a pleasure – and thereby on our wellbeing. A key element of built environments that promote happiness is that they lower the barriers to interaction, while also enabling us to choose when, where and with who that interaction will occur. Get that right, then worry about aesthetics*" (Halpern 2008: 72)

Balancing privacy and social connection are essential for a positive home experience, people need a place to connect and then to withdraw. The discomfort of having your privacy breached is significant, and therefore architects should seek to control this relationship between users of space through design.

Privacy and its relevant distal and proximal cues are shown in the diagram below, and privacy as a TOW (theme of wellbeing) and DOG (design outcome goal) is discussed throughout the relevant following chapters.

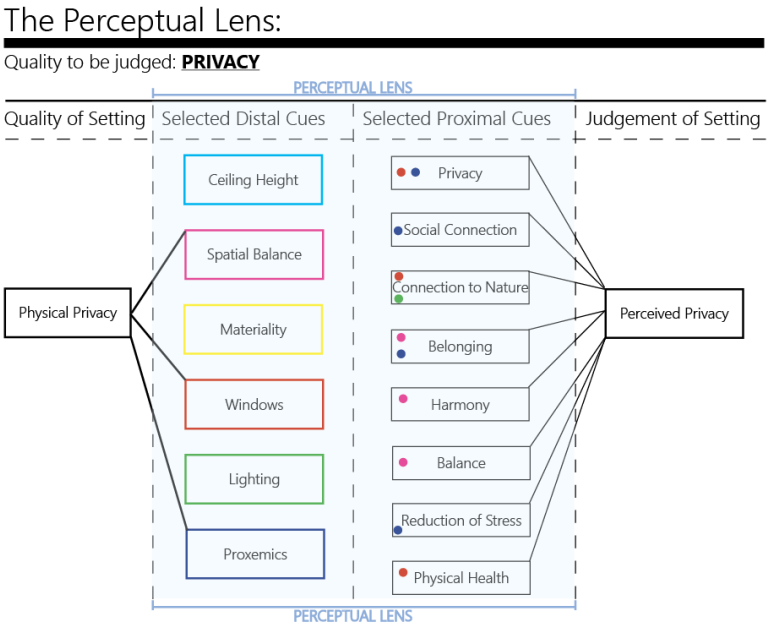



*Figure 10 - Privacy Perceptual Lens Diagram*
*Source: Author, 2020*

## 6.34 Social Connection – Perceptual Lens Diagram

Opposing the need for privacy within residential spaces is the need for social connection. To reiterate what Halpern (2008) said previously,

> *"A key element of built environments that promote happiness is that they lower the barriers to interaction, while also enabling us to choose when, where and with who that interaction will occur"* (Halpern 2008: 74)

While a lack of privacy poses a serious risk to wellbeing within residential design, a lack of spaces that promote social activity and connection present the same risk. A home where individuals are stuck in their rooms and there is no space for them to positively interact can lead to feelings of isolation, and an uncomfortable home environment that negatively impacts residents' wellbeing.

Social connection and its relevant distal and proximal cues are shown below, and its relationship with the WIPs and TOWs is described in the relevant following chapters.

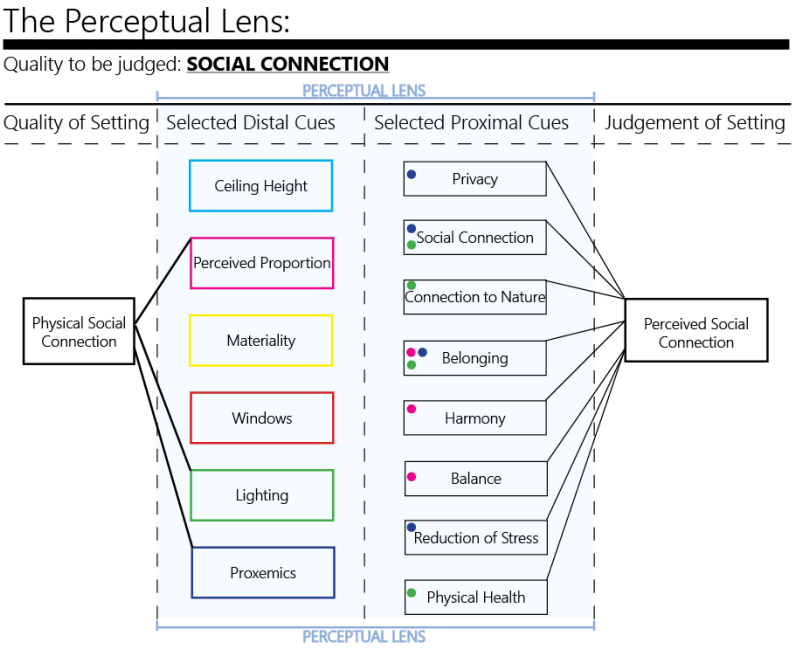



*Figure 11 - Social Connection Perceptual Lens Diagram*
*Source: Author, 2020*

## 6.35 Spatial Balance – Perceptual Lens Diagram

Spatial balance, perceived proportion, harmony, and other visual qualities of designed space are all key elements in humans' perception of space that are discussed primarily in the baseline design chapter. The relationship between how residential space is organised, arranged, and designed and how appealing the space is to users is a key area of architectural theory that has been discussed for centuries. Understanding a positive example of this relationship through achieving balance and harmony amongst built components of the home presents an opportunity for wellbeing to be enhanced through improving visual cohesion and comfort for occupants in their home environment.

The innate sense of dissatisfaction or even discomfort that arises when one sees misaligned geometrical patterned floor tiles - or when windows along a building's elevation are staggered randomly and differing in size - is a result of a negative experience of perceived proportions of designed space. In the home this could relate to the scale of key areas, the arrangement of features within the space or the finishing, materials and detail of the space. Providing an appealing design is a large part of an architect's role, and this thesis proposes that based off the baseline research into spatial balance; that providing a balanced and harmonic design results in a comforting experience of space for users. An unbalanced design can feel 'random' and lead to a sense of dislocation and unease within the space, and therefore spatial balance is a key DOG of this thesis.

The relationship between spatial balance and its distal and proximal cues is shown below, and its relationship with TOWS is discussed in the following chapters – justifying its relevance to wellbeing and showing how the selected WIPs influence it.

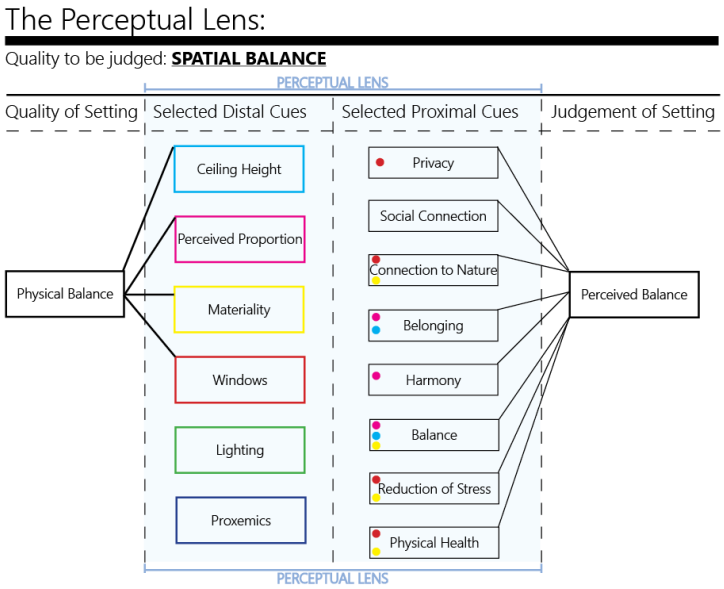



*Figure 12 - Spatial Balance Perceptual Lens Diagram*
*Source: Author, 2020*

# 7.0 Proxemics

## 7.1 Introduction

Following from the consideration of human scale and its influence in the design of balanced and harmonic spaces is the field of proxemics. Tied in theme to the use of human scale as it relates to the body in terms of 'its relationship with space'. However, it goes further and incorporates knowledge from fields of psychology to better understand this relationship in terms of the minds of individuals. This knowledge is used to inform the physical scale of spaces with the goal of manifesting certain social environments within architecture. The term 'proxemics' was coined by American anthropologist Edward T. Hall (1990), and according to Nussbaumer (2014: 6) it relates to "the social, physical and psychological aspects of space" and is defined as the field of study *"used to define relationships between humans within a space; hence, interior designers encourage or even discourage human interaction by the way they organise space"*. As the perspective of wellbeing for this thesis revolves around an understanding of spatial experience in terms of its designable qualities, personal qualities, and social qualities (through their influence on the body and mind) – the field of proxemics is directly relevant as it examines the relationship between individuals and the space that composes their environment. In addition, it does so in a quantifiable manner - allowing integration into design processes through key dimensions and arrangement considerations. The field also revolves around addressing the specific needs of the client/individual to enhance their spatial experience and involves processes of interviewing or observing clients in order to do so; a concept central to the goals of this thesis that relates to the testing processes outlined in the later chapters.

Nussbaumer (2014) has been used as a key reference for a recent account of proxemics and their use within architecture. The first step in understanding proxemics role in design is to understand the different types of physical space that can compose a residential environment; these include fixed-feature space, semi-fixed feature space and informal/non-fixed space. Following this it is important to understand the different types of social spaces that can compose a residence, either 'sociofugal' or 'sociopetal space' or somewhere in-between. The final perspective on spatial environments that must be explored to understand proxemics in architectural design is the different types of personal space that exist, these are broken down into the following zones established by Hall (1990): Intimate, Personal, Social (Intimate), Social (Formal) and Public. This breakdown of the different qualities of occupiable spaces provides a physical, personal, and social perspective to be considered. These categorisations of space are discussed in the

following chapter. Finally, underlying concepts that inform the quantifiable qualities of proxemics/space such as privacy (and opposingly, social connection), 'territoriality' and 'avoidance' must be explored to ensure this mind/body/space relationship is better understood, and the reasoning for each design decision is clearly linked to relevant psychological concepts.

## 7.2 Spaces: Fixed, Semi-Fixed and Informal

Nussbaumer (2014) breaks down the physical types of architectural space into either fixed-feature space, semi-fixed feature space or informal/non-fixed space. This is important as each type of physical environment has different proxemic applications and considerations for user wellbeing/experience.

### 7.21 Fixed-Feature Space:

Fixed-feature spaces are composed of permanent building elements such as immovable walls or fixed furnishings, and provide the basis for organising activities and ensures that people can engage in groups or choose to be isolated (Nussbaumer 2014). The important underlying concept for this type of space relates to the specific function that many fixed-feature residential spaces are designed for. For example, kitchen spaces are often comprised of fixed features in western culture (stoves, sinks, refrigerators) and are functionally specific in that they are designed for food preparation. Permanent spaces become functionally driven; bathrooms are for personal hygiene, offices for working, dining rooms for eating etc. While one may be able to use a spare room as an office or guest bedroom, spaces that are composed of permanent features and fittings such as the kitchen will remain defined by their functional purpose. The significance of this comes through the psychological implications that the specific functionality of spaces present. Described by Hall (1990):

> "*if an activity or object normally associated with one space is moved to a different space, the room may be considered 'a mess' because the activities or objects are incompatible with the function of the space. If office work took place in a dining room for example, the activity would be considered inappropriate and render the space messy."* (Hall 1990: 132)

This quality of fixed spaces has significant implications on social and personal wellbeing within the home as people typically do not like to see their living space as disorganised or messy; and do not like to be seen by others as messy or disorganised. This presents two important considerations for designers in order to prevent 'functional clashing' occurring in fixed-feature spaces; firstly, that all of the clients' functional requirements for the home

are met – and thus that no necessary spaces for the everyday life of the occupant are missing that could lead to a crossover (such as a lack of workspace leading to the use of the dining area for work), and secondly: that the functionality of each space is addressed in depth according to the specific needs of the occupant, i.e. that the kitchen is functional for the type of food preparation that will be undertaken, the workspaces are designed appropriately for the occupant to complete their specific type of work.

## 7.22 Semifixed-Feature Space

Semifixed-feature space are spaces composed of movable objects such as furniture or decoration. The significance of this type of space for wellbeing design is that the different arrangements of objects within it are capable of connoting different social and personal experiences of the space.

The arrangement of movable objects in a space informs human behaviour within that space, such as arrangements of seats into rows rather than circles clearly defines different social and personal experiences within space. Two types of arrangement design defined by Hall (1990) for their social connotations are the "sociofugal" (to keep people apart) and the "sociopetal" (to bring people together).

## 7.23 Informal (nonfixed) Space

Informal or nonfixed space according to Nussbaumer (2014: 9):

> *"relate people to people – that is, interaction between individuals with the spatial experience occurs with or without the aid of fixed or semifixed features. Most importantly, informal or nonfixed spaces relate to distance zones – the distance between two people"*.

This type of space presents the purely personal and social elements of spatial experience between individuals; addressing the wellbeing of the body and the mind while space serves as the intermediary for comfortable engagement.

## 7.24 Summary

For the designed component of this thesis, functional spaces are being defined as fixed. This is to address the key goal of enhancing responsivity to the client's body and mind. If one were to attempt to specifically design for an individual, utilising testing and simulation; and then the individual moved into the space and change all of the fittings and arrangement of the space – then all expected and measured responses to the 'wellbeing design' undertaken would be irrelevant. The other reason that all spaces are designed as fixed feature is that due to the small scale of the dwelling and the focus on

removing all excess floor area from the design (in order to respond to sustainability and cost), many features simply will not be able to be moved to different areas due to their size, and the reduced flexibility of spaces. The implication of this is simply that each functional space must serve its purpose with the highest degree of responsivity to client expectation, as to prevent functional redundancy or the need for changes to the design. While the needs of spaces/occupants may change over time, and some proxemic considerations may be able to be designed adaptably; it is the perspective of this thesis that by designing a kitchen or living space for considerations that will only be relevant 10+ years in the future, or to serve numerous other potential functional requirements; the result will only be reducing its immediate responsivity to the current function it must serve, and to the current everyday needs of the residence's occupants, thereby not enhancing wellbeing in space to the maximum potential, or in any quantifiable way.

This is not to say that considerations applicable to other types of space (semifixed/informal) will not be applied to the design of fixed spaces, as many are still relevant, such as the concepts of sociofugal and sociopetal space and distance zones.

## 7.3 Sociofugal and Sociopetal Space

Sociofugal spaces, which discourage interaction between occupants have a purpose within architecture, although perhaps less so in a residential context. Typical examples of spaces designed to be sociofugal include lecture halls and medical waiting rooms (Nussbaumer 2014). Within these spaces seating is typically arranged in rows facing forwards, or around the perimeter of the room. With these spaces there is a clear reason to isolate people (to prevent students getting distracted or to prevent the spread of illness), and while these do not apply to a residential context – there are still benefits to understanding sociofugal design in terms of enhancing wellbeing in space. These include the ability to address the need for privacy between spaces within the home. For example, a client may want there to be little/no social connection between a living and dining area – but for the space to remain open and light; this presents an opportunity for sociofugal arrangement of furniture and fittings to be considered. Sociopetal spaces, which encourage interaction have a stronger precedent in residential design – including living rooms, dining rooms or some workspaces. The need to encourage interaction; or to provide spaces that allow people to socialise within the home revolves around the goal of preventing isolation and is clearly tied to the theme of wellbeing. Commonly, to encourage interaction furniture/seating is arranged at right angles to each other or facing each other. It is important to note however, that different cultures have different preferences for both

sociofugal and sociopetal space, and the individual and their cultural background must be considered when implementing this knowledge in design.

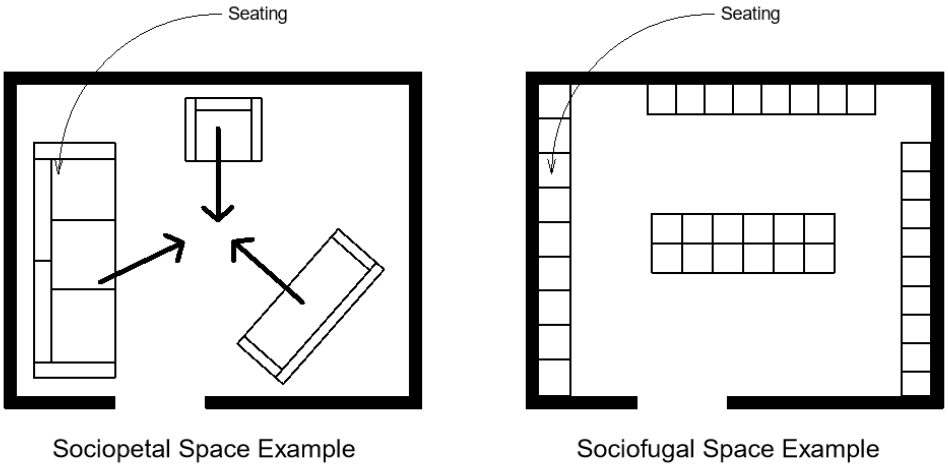



*Figure 13 - Sociopetal & Sociofugal Seating Arrangement Examples*
*Source: Author, 2020*

## 7.4 Distance Zones

DeLong (1991) and other researchers of proxemics have established concepts of social distance zones, that inform designers of the comfortable distances between two people for different kinds of social interactions to occur. Hall's zones were defined as the: intimate zone, personal zone, social zone, and public zone. DeLong's take on distance zones was to consider people seated in furniture, and the result was a more oval-like shape as well as some minor distinguishments between zone names in comparison to DeLong's (Nussbaumer 2014).


*Figure 14 - Distance Zones Diagram (recreated from Hall's distance zones diagrams)*
*Source: Author, 2020*

## 7.41 The Intimate Zone:

The intimate zone is the zone for those who feel close to one another. As Nussbaumer (2014: 10) notes:

*This zone relates to comfort, affection, and protection as well as aggressive behaviour. A stranger entering an individual's intimate space may cause both to feel uncomfortable and uneasy… for these reasons, designers must avoid creating environments that penetrate the intimate space*."

The intimate zone ranges from the point of contact outwards, a distance of 18 inches (0-457mm).

## 7.42 The Personal Zone

The personal zone ranges from 457mm to 1219mm (1.5 – 4 Feet) and relates to personal relationships between people in space. Nussbaumer (2014: 10) observes *"friends are permitted in the personal zone at arm's length, but they do not enter the intimate zone, with a few possible exemptions such as a handshake or possibly a pat on the back".*

She goes on to explain however, that the 'personal bubble' can differ between cultures, and that it is smaller than the American (Hall & DeLong models) for some. Because the personal bubble can differ culturally designers need to understand who will be using the space and what they will be using the space for (Nussbaumer 2014).

## 7.43 The Social Zone(s)

The social zone can be either be for formal or informal interactions and ranges from 1219mm to 2438mm (4 – 8 Feet) for informal engagements, and 2438mm to 3658mm (8 – 12 Feet) for more formal interactions. According to Hall (1990), the outer boundary of this zone is the range that people can converse at voice levels which are normal and can see each other clearly. The closer the distance between individuals - the more interaction increases, and can become less formal (Nussbaumer 2014).

## 7.44 The Public Zone

The public zone is when the distance between subjects is 3658mm (12 Feet) or greater, and "little or no interaction" occurs here (Nussbaumer 2014). A common example of this relationship is the distance between a speaker and an audience.

## 7.45 Summary

This information is valuable for the design context of this thesis and its goals of enhancing wellbeing as understanding these different spatial/social zones allows the designer to cater the space to the client and attempt to foster productive and comfortable social environments within the home. It presents important considerations that have a direct impact on the comfort and wellbeing of occupants, such as to avoid creating designs that penetrate the intimate zone. This proxemic knowledge helps designers better understand the relationship between space, people and the mind.

The cultural differences that affect these distance zones, mentioned by Nussbaumer in her more recent writings on proxemics, must also be taken into account when implementing these proxemic factors into design (Nussbaumer 2014). This further reiterates the need for client specific testing/involvement early in the design process, as generic values cannot be used successfully for people with different social needs and cultural habits.

## 7.5 Privacy

Privacy is a concept central to proxemics, and a DOG and TOWS for this thesis. Defined as relating to *"all personal spaces – intimate to public. It is a means of controlling access to oneself or a group"* (Stewart-Pollack & Menconi, 2005: 27). According to Nussbaumer (2014: 12) privacy:

> *"can be divided into two areas, each with its own descriptors: (1) separation from others – solitude, anonymity, reserve, and isolation; and (2) being alone with selected individuals – intimacy with family, friends or others of one's choosing".*

This presents important knowledge for the design of spaces that are to be occupied by people, which are expected to support a variety of different types of social interaction/environments. Implementing concepts and utilising knowledge of privacy, and its underlying descriptors in the design process has the potential to enhance wellbeing, as unwanted social situations can be avoided, and desirable ones can be catered to through specific design. The descriptors of privacy are defined by Stewart-Pollack and Menconi (2005: 19):

Solitude – the need to be alone and free from observation by others; a place where others cannot hear or see what someone is doing – retreating to our bedrooms or offices and closing the door.

Anonymity – The freedom to be in public while at the same time free from identification or surveillance by others; being lost in the crowd.

Reserve – The need to limit communication about ourselves, and which is protected by the cooperation of others.

Isolation – The separation of ourselves physically from others by means of physical distance – going for a long drive alone.

Intimacy – The need to be alone with others such as friends, lovers, or family without interference from unwanted intrusions.

Understanding these descriptors of privacy gives some clarity in terms of the different types of space that occupants may need at different times within their homes, depending on their relationship with privacy at that given moment. In terms of the design component of this thesis privacy is a key component of wellbeing within space; and iteration in the following chapters will seek to provide suitable environments for each privacy descriptor to be achieved within the residence.

## 7.6 Territoriality

According to Hall (1990: 44) another component of privacy is territoriality – which is used to *"communicate one person's control over an area".* These areas may be defined by walls or physical features, or by invisible boundaries that define the distance zones previously described. Sommer (2007) categorised territories into four types: public, home, interactional and body. The most relevant for the scope of this thesis is the concept of body territories, which tie into proxemics. Body territories *"relate to one's personal space with its invisible boundaries. Encroachment into this territory by another may be considered an invasion, violation or contamination"* (Sommer, 2007). An example given by Nussbaumer (2014) describes taking the last seat in a waiting room between strangers – and how this may feel like a body invasion into the 'invisible boundaries' or intimate/personal space of strangers.

The concept of territoriality enables understanding that people inherently desire to have a space for themselves, which is different to the concepts of privacy and distance zones which relate people to space in social contexts only. In the words of Nielson and Taylor (2007)

> *"individuals may identify and create their own territory within a space… For example, many individuals have their own seat in a classroom, sit in the same*

*pew in church, or occupy a favourite chair in the family room. If one's seat is taken, he or she may feel annoyed and even displaced"* (Nielson & Taylor, 2007: 215).

Nussbaumer (2009: 16) summarises the value of this knowledge in a design context aptly: *"territoriality is a basic need to have space; therefore, if spaces are shared, areas must be provided for individuality and privacy"* (Nussbaumer, 2009). Therefore, it will be a focus in proxemic iterations to provide ample area for users to occupy without having to share the space.

## 7.7 Individuality and Variables

As mentioned previously, there is a need to consider the individual/occupant in question when applying these proxemic considerations to the design process, as there are different cultural norms and individual responses to situations based on a myriad of variable factors, including gender and anthropometrics, that effect peoples' personal interpretation of privacy and distance zones. The way to respond to this is to utilise questionnaires or interviews to determine how applicable these concepts are to the specific client being designed for. When discussing the differences between genders and distance zones, Nussbaumer (2014) explains that they may be closer amongst women. The significance of this being that these proxemic considerations are only guides, and that true design responsivity comes through knowing the end user of the space, not generic rules. Reaffirmed by Nussbaumer (2014: 21) when she says:

> *"in creating spaces, interior designers must understand and know their client… During the programming phase, prepare interview questions or make careful observations of the client concerning how that person regards personal space".*

This is the goal of the testing and iterative procedures in the following chapters, to determine the specific relationship between the client and (personal) space, rather than to use a generic understanding and risk creating uncomfortable environments due to individuality.

## 7.8 Conclusion

From this investigation into proxemics, the key findings to take through into the design phase are the concepts of fixed, semifixed, and informal space, sociofugal and sociopetal space, distance zones, privacy, territoriality, and the element of individuality and cultural beliefs that influences the concepts. From this literature review, key themes of wellbeing have been established, as well as knowledge that helps inform designers about the relationship between the mind, body, and space. Following from anthropometrics proxemics allows an understanding of the social elements of space, and how these relate to the body/mind as well as physical dimensions. From this literature review 'privacy' has been established as a Design Outcome Goal of this thesis for its relationship with mental wellbeing in space. In addition, the concepts will be integrated into the iterative design and testing processes that follow, with the goal of enhancing responsivity to the social and personal needs of the residence's occupants.

# 8.0 Ceiling Height Research

## 8.1 Introduction:

This chapter examines specifically the influence of ceiling height on human perception of space, and its impact on the mind and body of users of space. When selecting distal cues to be examined for their relationship with wellbeing in residential space, ceiling height is one feature present throughout the home. As walls and general arrangement of form have been designed according to the DOG of spatial balance and refined and iterated following this according to proxemic considerations – ceilings are one remaining constant throughout the home that have the potential to be iterated and examined for their potential role in enhancing wellbeing in space through design.

There are a number of studies that examine the effects of different ceiling heights on users of space; with many concluding that there is both a basic preference for the height of ceilings, and that changing this height impacts the spatial experience of the user through priming concepts. The goal of this section of research is to establish how and why ceiling heights are a worthwhile Wellbeing Iterative Parameter.

## 8.2 General Preferences for Ceiling Height

Existing research on the influence of ceiling height includes a study by Fischl and Gärling (2004) which examines the potential of architectural design to improve wellbeing within healthcare facilities. The study concluded that ceiling height ranked among the top three architectural details that influenced consumers' psychological well-being, alongside windows, floors, and walls. As walls are designed through spatial balance and proxemic considerations, and windows are examined in the following 'connection to nature' chapter; ceiling height as an influential distal cue/wellbeing iterative parameter needs to be explored.

A fairly typical ceiling height in New Zealand is 2400mm, with this being the typical stud height of many of the older housing stock from the early to mid-twentieth century. Ceiling height trends have changed throughout history and many new builds are reflecting a preference for higher stud heights such as 2700mm or 3000mm. Historically, higher ceilings typically reflected status in the sense that only the wealthy could afford homes with grand high ceilings. Today, it seems that ceiling height is more directly impacted by industry standards and building practice rather than individual preference.

Coburn (2020) focussed on psychological and neural responses to architectural interiors and concluded that there is sufficient evidence to support a general preference for ceilings heights "across a range of spatial functions" of approximately 10 feet or 3048mm. This study reaffirms the notion that people have a preferred ceiling height, and that altering height has an effect on users' spatial experience. Similarly, a study supporting Coburn's (2020) noted, *"people tend to prefer ceilings that are about two feet (.61 m) higher" than the 2440mm standard ceiling height in the US, which adds to around 3050mm"* (Vartanian et al. 2015: 10). The same study also found that "*participants preferred higher ceilings for the activity of listening then reading, dancing, dining and talking"* (Vartanian et al. 2015: 10). This finding reflects a connection between ceiling height and human ability or comfort in performing activities. Utilising this knowledge in the design process offers an opportunity for enhanced responsivity to human spatial needs and wellbeing.

## 8.3 Freedom VS Confinement

Coburn's (2020) study on responses to ceiling height also noted what was considered a 'surprising' finding that open spaces and high ceilings were associated with higher hominess score. Explaining that rooms with lower ceilings were expected to be more strongly associated with "coziness"; he then acknowledges the potential role of other features in the room (such as lighting, textures and furniture) on this rating before stating that it was also possible that "*the low ceilings in our stimuli conveyed a sense of confinement and claustrophobia rather than coziness*" (Coburn et al. 2020: 221). This is a valuable consideration for wellbeing design; the ability of one object such as a ceiling to prime different psychological responses in users – ones of comfort/cosiness, or of discomfort/confinement.

This is not a new theory in environmental psychology or architectural design. This body of research includes work on the effects of ceiling height on people through psychological priming, where particular objects can prime concepts related to them (Myers-Levy 2007, Aarts & Dijksterhuis 2003, Garcia et al. 2002). Further, the heightened accessibility of such primed concepts can spill over and affect people's perceptions or even their overt behaviours (Bargh, Chen, and Burrows 1996; Mandel 2003; Meyers-Levy, Zhu 2007). This shows the capability of design to respond to potentially subconscious human preferences within architecture that effect wellbeing through individual perceptions and behaviour.

The literature review on ceiling height revealed there was consensus that ceiling height can prime concepts of either confinement or freedom, can alter behaviour (Moore et al, 1996) and can enhance wellbeing (Meyers-Levy, Zhu 2007). Whether this effect is referred to as a primed concept or proximal cue does not matter, it is the understanding of this relationship and its relevance to enhancing spatial wellbeing through design that is valuable. From this, spaces where users would prefer to feel 'free' or 'confined' can be established within the home, and the ceiling height can be manipulated through design accordingly to meet the needs of the user.

## 8.4 Frank Lloyd Wright & Ceiling Height

Outside of the field of psychology, architects have manipulated ceiling height in their designs to provide various spatial experiences for some time. One such architect is Frank Llyod Wright, whose works serve as a valuable precedent. Wright explored the effects of ceiling height on occupant experience through careful, programmatic, and experiential based design. Discussed in depth by Sprague and Brooks (1991) the differing ceiling heights within the Robie House (1909) when walls have been removed triggers the psychological recognition of boundaries. Wright utilised ceiling height to define function and seemed to understand its ability to control human spatial experience. Furthermore, his decision to alter the height of spaces depending on what their use is reflects an understanding of the primed concepts previously discussed. Wright uses high ceilings over the living and dining areas and lower ceilings at the sides of each room and passageways, moving from low to high triggers the psychological response of moving from a compressed space to an expanded space gives a sense of release and creates the illusion the space is bigger than it is (Brooks 1991; Sprague 1985). Wright's design of the Robie House and other homes are valuable as a well-known examples of residences whose ceiling heights have been specifically designed to create a psychological effect on users. Not only does the height of the ceiling effect users the changing of heights between spaces also produces a secondary impact of increasing the intensity of the effect of the change.

*Figure 15 (prev. page) - Wright's Trier Residence, Johnston (1956) with a lowered ceiling over a seated area.*
*Source: Douglas M. Steiner, 2010. Retrieved from http://www.steinerag.com/flw/Artifact%20Pages/PhRtS398int.htm*

*Figure 16 - Wright's Haddock House (1939) featuring varied ceiling heights across spaces*
*Source: The Barrett Group (n.d) Retrieved from https://thespaces.com/little-known-frank-lloyd-wright-home-in-michigan-lists-for-1-2m/*

*Figure 17 - Wright's Robie House (1909) featuring a higher ceiling over the dining area*
*Source: Abel Uribe/Chicago Tribune (2019) Retrieved from https://www.chicagotribune.com/columns/blair-kamin/ct-biz-robie-house-restoration-kamin-0325-story.html*

## 8.5 Item-specific & Relational Processing

What effect do these primed concepts have on user experience? Meyers-Levy's (2007: 174) study proposed that the effects on behaviour and perception in space originating from distal cues are caused by "*primed concepts actually affecting the type of processing that people use."* The conclusions of the study seem to confirm their thesis, with findings revealing that when occupying a relatively high ceiling environment individuals rely on relational processing, when in a low ceiling environment and sensing confinement individuals engage in item-specific processing (Meyers-Levy et al. 2007).

Meyers-Levy et al. (2007) explain that to some extent these responses should be expected for high-ceilinged spaces, as 'relational elaboration' relies on *"elaborating freely or uninhibitedly on multiple pieces of data so as to discern commonalities or higher-order abstract points of intersection that they share"*(Einstein and Hunt 1980; Hunt and Einstein 1981 cited in Meyers-Levy et al. 2007). The same for low-ceiling spaces which promote item-specific processing where an individual focuses on each item by itself with

specific context related concentration (Hunt and Einstein 1981; Malaviya, Kisielius, and Sternthal 1996 cited in Meyers-Levy et al. 2007: 175). The evidence suggests the primed concepts of freedom and confinement (created through the manipulation of ceiling heights) can in fact determine the type of processing that users of the space engage in. The other interesting finding was that these differences in people's processing were only found when *"ceiling-height salience and thus their awareness of ceiling height was reasonably high"* (Meyers-Levy et al. 2007: 182).

This research into ceiling heights and their primed concepts affecting individual processing is relevant and useful for wellbeing design applications as types of processing can be prescribed according to room function and ceiling height can be changed accordingly. It also provides potential for commonalities to be highlighted through increasing ceiling heights, such as the harmonic or balanced designed elements implemented in the baseline design. Perhaps by encouraging relational processing through ceiling height interventions an opportunity for a more harmonious architectural/home experience can be created through increased recognition of commonalities in design?

| Ceiling Height | Associations to Primed Concept | Type of Processing Induced | Result |
|---|---|---|---|
| Low | Confinement Related | Item-specific | An emphasis on seperately analysed and specific, relatively concrete data |
| High | Freedom Related | Relational | An emphasis on data integration and abstraction |

*Figure 18 - Table of Ceiling Height Findings - from (Meyers-Levy, Zhu, and article. 2007: 176, Figure 1)*
*Source: Author, 2020 (based on the work of Meyers-Levy et al. 2007)*

## 8.6 Summary

In summary: there is a general preference for higher ceilings than is typical in New Zealand's homes, of approximately 3050mm. High ceilings have been shown to evoke feelings/prime concepts of freedom, while low ceilings have been shown to prime concepts of confinement. Furthermore, these primed concepts can change the type of processing occurring in users of the space to relational or item-specific processing respectively when ceiling height is salient. Architects such as Frank Lloyd Wright have

recognised the influence changing ceilings heights has on experience within the home and used this knowledge to define spaces. The value of this knowledge when it comes to implementing it in design to respond to wellbeing needs is significant. The value is ceiling heights can be designed to inform spatial experience; spaces that are meant to make users feel free can do so, places of retreat where one may want to feel cosy or even confined can be created, places where people need to focus directly on a task 'at hand' can evoke item-specific processing to help this, and places where free thought is needed can be designed to evoke relational processing. This information adds to the knowledge from proxemics, but also shows that vertical distances in architecture can impact user experience just as the horizontals do.

# 9.0 Materiality Research

## 9.1 Introduction

In terms of the defining qualities of physical environments, materiality is omnipresent and as such is an important element to understand when designing spaces for people. Material selections not only affect construction and the presentation of exposed surfaces in a residence, but also how the space is used by people, and their comfort within it. In architectural practice primary material decisions are made early in the project, while the more detailed selections such as for the kitchen and bathroom are typically made later. There is an opportunity for designers to better understand the impact of materiality on user experience and specifically, wellbeing. By understanding the physiological and psychological qualities of different materials, choices can be made that respond in greater depth to the end-user's wellbeing within the home.

## 9.2 Material Preference

It is known that the exposure of timber in built environments has positive effects on the minds and bodies of the users of the space, and this is the relationship examined primarily in this section of research. According to Jalilzadehazhari & Johansson (2019) using wood on walls, ceilings and floors can change the quality of the indoor environment and trigger positive psychological and physiological responses in people. Understanding and attempting to measure and control these responses, and therefore gain a better understanding of material qualities - provides an opportunity to enhance wellbeing within the home.

Studies originating from New Zealand on the impact of materiality and exposed timber are limited to the effect in office space. A New Zealand study examining the appeal of exposed timber in a corporate/office context in which 69 adults were presented with images of 10 modern interiors, with five of the interiors heavily featuring timber while the other five featured no wood at all. Participants were more likely to want to work in interiors with wooden furnishings. Australian research has demonstrated that the use of wood in office design impacts positively on productivity (Knox 2018). Australian research has also demonstrated that Australian workers are drawn towards wood and there has been reported increased productivity in offices which use wood in their design. Offices with wooden interiors also conveyed feelings of innovation, energy and comfort, whilst offices without wood conveyed feelings of being impersonal and uncomfortable (Ridoutt and Ball

2002). In another Australian study similar results were found when participants were asked their preference out of a timber and non-timber environment – and furthermore, this was the case despite one in two people being unaware that exposed timber had any potential health benefits (Planet Ark 2015: 3). In regard to responses to other material options, findings suggest that timber has the most benefits to the mind and body, with the Planet Ark study revealing that participants valued wood interiors as they were "natural", "feel warm and cosy" and are nice to touch. Second to wood was brick, and plastic was the lowest scoring for pleasantness of the five categories presented to participants (Planet Ark 2015).

Through these studies we see there is an innate preference for exposed timber in buildings, and that its use is seen to create a more pleasant environment that can potentially improve productivity in comparison to other material options.

## 9.3 Wellbeing – Introduction

On top of this preference for timber in interior environments, there are many known psychological and physiological benefits of human exposure to timber. These include improvements to a person's emotional state and level of self-expression, increased happiness and self-esteem levels, increased cognitive abilities and productivity, reduced blood pressure, heart rate, cholesterol and stress levels and improved air quality through humidity moderation (Zelenski & Nisbet 2014; Zhang, Howell & Iyer 2014; Berman, Jonides & Kaplan 2008; Berman et al. 2012; Lee et al. 2009; Tsao et al. 2014; Planet Ark 2015)

A review of the evidence found the use of wood in design can reduce stress responses in people and consequently has positive health benefits and wellbeing outcomes (Burnard & Kutnar). It is known that humans have physiological responses to wooden surfaces in interiors, these responses are changes in the brain, the autonomic nervous system, the endocrine and the immune system. The changes are triggered by the impact wood has on a range of senses: visually, auditorily, tactilely and olfactory (Rowlinson 2020).

What this means for designers is that they must consider more than only the visual qualities of materials when making selections, as other senses also engage with them and impact human wellbeing through their stimulation. While there are reported health and experiential benefits of timber in terms of the olfactory and hearing/acoustic qualities of the material, these benefits are less studied and less measurable. In comparison to many synthetic materials, timber is said to have a more comforting scent, and similarly a

more comforting acoustic quality for floors and other touched surfaces (Rowlinson 2020). However, for the purposes of this thesis the focus is limited to sight and touch as these are considered the primary senses that can provide wellbeing enhancement potential through engagement with materials such as timber. These two senses can also be tested using VR and the use of material samples – this process is described in further detail in the testing chapter.

## 9.4 Wellbeing, Timber and Vision

As humans' primary sense, vision is an important factor in explaining how materials such as timber effect the mind and body. Research on how timber impacts the human experience of space through vision highlighted that timber typically emits long-wave light and is therefore perceived to have a yellow-to-red hue, which in turn can improve cognitive performance (Jalizadehazhari & Johansson 2019). Furthermore, the aromatic lignin component present in timber is capable of absorbing a high amount of ultraviolet light (Kutz 2005), which creates a comfortable environment for the eye (Jalilzadehazhari and Johansson 2019). The research concluded that a number of studies have noted the benefit of the colour of wood for cognition and eye health (Jalilzadehazhari and Johansson 2019). There is an established relationship between the visibility of timber in the built environment and human wellbeing factors. Wood surfaces can also induce light to scatter and therefore dimmish surface glare and increase luminance, this can reduce eye fatigue, eye strain and headaches and stress (Hirata, Kageyama & Ohta 2012; Jalilzadehazhari & Johansson 2019).

When discussing the specific qualities of timber itself, there are several useful studies which describe the influence of texture and knots in timber on human perception. Nakamura & Kondo (2007) showed a positive linear relationship between the number of knots exposed in wooden surfaces in interiors and eye fatigue, which as mentioned earlier can lead to headaches and increased stress. Research by Edwards & Torcellini (2002) showed that eye fatigue can also cause difficulties in learning and information processing, as well as higher levels of anxiety. This knowledge is valuable to designers as it demonstrates excessive exposed knots in the wood's texture can lead to negative wellbeing effects due to potential eye fatigue.

In conclusion, timber offers many vision-based wellbeing benefits in interior environments for people. These include improved cognitive performance and eye comfort, and decreased stress and anxiety levels, although the effectiveness of this visual stimulation depends on the number of knots visible as well as the colour of the timber itself.

## 9.5 Wellbeing, Timber and Touch

Other than through vision, the materiality of homes obviously influences spatial experience through other human senses. Another sense that has an interesting relationship with the material qualities of timber is touch, this is referred to as tactile stimulation. According to Jalilzadehazhari & Johansson (2019) tactile stimulation depends on the heat flux of materials. Heat flux is controlled by the thermal conductivity of materials and the temperature differences between the material and the skin when in contact. The thermal conductivity of wood is much lower than that of other materials commonly used inside homes, such as tile, marble or concrete, and therefore less likely to feel cold or hot when touched (Rowlinson 2020). This is valuable knowledge for designers as surfaces that are exposed to touch, including structural members, can be timber to improve comfort through touch. Floors, columns, cladding, wall linings and benchtops are prime examples where the use of timber has the potential to directly impact comfort of use, through decreasing stress through temperature mediation. One scenario where this knowledge would be applicable in design would be to use timber flooring to mitigate the discomfort of a cold floor on barefeet on a cold morning, while also providing the other visual wellbeing benefits of timber.

Canadian architect Michael Green notes people respond differently to timber than they do to steel or concrete, they typically do not hug concrete or steel columns like they have been seen to do with timber (Rowlinson 2020). This shows that when considering materiality in design more than just the visual qualities of materials must be considered, as there are other methods of interaction that can affect wellbeing such as touch. It also emphasises the pleasant environment created by exposed timber, and its potential affects in lifting peoples' moods.

## 9.6 Conclusions

Considering this research on the effects of exposed timber in architecture on human wellbeing, we can conclude that there are significant health and wellbeing benefits in using wood. The known potential benefits covered in this literature review include improvements to a person's emotional state and level of self-expression, increased happiness and self-esteem levels, increased cognitive abilities and productivity, reduced blood pressure, heart rate, eye fatigue, cholesterol and stress levels and improved air quality.

The positive effects and connotations timber seems to conjure experientially in comparison to other synthetic material options, as well as these measured physiological and psychological effects shown in the research, make it a clear wellbeing iterative parameter, and its use by designers beneficial for enhancing spatial wellbeing within the home.

# 10.0 Connection to Nature Research

## 10.1 Introduction

Connecting interiors to nature is another significant theme of wellbeing in space. Capaldi's (2014) study concluded being in contact with nature has beneficial effects on people's mood, cognition and health. It has been found that those that are connected to nature tend to have greater life satisfaction, vitality and experience positive affect, when compared to those who are less connected to nature. Ulrich's Biophilic studies demonstrated patients were able to heal quicker whilst requiring less medication if they had a view to natural surroundings (Ulrich 1993). There is a wealth of evidence that suggests a connection to nature can produce positive physiological and/or psychological effects. Other benefits according to Rowlinson's (2020) review include greater happiness and self-esteem, lower stress response, blood pressure, pulse rate and cholesterol levels and increased cognitive abilities.

The effect of natural landscapes on humans has been demonstrated, for example having a view of a forest landscape can lower stress, assist the autonomic nervous system and facilitate relaxation and positivity (Lee et al. 2009). Even viewing pictures of nature can improve directed attention and restore attention (Berman, Jonides, and Kaplan 2008). A study by Zelenski & Nisbet (2014: 3) examined other types of connection such as with friends or community, to try and explain the link between nature relatedness and happiness. They found that *"general connectedness predicted happiness well, yet nature relatedness remained a significant distinct predictor of many happiness indicators, even after controlling for other connections"*. The study concluded that connection to nature is a potential path to human happiness and environmental sustainability (Zelenski and Nisbet 2014). Connection to nature is a key theme of wellbeing in space that should be designed for to enhance health and wellbeing.

## 10.2 Frank Lloyd Wright & Nature

The relationship between human wellbeing and a connection to nature is clear and well documented, but what does it mean for designers? To understand how we can design for nature connectedness; the most effective approach is to explore historical precedent. Attempting to bridge the divide between nature and architecture is not a new theme in the history of practice, and many architects have brought different approaches and understandings of this relationship to the table.

One perspective that aligns well with the goals of this thesis is that of Frank Lloyd Wright, whose residential architecture is well known for its connection between site and nature. Wright believed that the relationship between the occupant, the home's interior and the outside world was particularly influential in the physiological and psychological experience of the home, and that by having a strong connection between nature, interior and the occupant, there is potential to create a more harmonious user experience of space. Reflecting on the Robie House and its emphasis of open interior spaces and 'unobstructed' views of exterior surroundings, Wright said:

> *"the relationship of inhabitants to the outside became more intimate; landscape and building became one, more harmonious; so the life of the individual was broadened and enriched by the new concept of architecture, by light and freedom of space"* (Wright, 1955: 84).

This was the approach used by Wright in the Robie House and many of his other works, to connect interior space to the landscape through opening up living areas so there are no walls to obstruct exterior views. Because of the many wellbeing related benefits of connecting interior spaces to nature and landscapes shown through the aforementioned studies, and Wright's fascination with fostering this connection within his works; it is worthwhile considering the design techniques used by this pioneering modernist. Diane Maddex (2003) describes some of the methods and design logic used in Wright's houses in her book, Wright-sized Homes and these are summarised below.

## 10.3 Landscape + Site

The first considerations important to Wright in establishing a connection to nature, were the site and its landscape. He said a home:

> *"should appear to grow organically from its site like a tree from the soil, built of the hill, not on it, and giving few hints where the ground leaves off and the building begins. It should be a 'companion to the horizon"* (Maddex 2003: 23).

As well as connecting through form to its surroundings, his buildings were designed to connect to nature through their directionality and views of key landscape features. He was known to 'borrow' distant scenery, with the aim of enlarging the property – with the framing of views of distant mountains, bodies of water or forests, the perception of a larger environment and landscape could be created. This can be especially valuable for the design of smaller spaces, on small sections of land. According to Maddex (2003), capturing the sun and vistas of a site and building to preserve the views from the inside is where to start. Other techniques mentioned include raising the house to ensure better

views. Using trellises and garden design to connect a house to the land. These are valuable considerations for designers seeking to connect their architecture to the environment. Learning from Wright's design approach can allow a design that is connected to nature.

*Figure 19 (left) - Zimmerman House (1951) surrounded by nature*
*Source: 'mwms1916' (2011) via Flickr, retrieved from https://www.flickr.com/photos/mmwm/6110662974/*

*Figure 20 (right) - Stuart-Richardson house (1941) surrounded by nature*
*Source: unknown (2019), retrieved from https://www.6sqft.com/frank-lloyd-wrights-unique-hexagonal-house-in-glen-ridge-nj-is-back-on-the-market-for-1-2m/*

*Figure 21 (above) - Norman Lykes House (1959) integrating with the form and tones of the landscape & nature*
*Source: Heritage Auctions, ha.com (2019), retrieved from https://www.forbes.com/sites/brendarichardson/2019/10/20/the-last-home-designed-by-frank-lloyd-wright-sells-for-167-million-in-phoenix/?sh=6d1e85f36b69*

## 10.3 Windows/Openings

Wright's other key approach to connecting his architecture to nature revolved around the use of windows – or as he referred to them: 'light screens'. In the design of many of his homes, Wright had a preference for breaking down the solidity of walls with large bands of windows, to let in large amounts of light and create a more open feeling space,

connected to the exterior landscape (Maddex 2003). With the same logic he also used windows mitred at the corners, to make walls seemingly disappear. Wright's perspective was that windows should not just be holes punched randomly into walls, they should be oriented to key views and suited to each room. He commonly utilised glass curtain walls, which he believed had the capability to "turn small houses from boxes – caves – into roofed shelters that invite nature inside" (Maddex 2003: 36). Similarly, French doors and casement windows were frequently found in his designs, as he believed that the action of opening outwards was important in establishing this connection to nature in his buildings. In his more decadent homes, Wright utilised windows further for building this connection to nature by etching them with geometric or natural designs, that cast their patterns back onto interior walls and floors. In later homes where the cost of artistic glass was too high, he simply used more and larger windows, with timber frames that had a beauty of their own (Maddex 2003). These considerations explored in Wright's works are valuable for designers deciding where to place and how to size windows, as this is a key part of connecting the interior to surrounding nature.

*Figure 22 (left) - Stuart-Richardson house (1941) windows opening the space to nature*
*Source: unknown (2019), retrieved from https://www.6sqft.com/frank-lloyd-wrights-unique-hexagonal-house-in-glen-ridge-nj-is-back-on-the-market-for-1-2m/*

*Figure 23 (right) - Stuart Richardson House (1941) skylights and internal views out to nature*
*Source: unknown (2019), retrieved from https://www.6sqft.com/frank-lloyd-wrights-unique-hexagonal-house-in-glen-ridge-nj-is-back-on-the-market-for-1-2m/*

*Figure 24 (above) - Stuart Richardson House (1941) light screen to nature at night*
*Source: unknown (2019), retrieved from https://www.6sqft.com/frank-lloyd-wrights-unique-hexagonal-house-in-glen-ridge-nj-is-back-on-the-market-for-1-2m/*

### 10.4 Biophilia – A Modern Take

This interest in connecting people to nature in architecture and urban environments, and the corresponding wellbeing benefits, is also referred to as biophilia. Literally translating as a love of living things, the term was first used by the German-born American psychoanalyst Erich Fromm in 1964 to describe the psychological orientation of being attracted to all that is alive and vital (Rowlinson 2020). The term was popularised however by American biologist Edward Wilson, in his 1984 book '*Biophilia*'. The theory proposes that there is a connection between human beings and other living systems, with Wilson describing it as *"the connections that human beings subconsciously seek with the rest of life"* (Wilson 1984: 24). In more recent times, biophilic architecture has been increasing in popularity as more research has arisen highlighting the many benefits of a nature connection. Particularly in office or commercial contexts, companies and corporations are recognising the benefits to productivity, creativity and employee health and wellbeing of incorporating natural elements into the interior working environment. The potential to connect architecture to nature in a residential context is much greater than for many commercial contexts, and the benefits of doing so in terms of occupant wellbeing can be expected to be greater too, due to the large proportion of time typically spent in the home. There is an opportunity for designers and architects to seek out these wellbeing benefits for their clients, and design with biophilia or a connection to nature in mind.

## 10.5 Natural Light

Another design and wellbeing consideration that relates to a connection to nature is that of natural lighting. Referring to light from the sun, and its influence on the experience of interior spaces, natural lighting is a key element in designing comfortable spaces for people. Beyond immediate and obvious physiological effects on vision, *"light, like sound, also helps us to communicate with other people, and to experience our surroundings"* (Fordham 2008: 59). In addition, physically, exposure to bright and natural light helps the body to produce serotonin, increased serotonin is associated with happiness, under production is associated with depression (Fordham 2008). In terms of artificial lighting, research is primarily based on a commercial context, and although there are known wellbeing-related effects and valuable conclusions such as that "*high correlated colour temperature fluorescent lights could provide a useful intervention to improve wellbeing and productivity in the corporate setting"* (Mills, Tomkins, and Schlangen 2007: 1); the difference in context between an office and a home, as well as the focus on a connection

to nature in this thesis – mean that the focus of this research will be on the wealth of material highlighting the benefits of human exposure to natural light.

One benefit of exposure to natural light in interior spaces comes through its effect on our daily rhythm – or 'circadian rhythm'. Humans are expected to be exposed to bright light during the day and then a gradual descent into darkness in the evening for sleeping. According to Christoffersen (2011) light is central to maintaining our natural daily rhythm. Being outdoors and exposed to natural light can be expected to play a large role in maintaining our circadian rhythms, but with the reality being that we typically spend around 90% of our time inside (Evans & McCoy, 1998), people are lacking sufficient exposure to bright/natural light – especially in winter months. Furthermore, research suggests that when people experience low light exposure they have diminished health and wellbeing, it can impact on sleep quality and lower mood, energy levels and lead to a reduction in social interaction (Christoffersen 2011).

Other studies focussing on the effects of natural light exposure in schools have shown that "students in daylit rooms achieve higher test scores than students in windowless or poorly lit classrooms. Along with better test scores, student health also improves from the increase in vitamin D intake and students have fewer dental cavities and grow more under full-spectrum lighting" (Edwards and Torcellini 2002). Similarly, studies in a healthcare context have demonstrated that natural light can improve patient recovery outcomes (Edwards and Torcellini 2002). This shows the impact natural lighting can have on our bodies and minds, and its role in enhancing wellbeing. On top of the physiological and psychological benefits of designing to maximise natural light, there are also cost benefits due to reduced artificial lighting (and heating) needs.

In summary, the provisioning of natural light is essential for wellbeing in the home environment, and it is the responsibility of the designer to ensure that the building's design (with particular attention to windows/skylights) allow suitable exposure to daylight.

## 10.6 Conclusion

In conclusion, establishing a connection to nature is essential for enhancing wellbeing in residential design. Supported by numerous studies, this connection has the potential to increase levels of happiness and self-esteem, increase cognitive abilities, and decrease stress response, blood pressure, pulse rates and cholesterol levels. It also has several other physiological and psychological benefits, with studies showing that those who are more connected to nature tended to experience more positive affect, vitality, and life satisfaction compared to those less connected to nature. The provision of natural light is also an essential connection to nature in terms of its wellbeing benefits. This literature review has shown that a connection to nature can be fostered through various design methods advocated and practiced by Frank Llyod Wright. Valuable design knowledge for wellbeing enhancement comes through some of Wright's methods and theories including establishing a connection to nature, such as the use of windows as 'light screens', mitred corner windows, and a strong siting and link to the surroundings/garden.

# 11.0 Summary of Research for Design

The information from this research has informed the development of the selected WIPs. It has also helped form the questions and procedure for the testing and design process in the following chapter. Below is a summary of the design outcome goals (DOG) engaged and how each parameter will be explored in design iterations.

Proxemics: (linked to comfort, stimulation, privacy, social connection, and spatial balance) will be explored through use of distance zones and other factors, focussing on the development of different social environments within the home.

Ceiling Height: (linked to comfort, stimulation, and spatial balance) Will be explored through iterating and testing variations of ceiling height inspired from the research – Low ceilings, High Ceilings and Varied Ceilings.

Materiality: (linked to comfort, stimulation, and spatial balance) will be explored through presenting different varieties of materials and arrangements, with a focus on the involvement of natural materials and a consideration of texture and balance.

Connection to Nature and Light: (linked to comfort, stimulation, and privacy) will be explored through the design of key openings as well as the site, attempting to connect the space to the exterior and bring natural light inside.

## 11.1 Development of a Testing Process

When first broaching this topic personally, a common response that has been received is that you 'cannot measure wellbeing'. Well, in the same way that psychologists, scientists and researchers conducted studies that have determined the effects of environmental factors on the mind and body, wellbeing in the home can be measured. In the words of well-known psychologist David Halpern *"It is sometimes said 'you can't measure happiness' – but not by any psychologist that has studied the issue"* (Halpern 2008: 70).

The ability to measure human levels of happiness is well established, as people tend to know how they feel in a given moment, and even to be able to communicate and rate these feelings on a numerical scale. The purpose of this thesis is to establish certain parameters that designers can manipulate in residential architecture that are known to have effects on wellbeing, the research phase has achieved this and now there are five established Wellbeing Iterative Parameters. However, to ensure the findings from the research are applicable for the individuals who will be occupying the residences designed,

testing and measuring their responses before design is completed and long before construction has undeniable benefits. As said by Fischl (2006)

> *"the environment surrounding us, the form of buildings, color, lighting, materials, and many other details in the built environment have the possibility to influence humans either in a negative or a positive way"* (Fischl 2006: 1).

The question is, which details and how?

## 11.2 The Need for Client Involvement

One study that highlights the need for client involvement in the testing process was conducted by Halpern (2008) amongst students at Cambridge University. In his own words, the experiment

> "*involved showing a mixture of images of buildings and faces to students subjects who were either architects or 'normals' to see whether their liking for the building or face was affected by how often they saw it. One side result was that, while architectural or other students agreed very highly on the attractiveness of faces, there was almost no relationship between their ratings of the attractiveness of buildings. This divergence between the preference of 'normals' and architects got larger the longer the students had been studying architecture"* (Halpern 2008: 79).

If the aesthetic preferences of both the architect and the average end user of an architecturally designed space are different, then there is a divide between the architect's vision for the design and the clients. This is more reason to use a testing process to establish the client's spatial preferences, especially for important wellbeing-related factors.

In terms of using questionnaires and relying on the information from the answers from the occupants to the wellbeing and spatial experience related questions to inform design decisions, there is evidence to suggest that people can accurately relay their emotions and wellbeing on the spot. According to Jane Wernick (2008):

> *"generally, people can say quite accurately how they feel at a given moment, on a scale of say, zero to ten. Researchers have found that people's self-reports tally pretty well with what electrodes planted on their scalp reveal about the frequency and voltage of electrical waves in their left forebrain, which is the area that lights*

> *up when they are feeling good. So, some researchers claim that we can measure happiness quantitatively"* (Wernick 2008: 6).

When it comes to the issue of response bias, there is no apparent incentive for occupants being tested to mislead results – as the goal of the process is to enhance their wellbeing at home. The questions have also been framed around the research and can be highly contextual and specific, which will generate more accurate responses.

Halpern (2008) mentions the response bias issue when attempting to measure happiness, which applies to spatial wellbeing also. He says:

> *"there is the problem of 'response bias'. If you're happy, the world looks good. If you're depressed, the world looks bad… This again demands very sophisticated statistical controls – such as measuring wellbeing before and after a change in environment"* (Halpern 2008: 71).

This is precisely the process for testing, with baseline testing being conducted before the WIPs are iterated and tested, to isolate the effects of specific design decisions. In terms of understanding and breaking down how these features are impacting users of the space, the perceptual lens model discussed earlier can be used. Fischl (2006) emphasises the value of using this model in the context of analysing individual responses: "the importance of the lens model in architectural thinking could be characterized by its simplicity of use and the adaptability for describing certain individual perception differences" (Fischl 2006). This has informed the testing process and helps to inform how responses/results are measured.

## 11.3 Case Study/Methodology

In terms of precedent for studies conducted in a similar fashion around wellbeing, the 2004 study by Fischl and Gärling 'Enhancing well-being in health care facilities by architectural design: a methodological study' is a valuable source of knowledge. The aim of this research was to "develop a method which gathers both quantitative and qualitative measures on the well-being supportiveness of the environmental attributes and also useful tool for design or re-design purposes" (Fischl and Gärling 2004). This aligns very well with 'objective one' and 'objective two' of this thesis. The process they employed for gathering information on the effects of distal cues involved the use of what is referred to as the 'Triple-E' tool. The Triple-E tool consists of three stages: (1) the Empowerment session, (2) Environment assessment session and (3) the Evaluation of architectural

details. The process undertaken in this thesis involves environmental assessment and evaluation of architectural details simultaneously. Fischl & Gärling's (2004: 1) evaluation method also involved the use of a questionnaire *''focusing on perceived well-being and preferences, specific to the quality of the environmental elements''*. As well as affirming the methodological decisions made for the testing process of this thesis, this study provides support for the notion that there is a real need to better understand how humans are affected by designed environmental factors. Furthermore, this study ranked the influence of architectural details on 'perceived supportiveness', the top three ranked results were as follows: 1) window; 2) floor and wall; 3) ceiling and furniture (Fischl & Gärling 2004). These respectively are related to the: Connection to Nature iterations, Proxemics and Spatial Balance design, and Ceiling Height iterations. This confirms the relevance of the selected WIPs/distal cues of this thesis in a wellbeing context.

## 11.4 The Use of Virtual Reality

One key difference between the testing process of this thesis compared to Fischl and Gärling's (2004) work is that this thesis completes environmental assessment prior to construction through the use of Virtual Reality and three-dimensional digital modelling. While this may limit some environmental qualities of the space's experience, such as true human movement, tactile stimulation, and olfactory and auditory stimulation; the benefits it offers designers outweigh these in the opinion of the author. Being able to iterate and change the space through design according to occupant responses offer the greatest potential to enhance wellbeing design. As the goal of this thesis is to establish a wellbeing design process as well as an evaluative method, it makes sense to utilise modern methods that allow this procedure to take place before it is too late or expensive to make the suggested or necessary design changes to the residence. On the other hand, this process could be valuable in terms of wellbeing enhancement for the renovation of existing premises also.

With the quality of virtual reality (VR) spaces improving rapidly, it is already at a near photorealistic standard. From personal experience, motion and movement is smooth and spatial qualities are very realistic. The true perspective, including peripheral view offered by the headset creates a convincing environment, and the ability to model accurate and specific lighting and sun environments adds value. Compared to typical methods of design presentation to clients, such as renders or architectural drawings, VR provides a significantly more accurate representation of environmental qualities. One key study that

affirms the success of the use of VR for experiencing spatial qualities was completed in 2017. The research claimed that *"the emotional response a person has to a living space is predominantly affected by light, color and texture as space-making elements"* and set out to determine whether *"the emotional response in a simulated environment is affected by the same parameters affecting real environments"* (Naz et al. 2017: 1). The results of this study concluded that:

> "*perceivable emotional aspects of real-world spaces could be successfully generated through simulation of design attributes in the virtual space"*, furthermore *"The subjective response to the virtual space was consistent with corresponding responses from real-world color and brightness emotional perception"* (Naz et al. 2017: 1).

This knowledge is invaluable for this thesis as it confirms the validity of not only using VR to experience spaces accurately, but to also measure emotional or wellbeing related experiences/responses.

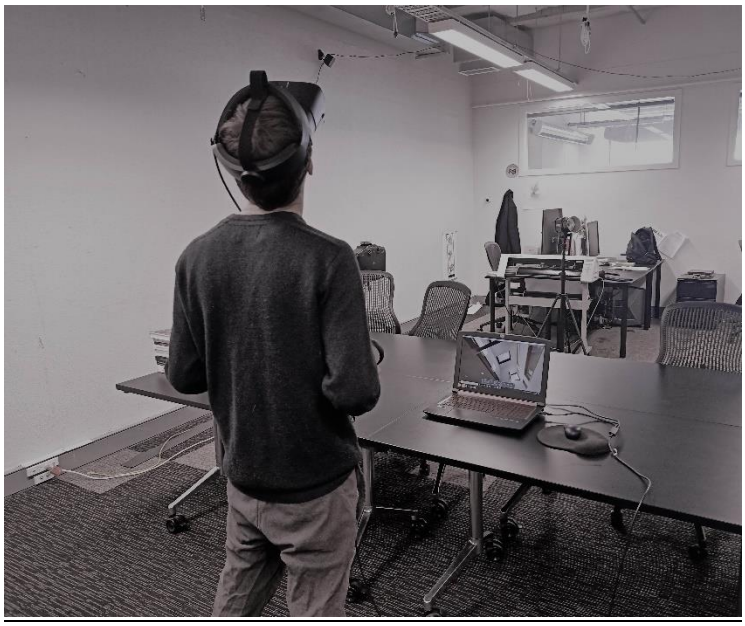


*Figure 25 - photo of the author during virtual reality testing*
*Source: Rei Yoshinari (2020)*

## 11.5 Covid-19 Limitation

One key thing to consider for the testing procedures undertaken in this thesis is that the 'occupant' being walked through the process is the author. This is partially due to the limitations that the Covid-19 pandemic brought about at the time of this thesis's conception and key methodological work. There was, and continued to be, a real risk of lockdown that would prevent the use of test subjects due to serious health threat. Deciding to involve others in this process would have presented a real risk, to the author as well as others, and to the thesis itself. This, however, does not present a major limitation for the testing undertaken in the thesis. As the design produced for the baseline, and the one iterated and used for testing is a product of the author and was not designed for anybody else, the author is the best person to test it. Ultimately, anybody else to go through the testing place would not end up living there, and therefore the author is no less valid to complete the process.

Furthermore, the results generated are not only the focus of this thesis; it is the validity of the process itself that is in question, not whatever the author personally preferred. If the design and testing process succeed in improving wellbeing responses, it would show that the process has potential validity – pending further study. The scope of thesis is to determine the validity of the process for individuals, not groups – only a larger sample of occupants over a much longer period could allow for group conclusions to be made regarding wellbeing and spatial experience. This is discussed further in the conclusions of the thesis.

## 11.6 Questions & Testing Procedure

The questions and guides were developed by the author, focussing on the key DOGs being engaged by each WIP, as well as specific themes found from the research relating to the parameter itself. They focus on the key changes made across each iteration, to attempt to measure their effects on spatial experience. The goal was to generate some verbal feedback on design changes and spatial qualities with the first questions (specific to the iteration), and then receive numerical ratings of the overall space according to the DOG. The logic of this is that it makes the user think about what has changed, and how it makes them feel – and to get them to explain this to the designer so they can address it in the next iteration. The scores allow the person to establish standards for the space and helps them to be able to consider whether it is improving or deteriorating – and similarly provides this information for the designer.

## 11.7 Summary:

In summary, there is precedent and research to support the need and the validity of using environmental assessment and evaluation of architectural features to determine wellbeing within architecture. The use of virtual reality offers a unique opportunity for this to be done prior to construction. David Halpern's (2008) perspective summarises that of this thesis:

> *"my personal view is that at least some of the design details that architects and citizens seem to enjoy... probably do have an impact on subjective wellbeing, if only we took the trouble to measure it. So it is pretty frustrating how rarely architects or planners do measure this impact, especially since we know how to do it"* (Halpern 2008: 72).

This thesis is attempting to develop a process that shows how architects can do exactly this with relative ease.

# 12.0 Testing and Design

## 12.1 Process

The process for the testing was reasonably consistent across the iterations. The first test was a baseline (pre-iteration) to provide a model and scoring results for the design and experience of the following wellbeing iterations to be compared to. The next two iterations (per Wellbeing Iterative Parameter) respond to the feedback from the test before them, which has been shaped by the questionnaire to direct focus toward the parameter being investigated and designed. The physical process involved the use of Virtual Reality technology and software and took place in a computer lab. Separate digital models were used for each test and a questionnaire/guide was prepared based on findings from the literature review, and specifically the DOG, and TOWS relevant to the WIP. During the testing process the instructions and questions were read to the author while they used the virtual reality equipment to experience the designs – the responses were recorded and transcribed. The questionnaires along with the author's responses are appended at the end of this thesis (Appendix A). General instructions were given – such as which space to travel to or observe in the home. Key findings and informative responses have been extracted under the 'Findings' heading for each following testing section. After each test the results were analysed by the author and this informed the design decisions for the next iteration, scores were also recorded and presented visually to monitor improvements or deteriorations in spatial experience across the tests.

## 12.2 Proxemics Testing

For the testing of proxemics and their influence on wellbeing in the spatial experience of the home, the key concepts that were considered were those of sociopetal space, distance zones (particularly the intimate, personal, and social zones), the different types of privacy (specifically: solitude, isolation, and intimacy) and the notion of territoriality. The testing took part in three stages, one per design iteration. The first test was for the baseline design; the product of the initial design phase which focussed on spatial balance, floor plan reduction and modularity, as well as the use of human scale and the golden ratio. The purpose of this testing was not to evaluate the author's design but rather generate a base score to compare the proxemic iterations', as well as the following WIPs' results to. This presented a clearer view of whether experiential/wellbeing qualities had been enhanced through proxemic design.

The key areas of the home in which proxemics have the potential to enhance wellbeing are the kitchen, living room, dining space and foyer/entry area. These are the social spaces of the home, while the bedrooms and bathroom are private areas. The social areas

were the key focus as they are expected to host a variety of different social settings, as well as different individuals with different social and privacy related needs; therefore, it is essential that they respond to the proxemic preferences of the occupant.

In terms of the iterative approach; the first iteration (second test) focuses on the proxemic consideration of territoriality – and the understanding that people have 'body territories' (Sommer 2008), and require spaces for individuality as well as privacy (Nussbaumer 2014). The key design decisions implemented in this phase related to: (1) the implementation of distance zones for social areas – altering arrangement of the workspace, dining space and living space, (2) the addition of the workspace and desks for individuality/territoriality, (3) the design of the dining booth for intimate privacy and separation from adjacent spaces, and (4) the redesign of the living area using distance zones and sociopetal principles, to create better social/personal space.

The approach for the design of the second iteration (third test) was to respond to the feedback from the first iteration's testing through further proxemic design and intervention. The iteration focussed on defining the boundaries between social spaces. These boundaries have the potential to alter the social and private balance within the home, they also define the connection between programmatic areas (physically and/or experientially). The following changes were made: (1) vertical louvres were added to the dining booth boundaries to enhance privacy and intimacy, plus reduce the connection to the workspace and living space, the size of the booth was increased to prevent unwanted breaches of intimate space (2) dimensions of the workspace and kitchen space were adjusted according to personal/social distance zones, and the opening between the spaces increased to increase social connection, (3) small workspaces for individuality in privacy/solitude/isolation were designed for the bedrooms and (4) seating was added to the workspace area to enhance potential social engagements with more people and increase connection with the kitchen space.

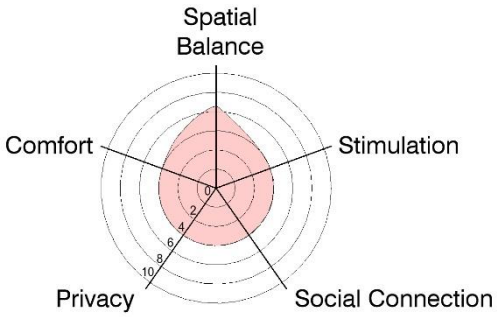



*Figure 26- Proxemics Baseline Scores*

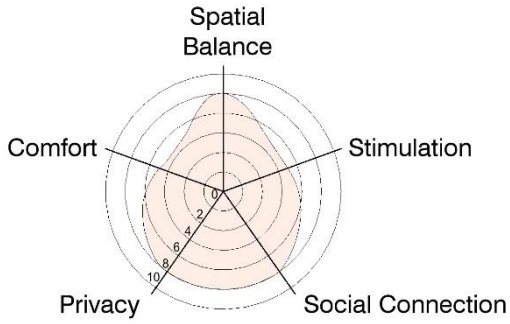



*Figure 27 - Proxemics Iteration 2 Scores*

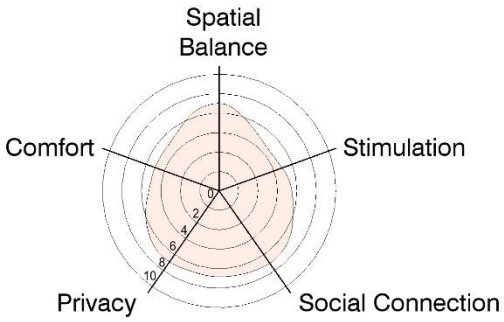
**All score diagrams are the original work of the author (2021)*

The testing process revealed that the design changes made to the space based off the proxemic considerations and user feedback increased ratings from the user for all the DOG. Above, for comparison are the first and final test for the Proxemic WIP. Comfort and Stimulation increased from a 4/10 to a 5/10, Spatial Balance improved from a 6.5/10 to an 8/10, and Privacy and Social Connection increased both from a 4/10 to an 8/10. As proxemics address privacy and social environments specifically, it is promising to see that the design interventions improved responses to these themes significantly.

## 12.3 Ceiling Height Testing

The ceiling height testing was based on the literature review findings that showed that typically high ceilings are preferred to low, and that different ceiling heights prime different concepts in people, as well as having the potential to change the type of mental processing they use. Also, the architectural theory that changing the ceiling heights between spaces produces dramatic experiential effects was utilised. The process involved three tests: (1) the Baseline test, (2) Iteration 1 and (3) Iteration 2. The aim of this process is to establish the most comfortable balance of ceiling heights for the theoretical occupant as well as to test the theories relating to ceiling height's ability to enhance wellbeing in space. The Baseline test was again, primarily for establishing a base standard to compare the effects of altering ceiling height to. In this model, all ceilings were set to a typical, but relatively low height of 2400mm. In Iteration 1, the ceilings heights were all set to 3050mm, which has been shown in studies to be a preferred ceiling height, and by most standards would be considered a high ceiling. In Iteration 2, the ceiling heights were changed according to responses to the previous testing processes – as well as according to the psychological implications of high versus low ceilings (primed concepts and processing types) and the programmatic use of the space they reside over. Design in

Iteration 2 also tested the ability of using ceilings to define the boundaries between spaces, and to create dramatic experiential effects.



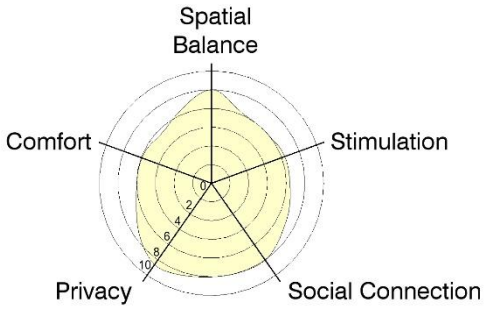




*Figure 28 - Ceiling Height Baseline Scores*

*Figure 29 - Ceiling Height Iteration 2 Scores*

**All score diagrams are the original work of the author (2021)*

The testing process revealed that the design changes made to the space based off the ceiling height considerations and user feedback increased ratings from the user for all of the DOG. Above, for comparison are the first and final test for the Ceiling Height WIP. Comfort and Stimulation increased from a 5/10 to 6/10 and 6.5/10 respectively, Spatial Balance improved from a 7/10 to an 8/10, and Privacy and Social Connection increased from a 7/10 to an 8.5/10 and an 8/10 respectively. As the Ceiling Height parameter addresses comfort, stimulation, and spatial balance primarily, it is promising to see that the design interventions improved responses to these themes.

## 12.4 Materiality Testing:

The materiality testing is based around the findings from the literature that showed that the visibility and exposure of timber in interior environments has the capability to reduce stress and eye fatigue, and improve self-esteem, productivity, and cognitive abilities. It has other health related benefits such as improving recovery time in patients, and reducing blood pressure, cholesterol and heart rates – these are not the focus of the testing as they would involve medical equipment and training and are beyond the scope of this thesis. The welcoming and comforting effects wood can have on interior environments is the design quality being explored in these iterations and testing. Materiality's impact on general spatial qualities and experience as well as on perceived balance are also themes explored.

The first test was the Baseline test. This purpose of this test is to establish scores in an interior environment with minimal exposed wood, which is typical in many new homes; with GIB board and synthetic or painted surfaces being commonplace.

The second test and first iteration utilised exposed timber for all major surfaces. Its goal was to establish the effects of maximum visual exposure to timber and whether excessive timber can cause discomfort due to eye fatigue or other causes. Floors, walls, benchtops, cupboards/drawers, and other fittings are all different types or stains of timber available in New Zealand, such as Pine, Oak, Douglas Fir, Cedar – or products such as Plywood.

Iteration 2 (the third test) responded to the results of Iteration 1 and the Baseline, and the feedback from that testing process. It presented a balance of exposed timber and white or 'plain' surfaces. With the theory that the effects of timber exposure when placed more strategically rather than everywhere would have more significant experiential effects. Key visible and engaged (touched or frequently interacted with) surfaces were selected to be timber, while some walls and other surfaces that are less engaged with were white to provide balance and carry light better, and to emphasise the qualities of the timber.

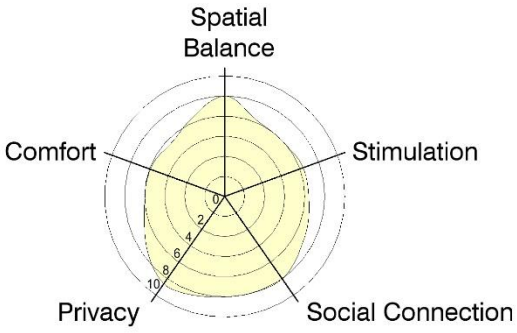



*Figure 30 - Materiality Baseline Scores*

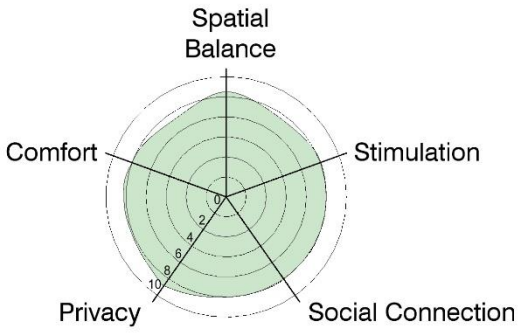



*Figure 31 - Materiality Iteration 2 Scores*

**All score diagrams are the original work of the author (2021)*

The testing process revealed that the design changes made to the space based off materiality considerations and user feedback increased ratings from the user for most of the DOG. Above, for comparison are the first and final test for the Materiality WIP. Comfort increased from a 6/10 to an 8/10, Stimulation from a 6.5/10 to an 8/10, Spatial Balance improved from an 8/10 to an 8.5/10, while Privacy and Social Connection remained at 8.5/10 and 8/10 respectively. As the Materiality parameter addresses comfort, stimulation and spatial balance primarily, it is promising to see that the design interventions improved responses to these themes.

## 12.5 Connection to Nature & Natural Light Testing

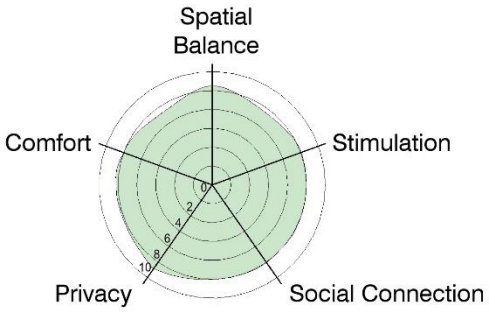
The connection to nature testing is based around several factors revealed in the literature review. These include the fact that the presence of, or connection to nature within architectural spaces has the potential to enhance peoples' vitality, life satisfaction, attention, and happiness as well as to reduce stress. The research suggests that this is achieved through viewing nature, or by having it present or nearby – this includes plants, sunlight, the sky, ocean, and landscapes. The iterative approach has been informed by the need for natural light and a connection from the interior to the surroundings and nature outside. Throughout the tests the time of day was changed from morning to evening, to simulate real sun positions and lighting conditions – and to produce data that corresponds to natural light across a full day rather than at a given moment. Clouds were set to a medium level and the season was set to winter as this is typically when there is less natural light – and it is therefore needed by people the most.

The Baseline test was conducted first and was the final model from the Materiality testing, with some small site changes such as the addition of a driveway and more topography modelled. Its purpose was to provide a basis for comparison once connection to nature design interventions had been made in the following tests and iterations. Windows were kept consistent to the previous test and analysed from key spaces individually. Lighting was also focussed on in key spaces throughout the day. The house's orientation on site was decided according to maximising North sun and to provide privacy from the street and views towards the harbour. The location of the hypothetical site is (-41.23008,174.82683).

The first iteration (and second test) started by addressing the building's connection to the site's landscape through design, this revolved around the deck space, veranda, and planters as well as site plantings. Following this, the design approach involved the iteration of windows and openings to the exterior according to the responses to the previous test and the siting of the residence itself. This meant redesigning window sizes, locations, and shapes in key spaces, changing frame and sill designs, and attempting to frame views of natural elements.

The second iteration (and third test) was based on the results of iteration one, and further design changes were made to the site and house to improve natural lighting and the connection to outside nature and views. Specifically, results led to the altering of some window sizes and positions, the addition of a skylight over key spaces to enhance natural lighting, the addition of high interior windows to carry light through into private areas, and increased planting and site work – including minor terracing to enhance views and bring

more natural light inside, and changes to the deck design. Some exterior design changes were made also in terms of roof shape and cladding type, but these are not the topic of the testing and they did not change interior qualities or dimensions.



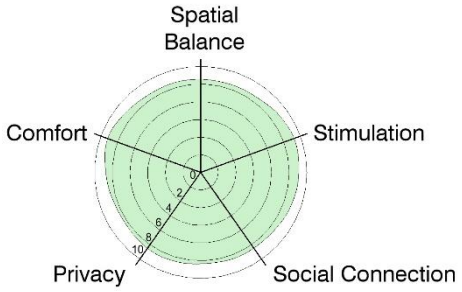




*Figure 32 - Connection to Nature/Light Baseline Score* *Figure 33 - Connection to Nature/Light Iteration 2 Scores*
**All score diagrams are the original work of the author (2021)*

The testing process revealed that the design changes made to the space based off a Connection to Nature and Natural Light as well as user feedback increased ratings from the user for most of the DOG. Above, for comparison are the first and final test for the Connection to Nature and Natural Light WIP. Spatial Balance and Privacy remained at 8.5/10, while Comfort and Stimulation both increased from 8/10 to 9/10, Social Connection increased from an 8/10 to an 8.5/10. As this parameter primarily addresses comfort, stimulation and privacy, it is promising to see that the design interventions improved responses to comfort and stimulation and did not negatively impact perceived privacy.

## 12.6 Design Decisions

Please refer to the appended table of questions and responses for context; questions are organised by test and WIP and proceed in order (Appendix A). All the questions for each WIP informed design decisions or the designer in some way and to list them all in the main text would be disruptive. The design process, however, is presented visually with annotation at the conclusion of this thesis; these sheets follow the process from the initial baseline development through until the final testing and results. Referring to these drawings makes it clearer which changes were made at which point, and how the process continued from one WIP to the next. It is worth noting that as images could not be captured during testing without severely disrupting the process that images on the design sheets are indicative and were rendered in the same digital model under the same conditions after the test was completed.

**It is recommended at this point that you follow the design sheets at the conclusion of this thesis for a visual guide of the aforementioned process.**

# 13.0 Discussion

For all scores across iterations please refer to design sheet A600. For all questions and answers from the testing process please refer to Appendix A.

## 13.1 Design Outcomes:

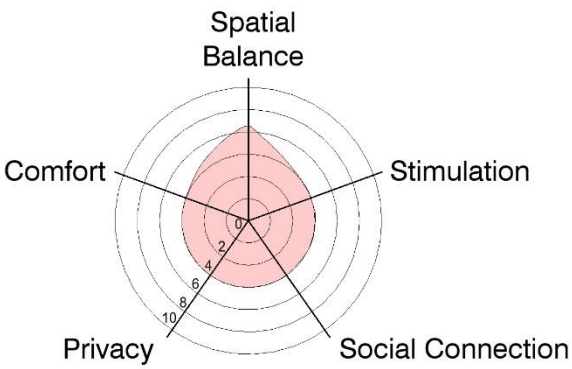



*Figure 34 - Initial Test Score (Baseline)*

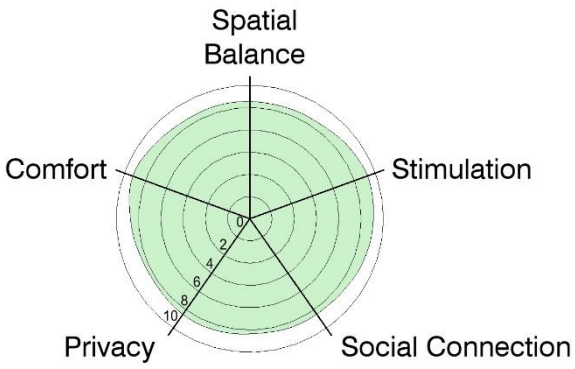



*Figure 35 - Final Test Score - Full WIP Design*

**All score diagrams are the original work of the author (2021)*

In terms of the design outcomes of this thesis, the above results; comparing the initial design test of the space to the final test after all Wellbeing Iterative Parameters had been explored reflect a clear improvement in all Design Outcome Goal scores. With Comfort and Stimulation ratings increasing from a 4/10 to a 9/10, Privacy and Social Connection scores increasing from 4/10 to 8.5/10, and Spatial Balance going from a 6.5/10 to an 8.5/10, the results indicate that Wellbeing in Space (as defined by these DOG) has been successfully enhanced through this design and evaluative process. Not only are the scores higher, but the dualities of Comfort and Stimulation, as well as Privacy and Social Connection, as described earlier in the thesis, remain balanced with one another.

This is important as the home must provide adequately for both opposing wellbeing needs; as seen by the spike in the Stimulation score for Materiality Iteration 1 (from a 6.5/10 to a 9/10) with the overwhelming timber interior – leading to a decrease in Comfort ratings from a 6/10 to a 5.5/10. A high Stimulation rating on its own does not mean an enhanced environment, the space must provide equally to the user's need for Comfort. Also, the improvement seen in the perception of Spatial Balance from the initial score of 6.5 (which was the highest of the first test ratings) to an 8.5/10 testifies that this design process does not need to detract from the initial spatial qualities of the designer's concept design. Similarly, with the exterior aesthetic changes made to the roof design and cladding system in the final iteration, this wellbeing design process can be followed and still allow for aesthetic preferences and formal design changes to be made without

impacting interior qualities. The scoring diagrams themselves proved to be a useful addition as they not only convey the scores for each DOG in one place, but also the balance between them. The repeated process of design, followed by evaluation (targeting specifically each parameter) proved to be an efficient method, and ultimately meant that problematic areas were quickly identified and addressed in the following iteration – which has been seen to lead to an enhanced spatial experience in terms of the DOG that define Spatial Wellbeing in this thesis.

## 13.2 Questionnaires and Testing

In terms of the effectiveness of the questionnaires in generating useful information for design, they were extremely beneficial. However, the author was in the somewhat unique position of being both the designer and the test subject – this limitation is discussed below. To try and select which questions were most beneficial to design would be impossible, as they were all very specific to the parameter and spaces being investigated, (or were scoring questions, constant throughout the iterations) they all yielded valuable information about the subject's personal interpretation of the space. In total there were 128 questions across all of the tests, with between nine and sixteen questions per test. Questions were kept brief and specific to try and receive only relevant information. A good example of the way the questions were framed to inform a relevant answer, and a question that yielded useful information is Question 1.3M (Proxemic Iteration 1, Question 3) which was based in the Living Space. It asked: '*Do you feel this space is a comfortable setting for informal or personal social interactions? E.g. would you feel comfortable conversing in a small group here, with people with who you are close with and/or people you do not know very well?'*. The response was '*The new seating arrangement is much better and I could see a small group of maybe up to 5 people using this area to have a conversation, it feels a little more private but still kind of connected to the dining area while I don't like, but I like that it is open to the rest of the house, but tucked into a cosy corner'.* The design implications of this were clear: the centripetal seating in the Living Space was a success, but more Privacy from the Dining Space was needed. In the following Iteration louvres were added around the Dining Space and Privacy scores increased from a 6/10 to an 8/10. Other useful feedback includes findings such as that the material sample touching process in the Materiality testing was "*very awkward to do while using the VR headset*" (Question 3.3B), which helped to highlight flaws in the process, suggesting that samples should be examined after the VR testing is complete. Following the design sheets after this chapter, and the appended Questionnaire and Responses table presents a clear and unified linear process of designing in response to the testing feedback for the reader's reference.

## 13.3 Limitations

As previously mentioned, the author was involved on both sides of the testing and design, as a subject and designer - which presents a potential limitation. A positive of this is that the designer got to experience the process first-hand – to experience the space in Virtual Reality, analyse it critically and then design to improve it. Experiencing the spaces first-hand was very beneficial, as the true field of vision offered by VR gave the author a better understanding of the scale of the home – which is especially important when designing small spaces. Spaces that appeared confined in plan were realised to be sufficiently large when experienced in VR due to its accurate field of view and human scale element as you move through the space. From a design perspective this was very valuable and presented an effective process; but the purpose of this design and evaluative process is assuming that the client and designer are different people. In this situation the designer and the subject obviously had the same preferences, and the process was seen to improve results (which could be expected). The difference between how this process was conducted in this thesis to how it would be conducted in practice is that the designer would have to respond to feedback that they do not necessarily relate to (the client's), which is a fair expectation. This has been implied throughout the development of this process. Although utilising this process with a client with different spatial preconceptions to the designer may present a more challenging process and require more communication and explanation, there is no reason that if the designer receives adequate feedback and responds to it – that the process would not be effective in enhancing wellbeing (according to the DOG) for the client within in the designed space. It would be beneficial for the designers of the space to experience it in VR as well as the client; so that they have the same understanding of the space's qualities, and are considering the space with a more accurate perspective (due to the qualities of VR being much more reflective of real spatial experience than a plan drawing, section or render).

In terms of there being any potential bias in the author's responses to questions or scores, this would have the potential to make these responses invalid for use by other people; but this was always going to be the case, and is expected. The design of this process has been based around the notion of individuality, and never sought to find universal rules for how to design to enhance wellbeing in space for everyone – but rather to identify parameters that have been proven to be influential in experience and that are designable for different individuals with different needs. For example, seeing an improvement in the author's scores for Privacy due to the design decisions made in this thesis that attempted to seclude the Living Space from other areas (the addition of louvres, lowering of the ceiling), may not work for the next client, and may reduce scores – as they may prefer an

open central lounge that is connected with the dining space. The value of the testing process comes through its ability to extract useful information based around the WIPs that inform specific design for individuals – not the results themselves, which are only valuable to that one client and project. Additionally, the author had no reason to be misleading or to give misinformation, as the questions were all addressing their personal interpretation of the space, and how it made them feel. Research has shown people have an innate ability to be able to answer questions about how they feel at any given moment, and even rate it on a scale, which was the process utilised. There were no reasons for the author to ignore design features that were negatively impacting spatial experience – as they could be addressed in the following iteration.

This leads on to another related limitation, which is the fact that as the author was the test subject that they came into the process with potentially more background knowledge than the average client, having researched how each parameter impacts human experience. The solution to this limitation, and the aforementioned, would be to test the entire process on another individual (preferably a real client), and to receive their feedback in order to address any problematic areas in the testing process itself. Also, it would be beneficial to give a summary of the key wellbeing related themes, parameters and concepts being explored to the client prior to testing; although the questions themselves do highlight the concepts and parameters being explored, and the separation of the WIPs into separate testing means that only one element of design is being focussed on at a time – which is clearly identified. This highlight another potential benefit of this design and evaluation process: that it has the potential to increase the client's understanding of their own specific spatial needs, which in turn could lead to better design outcomes for them in the future as they are more aware of how space and its design impacts their personal experience and wellbeing.

Another limitation worth mentioning includes the environment of the testing procedure itself. How comfortable the test subject is with the VR technology being used could have an impact on how spaces are scored and evaluated. While the author did not report any major issues relating to the use of technology in the process, people who are prone to motion sickness or other similar conditions may not be able to comfortably use the necessary equipment, and therefore the process may not yield useful results for them and the designer. Similarly, people will vision impairments would have difficulty using this process effectively. This is unfortunately an unavoidable limitation of the process currently, until technology develops to a point where it can be addressed.

Another obvious concern is the fact that often there will be more than one client for a project, and usually more than one occupant will live in the residence designed. So how

does one utilise this testing process and consider the wellbeing of all occupants? In the same way that architects must address the needs or preferences mentioned by multiple clients such as a couple or family, they must complete testing for all occupants and work to find a middle ground that is satisfactory for all (if their results do not align when examined). This undoubtedly would be a more difficult process, and involve more work for the designer, but is achievable and plausible.

Finally, as there is a myriad of different factors that impact human experience and therefore wellbeing, this thesis had to have a tight scope for selecting designable parameters. The WIPS selected; Proxemics, Ceiling Height, Materiality and Connection to Nature and Light, were chosen as there was sufficient evidence available outlining their potential effects on wellbeing. There are undoubtedly many other factors that influence wellbeing within the home, and some of them may be designable also – but to evaluate every designable component of the home would be far beyond the scope of this piece of work and require further research. This is not necessarily a limitation, but it is worth acknowledging that there are many other factors than those selected that impact wellbeing in space. The parameters that were selected however presented ample opportunity for design exploration, and the qualities and appearance of the space changed significantly over the iterations - ultimately leading to an enhanced spatial experience in terms of the established Wellbeing DOG. Therefore, this process remains valid in terms of its scope, as it did enhance the existing design; but it also has the potential to expand to include more WIP as they are discovered and researched. Similarly, only three iterations (including the baseline) were conducted for each parameter; if necessary, the process could continue with further iteration until the desired results are achieved.

# 14.0 Conclusion

## 14.1 Thesis Aims:

Relating back to the question that inspired this thesis, now an informed answer can be made.

*'How can an improved understanding of the relationship between the mind, body and space enhance responsivity to wellbeing within residential design?'*

Through the collation of key information relating to the impacts of certain spatial features and qualities on human experience, specific design parameters (WIP) have been identified that informed a design process based around themes of wellbeing in space (TOWS). Using VR technology to simulate different design iterations, and questionnaires that focus on key themes of wellbeing in spatial experience, design was catered specifically to the client's spatial needs through the iteration and design of the established design parameters (WIP). The evaluative methods of this testing process, collecting scores across iterations for the DOGs (that define wellbeing in the context of this thesis) and score diagrams to reflect progress ensured that the desired enhancements were being achieved. In summary: an improved understanding of this relationship can inform a process that helps to design residences that respond in-depth to the spatial wellbeing needs of the individual for whom the residence is being designed.

Now referring to the objectives established at the beginning of the thesis, it can be considered whether they were successfully achieved.

*Objective 1:*

*To determine the key* ***themes of wellbeing*** *in residential architecture from research and literature review, and from these themes extract key* ***designable parameters*** *that have been shown to influence the wellbeing of users in their experience of architectural space through their body and/or mind. Following this, to integrate these parameters in the design process and explore and iterate them according to research and theory – across each module of the home.*

This was successfully achieved through the literature review and research phase, where themes of wellbeing in space (TOWS) such as harmony, balance, belonging, and reduction of stress were identified. From these themes, and the research in which they were identified, the WIPs were developed – which were the designable spatial component effecting wellbeing. These include proxemics, ceiling heights, materiality, and connection

to nature through the design of openings and the site. These factors were iterated according to responses from the testing questionnaires and designed in a linear iterative process addressing all relevant spaces of the home. This objective was met successfully through the design process created.

*Objective 2:*

*To develop an* ***evaluative method*** *for analysing the outcomes of this design process in terms of the effects of parameter inclusion on the user's wellbeing and experience of the space. In order to evaluate the experience of the designed spaces, wellbeing in space will be defined in the context of this thesis. The evaluation will include testing that involves the use of virtual reality and should offer an accurate reflection of the user's experience of the space pre-construction - and therefore an opportunity to improve its responsivity to users' wellbeing through design.*

The use of VR simulations and verbal questionnaires formed the method for evaluating design outcomes. Wellbeing in the context of this thesis was defined as an enhancement and balance of the DOGs, and these became the scoring factors for evaluating iterations of the spaces – which added the quantitative element for analysis. Answers to questions presented qualitative information as to the subject's design preferences and informed the following iterations. The improvements in scores achieved, and the development and presentation of testing process itself are evidence that this objective has been met.

*Objective 3:*

*To* ***evaluate*** *and summarise the value of the testing and design methods used, in regard to their ability to improve responsiveness to wellbeing in the design process, and to provide users with a truer spatial experience of the home and its parameter iterations than is typical in architectural practice.*

The summary of the value of this testing and design process comes through the results of the process itself. The responses to questions, and the recorded scores have suggested that the process was successful in providing a truer experience of the home pre-construction, and in enhancing wellbeing related qualities in the space. The testing and design methods and process developed has a lot of potential value, and this is seen through the analysis in the preceding two chapters. There are also limitations that have been identified and discussed, with the conclusion that this process still presents value

for improving responsiveness in design to wellbeing, and for presenting a truer and more informative spatial experience for clients than is typical in practice. For these reasons, this objective has been successfully met.

## 14.2 Potential

The word potential has been used a lot over the preceding chapter, which is indicative of the number of other applications that the knowledge and process explored in this thesis could be useful for in the view of the author. While these topics have not been researched or included as a key component of the thesis, they are valuable considerations and potential benefits for the products this thesis has produced. To precede these future potentials for the Design and Testing Process developed, it must be said that to utilise this process in a professional context, or to be sure of the data collection process and appropriateness of questions and directions; it would be beneficial to work alongside somebody with more experience in, and a deeper knowledge of psychology and psychological testing processes. The symbiosis of these two professions – architect and psychologist, ultimately presents a vast opportunity to address wellbeing in design, through an improved understanding of space itself, and the people who inhabit it, interact with it, and experience it. The input of professional psychologists into the developed process would undoubtedly prove valuable and improve its validity in a professional context.

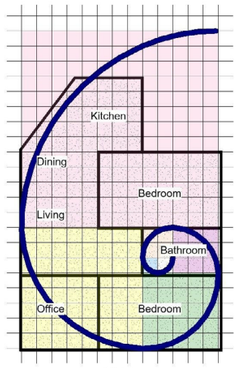
Some of the key future applications of the developed process include for use in prefabrication, where spaces could be specifically designed for clients through the WIPs and then prefabricated in detail, for faster and potentially cheaper construction that aligns with the user's spatial needs. For use in renovation work, where the existing residence can be modelled (as the baseline) and iterations can follow in the same process from there to enhance responsivity to wellbeing (DOGs). For use in large scale housing developments, such as social housing, where many similar houses (if not identical) would typically be built for many people with different spatial needs – the process would allow for customisation and analysis of the initial design (which would serve as the baseline) to happen pre-construction and allow for wellbeing related design changes to be made before it is too late. Finally, despite the focus on individuality in the context of the approach for this thesis; if this process were to be used on a large scale and the results to be accumulated over a large sample size – there is potential for valuable findings or trends to be identified in regard to the effects of architectural design decisions on experience.

## Design Sheets – Contents

# Baseline

Some of the iterative process for the baseline has been presented for context for the reader. The themes focussed on include: small scale, human scale, golden ratio use, balance, harmony and gestalt theory. The design of the baseline is not the focus of the thesis so it has been kept brief. More detail is found in the Wellbeing Iteratative Parameter iterations that follow and attempt to enhance the space.through design.

The golden ratio was used to inform plan design generation and iteration. The goal was to incorporate human scale, the golden section (and spiral) and space reduction (reducing plan footprint, tiny home) into one process, and to quickly generate a starting point for testing. Below the iterations seek to reduce the size of the house to as small as possible, while incorporating stride length to dictate space sizes and trying to adhere to the sweeping cruve of the golden spiral. Spaces were attempted to be balanced according to the spatial parameters of the golden ratio.



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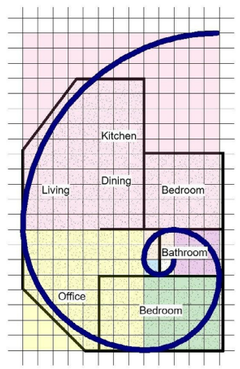

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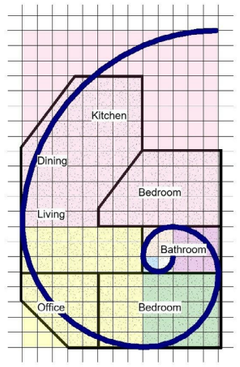

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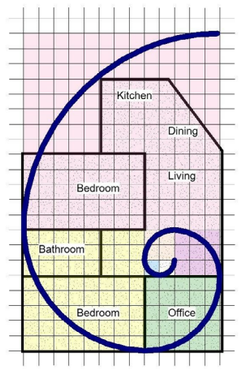

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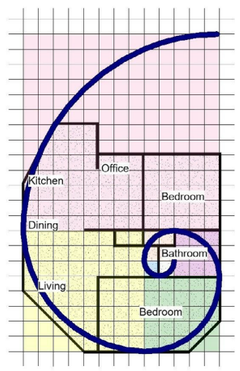

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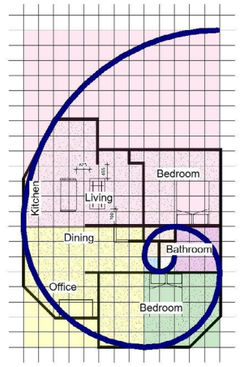
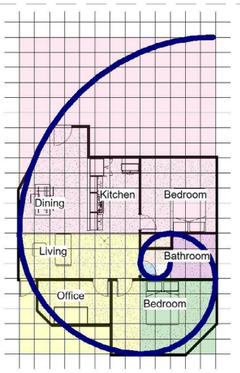


80.5m²



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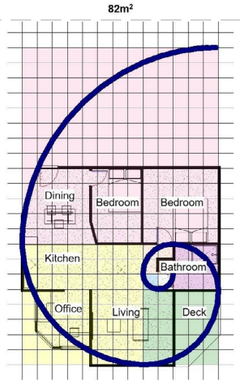
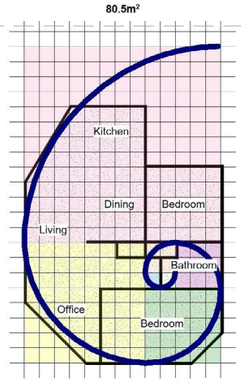


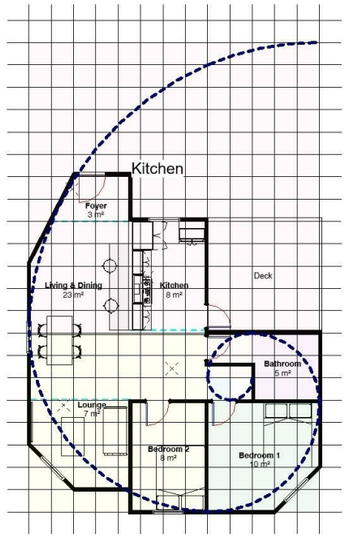
72m²



90m²

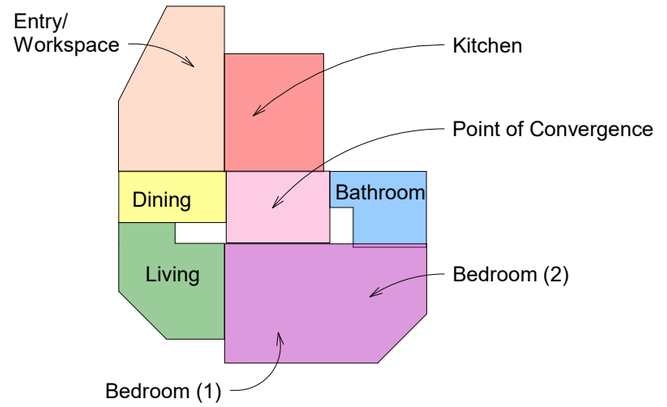
# Scale

The scale of the grid and therefore golden ratio and spiral was informed by a human element - stride length. The author's stride length was measured (as test subject) and the grids were set at 695mm centres. This was to relate the sizing and design of the spaces to something tangible and related to the body, so areas were defined by how many strides it takes to move around or between them.



70m²

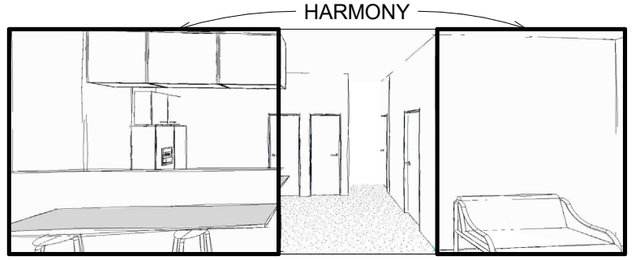
Much of the design work was done in sketch, or conducted live in the model and unrecorded. As the baseline design is not the focus of this thesis, and its more refined design is shown clearer and in more detail in proxemic testing; much process work has been left out - and what remains is just to provide a basic understanding of where the design originated.




The above plan was selected to move forward, as it had the smallest square meterage, adhered to the golden spiral and spaces were balance in plan. After this more programmatic decisions could be made, and areas' design, arrangement and scale were changed from there. 3D modelling continued and perspective views were used to assess balance, often with live draw overs and adjustments. Examples of such design considerations are below.

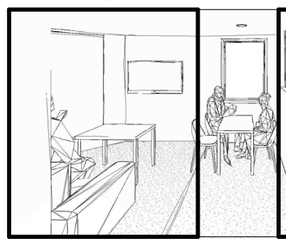
BALANCE

HARMONY



HARMONY

HEAVY



LIGHT

| | |
|---|---|
| Date: 13/04/20 | Baseline Design |
| Drawn By: OL | |
| Reduced Scales: 1:100 - x 1.50 1:50 - x 0.75 Scale: 1 : 125 | Sheet: _A100 |

# Baseline

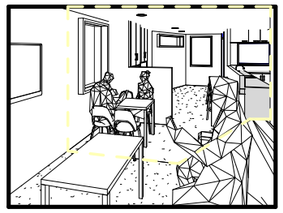
Test One:

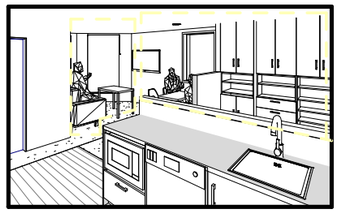
This test is the first test of the entire process, and for this reason it is the unchanged baseline design, which is shown earlier in the thesis.

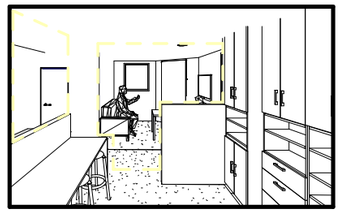
## Method

This test involved the same questions and guides as the following tests to allow comparison of answers after design intervention. Key areas were highlighted that could be redesigned with proxeimic consideration to enhance the social environment(s) of the home. At this stage the design was still in concept and unrefined, so testing took place with white (clay) surfaces in VR, as to put the focus on the spatial design itself, not materiality. As such, design has been shown primarily through 3D sketches and plan views rather than renders.

## Key Views







These views highlight the key connections of the different social spaces. Clockwise; the living to dining, the kitchen to foyer/living, and the foyer to living/kitchen. These areas and connections must be suitably designed for the social settings they will host.

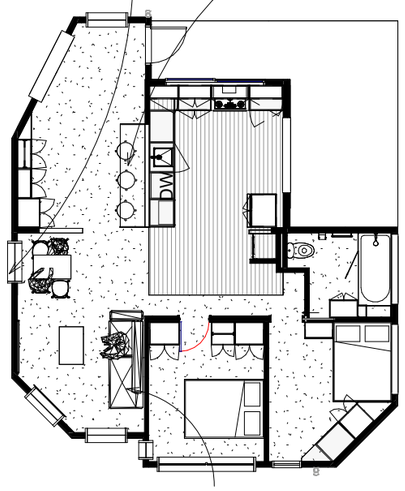
# Iteration 1

Test Two:

This test is where the first conscious proxemic considerations are made in design. They are outlined visually below and on the following page.

The existing dining area was openly connected to the living area and partially separated from the foyer area

The existing foyer area had storage and a breakfast counter with stools



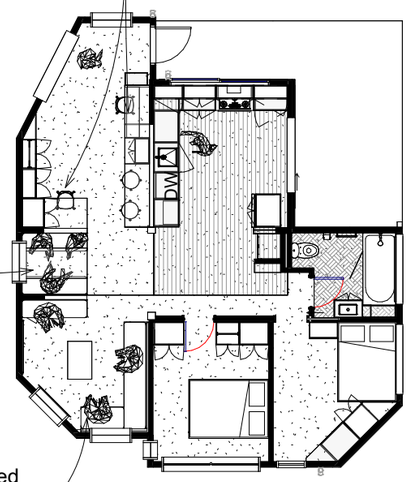
The existing living space had one couch and a singular directionality. It was connected to the dining space and foyer, and partially with the kitchen

**BASELINE** (Before) 1:100@A2

Workspace modified through distance zones: work stations added

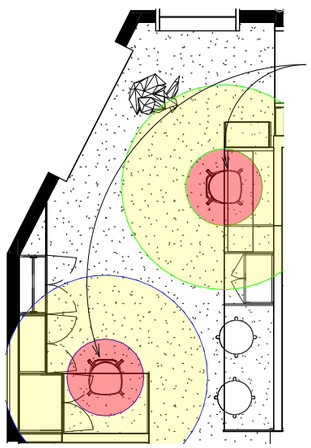
Dining Space modified through distance zones: Private/intimate seating booth added

Living Space modified through distance zones: semi-private sociopetal seating added



**ITERATION 1** (After) 1:100@A2

## Design Process of Key Spaces: Iteration 1



Using proxemic distance zones to suitably separate the work stations can allow territoriality to develop as residents claim their own area.

The Intimate Distance Zone

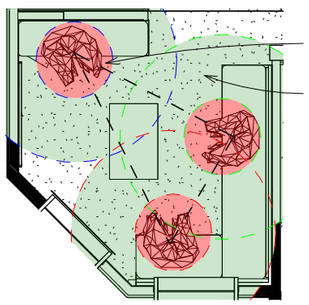
The Personal Distance Zone

The work stations have been suitably separated and oriented away from each other to provide a potentially social, but non-intrusive working environment.

1:50 @ A2 Plan

The sociopetal arrangement of the new seating in the living space, as well as to some extent in the workspace allows for multiple seating options and three orientations with perpindicular arrangements. This encourages interaction between users.

The space is arranged so persons can choose whether to sit within each others' intimate, personal or social zones - allowing for different social settings.

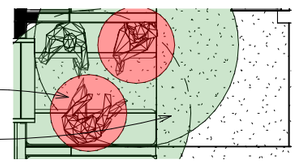


The Intimate Distance Zone

The Personal Distance Zone

1:50 @ A2 Plan

By enclosing the dining space into a booth an intimate social space has been created.



1:50 @ A2 Plan

It is separated from the living space by a wall/half height wall and users are seated within the personal - intimate zone.

| | |
|---|---|
| Date: 10/12/20 | Proxemics Testing Iterations |
| Drawn By: OL | |
| Reduced Scales: 1:100 - x 1.50 1:50 - x 0.75 Scale: As indicated | Sheet: _A200 |

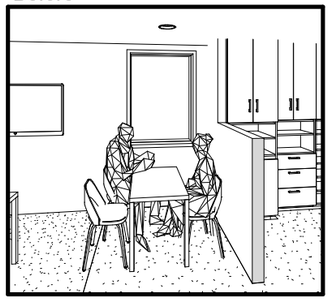
# Iteration 1

## Test Two Continued:

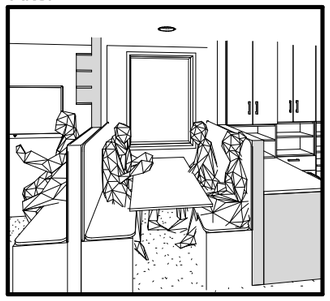
This test is where the first conscious proxemic considerations are made in design. They are outlined visually below and on the following page.

### 3D Sketches of Key changes

Before



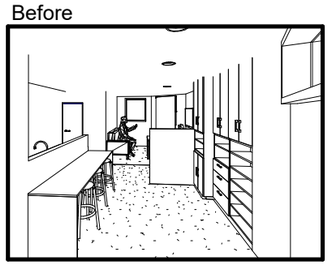
After



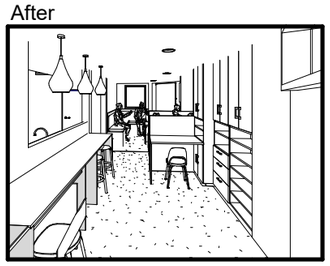
Notes

Enclosing the dining space into a booth will separate it from the living area and allow for private and personal or intimate social interations to occur even if the living space is being used. Due to the scale of the home (2BDR) a smaller dining area may be suitable.

Before



After

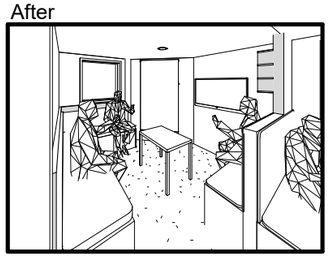


Notes

Limiting the size of the breakfast counter and adding a desk as well as one to the rear of the dining booth's wing wall allows for social or semi-private work to be done outside of the bedroom. Facing them away from each other and obscurring them from view from other areas could aid productivity.

Before

After



Notes

Enclosing the lounge in a sociopetal seating arrangement encourages more social interaction than the previous single seating arrangement. The size of the space permits intimate, personal and social (formal and informal) seating distances.

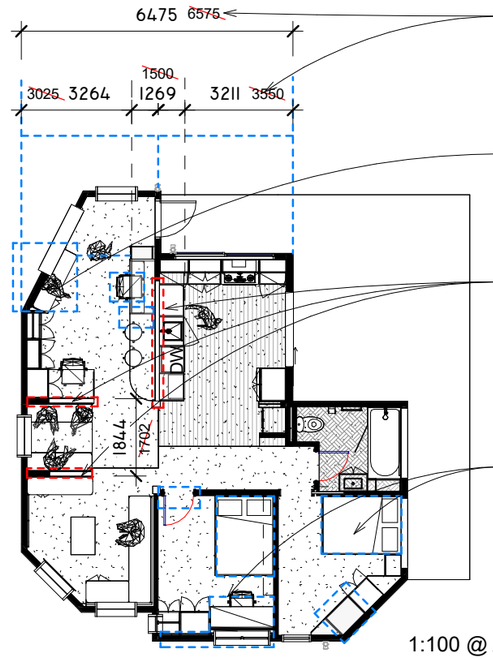
## Summary:

The results of this test that impacted the next iteration were that the dining booth was too intimate/confined and not sufficiently separated from adjacent spaces, that additional attention was needed for providing a place of retreat, and that the social connection between the kitchen and workspace needed enhancing.

# Iteration 2

## Test Three:

This test responds to the findings of the previous tests (iteration 1 and the baseline) and implements further design changes. It is the final proxemic iteration and test and is carried through to serve as the baseline for ceiling height testing.




According to responses from previous testing the workspace and kitchen were slightly too small and too large respectively. They have been modifed according to distance zones to enhance their connection.

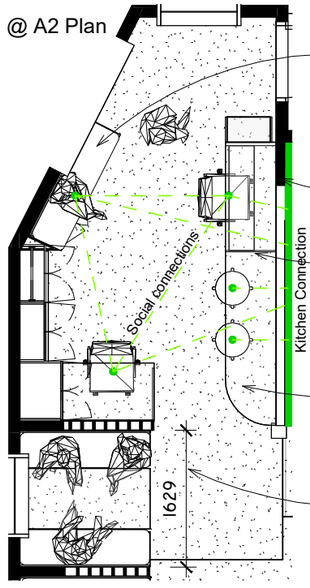
According to responses from previous testing suggesting a desire for an increased social environment in the workspace + a connection to the kitchen, a seating bench has been added.

These areas were identified through the previous test as problematic boundaries. They have been addressed by increasing the size of the dining booth and enhancing its privacy (from the workspace and living space). The size of the kitchen opening to the workspace was increased also to enhance social connection.

Responding to preferences found through testing, a workspace as a 'place' of retreat was added to the bedrooms, and the space rearranged to allow this. The left bedroom has been focussed on as the assumed client's bedroom choice.

1:100 @ A2 Plan

1:50 @ A2 Plan




A built in bench (with storage) was added to the unused space to enhance the social environment within the workspace and its connection to the kitchen

The size of the wall opening to the kitchen was increased from 2444mm to 2861mm to improve social connection between the spaces

The existing storage unit was removed to allow more workspace

The bench was tapered to open the connection to the kitchen around the corner, and allow the workstation behind it to expand slightly

The dining space was expanded 142mm to allow for more space between users on either side, Privacy louvres were added

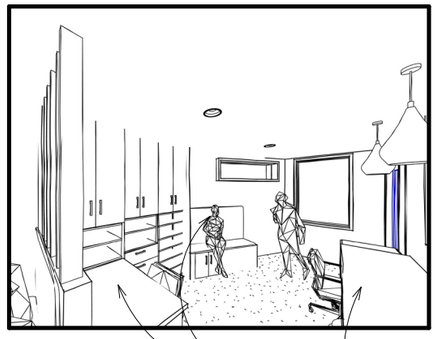
| | |
|---|---|
| Date: 11/12/20 | Proxemics Testing Iterations Cont. |
| Drawn By: OL | |
| Reduced Scales: 1:100 - x 1.50, 1:50 - x 0.75 Scale: As indicated | Sheet: _A210 |

# Iteration 2

Test Three Continued:

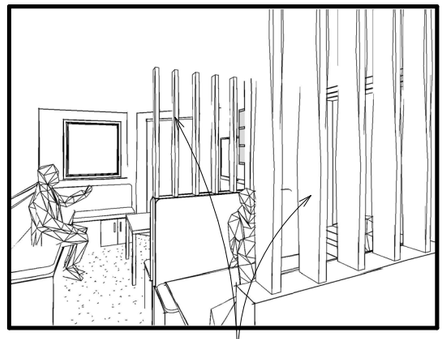
This test responds to the findings of the previous tests (iteration 1 and the baseline) and implements further design changes. It is the final proxemic iteration and test and is carried through to serve as the baseline for ceiling height testing.

## Workspace Additions



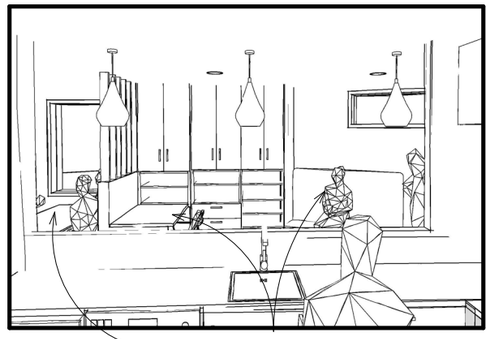

The new workspace arrangement aims to enhance the social environment by allowing more interaction, while maintaining separate workstations for isolated work

## Privacy Louvres



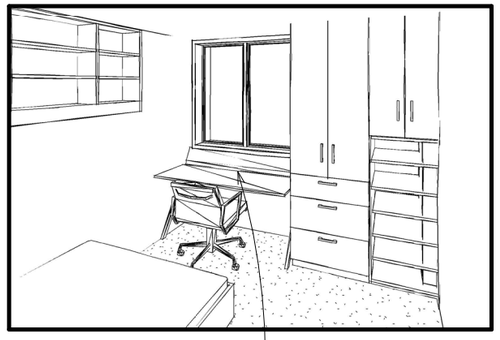
Privacy louvres have been added to the boundaries of the dining space to seclude it from nearby spaces, but allow light to travel through and prevent feelings of confinement, the width of the booth was also increased

## Kitchen to Workspace




The increased size of the opening between the kitchen and workspace allows for more social interaction between the areas, the addition of the extra seating (bench) enhances the areas capability to house larger/different social contexts

## Bedroom Workspace



The addition of a desk/workstation to the bedroom provides a private place for solitary work to be completed. It also enhances the bedroom space as a place of refuge, offering more than just a place to sleep and dress (while maintaining the same small footprint)

### Finding 1:

This test found that the design interventions made in the workspace enhanced social connection, senses of belonging and feelings of comfort. It was still felt to be relatively confined however.

### Finding 2:

The test revealed that the dining space design interventions enhanced the perception of privacy of the space, as well as comfort and intimacy

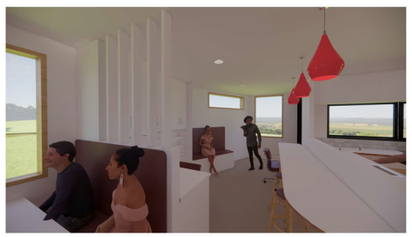
### Finding 3:

The test also showed that the design changes made between the kitchen and workspace succeeded in enhancing perceived social connection

### Finding 4:

Finally, the test showed that the addition of the workstation to the bedroom enhanced the perception of comfort within the space, although the space still felt relatively confined as a place of refuge

### Testing/VR:



Testing utilised live rendering and a VR headset. Due to the nature of VR it, and its experiential qualities cannot be displayed on a page. Above are indicative renders from the same software showing visual qualities of the space and image itself. A video walkthrough of the final model of this design process is linked at the conclusion for the readers reference, and to improve experiential understanding of the space in motion.

### Summary:

The findings of this testing were considered for their relevance to proxemic design, and its implementation has appeared to enhance the home's spatial experience. Areas will be continually developed and assessed with the goal of wellbeing enhancement throughout the next series of iterations.

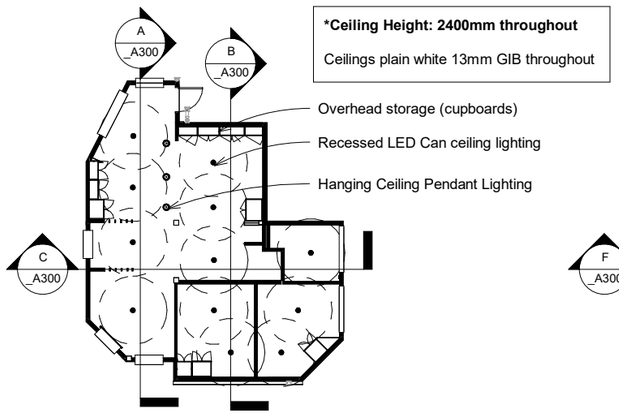
| | |
|---|---|
| Date: 19/12/20 | Proxemics Testing Iterations Cont. 2 |
| Drawn By: Author | |
| Reduced Scales: 1:100 - x 1.50 1:50 - x 0.75 Scale: | Sheet: _A220 |

# Baseline

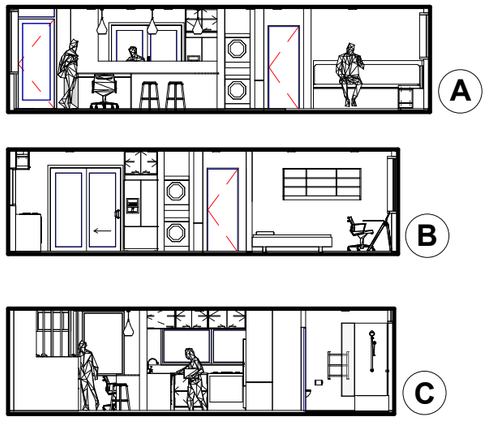
Test One:

This test is the first test of the ceiling height testing, and is the result of the proxemic iterations. It has a singular ceiling height of 2400mm to assess the effects of low ceilings.

## Baseline RCHP (1:150@A2):




## Baseline Sections (1:100@A2):

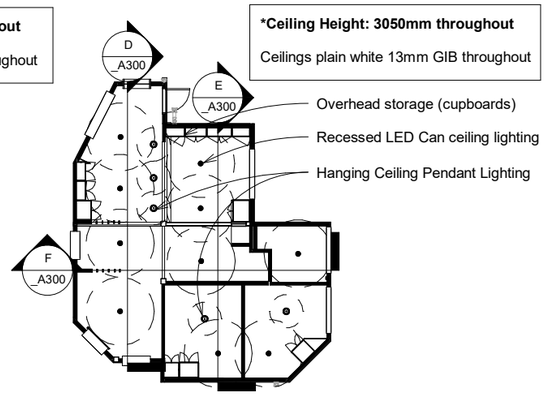



# Iteration 1

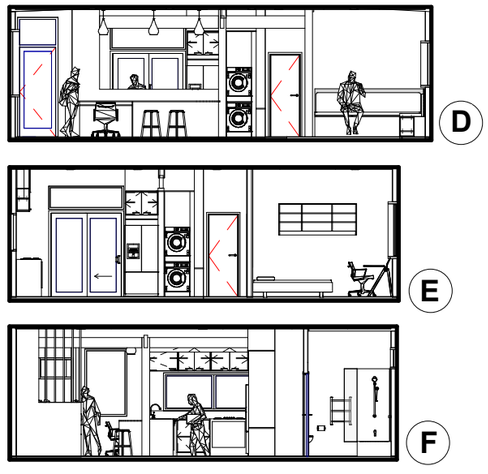
Test Two:

This test is the same as the previous, except that the ceiling heights have all been set to 3050mm to assess the effects of high ceilings.

## Iteration 1 RCHP (1:150@A2):




## Iteration 1 Sections (1:100@A2):




## Before (2400mm):

With a singular ceiling height there is little distinction between spaces in section

Hanging pendant lights to increase salience of ceiling

The space feels more unified and smaller/more confined with the lower ceilings.

## After (3050mm):

The space feels larger and more free with the higher ceilings.

Hanging pendant lights to increase salience of ceiling

The higher ceiling gives space for details like beams to be exposed

| Space: | Baseline Ceiling Height: | Iteration 1 Ceiling Height: | Iteration 2 Ceiling Height: |
|---|---|---|---|
| Workspace: | 2400mm | 3050mm | 3050mm |
| Dining Space: | 2400mm | 3050mm | 3900+mm |
| Kitchen Space: | 2400mm | 3050mm | 2700mm |
| Living Space: | 2400mm | 3050mm | 2400mm |
| Bedroom Space: | 2400mm | 3050mm | 2700mm |
| Centre of House: | 2400mm | 3050mm | 3900+mm |

**HIGH CEILINGS**

Freedom
Stimulation
Relational Processing

**LOW CEILINGS**

Confinement
Comfort
Item-Specific Processing

**Logic:**

By testing the spaces with low versus high ceilings, a comparison can be made between the two's experiential responses and the researched prediction of primed concepts of confinement & freedom.

Date: 21/12/20
Drawn By: OL
Reduced Scales: 1:100 - x 1.50 / 1:50 - x 0.75
Scale: As indicated

Ceiling Height Testing Iterations

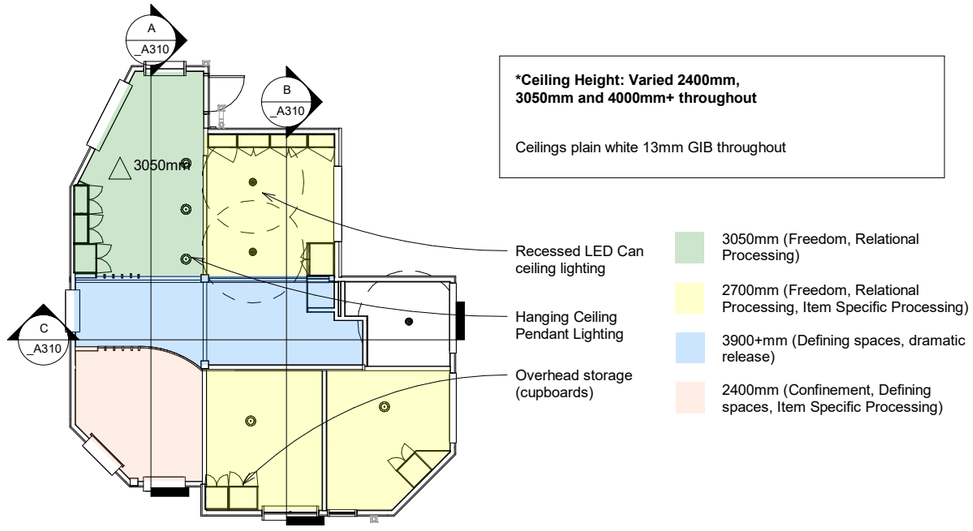
Sheet: _A300

# Iteration 2

## Test Three Continued:

This test responds to the findings of the previous tests (iteration 1 and the baseline) and implements further ceiling height design through Frank Lloyd Wright's principles as well as researched wellbeing effects. It is the final ceiling height iteration and test and is carried through to serve as the baseline for materiality testing.

## Iteration 2 RCHP (1:150@A2):



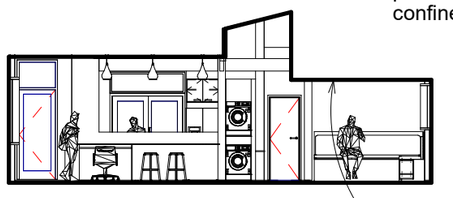

***Ceiling Height: Varied 2400mm, 3050mm and 4000mm+ throughout**

Ceilings plain white 13mm GIB throughout

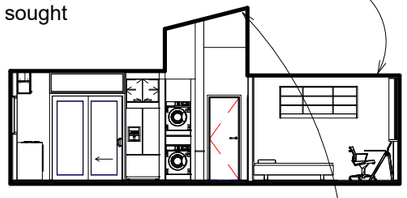
- 3050mm (Freedom, Relational Processing)
- 2700mm (Freedom, Relational Processing, Item Specific Processing)
- 3900+mm (Defining spaces, dramatic release)
- 2400mm (Confinement, Defining spaces, Item Specific Processing)

## Iteration 2 Sections:

The bedroom ceiling was set to a medium height, as a space where both relational and item specific processing could be used, and both freedom and confinement may be sought



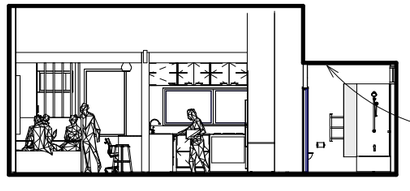
Section A: 1:100@A2



Section B: 1:100@A2

A lower ceiling in the lounge was added to create a confined 'nook', and to further separate it from nearby areas by emphasising its boundary

The 'atrium-like' high ceiling in the central space of the home was to create a stronger distinction between the private and social areas, and emphasise the horizontal axis of the plan



Section C: 1:100@A2

As the area people spend the least time in, and due to the small area and to maintain proportion the bathroom ceiling was kept low


# Iteration 2

## Test Three Continued:


## Key Areas - Ceiling Height Interventions

Notes

The high ceiling in the central space of the home, following the horizontal axis to the bedrooms and bathroom accentuates it from the surrounding spaces and makes it feel more identifiable as a thoroughfare as well as larger and less confined

Notes

The high ceilings in the workspace make it feel larger, especially when next to the lower ceiling in the kitchen. Entering the house through under the high ceilings makes it feel more open and free

Notes

The medium height ceiling in the kitchen space, along with the exposed structure distinguish it from the adjacent workspace with higher ceilings, while keeping visibility and the plan open

**Summary:**

From these tests it seems that by changing the ceiling heights of spaces according to their function (from a human psychology and physical perspective) a more comfortable and responsive environment can be designed. Spaces can be defined more dramatically and when salient, ceilings can prime concepts related to wellbeing in space.

| | |
|---|---|
| Date: 29/12/20 | Ceiling Height Testing Iterations Cont. |
| Drawn By: OL | |
| Reduced Scales: 1:100 - x 1.50 1:50 - x 0.75 Scale: 1 : 100 | Sheet: _A310 |

## Design Logic:

The low ceiling of the living space makes it feel more confined and separate from the other social areas; especially with the very high ceiling of the central space beside it - this defines it as a more 'cosy' place of retreat, which suits its passive function as an area for relaxation

## Design Logic:

This medium ceiling in the kitchen space allows it to feel open and unconfined enough to comfortably serve its function, while also being notably lower than the ceilings of the adjacent spaces. This defines it as a separate area, and makes views out from it into the workspace, dining space and central space more dramatic. It makes the kitchen a compression space that releases into the nearby social areas

## Design Logic:

The curved front of the living space ceiling and covering plasterboard to meet the high dining space ceiling emphasises the boundaries of the spaces. It makes the adjacent spaces read as separate despite their proximity

## Design Logic:

The high ceilings of the workspace make it feel more open and larger than the low ceilings. The exposed structure helps distinguish where the space ends, and then releases into the very high ceilings of the dining and central spaces. Looking to the kitchen the space feels connected socially, but functionally separate, the lower ceiling making the focus more within the boundaries of the room

## Design Logic:

The addition of the hanging pendant light increased salience of the ceiling, and the medium height allows the space to feel balanced and unconfined for active use, while still 'cosy' enough to be a place of retreat and rest. The low ceilings made it feel too confined, while the high ceilings made it feel unbalanced

## Summary

Overall the results reflect subtle improvement throughout the iterations. Specifc responses to questions and designs will be addressed/analysed in the thesis conclusions.

| | |
|---|---|
| Date: 05/01/21 | Ceiling Height Testing Iterations Cont. 2 |
| Drawn By: OL | |
| Reduced Scales: 1:100 - x 1.50 1:50 - x 0.75 Scale: | Sheet: _A320 |

# Intro

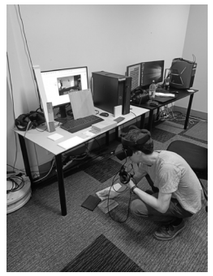
## Testing:

Though the questionnaire and guide process was very similar to the other WIPs, the materiality testing had some key differences which are outlined below.

## Method

This test involved the same questions and guides as the following tests to allow comparison of answers after design intervention. The difference between this testing and other iterative testing was that material samples for some key surfaces were incorporated into the process. This meant guiding users to where the object/surface in question was in the virtual space and getting them to touch a sample of the material in real space simultaniously. This was investigating the role of touch as well as vision in the experience of material qualities within space.

## Process pictures



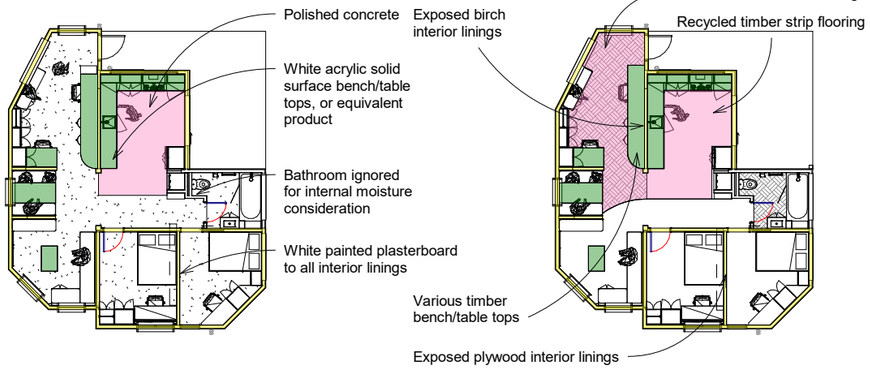
Images of author completing material testing

Samples for flooring, bench materials, cupboard materials and interior linings were used. The subject (author) was asked to touch the sample while experiencing it within the virtual space.

# Baseline

## Test One:

Internal Linings Plan 1:150@A2:




# Iteration 1

## Test Two:

Internal Linings Plan 1:150@A2:




Key vertical surfaces

Key horizontal surfaces

Key floor surfaces

# Baseline

## Test One:

This test uses the same model as the final ceiling height iteration and serves as the baseline. Materials have been largely ignored and standard finishes such as plasterboard and carpet applied for the sake of being realistic.

## Baseline Key Views

There is little distinction between the workspace and kitchen with the same materiality in both, however iteration 1 feels warmer and more inviting

The baseline carried light better than iteration 1, however was still less comfortable and austere feeling

The dining and living space were felt to be uninviting and austere when most surfaces are white, although the space felt larger

The baseline workspace felt uninviting and visually overwhelming with the white materials, although the contrast with the exposed beams was pleasing

# Iteration 1

## Test Two:

This test focuses on the influence of the material qualities of timber in the space, and as such many surfaces have been redesigned in various timbers.

## Iteration 1 Key Views

The two types of timber flooring (patterned tile and strip) proved to be overwhelming and created a less comfortable environment

Keeping ceilings painted white with the timber walls around them increased their salience. The two materials worked to balance each other visually

The timber in the living space made it feel more inviting, but was overwhelming on all surfaces within the space

The workspace was found to be visually over-whelming with its current amount of timber, although the space's materials carried light pleasantly

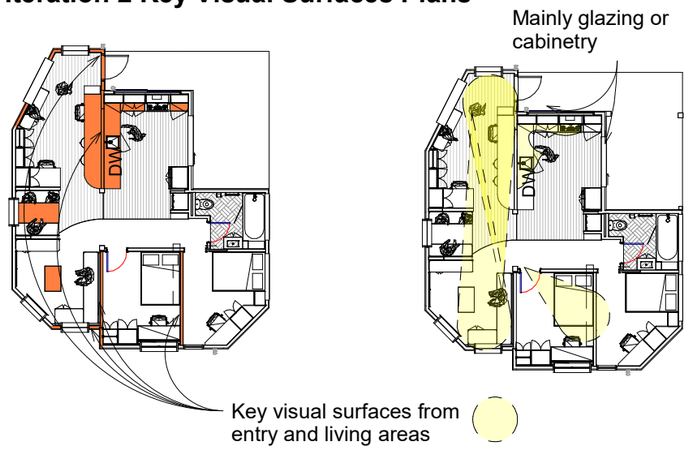
| | |
|---|---|
| Date: 06/01/21 | Materiality Testing Iterations |
| Drawn By: OL | |
| Reduced Scales: 1:100 - x 1.50, 1:50 - x 0.75 Scale: 1 : 150 | Sheet: _A400 |

# Iteration 2

Test Three:

This test responds to the findings of the previous tests, and its design explores using timber for key surfaces and balancing them with non-timber or painted surfaces.

## Iteration 2 Key Visual Surfaces Plans




## Approach

As the baseline test found the white to be overwhelming, and iteration 1's test found the timber to be a comforting but overwhelming in its current quantity - this iteration sought to use timber for key visual and touched surfaces only, and to offset and balance these surfaces with plainer materials or white painted surfaces. White (plaster surfaces) were also used to carry (reflect) light better into the central space

## Material Modeling

The qualities of the materials in VR live rendering, for testing purposes are not perfectly realistic. They are however about as close as current technology allows. The materials include photographic textures, bump patterns, grain and are scalable and fully customisable. They have been created to be as realistic as possible

## Textures

One timber wall covering material used was Finnish Birch. This ply has an A-grade finish and is less textured, with fewer knots than other ply - causing less eye strain

Another timber wall covering used was was a less finished Pinus Radiata ply, with more visible grain, texture and knots - creating more visual interest and salience, but potential eye strain

# Iteration 1

Test Two: Iteration 1 Key Views

# Iteration 2

Test Three: Iteration 2 Key Views

Changing the outside workspace wall to white plaster balances the space. Key touched and visible surfaces were kept timber, the effect was less overwhelming

Changing the materiality of the dining space to white laminated ply (except the table) increased contrast with the living space. Using white plaster for the walls inside the living space made it less visually overwhelming

Using white plaster for the walls of the central space allowed light to fill the space more effectively, making it more inviting. It also contrasts with adjacent areas' materiality and separates the private spaces from the social

Changing the fittings to white laminated ply and 3/4 walls to white plaster made the space feel lighter and less confined. Keeping one wall as ply provided visual interest and contrast

| | |
|---|---|
| Date: 08/01/21 | Materiality Testing Iterations Cont. |
| Drawn By: OL | |
| Reduced Scales: 1:100 - x 1.50 1:50 - x 0.75 Scale: 1 : 150 | Sheet: _A410 |

# Iteration 2

## Test Three Continued:

This test responds to the findings of the previous tests, and its design explores using timber for key surfaces and balancing them with non-timber or painted surfaces.

## Renders of key surfaces:

Contrast in materiality between opposing spaces

Less viewed surface - higher grain and knots

Dark stained timber for exposed structure and louvres emphasise them as important elements and help define the spaces

Key touched surfaces

Key visual surfaces

## Materiality Balance of Spaces

1:150@A2


Primarily exposed timber materiality

Primarily white ply or plasterboard materiality

## Key Finding 1:

Exposing timber for interior materials increased the comfortability and appeal of the spaces, except for when used in overwhelming quantities (all surfaces)

## Key Finding 2:

The use of VR and live rendering was quality enough to reveal experiential differences arising from the qualities of materials used in the design

## Key Finding 3:

That materiality between spaces effects overall spatial balance, as well as the perceived connection between said spaces

## Summary:

The three materiality iterations (including baseline) reflected that the experiential qualities of timber discovered through research seem to align with the results of testing. While the more physical or health related benefits cannot be measured or experienced through VR - the psychological or experiential seemingly can. These include mood, stress and comfort related responses. Overall a balanced space was preferred, using non-timber materials seemed to increase salience of key timber surfaces. Using material samples during the process was beneficial to understand qualities relating to touch, but the process itself was awkward - and larger samples would have been more effective.

| | |
|---|---|
| Date: 08/01/21 | Materiality Testing Iterations Cont. 2 |
| Drawn By: OL | |
| Reduced Scales: 1:100 - x 1.50, 1:50 - x 0.75 Scale: 1 : 150 | Sheet: _A420 |

## Baseline

Test One:

For this test the site was remodelled replicating a NZ section of land (-41.23008,174.82683). Basic site-design decisions were made such as the addition of a driveway, and building orientation according to views and sun direction

## Iteration 1

Test Two:

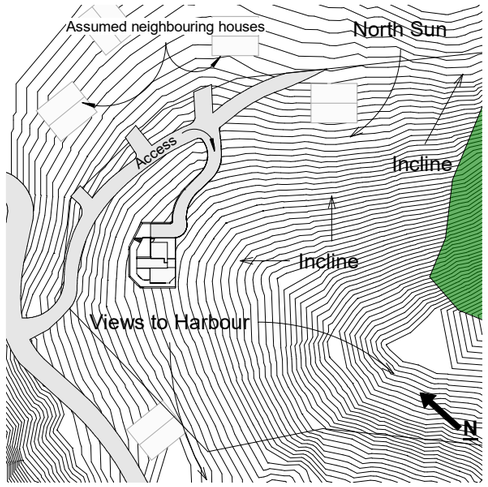
This iteration addressed views from within the space as well as site work. Window design was a key focus. A verandah was designed and a deck added. Some minor landscaping was done to the west and plantings were added to key areas.

## Iteration 2

Test Three:

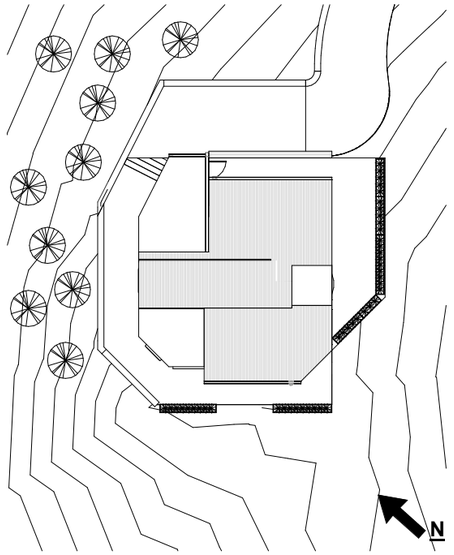
This iteration addressed interior natural lighting conditions, and further site design. A skylight and interior windows were added. The deck was redesigned and more planting was added to further integrate the interior with outside nature.

### Basline Context Plan (1:200@A2):



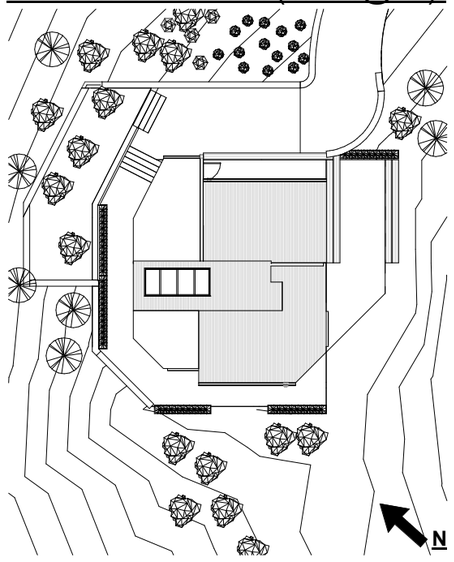

The site was selected from online maps and modelled according to its contours. The site has views of the harbour to the south & west, and inclines north, north-west and east to form a small valley, with forest at the lower end. It is currently a vacant section so assumed neighbouring houses were modelled to ensure privacy from.

### Iteration 1 Site Plan (1:200@A2):



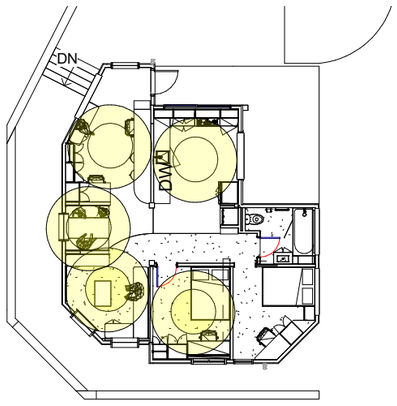

Iteration 1 extended the deck and followed the profile of the house, added plantings and planter boxed to the North, East and South, and changed the key openings to enhance views.

### Iteration 2 Site Plan (1:200@A2):




Iteration 2 lowered the deck and extended it further to integrate with the landscape more. It involved landscaping to the North to bring more light inside and to ehance views, and added a skylight and internal windows as well as further planting. Some openings changed.

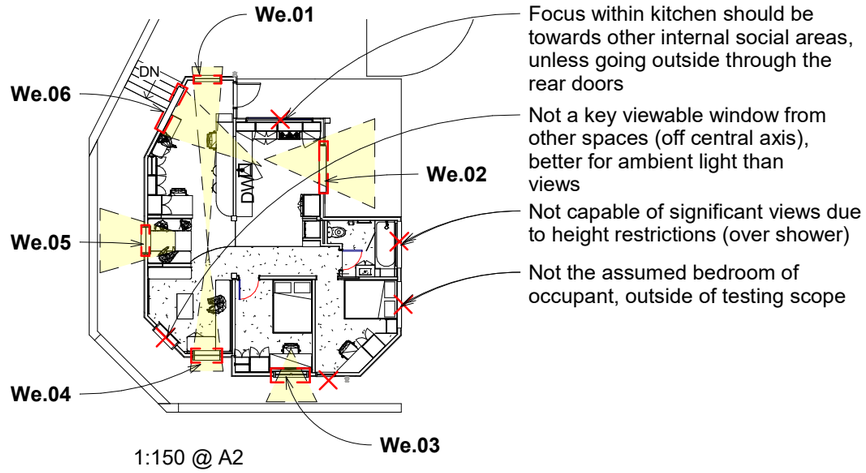
### Key Spaces for Lighting Plan:




1:150 @ A2

Baseline: Five spaces were selected as key areas for natural lighting, and testing across different times of day in site-specific Winter sun conditions. Iteration 2 addressed bringing more natural light into these areas.

### Key Openings Plan:




1:150 @ A2

Baseline: Key windows/doors were selected for iteration (to capture views and enhance interior connection to nature) based on their outlook or position/orientation in the house. Windows off the key axis or less viewed were ignored.

### Baseline 3D - Site View

### Iteration 1 3D - Site View

### Iteration 2 3D - Site View

| | | | |
|---|---|---|---|
| Date: | 14/01/21 | Nature & Light Testing Iterations | |
| Drawn By: | OL | | |
| Reduced Scales: | 1:100 - x 1.50<br>1:50 - x 0.75 | Scale: As indicated | Sheet: _A500 |

## We.01

Window 1 is North-East facing and is at the entry of the house (end of the Workspace). It is on the key vertical axis and offers views from many areas of the home. There are neighbouring structures on the hill to ensure privacy from. The window size was increased, frame size decreased and site work was completed to enhance views.

**Baseline**

**Iteration 1**

**Iteration 2**

## We.02

'Window 2' is (South) East facing, is in the Kitchen space and is the sliding door access to the deck outside. It offers views of Wellington Harbour and down the valley. Different arrangements were tried, and a larger door was found to be preferable. Deck design changed the outlook and enhanced views.

**Baseline**

**Iteration 1**

**Iteration 2**

## We.03

Window 3 is in the Bedroom space and is South-West facing. It offers views down the valley and of the morning sunrise. There is a neighbouring house to ensure privacy from. The window was increased in size, the sill became a shelf, and site work was done to enhance views.

**Baseline**

**Iteration 1**

**Iteration 2**

| | |
|---|---|
| Date: 15/01/21 | Nature & Light Testing Iterations Cont. |
| Drawn By: OL | |
| Reduced 1:100 - x 1.50<br>Scales: 1:50 - x 0.75 Scale: | Sheet: _A510 |

## We.04

Window 4 is South (West) facing and is in the Living space. It offers light into the seating area and views down the valley. There is a neighbouring house to ensure privacy from. The size of the window was increased to fill the space, and the sill was increased to become a shelf integrated with the seating.

**Baseline**

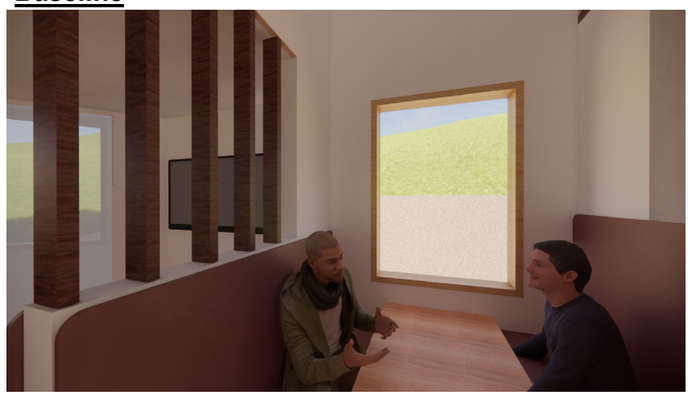
**Iteration 1**

**Iteration 2**

## We.05

Window 5 faces North-West and is in the Dining space. It has limited views due to the rising hill in that direction. It has been greatly increased in size and site work has been undertaken to enhance its view.

**Baseline**



**Iteration 1**

**Iteration 2**

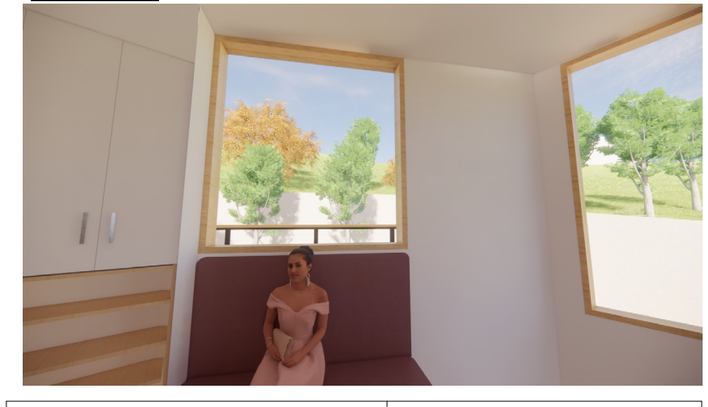
## We.06

Window 6 is North facing and offers views up the hill, as well as a lot of natural light. Views are limited due to topography. The size, position and shape of the window was changed, and site work undertaken to enhance views.

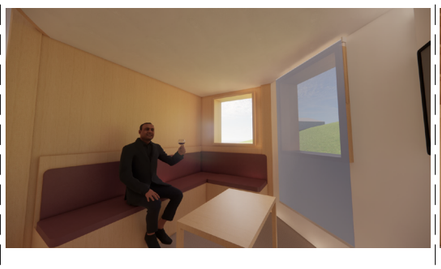
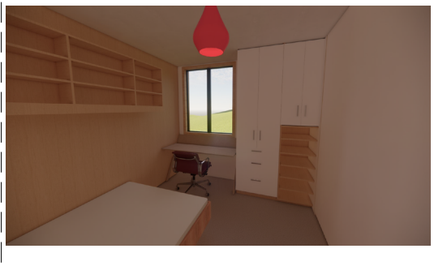
**Baseline**

**Iteration 1**

**Iteration 2**



| | |
|---|---|
| Date: 16/01/21 | Nature & Light Testing Iterations Cont. 2 |
| Drawn By: OL | |
| Reduced Scales: 1:100 - x 1.50 1:50 - x 0.75 Scale: | Sheet: _A520 |

| | Workspace | Kitchen Space | Dining & Central Space | Living Space | Bedroom |
|---|---|---|---|---|---|
| | Baseline | Baseline | Baseline | Baseline | Baseline |
| 8.00AM |  |  |  |  |  |
| | The existing natural lighting conditions of the Workspace after Materiality Iteration 2. | The existing natural lighting conditions of the Kitchen space after Materiality Iteration 2. | The existing natural lighting conditions of the Dining and Central space after Materiality Iteration 2. | The existing natural lighting conditions of the Living space after Materiality Iteration 2. | The existing natural lighting conditions of the Bedroom space after Materiality Iteration 2. |
| 12.00PM |  |  |  |  |  |
| | The existing natural lighting conditions of the Workspace after Materiality Iteration 2. | The existing natural lighting conditions of the Kitchen space after Materiality Iteration 2. | The existing natural lighting conditions of the Dining and Central space after Materiality Iteration 2. | The existing natural lighting conditions of the Living space after Materiality Iteration 2. | The existing natural lighting conditions of the Bedroom space after Materiality Iteration 2. |
| 5.00PM |  |  |  |  |  |
| | The existing natural lighting conditions of the Workspace after Materiality Iteration 2. | The existing natural lighting conditions of the Kitchen space after Materiality Iteration 2. | The existing natural lighting conditions of the Dining and Central space after Materiality Iteration 2. | The existing natural lighting conditions of the Living space after Materiality Iteration 2. | The existing natural lighting conditions of the Bedroom space after Materiality Iteration 2. |

Notes: In order to measure whether increased natural lighting benefited wellbeing related factors in the experience of space, lighting across the day had to be tested. Key spaces were chosen and views were set up to show the difference in lighting between iterations, with iteration 2 seeking to maximise natural light. The actual testing process was included in the connection to nature testing and followed a similar structure to previous tests. Sun conditions were set accurate to the site and in Winter, as this is when natural light is needed most inside. All the images shown are indicative and not images from the testing, but they are from the same digital model used for testing and rendered in the same conditions.

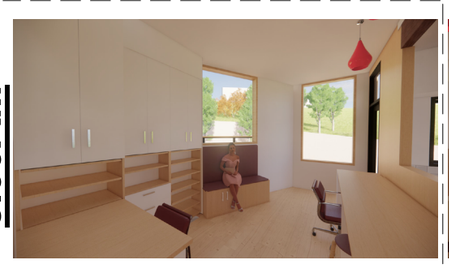
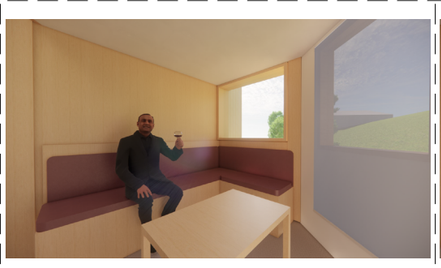
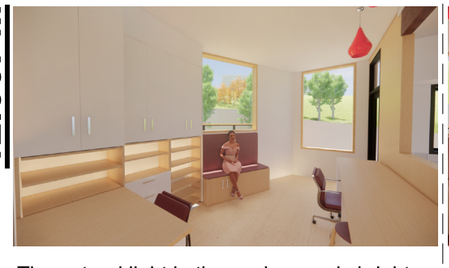
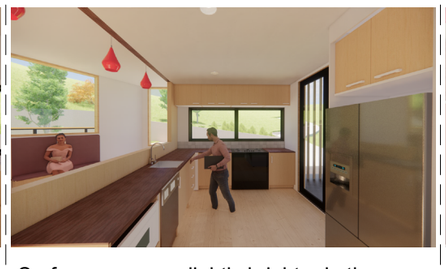
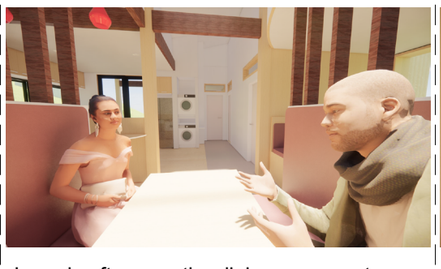
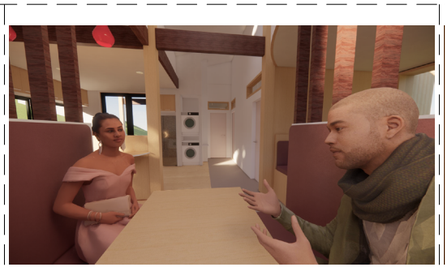
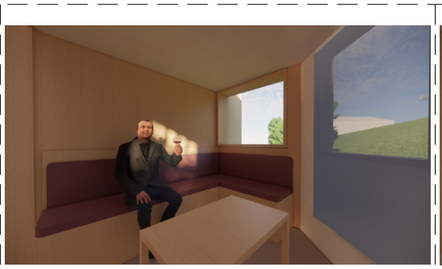
Date: 17/01/21

Drawn By: OL

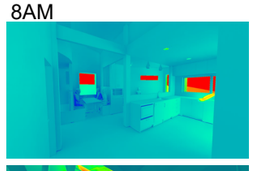
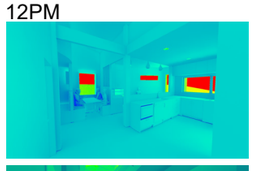
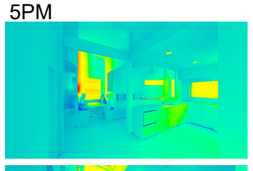
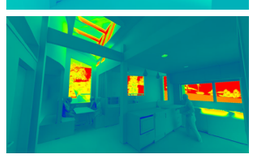
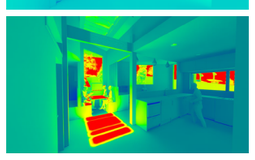
Reduced Scales: 1:100 - x 1.50 1:50 - x 0.75 Scale:

Nature & Light Testing Iterations Cont. 3

Sheet: _A530

| | Workspace<br>Iteration 2 | Kitchen Space<br>Iteration 2 | Dining Space<br>Iteration 2 | Living Space<br>Iteration 2 | Bedroom<br>Iteration 2 |
|---|---|---|---|---|---|
| **8.00AM** |  |  |  |  |  |
| | The new window arrangement and external landscaping allowed more ambient natural light into the space in the mornings | This increased door height and larger We.06 size allowed more ambient and direct sunlight into the space in the mornings | Conditions in the morning are similar from the baseline to It.2 for the dining and central space's natural lighting | The living space receives some direct sunlight and higher ambient natural light than the baseline in the mornings | Natural lighting conditions are similar in the mornings for the Bedroom space accross iterations. |
| **12.00PM** |  |  |  |  |  |
| | The natural light in the workspace is brighter than in the baseline model, there is more ambient light from the windows and skylight | Surfaces appear slightly brighter in the kitchen space at midday than the baseline, with more ambient natural light | In early afternoon the dining space gets significantly more direct sunlight due to the skylight addition, and the central space is more brightly lit | The living space receives some direct sunlight and higher ambient natural light than the baseline in the early afternoon | Although similar, there is more ambient natural light in Iteration 2's bedroom space due to its internal window to the central space (with skylight) |
| **5.00PM** |  |  |  |  |  |
| | The workspace in the early evening gets significantly more direct sunlight from the skylight and larger We.05 | The kitchen space gets more direct sunlight in the early evenings, making conditions more comfortable than the baseline | In the early evening the dining and central spaces still receive some (but less) direct sunlight, and more ambient natural light than the baseline | While still relatively dim (low ambient natural light), the living space receives more direct sunlight in the early evenings in Iteration 2. | While still having relatively low ambient natural light in the evening (due to East facing window), Iteration 2's Bedroom space is brighter than the baseline at 5pm. |

LUX:

| | 8AM | 12PM | 5PM |
|---|---|---|---|
| Baseline: |  |  |  |
| Iteration 2: |  |  |  |

The design changes made to the baseline to enhance natural lighting conditions in the home in Iteration 2 were seen to be successful through the testing process, shown indicatively above and on the previous page. Additionally, using the same software a brief LUX analysis was conducted in the central areas of the baseline and It.2, which supported the testing's conclusions - showing more and brighter sunlight entering It.2 than the baseline.

Date: 19/01/21

Drawn By: OL

Reduced Scales: 1:100 - x 1.50 / 1:50 - x 0.75 Scale:

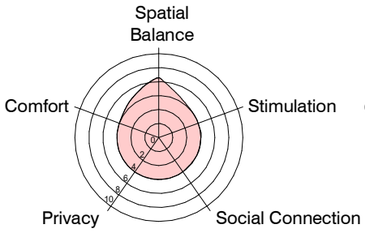
Nature & Light Testing Iterations Cont. 4

Sheet: _A540

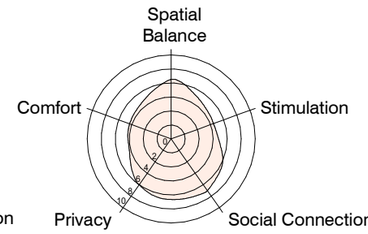
## Scoring Results - Proxemics

| Test | Comfort | Stimulation | Privacy | Social Connection | Spatial Balance |
|---|---|---|---|---|---|
| Baseline | 4 | 4 | 4 | 4 | 6.5 |
| Iteration 1 | 4.5 | 4.5 | 6 | 7 | 7 |
| Iteration 2 | 5 | 5 | 8 | 8 | 8 |

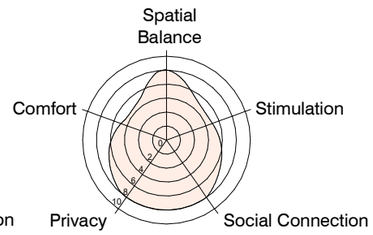
**BASELINE**




**ITERATION 1**




**ITERATION 2**



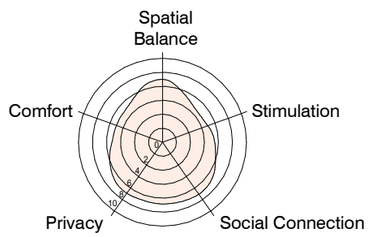

## Summary

The scores for the DOGs can be seen to improve from the Baseline through to Iteration 2, suggesting that the proxemic iterations and considerations improved spatial quality and wellbeing within the space.

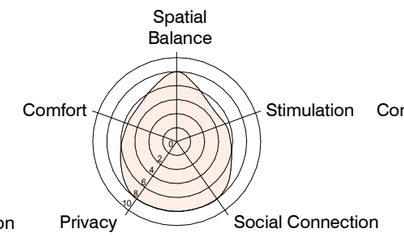
## Scoring Results - Ceiling Heights

| Test | Comfort | Stimulation | Privacy | Social Connection | Spatial Balance |
|---|---|---|---|---|---|
| Baseline | 5 | 5 | 7 | 7 | 7 |
| Iteration 1 | 5.5 | 5.5 | 8 | 8 | 8 |
| Iteration 2 | 6 | 6.5 | 8.5 | 8 | 8 |

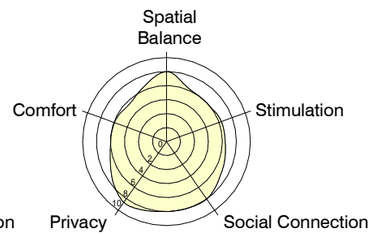
**BASELINE**




**ITERATION 1**




**ITERATION 2**



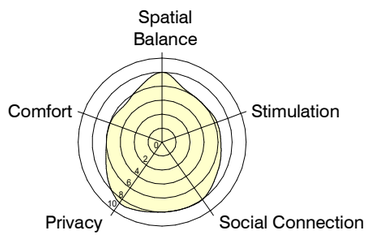

## Summary

The scores can be seen to decrease from the previous test for the baseline, and then increase back to similar values for iteration 1, before increasing to higher values in Iteration 2.

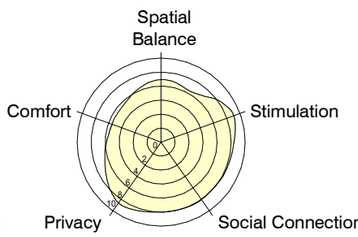
## Scoring Results - Materiality

| Test | Comfort | Stimulation | Privacy | Social Connection | Spatial Balance |
|---|---|---|---|---|---|
| Baseline | 6 | 6.5 | 8.5 | 8 | 8 |
| Iteration 1 | 5.5 | 9 | 8.5 | 8 | 7 |
| Iteration 2 | 8 | 8 | 8.5 | 8 | 8.5 |

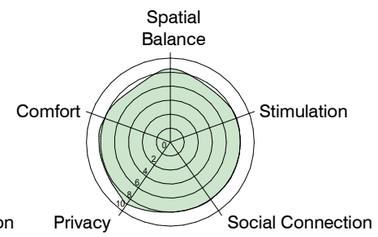
**BASELINE**




**ITERATION 1**




**ITERATION 2**




## Summary

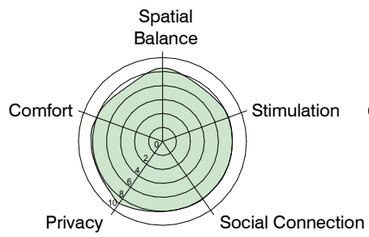
The scores are the same as the previous test for the baseline, and then drop for Comfort and Spatial Balance and raise a lot for stimulation in Iteration 1. They then Comfort and Spatial Balance raise again in Iteration 2, and Stimulation drops to 8.

## Scoring Results - Connection to Nature and Light

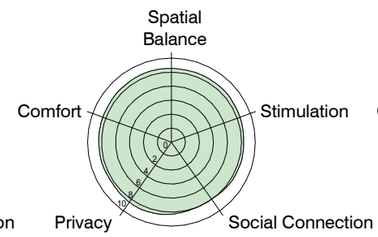
| Test | Comfort | Stimulation | Privacy | Social Connection | Spatial Balance |
|---|---|---|---|---|---|
| Baseline | 8 | 8 | 8.5 | 8 | 8.5 |
| Iteration 1 | 8.5 | 8.5 | 8.5 | 8 | 8.5 |
| Iteration 2 | 9 | 9 | 8.5 | 8.5 | 8.5 |

| Avg. Scores: | Views | Light |
|---|---|---|
| Baseline | 2.3/5 | 3.3/5 |
| Iteration 1 | 3.0/5 | |
| Iteration 2 | 3.5/5 | 4.2/5 |

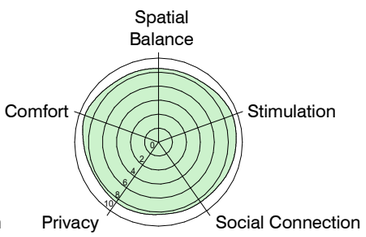
**BASELINE**




**ITERATION 1**




**ITERATION 2**




## Summary

In the final iterations improvements to scores can be seen in all of the DOGs, except Spatial Balance which remained constant. Scores for lighting and views were also recorded in testing, the results from spaces were averaged and are above.

Date: 27/01/21

Drawn By: OL

Reduced Scales: 1:100 - x 1.50 / 1:50 - x 0.75 Scale: 1 : 150

Scoring Results

Sheet: _A600

The exterior aesthetics and appearance of the house was not the subject of this thesis, but has been developed roughly anyway - supporting the idea that incorporating wellbeing factors in design processes does not need to the dictate the overall form of architect's/client's design concept. The external form, cladding and roofing designs have changed throughout the project, without impacting interior spaces or qualities, or moving any key elements (walls, windows, fittings).

| | | | |
|---|---|---|---|
| Date: | 22/01/21 | | Final Design |
| Drawn By: | OL | | |
| Reduced Scales: | 1:100 - x 1.50<br>1:50 - x 0.75 | Scale: | Sheet: _A700 |

## QR Code:

SCAN ME

Scan the code to the left with your cellphone's camera, google lens, or specified QR reader (downloadable from application stores) to be taken to an online video walkthrough of the final product of this thesis's Wellbeing Iterative Design approach.

| | |
|---|---|
| Date: 25/01/21 | Final Design Cont. |
| Drawn By: OL | |
| Reduced Scales: 1:100 - x 1.50<br>1:50 - x 0.75 Scale: | Sheet: _A710 |

| Test – Proxemics | Q# | Space | Question | Answer/Score |
|---|---|---|---|---|
| Baseline (B) | 1.0B | Workspace | What sort of social or private activities would you feel comfortable doing in this area? E.g. reading, studying/working alone or with others, socialising in a medium sized or small group, relaxing alone or intimately, eating in a small group. | *This area would be nice to work in, as it is open but also semi-private from the other areas – but the bench might not be very comfortable to work at for long periods. Eating breakfast there would still be nice though.* |
| | 1.1B | Dining | Do you feel this space's design produces a comfortable social setting for a small group of people you are close with? Why/why not? | *I feel like this space is well positioned with the foyer area and window, but the openness to the living space is a little awkward, as some people will have their back to it. It could be a little more private.* |
| | 1.2B | Dining | How socially connected do you feel this space is to other areas of the home? Which areas do you feel this space should be socially connected to and/or private from? | *Quite connected. It would be more comfortable if it was more private from the living space, but still partially connected to the kitchen space so you can talk between the spaces (but not a priority).* |
| | 1.3B | Living | Do you feel this space is a comfortable setting for informal or personal social interactions? E.g would you be comfortable conversing in a small group here, with people who you are close with and/or people you do not know very well? | *The single couch facing the tv would make for an awkward setting, it would be hard to talk to the people next to you. The space is quite small which would be nice for a cosy place to relax with someone close if it was more private, but it wouldn't be suited for any group socialising.* |
| | 1.4B | Overall | How well do you feel the design of this house's different spaces provide for your individuality and **privacy** needs on a scale of 1-10? Feel free to comment. | *At the moment probably a **4**. The connections between the foyer, dining and living space need to be improved so they are more private, and there is no suitable area for doing work alone or in a group.* |
| | 1.5B | Overall | How well do you feel the qualities of this house's different spaces provide for your needs from different **social** environments on a scale of 1-10? E.g, intimate, personal and informal or formal social engagements. Feel free to comment. | *At the moment maybe a **4** as well, the living area can't really be used for socialising, and there isn't really anywhere else to socialise in a group except the table. The kitchen to workspace connection is nice though, and the overall arrangement is good too, with all the social spaces on that side of the house and open.* |
| | 1.6B | Overall | How **comfortable** do you feel overall when moving through these different spaces, and thinking about how you will use them – on a scale of 1-10? Feel free to comment. | *I think a **4** again. But this one is hard to say, as the house doesn't have materials it feels a bit surreal, and the VR process of moving around in the space is a little uncomfortable itself.* |
| | 1.7B | Overall | How **stimulated** do you feel by the qualities of the social spaces in the home overall, when thinking about how you will use them, on a scale of 1–10? Feel free to comment. | *The arrangement of the spaces is interesting and I think it has potential. It feels quite open for a small house, it was quite exciting moving around the spaces, but again the VR model itself would be more exciting with more detail and colours etc. So I think a **5**.* |
| | 1.8B | Overall | How **spatially balanced** do you feel the spaces are on a scale of 1-10? E.g. is there anything uncomfortable or unpleasing to the eye about the scale, arrangement or general form of the key areas? Feel free to comment. | *I like the arrangement of the house, it needs refinement for some boundaries between areas, but overall it seems balanced and the spaces are a good size in relation to each other. The breakfast bench and storage in the foyer balance each other nicely when* |

| | | | | |
|---|---|---|---|---|
| | | | | *walking through the space. Nothing seems unpleasing to the eye really, but the living area is a little empty/awkward with one couch. Overall probably a **6.*** |
| | | | | |
| Iteration 1 (M) | 1.0M | Workspace | Do you feel that that you would be more comfortable working in this space with the addition of the workstations? Do you feel like you could comfortable work in this space while someone you know does as well (at the other workstation)? | *Yes, now there are spaces to do work it seems a lot more comfortable. The desks are facing away from each other and quite private, but the space is small enough that you could just swivel around and talk. The one beside the dining area could be more private if the dining space was being used. I feel like I would use the space a lot more now. I like the connection to the kitchen space so you can chat between the areas.* |
| | 1.1M | Dining | Do you feel this space's design produces a comfortable social setting for a small group of people you are close with? Why/why not? | *The addition of the booth instead of a table makes it much more private from the adjacent spaces, but it still kind of feels placed in the middle of them. I like the idea and arrangement better than before, but it is probably a little small, it would be cramped if there were more than 2 of you.* |
| | 1.2M | Dining | How socially connected do you feel this space is to other areas of the home? Which areas do you feel this space should be socially connected to and/or private from? | *It is more private than before which is good, but could still be more private so you don't feel like you're sitting in a box between the living space and new workspace. If other people were in those areas it might feel like that.* |
| | 1.3M | Living | Do you feel this space is a comfortable setting for informal or personal social interactions? E.g would you be comfortable conversing in a small group here, with people who you are close with and/or people you do not know very well? | *The new seating arrangement is much better and I could see a small group of maybe up to 5 people using this area to have a conversation. It feels a little more private but still kind of connected to the dining area which I don't like, but I like that it is open to the rest of the house, but tucked into a cosy corner.* |
| | 1.4M | Bedroom 1 | How comfortable do you feel this space is as a private area for yourself? If you were to use this space seeking isolation or solitude, what would make it more comforting? | *It is small-ish but fits a large bed and suitable storage which is good. If I were to be using this space for a long period of time it would feel confined, it would be nice to have a desk or place to sit other than the bed, and to work if there are other people in the living areas.* |
| | 1.5M | Overall | How well do you feel the design of this house's different spaces provide for your individuality and **privacy** needs on a scale of 1-10? Feel free to comment. | *Now I think a **6**. The dining space is more separated from the other areas with the booth, and there are two areas to work out in the workspace which I could see myself using regularly. The living space and dining space as well as the workspace could still be slightly more separated though, so you can't see all the areas at once from one end of the house.* |
| | 1.6M | Overall | How well do you feel the qualities of this house's different spaces provide | *If it was a 4 before, then now with the new seating in the lounge and the* |

| | | | | |
|---|---|---|---|---|
| | | | for your needs from different **social** environments on a scale of 1-10? E.g, intimate, personal and informal or formal social engagements. Feel free to comment. | *dining booth, as well as desks in the workspace by the kitchen opening, it would be a **7**. The foyer area has become a sort of semi-social workspace, and I like the cosiness of the living area for conversing or relaxing in a small group.* |
| | 1.7M | Overall | How **comfortable** do you feel overall when moving through these different spaces, and thinking about how you will use them – on a scale of 1-10? Feel free to comment. | *Compared to the last test, the addition of the fittings to the living area and workspace, as well as the dining booth make it feel more refined. I can see myself using the spaces and the process is still a little uncomfortable/unrealistic because of materials and movement, to be honest I like it more but don't feel that much more comfortable, maybe a **4.5.*** |
| | 1.8M | Overall | How **stimulated** do you feel by the qualities of the social spaces in the home overall, when thinking about how you will use them, on a scale of 1–10? Feel free to comment. | *Similar to with comfort, the space is more interesting with its refinement from the last test, and I like it more (dining booth, living arrangement, workstations) – so probably higher than the last score, but the space still isn't realistic and I didn't feel overwhelmed by its features so **4.5** again, I think.* |
| | 1.9M | Overall | How **spatially balanced** do you feel the spaces are on a scale of 1-10? E.g. is there anything uncomfortable or unpleasing to the eye about the scale, arrangement or general form of the key areas? Feel free to comment. | *Key areas have seemed to stay in the same proportions so it is definitely no worse than before, I think the addition of the seating around the outside of the living area makes it feel a lot more balanced, and it balances well with the workspace opposite it. The dining booth aligns with the central hallway which is satisfying. I would say a **7**.* |
| | | | | |
| Iteration 2 (N) | 1.0N | Workspace | Do you feel that that this area is suitable socially connected or private from nearby areas for you to use it comfortably and productively? | *Yes, the addition of louvres to the dining space makes it more separate from the workspace. The space feels a bit bigger and more open to the kitchen which is nice. The addition of a bench facing the kitchen/working areas makes it feel like a nice area for group work or conversations.* |
| | 1.1N | Dining | Do you feel this space's design produces a comfortable social setting for a small group of people you are close with? Why/why not? | *The louvres make it much more private from the workspace and living area, but still let light through and don't fully enclose it which is nice. The booth itself seems a bit bigger and more comfortable if there were more than 2 of you using it. It is more comfortable than before.* |
| | 1.2N | Dining | How socially connected do you feel this space is to other areas of the home? Which areas do you feel this space should be socially connected to and/or private from? | *I feel like it is at a good level now, where you could have a quiet or intimate conversation there while other areas are being used. It is still connected, but sufficiently separate that different social settings could happen there – more personal ones.* |
| | 1.3N | Kitchen | Do you feel this space is suitably socially connected to other areas such as the workspace, dining and living? | *Yes, with the opening to the workspace this creates a nice area for conversation while people are working* |

| | | | | |
|---|---|---|---|---|
| | | | | *or cooking in the different spaces. From the kitchen you can see the dining and living areas and could converse with people there due to the scale of the home, but also could easily have a separate conversation with privacy while those areas are being used by others.* |
| | 1.4N | Bedroom 1 | How comfortable do you feel this space is as a private area for yourself? Do you think you would use this space seeking isolation or solitude, or to work in privacy? | *It is a lot better just with the addition of the desk/work area. Now it can be used for something other than resting and getting ready, which is an improvement.* |
| | 1.5N | Overall | How well do you feel the design of this house's different spaces provide for your individuality and **privacy** needs on a scale of 1-10? Feel free to comment. | *Now with the louvres around the dining and the tucked away lounge, plus the workstation in the bedroom I feel like privacy has been better responded to. There are options for what sort of social setting you want, and spaces for multiple different kinds of interaction to happen at once. I would say it is now an **8.*** |
| | 1.6N | Overall | How well do you feel the qualities of this house's different spaces provide for your needs from different **social** environments on a scale of 1-10? E.g, intimate, personal and informal or formal social engagements. Feel free to comment. | *Similar to the last question, I feel like you could have intimate dinners in the dining booth - or social ones with a couple of friends, intimate social time with someone in the living room - or a group conversation, group or individual work in the workspace – or a larger social gathering between there and the kitchen. I would say now it is an **8** compared to the previous tests.* |
| | 1.7N | Overall | How **comfortable** do you feel overall when moving through these different spaces, and thinking about how you will use them – on a scale of 1-10? Feel free to comment. | *Ignoring the spatial qualities of the VR, the adjustments made since the last test have made the space more comfortable. I noticed larger size of the dining booth and workspace and the extra privacy and pleasing view with the dining booth louvres. I would say it has gone up to a **5.*** |
| | 1.8N | Overall | How **stimulated** do you feel by the qualities of the social spaces in the home overall, when thinking about how you will use them, on a scale of 1–10? Feel free to comment. | *Similar to before, the adjustments to the space notably improved it, but overall it still isn't realistic and not that stimulating or comforting. The louvres make the space more interesting, and I still like the arrangement. Probably a **5.*** |
| | 1.9N | Overall | How **spatially balanced** do you feel the spaces are on a scale of 1-10? E.g. is there anything uncomfortable or unpleasing to the eye about the scale, arrangement or general form of the key areas? Feel free to comment. | *Again, definitely no worse than before. The louvres make it feel more balanced and make the dining space stand out between the living and workspace, and its increased size makes it look less squished. The connection between the kitchen and workspace seems more balanced, and the workspace less confined than before. Probably an **8.*** |

| Test – Ceiling Height | Q# | Space | Question | Answer/Score |
|---|---|---|---|---|
| Baseline (B) | 2.0B | Overall | How aware are you of the height of the ceiling as you move through the spaces? Is this a good thing or a bad thing? | *Pretty aware, they seem relatively low and seeing as it's open plan it's quite prominent. It's not necessarily a bad thing but the space does feel quite small.* |
| | 2.1B | Overall | Overall, do you feel as though the height of the ceilings is more confining or freeing? Or neither? | *More confining.* |
| | 2.2B | Overall | Overall, how well do you think the different spaces are defined from one another? | *They are still quite well separated socially, but still definitely linked and sort of read as a divided whole rather than separate spaces. So, quite well.* |
| | 2.3B | Overall | How much do you think the ceiling height across the spaces is impacting your experience of the house? | *Maybe a moderate amount? I definitely notice it, and I would prefer for it to be higher, but it isn't very low and is more than tolerable.* |
| | 2.4B | Overall | Paying special attention to the ceiling height, and considering how you will be using the spaces you walked through; how **comforted** do you feel by the qualities and design of the overall home on a scale of 1 – 10? | *The model is more refined than the last testing which makes the process a bit smoother, the addition of lights makes it more realistic. It still isn't exactly comforting as a space even though I like the design, so a **5**.* |
| | 2.5B | Overall | Paying special attention to the ceiling height, and considering how you will be using the spaces you walked through; how **stimulated** do you feel by the qualities and design of the overall home on a scale of 1 – 10? | *Similar to the last question in terms of the model itself, but I would say unchanged apart from that, so **5**.* |
| | 2.6B | Overall | How well do you feel the spaces respond to your **privacy** needs on a scale of 1 – 10? | *If anything having this one relatively low ceiling height makes the spaces feel closer together, so maybe down to a **7**.* |
| | 2.7B | Overall | How well do you feel the spaces respond to your **social** needs on a scale of 1 – 10? | *I don't feel like this has changed from before, except that the space feels a little smaller so maybe a **7** again.* |
| | 2.8B | Overall | How **spatially balanced** do you feel the spaces are overall? Is there anything unappealing about the proportions or arrangement of the spaces? On a scale 1 -10. | *Again, fairly similar to before, but the spaces feel more like one big space than balanced separate ones, and the low ceiling makes it seem a little squished so a **7**.* |
| | | | | |
| Iteration 1 (M) | 2.0M | Overall | How aware are you of the height of the ceiling as you move through the spaces? Is this a good thing or a bad thing? | *I am more aware than the last test as they are notably higher and make the space feel larger and more open.* |
| | 2.1M | Overall | Overall, do you feel as though the height of the ceilings is more confining or freeing? Or neither? | *Freeing.* |
| | 2.2M | Overall | Overall, how well do you think the different spaces are defined from one another? | *More so than before, the exposed structure definitely helps, and the higher ceilings makes the place feel bigger and the spaces less squished together.* |
| | 2.3M | Overall | How much do you think the ceiling height across the spaces is impacting your experience of the house? | *Having been in the lower ceiling test and now this I would say a lot, this space feels much more inviting and open than the last.* |
| | 2.4M | Overall | Paying special attention to the ceilings of the spaces, and considering how | *With the higher ceilings and exposed structure separating the spaces more* |

| | | | | |
|---|---|---|---|---|
| | | | you will be using the spaces; how **comforted** do you feel by the qualities and design of the overall home on a scale of 1 – 10? | *the home feels more comfortable than before. It still doesn't feel super comfortable, so probably **5.5**.* |
| | 2.5M | Overall | Paying special attention to the ceilings of the spaces, and considering how you will be using the spaces; how **stimulated** do you feel by the qualities and design of the overall home on a scale of 1 – 10? | *I definitely feel more stimulated with the high ceilings, particularly in the entry/workspace, where I feel less confined than before. I would say a **5.5**.* |
| | 2.6M | Overall | How well do you feel the spaces respond to your **privacy** needs on a scale of 1 – 10? | *I feel like this hasn't really changed, maybe up to an **8** again as the place feels bigger and spaces more separate.* |
| | 2.7M | Overall | How well do you feel the spaces respond to your **social** needs on a scale of 1 – 10? | *Similar as for privacy, the spaces are more comfortable and feel more open but also more distinct with the exposed structure so back to an **8**.* |
| | 2.8M | Overall | How **spatially balanced** do you feel the spaces are overall? Is there anything unappealing about the proportions or arrangement of the spaces? On a scale 1 -10. | *It feels less squished with the high ceilings so an **8**.* |
| | | | | |
| Iteration 2 (N) | 2.0N | Overall | How aware are you of the height of the ceiling as you move through the spaces? Is this a good thing or a bad thing? | *Even more aware than before, I immediately noticed they were at differing heights and the openness around the dining and central spaces.* |
| | 2.1N | Overall | Moving through these areas one by one, please state whether they feel more confining or freeing when paying attention to the height of the ceiling. | *Workspace – freeing, Dining and central – definitely freeing, Kitchen – sort of somewhere in the middle, but in a good way, Bedroom 1 – same as the Kitchen, maybe a little more confining but not in a bad way, Living space – Confining, but more in a cosy nook kind of way.* |
| | 2.2N | Overall | Overall, how well do you think the different spaces are defined from one another? | *The spaces definitely feel a lot more defined from one another. Walking from the workspace to the living you immediately notice how high the ceiling is through the central area and it makes it feel a lot more open and larger, then you enter the living space and immediately notice the contrast and feel more tucked away with its much lower ceiling.* |
| | 2.3N | Overall | How much do you think the differing ceiling heights across the spaces is impacting your experience of the house? | *Majorly, as I said before. It makes the space feel a lot more interesting as there is stuff happening horizontally and vertically. It makes the different spaces feel more defined by their ceilings and overall the home feels larger.* |
| | 2.4N | Overall | Paying special attention to the ceilings of the spaces, and considering how you will be using the space; how **comforted** do you feel by the qualities and design of the overall home on a scale of 1 – 10? | *I think this model feels more comfortable than the previous tests, the dining area and hallway feel more open and freer, and the living space feels cosier and more tucked away. I would say a **6**.* |
| | 2.5N | Overall | Paying special attention to the ceilings of the spaces, and considering how you will be using the space; how **stimulated** do you feel by the qualities | *Much more stimulated than before, the central area feels much more important and the home as a whole* |

| | | | | |
|---|---|---|---|---|
| | | | and design of the overall home on a scale of 1 – 10? | *more is more visually interesting. I would say a **6.5**.* |
| | 2.6N | Overall | How well do you feel the spaces respond to your **privacy** needs on a scale of 1 – 10? | *I feel like the living area is much more private now, and the distinction between the different spaces clearer so maybe up to an **8.5**.* |
| | 2.7N | Overall | How well do you feel the spaces respond to your **social** needs on a scale of 1 – 10? | *I don't feel like this has really changed, but you could probably have more people around the central space now and it would feel less confined. I would say still an **8**.* |
| | 2.8N | Overall | How **spatially balanced** do you feel the spaces are overall? Is there anything unappealing about the proportions or arrangement of the spaces? On a scale 1 -10. | *Even though the spaces are more visually different with their ceiling heights, the high ceiling through the middle sort of connects them. They also feel more like separate spaces balancing rather than one balanced space. I like the contrast. So I would say still **8**.* |
| | | | | |

| Test – Materiality | Q# | Space | Question/Cue | Answer/Score |
|---|---|---|---|---|
| Baseline (B) | 3.0B | Overall | Describe your interpretation of the atmosphere or feeling of the house in a few words, e.g. cold/warm, inviting/uninviting, overwhelming/boring, homely/clinical, dull/bright. | *Cool (as in temperature), a bit bland or boring with mostly white surfaces. But relatively inviting, maybe a little too bright, and there's not much contrast. The form of the interior spaces is still appealing though.* |
| | 3.1B | Overall | Overall, how comfortable do you feel the spaces of the home are for concentrating in or spending a long period of time in? | *I wouldn't want to spend a whole lot of time here; it is too white and after time I think it would be overwhelming.* |
| | 3.2B | Overall | Do you find the material choices positively or negatively impact (or neither) your experience of the design | *The white sort of makes it feel brighter and larger, but also bland* |

| | | | | |
|---|---|---|---|---|
| | | | of the spaces? Did any areas or spaces stand out for their material choices for good or bad reasons? | *and not very homely, so probably negatively.* |
| | 3.3B | Overall | How pleasing do you find the material samples in front of you to touch? And does this help you to understand the materials in the model better? | *Neutral, they are fine to touch. It is very awkward to do while using the VR headset, but once I got there it was helpful. I think probably it would be better to see and touch the materials after the test.* |
| | 3.4B | Overall | Overall, how much do you think materiality is affecting your experience of the spaces? How? | *I would say a moderate to high amount. The form is one thing, but the materials are sort of how that form is presented. As in I like the design, but the materials overall make it seem more bland and less interesting as they're fairly uniform and white.* |
| | 3.5B | Overall | Paying special attention to the materiality of the spaces, and considering how you will be using the space; how **comforted** do you feel by the qualities and design of the overall home on a scale of 1 – 10? | *I think if anything the materials make the space a lot less comfortable than it could be. As I said before, I wouldn't want to spend a long time in the very bright white spaces. So still a* ***6.*** |
| | 3.6B | Overall | Paying special attention to the materiality of the spaces, and considering how you will be using the space; how **stimulated** do you feel by the qualities and design of the overall home on a scale of 1 – 10? | *In terms of the materials, they do not really do anything to make the place stimulating. Maybe they make it seem a little brighter and larger. I think still a* ***6.5****.* |
| | 3.7B | Overall | How **spatially balanced** do you feel the spaces are overall? Is there anything unappealing about the proportions or arrangement of the spaces? On a scale 1 -10. | *The whiteness of the space really makes it feel more connected. I don't feel like this has really changed. Still an* ***8****.* |
| | 3.8B | Overall | How well do you feel the spaces respond to your **privacy** needs on a scale of 1 – 10? | *I don't feel as though this has changed, an* ***8.5****. Apart from maybe when you're spending a long time in an all white bedroom.* |
| | 3.9B | Overall | How well do you feel the spaces respond to your **social** needs on a scale of 1 – 10? | *I don't feel like this has changed, still an* ***8****.* |
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| Iteration 1 (M) | 3.0M | Overall | Describe your interpretation of the atmosphere or feeling of the house in a few words, e.g. cold/warm, inviting/uninviting, overwhelming/boring, homely/clinical, dull/bright. | *Definitely warm, it has a nice ambience with the light on the timber. It is however very overwhelming, and I would say too many varieties of timber. It does feel more homely than before though.* |
| | 3.1M | Overall | Overall, how comfortable do you feel the spaces of the home are for concentrating in or spending a long period of time in? | *Not very comfortable, all the timber is overwhelming. It might be quite interesting to visit but not to live in. Particularly the living space, as it is more confined – is very overwhelming.* |
| | 3.2M | Overall | Do you find the material choices positively or negatively impact (or neither) your experience of the design of the spaces? Did any areas or spaces stand out for their material choices for good or bad reasons? | *Negatively and positively, but overall probably negatively. As I said, it feels warmer and more homely and inviting, but once you're in its very visually overwhelming and a bit stressful. The white ceilings are a nice contrast but not enough.* |

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| | 3.3M | Overall | How pleasing do you find the material samples in front of you to touch? And does this help you to understand the materials in the model better? | *The timber samples were nice to touch, but again the process itself while using the VR headset was awkward. It did help to understand the different timber finishes though.* |
| | 3.4M | Overall | Overall, how much do you think materiality is affecting your experience of the spaces? How? | *Significantly. It is impossible to ignore how much timber there is. The different patterns on the floor between the kitchen and workspace are too much. But the white ceilings are a nice contrast.* |
| | 3.5M | Overall | Paying special attention to the materiality of the spaces, and considering how you will be using the space; how **comforted** do you feel by the qualities and design of the overall home on a scale of 1 – 10? | *This is a hard one because some aspects of the timber are comforting, but the masses of it create the opposite effect. Overall, I would say that it makes it less comforting, so maybe a **5.5**.* |
| | 3.6M | Overall | Paying special attention to the materiality of the spaces, and considering how you will be using the space; how **stimulated** do you feel by the qualities and design of the overall home on a scale of 1 – 10? | *Well the space is definitely more visually interesting and captures the attention, but again it is too much. I feel overwhelmed or overstimulated, so maybe a **9**.* |
| | 3.7M | Overall | How **spatially balanced** do you feel the spaces are overall? Is there anything unappealing about the proportions or arrangement of the spaces? On a scale 1 -10. | *Overall most surfaces have remained pretty uniform with their materials so it hasn't really changed. But the different floor patterns in the kitchen and workspace make them less balanced, and the overall space feels smaller and darker – so down to a **7**.* |
| | 3.8M | Overall | How well do you feel the spaces respond to your **privacy** needs on a scale of 1 – 10? | *This hasn't really changed for me, **8.5**.* |
| | 3.9M | Overall | How well do you feel the spaces respond to your **social** needs on a scale of 1 – 10? | *This hasn't really changed for me, **8**.* |
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| Iteration 2 (N) | 3.0N | Overall | Describe your interpretation of the atmosphere or feeling of the house in a few words, e.g. cold/warm, inviting/uninviting, overwhelming/boring, homely/clinical, dull/bright. | *Much more inviting and balanced than the previous tests. It feels warm and bright.* |
| | 3.1N | Overall | Overall, how comfortable do you feel the spaces of the home are for concentrating in or spending a long period of time in? | *I feel like they would be suitable for spending long periods of time in now.* |
| | 3.2N | Overall | Do you find the material choices positively or negatively impact (or neither) your experience of the design of the spaces? Did any areas or spaces stand out for their material choices for good or bad reasons? | *Positively, the space reads as much more inviting, and more calming or comforting by far than the previous iterations. The use of white walls to balance the timber ones is very appealing, and makes spaces less overwhelming, particular in the living space and workspace.* |
| | 3.3N | Overall | How pleasing do you find the material samples in front of you to touch? And does this help you to understand the materials in the model better? | *I sort of got a feel for the timber ones before, but I prefer them to the baseline synthetic materials. The process itself is still awkward even with some practice.* |

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| | 3.4N | Overall | Overall, how much do you think materiality is affecting your experience of the spaces? How? | *Significantly. It highlights elements of the spatial design and makes the space much more interesting, without being overwhelming.* |
| | 3.5N | Overall | Paying special attention to the materiality of the spaces, and considering how you will be using the space; how **comforted** do you feel by the qualities and design of the overall home on a scale of 1 – 10? | *I really like this balance of materials, although some details could change for cabinetry etc. it is overall – very comforting. I would say it has gone up to an **8**.* |
| | 3.6N | Overall | Paying special attention to the materiality of the spaces, and considering how you will be using the space; how **stimulated** do you feel by the qualities and design of the overall home on a scale of 1 – 10? | *Retaining timber for the benches and some walls has created visual interest, and actually made them stand out more when beside or opposite white ceilings/walls. The space is less overwhelming, I would say it is down to a more enjoyable **8**.* |
| | 3.7N | Overall | How **spatially balanced** do you feel the spaces are overall? Is there anything unappealing about the proportions or arrangement of the spaces? On a scale 1 -10. | *Overall the use of white and timber walls adds another element to balance – colour and texture. It is less overwhelming than the last iteration, and less boring and uniform than the first. It has enhanced what already felt balanced so I would say an **8.5**.* |
| | 3.8N | Overall | How well do you feel the spaces respond to your **privacy** needs on a scale of 1 – 10? | *I don't feel as though this has changed, so **8.5**.* |
| | 3.9N | Overall | How well do you feel the spaces respond to your **social** needs on a scale of 1 – 10? | *I don't feel as though this has changed, so **8**.* |
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| Test – Connection to Nature & Natural Light | Q# | Space | Question/Cue | Answer/Score |
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| Baseline (B) | 4.0B | Workspace | Overall, how well do you feel the Workspace is illuminated by natural light throughout the day on a scale of 1 – 5 (1 being devoid of natural light and 5 being filled with natural light)? | *The workspace is pretty consistently well lit, but not super bright, and it doesn't get much direct sunlight.* ***3.5****.* |
| | 4.1B | Kitchen | Overall, how well do you feel the Kitchen space is illuminated by natural light throughout the day on a scale of 1 – 5 (1 being devoid of natural light and 5 being filled with natural light)? | *Similar to the workspace, but gets a little more direct sunlight.* ***4.*** |
| | 4.2B | Dining/Central | Overall, how well do you feel the Dining/Central Space is illuminated by natural light throughout the day on a scale of 1 – 5 (1 being devoid of natural light and 5 being filled with natural light)? | *The dining space doesn't get much light due to its window's orientation. It is a bit dim, but not dark* ***2.5.*** |
| | 4.3B | Living | Overall, how well do you feel the Living Space is illuminated by natural light throughout the day on a scale of 1 – 5 (1 being devoid of natural light and 5 being filled with natural light)? | *The living space is a bit darker with its lower ceiling and smaller windows, but not super dark. It gets little direct light apart from in the evening. Being a bit dimmer in this space is okay* ***3.*** |
| | 4.4B | Bedroom 1 | Overall, how well do you feel Bedroom 1 is illuminated by natural light throughout the day on a scale of 1 – 5 (1 being devoid of natural light and 5 being filled with natural light)? | *Bedroom 1 is well lit with natural light throughout the day except for in the evenings when it gets a bit dark* ***3.5.*** |
| | 4.5B | Workspace | How would you rate the views outside of the Workspace from key windows We.01 and We.06 in terms of their ability to 'connect' the interior to outside nature on a scale of 1 – 5? | *We.01 offers a nice outlook up the hill towards the sun, but the driveway isn't that appealing. You cannot see much out of We.06.* ***2.*** |
| | 4.6B | Kitchen | How would you rate the views outside of the Kitchen Space from key opening We.02 in terms of their ability to 'connect' the interior to outside nature on a scale of 1 – 5? | *There are great views out of We.02 towards the harbour, the view is a bit narrow and the exterior of the house seen is not that appealing.* ***3.5.*** |
| | 4.7B | Dining | How would you rate the views outside of the Dining Space from key window We.05 in terms of their ability to 'connect' the interior to outside nature on a scale of 1 – 5? | *While the position of We.05 is great for the dining space, the outlook due to topography is just a retaining wall and fairly unappealing* ***1.5.*** |
| | 4.8B | Living | How would you rate the views outside of the Living Space from key window We.04 in terms of their ability to 'connect' the interior to outside nature on a scale of 1 – 5? | *The outlook is quite nice across the hill and down the valley, depending on where you are, but the window is very small. It is also cool to see from the other end of the workspace. Currently,* ***2.*** |
| | 4.9B | Bedroom 1 | How would you rate the views outside of Bedroom 1 from key window We.03 in terms of their ability to 'connect' the interior to outside nature on a scale of 1 – 5? | *We.03 has a pleasing outlook similar to the living space. The window is a bit larger and the view nicer, but there is a neighbouring house that may ruin this in reality.* ***2.5.*** |
| | 4.91B | Overall | Overall, how much do you think the outside environment and/or nature is affecting your experience of the interior spaces in this test? | *A moderate/small amount, at the moment it feels like the focus is mainly on the interior. But I generally like the window placement.* |
| | 4.92B | Overall | Paying special attention to the natural lighting of spaces and their connection through openings with the exterior | *I don't feel like this has changed.* ***8.*** |

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| | | | and surrounding nature; how **comforted** do you feel by the qualities and design of the overall home on a scale of 1 – 10? | |
| | 4.93B | Overall | Paying special attention to the natural lighting of spaces and their connection through openings with the exterior and surrounding nature; how **stimulated** do you feel by the qualities and design of the overall home on a scale of 1 – 10? | *I don't feel like this has changed.* ***8.*** |
| | 4.94B | Overall | How **spatially balanced** do you feel the spaces are overall? Is there anything unappealing about the proportions or arrangement of the spaces? On a scale 1 -10. | *I don't feel like this has changed.* ***8.5*** |
| | 4.95B | Overall | Paying attention to existing conditions, as well as opening to the exterior; how well do you feel the spaces respond to your **privacy** needs on a scale of 1 – 10? | *I don't feel like this has changed.* ***8.5*** *But this depends on the neighbouring houses' view into Bedroom 1.* |
| | 4.96B | Overall | How well do you feel the spaces respond to your **social** needs on a scale of 1 – 10? | *I don't feel like this has changed.* ***8.*** |
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| Iteration 1 (M) | 4.0M | Workspace | How would you rate the views outside of the Workspace from key windows We.01 and We.06 in terms of their ability to 'connect' the interior to outside nature on a scale of 1 – 5? | *The larger windows and the planting of trees have improved the views from this space and make it feel more connected to the outside,* ***3.*** |
| | 4.1M | Kitchen | How would you rate the views outside of the Kitchen Space from key opening We.02 in terms of their ability to 'connect' the interior to outside nature on a scale of 1 – 5? | *I don't feel as though this has changed much, despite there being more windows, it is not very balanced and the view isn't much better. Extending the deck and adding the planters slightly improved the view maybe, or obscured it more.* ***3.5.*** |
| | 4.2M | Dining | How would you rate the views outside of the Dining Space from key window We.05 in terms of their ability to 'connect' the interior to outside nature on a scale of 1 – 5? | *Significantly better with the larger window and increased views outside, also the plantings on the hill improve the connection.* ***4.*** |
| | 4.3M | Living | How would you rate the views outside of the Living Space from key window We.04 in terms of their ability to 'connect' the interior to outside nature on a scale of 1 – 5? | *The window is larger and fits the space better but the outlook is pretty much the same.* ***2.*** |
| | 4.4M | Bedroom 1 | How would you rate the views outside of Bedroom 1 from key window We.03 in terms of their ability to 'connect' the interior to outside nature on a scale of 1 – 5? | *The window is larger and fits the space better but the outlook is pretty much the same.* ***2.5*** |
| | 4.5M | Overall | Overall, how much do you think the outside environment and/or nature is affecting your experience of the interior spaces in this test? | *More than before, with the very large window in the dining space it feels more connected, same with We.01.* |
| | 4.6M | Overall | Paying special attention to the natural lighting of spaces and their connection through openings with the exterior and surrounding nature; how **comforted** do you feel by the qualities | *With the better views and outlook from We.01 and We.06 I feel like the space is more comfortable than before.* ***8.5.*** |

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| | | | and design of the overall home on a scale of 1 – 10? | |
| | 4.7M | Overall | Paying special attention to the natural lighting of spaces and their connection through openings with the exterior and surrounding nature; how **stimulated** do you feel by the qualities and design of the overall home on a scale of 1 – 10? | *With the better views and outlook from We.01 and We.06 I feel like the space is more stimulating and interesting than before.* ***8.5.*** |
| | 4.8M | Overall | How **spatially balanced** do you feel the spaces are overall? Is there anything unappealing about the proportions or arrangement of the spaces? On a scale 1 -10. | *With the dining window filling that wall more, the space feels maybe a little more balanced but largely the same. The lighting carries more evenly which is nice.* ***8.5.*** |
| | 4.9M | Overall | Paying attention to existing conditions, as well as opening to the exterior; how well do you feel the spaces respond to your **privacy** needs on a scale of 1 – 10? | *None of the changes seem to effect privacy* ***8.5.*** |
| | 4.91M | Overall | How well do you feel the spaces respond to your **social** needs on a scale of 1 – 10? | *The increased views into the dining space make it more interesting, same with the workspace, but largely this feels the same.* ***8.*** |
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| Iteration 2 (N) | 4.0N | Workspace | Overall, how well do you feel the Workspace is illuminated by natural light throughout the day on a scale of 1 – 5 (1 being devoid of natural light and 5 being filled with natural light)? | *Very well throughout, brighter than before.* ***4.5.*** |
| | 4.1N | Kitchen | Overall, how well do you feel the Kitchen space is illuminated by natural light throughout the day on a scale of 1 – 5 (1 being devoid of natural light and 5 being filled with natural light)? | *Pretty good, seems the same as before, maybe a little brighter with ambient light.* ***4.*** |
| | 4.2N | Dining/Central | Overall, how well do you feel the Dining/Central Space is illuminated by natural light throughout the day on a scale of 1 – 5 (1 being devoid of natural light and 5 being filled with natural light)? | *Significantly better with the new window design and skylight addition.* ***5.*** |
| | 4.3N | Living | Overall, how well do you feel the Living Space is illuminated by natural light throughout the day on a scale of 1 – 5 (1 being devoid of natural light and 5 being filled with natural light)? | *Definitely more natural light than before with the new dining window and skylight, but still a bit dimmer than the other spaces – which is fine.* ***3.5.*** |
| | 4.4N | Bedroom 1 | Overall, how well do you feel Bedroom 1 is illuminated by natural light throughout the day on a scale of 1 – 5 (1 being devoid of natural light and 5 being filled with natural light)? | *Very similar to the previous test, but a bit more ambient natural light in the evenings from the internal windows.* ***4.*** |
| | 4.5N | Workspace | How would you rate the views outside of the Workspace from key windows We.01 and We.06 in terms of their ability to 'connect' the interior to outside nature on a scale of 1 – 5? | *I really prefer the new We.06 placement and size, and the exterior site work has improved views a lot, with the terraced section.* ***4.*** |
| | 4.6N | Kitchen | How would you rate the views outside of the Kitchen Space from key opening We.02 in terms of their ability to 'connect' the interior to outside nature on a scale of 1 – 5? | *The deck changes and planter wall are nice but this feels largely the same.* ***3.5.*** |
| | 4.7N | Dining | How would you rate the views outside of the Dining Space from key window | *Similar to the last test, but with the new landscaping more nature can be* |

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| | | | We.05 in terms of their ability to 'connect' the interior to outside nature on a scale of 1 – 5? | *seen, and the view is more pleasing.* ***4.5.*** |
| | 4.8N | Living | How would you rate the views outside of the Living Space from key window We.04 in terms of their ability to 'connect' the interior to outside nature on a scale of 1 – 5? | *Same outlook as before, except for plantings to obscure the neighbouring house which is nicer.* ***2.5.*** |
| | 4.9N | Bedroom 1 | How would you rate the views outside of Bedroom 1 from key window We.03 in terms of their ability to 'connect' the interior to outside nature on a scale of 1 – 5? | *Same outlook as before, except for plantings to obscure the neighbouring house which is nicer.* ***3.*** |
| | 4.91N | Overall | Overall, how much do you think the outside environment and/or nature is affecting your experience of the interior spaces in this test? | *Significantly, nature is much more viewable from most areas if not all areas of the home now. Which creates a more comfortable atmosphere and more visual interest.* |
| | 4.92N | Overall | Paying special attention to the natural lighting of spaces and their connection through openings with the exterior and surrounding nature; how **comforted** do you feel by the qualities and design of the overall home on a scale of 1 – 10? | *The connection to nature from most areas through views, and the masses of natural light in the key areas have made it more comfortable.* ***9.*** |
| | 4.93N | Overall | Paying special attention to the natural lighting of spaces and their connection through openings with the exterior and surrounding nature; how **stimulated** do you feel by the qualities and design of the overall home on a scale of 1 – 10? | *The connection to nature from most areas through views, and the masses of natural light in the key areas have made it more stimulating. Views and changing lighting conditions enhance the space.* ***9.*** |
| | 4.94N | Overall | How **spatially balanced** do you feel the spaces are overall? Is there anything unappealing about the proportions or arrangement of the spaces? On a scale 1 -10. | *I don't feel as though this has changed.* ***8.5.*** |
| | 4.95N | Overall | Paying attention to existing conditions, as well as opening to the exterior; how well do you feel the spaces respond to your **privacy** needs on a scale of 1 – 10? | *I don't feel as though this has changed.* ***8.5.*** |
| | 4.96N | Overall | How well do you feel the spaces respond to your **social** needs on a scale of 1 – 10? | I feel as though with the massive increase in natural light in the central area, and the views offered around the key social areas, that it would be more comfortable for larger groups, and make most social engagements more comfortable. **8.5.** |

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