REGENERATIONAL RESIDENCE

BY

BENJAMIN MACKIE

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ABSTRACT

New Zealand has an ageing population whose dwelling options for retirement are largely inappropriate. Retirement homes and villages are increasing throughout the country yet these often cause a decline in functional ability. Accordingly, demands on public healthcare have increased, necessitating a shift in recommendations towards homecare and ‘ageing in place.’ Ideally, aged-care should take place within extended families, yet this requires specific accommodation. Historically, standalone housing such as ‘granny flats’ or moving in with the extended family has been the solution. However, these have drawbacks such as inefficiency and distance from the wider community. There remains potential for a denser, economic housing solution within walking distance to local amenities. There is also a growing interest in developing medium-density housing (MDH) in New Zealand. However, this typology has shortfalls when it comes to multigenerational families such as small living rooms and limited outdoor areas. Further, the multi-storey nature of MDH promotes stairs, being particularly restrictive for ageing residents. Is it possible for MDH to be designed to accommodate ageing in place effectively within New Zealand?

The needs associated with ageing are important to consider for long-term living. For effective aged-care, the literature advocates designing for both health improvements and accommodating dysfunctions. These two needs are addressed

respectively in architecture through regenerative and intergenerational design. A personal and relational lens further investigates both of these terms. Regenerative elements involve personal wellness and relational reciprocity, whereas intergenerational elements include personal autonomy and relational interconnectivity. For each of these elements, the design methods draw qualitatively from existing precedents, indicating potential generators to inform an iterative, site-specific model. A suitable site and program provide relative design parameters. The chosen context is Nelson because the ageing population is straining healthcare while there is also significant potential for MDH. The generators and parameters drove the preliminary design process, ultimately integrating these drivers within a developed design proposal. This exegesis proposes that MDH can effectively accommodate ageing in place by overlapping such drivers through iterative modelling to create specific design principles.

PREFACE

I grew up in Nelson with my family in the suburb of Tahunanui. My grandma, Audrey Mackie, moved in with us for five years during which time I developed a deep appreciation of her intergenerational fellowship (see fig. 0.1). Nevertheless, there were various difficulties exacerbated by the built environment that conflated this experience. On the other hand, accommodating ageing from the outset mitigates such issues. I believe that the built environment should empower people rather than be simply neutral or disadvantaging them. Alongside this, the limitations prevalent for ageing in place within MDH stirred my interest in the growing demand for these developments.

Fig. 0.1 Grandma Audrey Mackie with Benjamin Mackie.

“Hope is a passion for the possible”

Søren Kierkegaard

DEDICATION

I dedicate this project to my grandparents for their cooperation and perseverance during their older years, despite the limitations increasingly evident in existing provisions for ageing in place.

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I want to acknowledge the incredible support I’ve received throughout these past five years of study.

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Those in the university workshop, particularly Graham and Phil, have gone out of their way to assist multiple times. The team at XLAM in Nelson provided several of us with a tour, helping us understand their product better. The building manager at the new Nelson Airport Terminal provided a colleague and me with a tour during construction, highlighting leading technologies.

My family have been supportive in a variety of ways. Aileen and Cheryl constantly encouraged me to pursue tertiary education. My cousin Jaime and Phill, along with Aunty Heather have gone above and beyond to make the transition to a new city easier. I would like to especially thank my parents, Ray and Heather, who have been particularly supportive both financially and physically. Also, I would thank my grandma, Audrey, for her readiness to visit and interconnect with our family over the years.

I want to honour my Lord and Saviour Jesus Christ for the peace he has provided me throughout this period of study, and for his foundational call to love our neighbours as ourselves: to seek personal and relational beneficial opportunities. I would also like to thank the team at ALC and NMIT who have helped make the dream of studying architecture a reality. Furthermore, my church family in Wellington and Nelson, especially Chris, have been inspirational and supportive through insights and prayer during this time.

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Fig. 1.1. Regenerational Residence Sketch, Image by Author.

1. INTRODUCTION

This chapter sets the scene by deriving a problem statement from background research. This statement is then developed into specific goals. Next, the project is outlined further by the methodological framework. Finally, the scope of the exegesis will be discussed alongside the chapter structure.

PROBLEM STATEMENT

In New Zealand, designing for ageing is not being effectively considered within our current built environment. The national ageing population (65+ years) is expected to reach 20% by 2025 and 25% by 2050 (see fig. 1.2, 1.3)(Stats NZ, *Population*, 8). The Ministry of Health (MOH) has cautioned a related increase in long-term health conditions, especially for those over 75: “We are living longer, but the age to which we are likely to live in good health and without disability is not increasing at the same rate as life expectancy” (11). In other words, older people will experience ill health for a longer period of time as well as reduced functional ability (11, 34). Accordingly, these factors produce a growing demand for support and healthcare. This demand is particularly evident in districts with higher proportions of people over 75, where hospitals are beginning to exceed capacity (NMDHB 7).

Retirement villages and rest homes appear to be solutions for providing support; however, these become burdensome due to ongoing expense while unfortunately speeding up functional decline (NMDHB 67). Rather, ‘ageing in place’ is advocated as an ideal solution to reduce the demand on healthcare, although varying levels of support are generally still required (67). Therefore, the MOH suggests improving the ability of families and communities to support and help care for older people (14). Extended family dwellings with granny flats initially seem

particularly appropriate for accommodating such situations. However, BRANZ researchers have noted that there is insufficient attention given to multigenerational families in the NZ housing market (Lysnar et al. 23). Moreover, the building market is shifting towards medium-density housing (MDH) developments (see fig. 1.4) with BRANZ expecting an increase to 35% of the market by 2025 (Page 13). This shift in focus improves the potential for walkability and efficiency in extended family situations but restricts the potential of flexibility. To reiterate, NZ has an ageing population recommended to age in existing homes with care ideally provided by the extended family, whereas the housing market undervalues this while increasingly focusing on MDH. These factors drive the research question: how can MDH effectively accommodate ageing in place within New Zealand?

HOW CAN
MEDIUM-DENSITY
HOUSING
EFFECTIVELY
ACCOMMODATE
AGEING IN PLACE
WITHIN
NEW ZEALAND?

Fig. 1.2. Ageing Population Until 2050, Image by Author.

Fig. 1.3. Ageing Population Until 2025, Image by Author.

Fig. 1.4. Medium-Density Housing.

The topic of ageing is more relevant to certain parts of the country. The ageing statistics previously showed highlight the national average, yet the population ratio is estimated to be higher than 20% currently in the districts of Northland, Bay of Plenty, Whanganui, Wairarapa, Nelson Marlborough and South Canterbury (Stats NZ, *Subnational*). Particular cities are increasingly developing retirement villages, especially Auckland, Wellington, Christchurch, Hamilton, Nelson and Palmerston North (JLL 21). However, such villages usually do not provide aged care, meaning that their residents often require long-term stays in hospitals. These long-term stays can overwhelm healthcare, as multiple hospitals throughout the country have approached capacity within the past two years (Stuff). Meanwhile, there is a housing shortage in many areas, provoking both further sprawl and higher density projects such as MDH. An important concern regarding MDH for ageing residents

is decreasing neighbourhood satisfaction, yet proximity to urban amenities can improve this (Yang 318). Another concern is the difficulty of navigating steps (Holland and Peace 240). The higher range of MDH requires more stairs and makes elevators economically viable, whereas the lower range lessens their necessity, being more appropriate for smaller cities or near suburban town centres. These distinct issues evaluate the need for alternative housing for specific parts of NZ.

The built environment limits the effectiveness of ageing in place in numerous ways. The MOH has highlighted a variety of environmental disadvantages for ageing residents, many of which are related to architecture. Of the more relevant problems, NZ's housing stock lacks quality, often worsening health (23). Older people lack opportunities to participate, causing burdensome connotations (12, 38). Physical barriers

Fig. 1.5. The contrast of MDH and Ageing Until 2025, Image by Author.

are another concern, restricting functional ability (12). Further, the limited capacity in dwellings to appropriately care for older people hinders familial support (14). Rather, NZ aspires towards an environment where older people are healthy, independent, respected and connected (Govt 5). One way to respond to these issues is through innovative housing (MOH 23). If future MDH projects accommodate effective ageing in place, they carry the potential to revitalise living arrangements for older people and positive associations with them. By 2025, NZ's ageing population is expected to intensify by 5%, while developments of MDH are expected to rise by 10% (see fig. 1.5). These factors suggest that our future developments can keep up with the demand if designing for effective ageing in place is considered at the outset.

Specific goals are important to achieve appropriate accommodation for ageing in place (see fig. 1.6). The overall aim is to indicate practical design principles that serve to improve housing developments for ageing in place. Several objectives based on observations by the MOH can accomplish this aim: to prevent or delay disease, to mitigate burdensome connotations, to reduce functional decline and to augment familial support. These objectives require background research and built examples to complement these ideas. These ideas are then outworked within an integrative design proposal, requiring a relevant context and specific program.

These objectives provide a framework for design enhancements. Related diseases can be prevented or delayed by improvements for physical health, such as stimulation from nature, simultaneously decreasing hospitalisation (Song et al. 13). Integrating potential for contributions and reducing ongoing costs diminish burdensome feelings (Durrett 35). Empowering people to be as independent and active as possible resists functional decline, with intensified dwellings providing a more walkable community (Gill et al. 1072). Close familial support is important, yet definable privacy between generations further serves to lessen tensions (Lysnar et al. 44-5). Such enhanced MDH within proximity to local amenities could improve living for ageing residents.

Several key reasons point to the suitability of the context of Nelson. By 2028, ageing residents are expected to represent 27% of the population and 33% by 2043, significantly higher than the national average (Stats NZ). Unfortunately, there has been a related focus on developing more retirement homes and villages in the region, seeing one of the highest percentage increases in NZ in 2017 (JLL 19). Another issue is that Nelson’s public hospital has been approaching capacity since 2015, attributed to an increase in older patients (NMDHB 48). This pressure indicates wider implications from undervaluing aged-care dwellings. Further, there is a growing need for MDH, as Nelson City Council has noted that this is still at the lower range of its density definition (NUGS 8). In light of these concerns, Nelson requires a better solution to ageing in place through MDH.

A program is important to indicate more precise design aspects: exploring occupancy issues and technical provisions. Occupancy issues focus on the appropriate scale of MDH, demographics and community needs. Technical provisions consider national regulations and local requirements and additional literature for enhancing the project. This program provides specific parameters for informing the design response.

DESIGN PRINCIPLES FOR AGEING IN PLACE

Fig. 1.6. Aim and Objectives Diagram, Image by Author.

The aim and objectives prescribe an explicit framework for this project, focused further by a context and program. This framework requires a justification of design methods to facilitate the desired outcomes. Moreover, background research and built examples also need clarification.

The overarching framework for this exegesis, based on the course of study and goals, is ‘research through design’, or ‘design-led research’. According to Hanington and Martin, there are two common approaches to ‘research through design’ within the wider design discipline: ‘interaction design’ and ‘design as research’ (146). To distinguish these, design as research is “the act and material of design as the means of investigation” that generates new information through iterative craft, rather than from interactions such as interviewing or observational studies (Burdick 81). There is an abundance of interactive information already available on ageing in place and MDH. Further, older people will not necessarily know about available alternatives in the housing market (Holland and Peace 254). These factors suggest interaction design is less appropriate to address the goals. On the other hand, investigative modelling is particularly suited for advancing design principles, prioritising design as research. Design as research requires existing data that has been collected and synthesized to inform the process of making. This synthesised data is called secondary research, in contrast with primary research with participants that produces original material (Hanington and Martin 154). Secondary research includes tactics such as literature sources and project examples (precedents), leading to design generators for the iterative modelling process. Wang and Groat have categorised these tactics as noninteractive

engagement factors within the wider qualitative strategy (244). Qualitative research can take in holistic qualities of real-life circumstances and is flexible, allowing adjustments as the research proceeds (Wang and Groat 258). This strategy indicates particular relevance in creating practical solutions to the research question. Subsequently, precedent research as an extension of the theoretical literature base increases the potential for the design process to result in realistic principles (see fig. 1.7).

A review of the literature highlights four elements of importance and an initial modelling typology. Ageing theorists form the foundation of theoretical research under environmental gerontology. This foundation features pioneer and current researchers such as Dr Mortimer Lawton and Dr Andrew Scharlach. The theory is then combined with post-occupation studies conducted by the architect Jeffrey Anderzohn. The combination indicates the relevance of regenerative and intergenerational research, in architectural terms. Two eminent regenerative experts are the architectural consultants Robin Guenther and Gail Vittori, whereas two noteworthy intergenerational theorists are the scholars Prof. Sheila Peace and Dr Caroline Holland. This review features three approaches to research, resulting in multigenerational cohousing as an initial typology alongside four elements for allocating precedents. These elements are personal health (wellness),

Fig. 1.7. Method Diagram, Image by Author.

relational health (reciprocity), personal disabilities (autonomy) and relational disabilities (interconnectivity).

Each of the four elements requires a relatable precedent for design inspiration and practical solutions. The optimal known precedents are European based: The REHAB Centre in Switzerland, East Whins Ecovillage in Scotland, 8 House in Denmark, and Mischen Possible (56 Oderberger Str.) in Germany. Various observations from these examples serve to highlight specific contributory factors for enhancing aged-care while increasing density. Integration between these precedents then informs the iterative process towards the final design proposal.

The main focus is to create MDH enhanced for ageing in place within walking distance to a city centre. One important limiting factor is that ageing residents are more likely to experience disabilities, particularly mobility impairments, making stairs troublesome to navigate. These concerns prioritise accessibility alongside proximity to local amenities.

Various factors are beyond the scope of this exegesis. Primary research methods such as interviews or surveys are unnecessary due to the research already available, although future feedback on this project may be useful. Designing on multiple sites is not prioritised, due to the site-specific nature of the project. This limitation was also due to the emphasis on advancing the integration of design principles. A collection of relevant precedents informed the four selected, resulting in European projects; however, it is plausible that further inspiration from countries that prioritise extended family living, such as China, could prove valuable.

The focus is less directed towards short-term construction costs due to the long-term nature of the project. The proposal prioritises the integration of relevant design principles rather than providing an immediate cheap solution. Ultimately, consideration of costs is important but not emphasised.

This project focuses on the ageing population

as a current issue, although in 70 years this may no longer be the case or perhaps the projections will be wrong. Nevertheless, it seems reasonable that dwellings designed accordingly could be further utilised in other manners: such as for accessibility within the wider population or being hireable to temporary students.

The structure of this exegesis begins with a literature review to clarify approaches and indicate the research basis, necessitating precedents. Next, the project review summarises the precedents and derives useful design generators. These two chapters inform the site analysis, which together contribute to the program. These generators and parameters are combined within an iterative process of preliminary design, culminating in a final developed design and indicating some useful findings. The conclusion summarises the process, critiques the outcome and provides suggestions for future research.

2. LITERATURE REVIEW

A review of the literature for effective ageing within the built environment highlights particular theorists as a suitable response to the research question and goals. These theorists inspire two complementary approaches, while a third approach represents the scale and typology. These approaches include combining theory with practice, distinguishing personal emphases with relational, and specifying a typology within MDH. This research motivates further literature sources while considering the particular context. The outcomes required built examples for assimilation into the design

process. This review indicates opportunities for the design, evidenced by a framework of four elements and an initial typology for modelling.

Certain theorists believe aged-care requires more effective design considerations. In the 1970s, Dr Mortimer Lawton, a leading researcher on the physical and psychological needs of the elderly, pioneered the term ‘environmental gerontology’ as a means of designing for ageing residents. He claimed that an effective focus is worthwhile, particularly for strained communities: “...the payoff for effective environmental intervention is very high for older people in poor mental or physical health (259).” Two contemporary gerontology professors, Graham Rowles and Miriam Bernard, explain that the older people get, the more likely they are to experience physical and psychological limitations, requiring support or environmental modifications to maintain quality of life (290). In other words, built environments should be optimised to support ageing. Three different approaches explore and advance this idea (see fig. 2.1).

The first research approach involved finding an overlap between theory and practice. Lawton proposed the following: “Attention to the design of health-engendering environments may either significantly raise the functional competence of the individual or elevate his functioning without altering his basic competence (257).” In other words, a project should not only stimulate health but also compensate for dysfunction. In 2007, this idea was also observed in practice by Jeffrey Anderzhon, a senior planner and design architect, who has compiled post-occupancy

evaluations on a variety of contemporary aged-care facilities. He summarises: “Effective residential aged-care environments must be both therapeutic, promoting resident improvement, and prosthetic, compensating for physical or cognitive dysfunction (xiii).” This combination of theory and practice provides a fundamental research approach while remaining too broad on its own.

A second approach complementing the previous one involves distinguishing between personal and relational factors. Lawton’s work has been explored more recently by Dr Andrew Scharlach, the Professor of the Graduate School at Berkeley University. Scharlach’s research focuses on innovations for healthy ageing. In 2017, he emphasised an individual and a social lens to extend conceptualisations of healthy ageing: “[The intention is to stimulate] additional theory building... through which aging-friendly communities might promote individual and community well-being (614).” He further notes that such approaches are “...essential for the creation of effective aging-friendly community change strategies designed to promote constructive personal-environmental processes as individuals and their communities change over time (614).” This recommendation supports the notion that a personal and relational approach further enhances the theoretical and practical approach toward a more effective development.

Fig. 2.1. Three Research Approaches, Image by Author.

The relationship of these first two approaches to ‘therapeutic’ and ‘prosthetic’ ideas encouraged further analysis of these topics within architectural research. Therapy corresponds to sustainability and biophilia: notably focusing on advancing wellbeing, also known as regenerative design. Prosthesis correlates with social and inclusive design and particularly considers ageing within intergenerational design. These architectural terms, regenerative and intergenerational, together form the ‘regenerational’ title (see fig. 2.2). Personal and relational aspects further partition these two terms, narrowing the research scope through the second approach (see fig. 2.3).

Regarding therapy, two experts in sustainability and healthcare, Guenther and Vittori, have co-authored on how to further holistic ‘regenerative’ care via architecture. They observe: “In

an era of chronic disease, the global health-care industry is shifting its focus from treating disease to creating the conditions for healthy people and communities (412).” They note, “Globally, the green building movement is evolving... toward ‘restorative and regenerative’ buildings designed with inherent capability to become net resource producers. This translates to moving beyond doing ‘no harm’ to a built environment that ‘heals...’” (400). They highlight numerous healthcare projects focused on creating a therapeutic environment. Viewing these environments through a personal and relational lens indicates the importance of individual health and the well-being of others. These correspond with two key objectives, to delay disease and mitigate burdensome connotations. Accordingly, the personal element is labelled wellness, while the relational element is named reciprocity.

Fig. 2.2. Exegesis Title Development, Image by Author.

Concerning prosthesis, two senior architectural academics from the UK, Holland and Peace, have co-authored on creating inclusive dwellings for ‘intergenerational’ ageing. They write “One of the challenges... is to create living environments that enable people to achieve the balance between independence and interdependence which suits them best” (246). They mention how support from others is important but ageing people should maintain as much autonomy as possible (235). Also, steps and heavy doors can worsen impairments and “barrier-free design and flexibility” is much easier to accommodate earlier in the process (240). Suitable living environments entail personal and relational aspects, respectively indicated by one’s disabilities and the ability of others to help when needed. These emphases further correlate with two objectives to reduce functional decline and augment familial support. As a result, the

personal element is named autonomy while the relational element is called interconnectivity.

A third approach prioritises a suitable scale and typology for the development. The importance and relevance of medium-density housing (MDH) require further clarification. Bryson and Allen, two BRANZ researchers, have carried out a variety of research projects on MDH concerning the New Zealand context, defining it as multi-unit dwellings up to six storeys (Bryson and Allen). Generally, the minimum number of units for an MDH project is four, with the maximum height further restricted by the immediate context (6). For an idea of the range, the number of dwellings can be anywhere from 15 to upwards of 60 dwellings per hectare (8). A building typology showing a combination of this scale with aged-care research is advantageous for an initial model. A trending typology

Fig. 2.3. Graph of Elements, Image by Author.

in Europe, known as cohousing, closely resembles the direction of this project in regenerative and intergenerational aspects, as well as scale. Charles Durrett has observed the initial inspirations of cohousing and noted: “To counter the view that seniors are merely old, frail people who are mostly a burden to the state, this [initial] group advocated that seniors are productive, valuable members of society and helped imagine and devise ways to keep them productive and connected (35).” From these ideas, this typology features: “housing that combines the autonomy of private dwellings with the advantages of community living. Each household has a private residence, but also shares extensive common facilities with the larger group (11).” This analysis indicates the importance and attractiveness of this typology, which could be enhanced further for ageing in place and relation to context.

The first project - representing personal wellness - is a rehabilitation centre in Switzerland (see fig. 3.1). Guenther and Vittori regard REHAB Basel as the “most important healthcare building of the 21st century to date” and an “effective environment for the rehabilitation of patients” (285). Herzog & de Meuron designed the building, which was completed in 2002 and currently accommodates patients with brain or spinal injuries. These patients inherently require long-term stays - up to 18 months - therefore promoting faster recovery enables them to help more people. The architects aimed to avoid the feeling of a hospital, with their primary approach being to connect the indoors with natural outdoor areas. Indeed, a growing amount of research is linking such natural stimulation to improved health (Song et al. 13; Ulrich 56). Conversely, there is a substantial body of evidence that the absence of natural connections enhances negative effects (Grinde and Patil 2339). Thus, connections to nature are of paramount importance.

This REHAB centre provides connections to nature in a variety of ways. Natural daylight has been enhanced through a narrow floorplate (via internal courtyards), full-height glazing, white walls and spherical skylights. Various plants fill most of the courtyards and surroundings and cover the roof, immersing the building into nature. The full-height glazing also allows for cross ventilation, providing fresh air when

desired. The horizontal panels are concrete, yet timber panelling covers these within the bedrooms, providing a warmer, tactile, natural association. A swimming pool provides additional therapeutic natural benefits for recovery. These aspects indicate specific design generators for modelling.

Some problems that this project is addressing are less appropriate for design integration. The layout is too communal in general with only private bedrooms and bathrooms. The bedrooms lack kitchen facilities and are on the first floor. The main circulation to these uses stairs, restricting spinal patients to use the elevator. The next three precedents highlight some comparable issues and solutions.

To summarise, this rehabilitation project helps to prevent or delay disease through connections to nature. Numerous practical methods display the integration of natural light, plants, fresh air, timber materiality and bathing (see fig. 3.2). These methods outline a variety of design generators: advancing personal wellness to inform the iterative modelling process.

Fig. 3.1. REHAB Basel: Internal Courtyard.

Fig. 3.2. REHAB Basel Overview: Wellness, Image by Author.

and relational aspects of cohousing. The previous research has identified that the most important aspects of cohousing are:

and are locally sourced, further benefitting the community. This variety of aspects form notable generators for the design process.

This project appears to be an appropriate response to the original research question: however, some concerns are different. The development is distant from local amenities, segregating older people from the wider community. Accordingly, there is less need for ground floor access, privacy, public interaction or commercial viability. The units are not flexible for varied use, although additional guest units are available. Accessibility is provided in some dwellings, although the 2-bedroom units, despite being more appropriate for older people, these aspects mostly relate to the design of other precedents will address

medium-density cohousing can avoid the burdensome connotations of high-density passive technologies, local green spaces and training spaces. It provides opportunities to give back, and to share skills (see fig. 3.4). The project is subject to the ideas present in the research, and the design is inspired by the research.

Fig. 3.3. East Whins Ecovillage: Training Space and Dwellings.

Fig. 3.4. East Whins Ecovillage Section: Reciprocity, Image by Author.

The third project – representing personal autonomy – is a massive mixed-use development in Denmark. 8 House is significant due to its unique access that enhances vertical inclusivity: indicating more significance than other low-density precedents that emphasise autonomy. Bjarke Ingels Group (BIG) designed the building, which was completed in 2010. Ingels has stated that the goal was to build a “three-dimensional community even though the building is in the middle of nowhere” (Gonchar). The team approached the project inclusively to provide accommodation for a variety of people. The unique way this project addresses autonomy within high-density dwellings serves as a useful example for design integration.

The inclusive approach of 8 House integrates several measures of independence particularly helpful for ageing residents. A large ramp that winds around the building allows those living on these levels to access their dwellings without stairs (see fig. 3.5, 3.6). Rather than simply providing an elevator, the ramp provides many of the residents with an opportunity for individual competence and exercise. Sliding doors have also been used in many of the dwellings to take advantage of the limited space. These doors are easier to use for those in wheelchairs. Shower units are prioritised throughout as these are smaller and more accessible than baths, requiring less mobility and risk during use. Elevators

allow a backup option for accessibility. Another opportunity for inclusivity is the provision of hireable function rooms throughout the building. These aspects indicate key generators for integration within the modelling process.

Some problems that this project is addressing that are inappropriate are worth noting. The scale of the project is higher than the intended scale of MDH; accordingly, the ramp is more difficult to integrate. 8 House is also beyond walking distance to town, making it less attractive for older people. However, the development mitigates this concern by accommodating various amenities on the ground floor. The dwellings vary in size; however, the units are not adaptable, unable to be connected. The remaining precedent will address these last two issues.

To summarise, this project can help mitigate functional decline. An integrated ramp, sliding doors, shower units and backup elevators enhance accessibility in different ways. This accessibility is accomplished within limited space, particularly suited for increasing density. This project furthers the potential for personal autonomy within the iterative design process.

Fig. 3.5. 8 House: Ramp Access.

Fig. 3.6. 8 House Overview: Autonomy, Image by Author.

The final project – representing relational interconnectivity – is a high-density, mixed-use building in Germany. Mischen Possible (“Mix Possible”, Oderberger Str. 56), near the fallen Berlin Wall, is important due to its flexibility within a limited site. BARarchitekten designed the building, and it was completed in 2010, aiming to provide internal variability amid restrictive surroundings. Their approach focused on flexible interconnections for differing relationships: the family, the workplace, neighbours and the community. This precedent is the best example of walking distance to amenities: highlighting unique, variable familial connections while accommodating engagement with the community.

The flexible approach provides opportunities for interconnectivity when desirable, rather than as a fixed solution. Units provide standalone accommodation yet can be joined together to create larger dwellings (see fig. 3.7, 3.8). The potential to live alongside relatives for occasional assistance and the ability to enlarge one’s living room for guests are unique enhancements for higher-density living. A café and a clothing store on the ground floor connect commercially with the street. A communal music room allows private practice and tuition, while a shared roof area provides recreational space. A small gallery engages passers-by. Offices are directly above the commercial spaces. These methods of variability for interconnections provide inspirational generators for the preliminary design.

Some issues that this project is addressing are less relevant. The surroundings are high-density, restricting the outcome accordingly. Offices are important due to the density; however, these are not essential for a medium-density scale. Stairs throughout the apartments are necessary for the differing levels but could prove problematic for ageing residents. Combined with the other precedents, these distinctions provide a good picture of what is more suitable for the iterative model.

To summarise, this high-density project shows the potential for familial support and social connections. Flexible dwellings that can be separated or joined, as well as communal rooms, recreational space and commercial engagements, demonstrate different ways of providing this interaction. Distinguishing between private and public areas indicates further possibilities for integration. These opportunities advance relational interconnectivity for the iterative model.

Fig. 3.7. Mischen Possible; Joinable Dwellings.

Fig. 3.8. Mischen Possible Axo: Interconnectivity, Image by Author.

In 1841, Nelson City was established in Tasman Bay near the top of the South Island of NZ (see fig. 4.1). The city has good proximity to the rest of NZ, featuring the geographical centre of the country on a local hill. The ethnicity is mostly European, with the next three largest groups identifying as Maori at 9.4%, Asian at 4.4% and Pacific Peoples at 1.8% (Stats NZ, 2013 Census, 7). The most notable demographic change since 2001 is the doubling of the Asian community by 2013. Nelson's economy relies on forestry, seafood, horticulture, agriculture and tourism (Wilson 59, 61, 64). There has also been growth in the areas of aviation and arts and crafts (Wilson 50, 64), as well as scientific research (NREDA 51). Nelson has a vibrant local music and arts scene and is known nationwide for its artisans (NRDA 5). It is mostly low-rise and has retained many heritage buildings near the city; however, unfortunately, this preservation reduces site availability for increasing density.

As has been noted, the ideal site should be within walking distance to local amenities. Some specific amenities are a priority, including medical support, food supplies, a library and recreational parks. Given this proximity requirement, brownfield development is fitting. As there is also growing anticipation for autonomous vehicles worldwide, some parking lots will be underutilised, making these available for projects. These variables inform the suitability of the site selection.

The chosen site extends a combination of two parking lots at 139 and 141 Collingwood St. As of 2018, a private landowner retains 139, whereas the local polytechnic, Nelson Marlborough Institute of Technology (NMIT), owns the remainder. [As a side note, NMIT may reduce their 350 parking spaces by up to 10% without consent, coinciding with this proposal.] By joining these lots together, this provides 1500m². The site is located within the inner-city fringe zone, meaning one can build to its boundaries, being unrestricted by daylight angles or setbacks. It is easily within walking distance to various amenities (see fig. 4.2), achieving a “Walker’s Paradise” score of 93 out of 100 for walkability (‘Walk Score’).

Fig. 4.1. Nelson City and Site Location, Image by Author.

Fig. 4.2. Local Amenities, Image by Author.

Fig. 4.3. 1940: Residential.

Fig. 4.4. 1980: Religious.

Fig. 4.6. 2005: Educational.

Fig. 4.8. 2010: Potential.

Fig. 4.10. 2013: Empty.

Fig. 4.11. 2014: Stalls.

Fig. 4.12. 2016: Parking.

Fig. 4.13. 2018: Resurfaced.

Fig. 4.5. 139 Church Building.

Fig. 4.7. 141 NMIT Building.

Fig. 4.9. 139 Apartments.

Fig. 4.14. Site Overview.

The history of this connected site contained four houses in the 1940s (see fig. 4.3) and transitioned to two religious buildings by the 1980s (see fig. 4.4, 4.5). One of the developments was turned into a parking lot while the other became an educational facility for NMIT (see fig. 4.6, 4.7). Further development was initiated, with a building consent provided for a 20m high apartment block on 139 as well as portable 1-bedroom units built by the polytechnic on their side

(see fig. 4.8, 4.9), yet these were not permanently substantiated (see fig. 4.10). Parking lots soon took precedence (see fig. 4.12), although a temporary setup of commercial stalls has also utilised the space (see fig. 4.11). More recently, most of the site was resurfaced as parking albeit with additional planting, suggesting its potential (see fig. 4.13, 4.14). There is also a common lime heritage tree to the northwest of the site (see fig. 4.15).

Fig. 4.15. Heritage Common Lime Tree.

Fig. 4.16. Flooding Risk.

Fig. 4.17. Earthquake Risk, Image by Author.

This site and its context present a range of problems amid potential. The northeast corner of the site has slumped, with a change in its height of 1.5m. Stormwater pooling further exacerbates this slump (see fig. 4.16). The site is within 500m of the Alpine fault, making it susceptible to earthquakes (see fig. 4.17). Nelson competes for the highest sunshine hours in the country, meaning that solar design is ideal. Vehicle access to 139 is currently awkwardly close to the nearby Selwyn Pl. intersection. Vehicle parking remains necessary, with local requirements of 1-2 per dwelling, although reducing this is justifiable closer to town (NCC, *A10*, 6, 18). Reducing parking also meets the expected decline and transition to autonomous vehicles, yet garages remain important for extra storage whether owners have vehicles or not. Surrounding buildings range from one to three storeys, encouraging a similar scale. A pedestrian walkway to the north of the site makes accessibility to NMIT difficult. Engagement with Collingwood St. is important, ideally with an overhanging balcony, as elsewhere in the city. Private outdoor areas are also crucial. A preschool to the south has an external area that could be connected to visually. The program and iterative modelling process will address these problems further.

Alternative sites would present a variety of different considerations. A long narrow site would have simpler circulation but a more disparate layout. Residential zones require stringent daylight angles and site boundary precautions, thus prioritising higher northern units and less sunlit areas. A larger site would reduce the ramp access space used. In larger cities throughout the country, different surroundings and densities suggest that overall height would increase.

To summarise, multiple site aspects provide parameters for design iterations. These generators include earthquake resilience, minimal parking garages, urban engagements, stormwater retention, driveway access, solar analysis and privacy provisions. Historical aspects and surroundings provide further inspiration for design choices. These parameters inform the program analysis and regulate the iterative model.

5. PROGRAM ANALYSIS

The program analyses more specific aspects of design, focusing on both the occupational needs of the community and technical enhancements. The occupancy includes the number of dwellings, parking, common spaces, number of bedrooms and ways to advance beyond existing MDH. Technicalities include requirements, improvements and building materials. This section provides more precise parameters for design improvements.

The literature review on MDH indicates the site size of 1500m² can house 4-12+ dwellings. The appropriate density depends on the context and surrounding buildings, being 1-3 storeys high. Nelson is a smaller NZ city, entailing the lower end of MDH at four dwellings, with five being more appropriate near the inner city. Nevertheless, due to the expected growth of the city, 6-8 dwellings appeared more reasonable. The reduction to one vehicle park per dwelling near the city requires a minimum of 6-8 parking spaces. The preschool to the south of the site is worth providing a visual connection to, as studies have shown that such interactions enhance elderly relationships (Morita and Kobayashi 2). Common spaces suggested by the precedents include a swimming pool, a workshop, a function room and a café. A swimming pool could be improved further with a gym for mobility. A workshop could also feature a gallery for interaction. A function room could provide kitchen facilities for reciprocity. A café could also contain a small store and library for engagement.

The main demographics nationwide for extended family living include NZ European, Māori, Pacific Islander and Asian households (Lysnar et al. 32). NZ European and Asian families are likely to have fewer children or none at all, prompting 2-3 bedroom units. Whereas Māori and Pacific Islander families are likely to have more children, prompting 4-5+ bedroom units. This contrast indicates that anywhere

from 2 to 5+ bedrooms per dwelling is suitable depending on the size of the family (see fig. 5.1). The Nelson City Council has noted there is a trend towards smaller households over the next three decades with most of the growth being single person households and those of couples without children (3). This trend suggests that although extended family dwellings tend to be larger, smaller units are just as important.

Fig. 5.1. Demographic Diagram, Image by Author.

Fig. 5.2. Priorities Diagram, Image by Author.

Fig. 5.3. Joinability Comparison, Image by Author.

According to research by BRANZ, particular opportunities exist to improve MDH for New Zealanders. Large outdoor areas allow large families to host gatherings while enabling outdoor cooking practices. Vegetable gardens and fruit trees satisfy economic and recreational needs. Large living rooms are especially important for housing guests, and garages provide additional spaces for entertainment. Maori families require food-related areas to be separated from laundry and bathroom spaces while requiring automatic ventilation. Wide and welcoming entrances are especially important for funerals. These practical needs are specific to existing MDH shortfalls. (Lysnar et al. 60-61)

This occupancy results in 6-8 dwellings and garages, a commercial area and potentially several communal spaces (see fig. 5.2). Dwellings could have a range of flexible units from 2-5+ bedrooms. Large outdoor areas and gardens are important. Living rooms could be joinable to provide larger spaces when needed (see fig. 5.3). Next, more technical aspects are detailed.

The NZ Building Code has various specific parameters for this project, able to be met by a variety of “Acceptable Solutions” provided by the Ministry of Business, Innovation and Employment. The maximum slope of an external ramp is 1:10 for residential access and 1:12 for commercial (see fig. 5.4)(D1, 25). Accessible stairs require a minimum tread of 310mm with a maximum rise of 180mm (D1, 28). More than one path of egress is required (C/AS3, 30). Garages for accessibility necessitate widening to 3.2m (D1, 46). The minimum dimensions of bathrooms for wheelchair users are 1.9 x 2.1m (G1, 18). Minimum acoustic precautions between units, using the old sound transmission method, necessitate an STC of 55dB for walls and an IIC of 55db for floors (G6, 3). A fire-rated wall between dwellings needs to resist fire for 60 minutes (C/AS3, 27).

Additional literature sources provide further improvements and recommendations. One aspect to improve design involves recrafting stairways so that two risers and one tread together approximate 630mm for ergonomics (Habermann 42). Acoustic standards are notably higher in Europe than New Zealand with the optimum Class A using a better noise reduction method, where $[R'w + C50-3150] \geq 61$ dB (Rasmussen and Lang 6). Earthquake resilience is improvable through lateral bracing and lighter materials such as timber. Concrete commonly provides thermal mass for solar

storage, yet engineered timber can also provide this to a lesser extent. Nelson manufacturers create a variety of engineered timber products, including GLULAM, LVL and CLT (see fig. 5.5). There are concerns about the toxicity of the adhesives used, encouraging alternatives such as DLT. However, this product remains unavailable in NZ at the time of writing. A government-owned research institute, Scion, are developing bioadhesives to reduce toxicity, yet zero formaldehyde adhesives can be used in the meantime (Scion). The sunrooms require openings to prevent overheating when needed. External insulation ensures the structure stabilises temperature while limiting thermal transfer and condensing moisture (Kolb et al. 116).

These technicalities show ways of enhancing prior parameters towards a more effective response. The maximum ramp slope is 1:10 yet two means of egress should be provided. Enlarging bathrooms allows private laundry machines to be separated from food areas. Stairs can combine accessibility with ergonomics for ideal performance. Layering particular materials can reduce acoustic issues to meet the higher 61dB threshold. Locally-produced, engineered timber provides thermal mass while featuring fire and earthquake resilience. These aspects provide parameters for the iterative preliminary design.

Fig. 5.4. Ramp Slope Comparison, Image by Author.

Fig. 5.5. Engineered Timber Comparison, Image by Author.

6. PRELIMINARY DESIGN

This chapter begins by summarising and prioritising design generators and parameters derived from the research. The modelling process follows this summary and consists of three iterative stages: starting with A and followed by B and C in parallel. An overview of the final stage is provided to conclude, leading to further analysis in the developed design chapter.

The precedents, site and program informed a variety of design drivers. Some of these drivers require earlier consideration in the design process (see fig. 6.1). The more important initial factors include a narrow floor plan and exposable engineered timber, sun-facing living rooms and gardening areas, dwelling accessibility, as well as joinable living rooms. Three key site generators are to engage with the street, to reduce storm-water runoff and to enhance seismic resilience. Early program generators include providing 6-8 dwellings with parking, recreational space and provisions for privacy.

A linear process appears to frame the background for the iterative modelling so far. However, the preliminary design developed alongside background research, feeding back into the research aspect as shown in the method diagram. The actual reflexive process explains why some drivers appear less important earlier in the process although the final stage integrates most of them.

- WELLNESS: PREVENT OR DELAY DISEASE THROUGH CONNECTIONS TO NATURE
- RECIPROCITY: MITIGATE BURDENSOME CONNOTATIONS THROUGH OPPORTUNITIES TO GIVE BACK
- AUTONOMY: REDUCE FUNCTIONAL DECLINE THROUGH ACCESSIBILITY
- INTERCONNECTIVITY: AUGMENT FAMILIAL SUPPORT THROUGH INTEGRATED CONNECTIONS

■ SITE: ENGAGE WITH THE STREET, REDUCE STORM WATER RUNOFF AND ENHANCE SEISMIC RESILIENCE

■ PROGRAM: PROVIDE 6-8 DWELLINGS WITH RECREATIONAL SPACE AND PRIVACY PROVISIONS

- 1. EXPOSED ENGINEERED TIMBER
- 2. NARROW FLOORS / INTERNAL COURTYARD
- 3. LOW-MAINTENANCE PLANTS
- 4. SWIMMING POOL

REGENERATIVE

- 1. SUN-FACING LIVING & THERMAL MASS
- 2. EXTRA GARDENING SPACE
- 3. ECONOMICAL FORM: SIDE BY SIDE
- 4. ACOUSTIC PRECAUTIONS
- 5. HEATED FLOOR
- 6. LOCAL MATERIALS
- 7. SOLAR HEATING

- 1. LEVEL ACCESS VS. RAMP
- 2. ROLL-IN SHOWERS
- 3. SLIDING DOORS
- 4. ELEVATOR

INTERGENERATIONAL

- 1. SHARABLE LIVING AREAS
- 2. COMMUNAL SPACES
- 3. COMMERCIAL AREAS
- 4. RECREATIONAL SPACE

Fig. 6.1. Primary Generator Diagram, Image by Author.

Fig. 6.2. Model Overview Diagram, Image by Author.

The design strategy involves combining the generators within massing models, both physically and digitally. This iterative process develops through three staged proposals (see fig. 6.2). The first (A3) combines the most important factors but lacks privacy and shared recreational space. The second (B5) improves privacy and recreational space but undervalues varied demographics while proving too dense at eight dwellings. The third (C6) aims to rectify these issues within an overhauled form of six dwellings.

Fig. 6.3. A1 Physical Model, Image by Author.

- NARROW FLOOR PLAN
- NORTH-FACING LIVING AREAS
- GROUND-LEVEL ACCESS
- JOINABLE UNITS
- PRIVATE EXTERNAL SPACE

A1

This early model encapsulates the terraced cohousing typology at ground level (see fig. 6.3, 6.4, 6.5, 6.6). As access is from the ground level, this avoids the need for stairs. The narrow floor plan allows light to permeate the units. Dwellings integrate joinability while external spaces accommodate some privacy. Parking runs alongside a single lane shared zone between the dwellings.

Fig. 6.4. A1 Digital Model, Image by Author.

Fig. 6.5. A1 Floor Plan 1:500, Image by Author.

Fig. 6.6. A1 Section 1:500, Image by Author.

Fig. 6.7. A2 Physical Model, Image by Author.

-
-
- RAMP WITH GRADIENT
-
- PARKING UNDERNEATH

A2

This iteration develops A1 by improving privacy for the southern units, by adding car parking underneath and by creating a slope with the existing terrain (see fig. 6.7, 6.8, 6.9, 6.10).

Fig. 6.8. A2 Digital Model, Image by Author.

Fig. 6.9. A2 Floor Plan 1:500, Image by Author.

Fig. 6.10. A2 Section 1:500, Image by Author.

Fig. 6.11. A3 Physical Model, Image by Author.

- EXPOSED TIMBER
- ROOF GARDENS
- SLIDING DOORS & SHOWERS
- SHARABLE LIVING AREAS, CAFE
-

A3

This stage shows the integration of the key precedent generators as well as site considerations, including garden space and the use of timber (see fig. 6.11, 6.12, 6.13, 6.14). Two autonomous features of sliding doors and shower units are also specified. Priorities include sharable living areas and a sharable bathroom. However, privacy remains inappropriate and the shared recreational space inadequate. Further, natural daylight insufficiently lights the parking areas.

Fig. 6.12. A3 Digital Model, Image by Author.

Fig. 6.13. A3 Floor Plan 1:500, Image by Author.

Fig. 6.14. A3 Section 1:500, Image by Author.

Fig. 6.15. B1 Physical Model, Image by Author.

- INTERNAL COURTYARDS
- ACCESSIBLE GARDENS
- EXTRA COMMUNAL SPACE
- RAISED UNITS FOR PRIVACY

- NO RAMP ACCESS

B1

This model improves privacy given the proximity to the city, by raising the units above street level thus providing room beneath for parking and communal and commercial amenities (see fig. 6.15, 6.16, 6.17, 6.18). Internal courtyards give the dwellings extra natural light, while the raised area provides space for gardens. However, the ground floor has minimal daylight, and the dwellings are not economical.

Fig. 6.16. B1 Digital Model, Image by Author.

Fig. 6.17. B1 Floor Plan 1:500, Image by Author.

Fig. 6.18. B1 Section 1:500, Image by Author.

Fig. 6.19. C1 Physical Model, Image by Author.

Fig. 6.20. C1 Digital Model, Image by Author.

Fig. 6.21. C1 Floor Plan 1:500, Image by Author.

Fig. 6.22. C1 Section 1:500, Image by Author.

- DOUBLE-HEIGHT LIVING AREAS
- ECONOMICAL (SIDE BY SIDE)
- STAGGERED PRIVACY
- SHARED COURTYARD
- VIEW VARIETY

- ONLY 4.5 UNITS

C1

This model provides a shared outdoor area as well as private external spaces (see fig. 6.19, 6.20, 6.21, 6.22). Units are connected side by side for efficiency. Staggering each dwelling enhances privacy, simultaneously creating a variety of views. However, the nine half units only provide 4.5 dwellings, and staggering them requires stairs or a ramp for circulation. There is hardly any space for communal rooms.

Fig. 6.23. B2 Physical Model, Image by Author.

Fig. 6.24. B2 Digital Model, Image by Author.

Fig. 6.25. B2 Floor Plan 1:500, Image by Author.

Fig. 6.26. B2 Section 1:500, Image by Author.

- FULL-HEIGHT COURTYARDS
- ECONOMICAL
- SHARED COURTYARDS
-

- WIDE FLOOR PLAN
- NO RAMP ACCESS

B2

This iteration improves on the courtyards by extending them through to the ground floor for more natural light and by making them shared rather than private (see fig. 6.23, 6.24, 6.25, 6.26). The dwellings are also made more economical by being connected. However, the courtyards are rather small, and access from the dwellings to the street is limited.

Fig. 6.27. C2 Physical Model, Image by Author.

Fig. 6.28. C2 Digital Model, Image by Author.

Fig. 6.29. C2 Floor Plan 1:500, Image by Author.

Fig. 6.30. C2 Section 1:500, Image by Author.

- GLULAM
- UNDERFLOOR HEATING
- LIFT ACCESS
- EXTRA COMMUNAL SPACE
- INCREASE # OF UNITS

C2

This iteration explores building to the boundaries while enlarging the internal courtyard (see fig. 6.27, 6.28, 6.29, 6.30). Elevator and stair access from the parking area improves circulation. Additional space underneath the dwellings allows communal rooms. Construction with engineered timber involves exploring GLULAM for suitability. The structure also accommodates underfloor heating. The total number of dwellings increases to 6. However, the external private areas are minimal, and the communal space is also restrictive.

Fig. 6.31. C3 Physical Model, Image by Author.

Fig. 6.32. C3 Digital Model, Image by Author.

Fig. 6.33. C3 Floor Plan 1:500, Image by Author.

Fig. 6.34. C3 Section 1:500, Image by Author.

C3

This iteration increases the dwelling capacity to eight, while the parking is moved to the south of the site (see fig. 6.31, 6.32, 6.33, 6.34). Some of the units have been given sharable private spaces, simultaneously providing accessible gardening areas. The main internal courtyard is also more private than before. However, the units lack personalisation and some connections on the flat roofs require improvement. Also, the middle-top units require an elevator or stairs for accessibility.

- ECONOMICAL
- ACCESSIBLE GARDEN SPACE
- SHARABLE PRIVATE BALCONIES
- SOUTH-FACING PARKING

Fig. 6.35. B3 Physical Model, Image by Author.

- NARROW FLOOR PLAN
-
- SHARABLE PRIVATE BALCONIES
- SOUTH-FACING PARKING
- NO RAMP ACCESS

B₃

This iteration reduces the number of courtyards to two while enlarging them; this narrows the floor plan to provide additional daylight (see fig. 6.35, 6.36, 6.37, 6.38). Car parking is integrated to face south. Sharable private balconies additionally improve each dwelling.

Fig. 6.36. B3 Digital Model, Image by Author.

Fig. 6.37. B3 Floor Plan 1:500, Image by Author.

Fig. 6.38. B3 Section 1:500, Image by Author.

Fig. 6.39. C4 Physical Model, Image by Author.

Fig. 6.40. C4 Digital Model, Image by Author.

-
- RAMP ACCESS
- UPSTAIRS CHILD BEDROOMS
- RAISED UNITS FOR PRIVACY

- LESS LIGHT TO COMMON SPACES
- LESS ECONOMICAL
- NO LIFT

C4

This iteration reduces the number of dwellings to seven while making the top-middle unit accessible (see fig. 6.39, 6.40, 6.41, 6.42). Communal space is provided underneath the units while raising the units for privacy. Individualisation is improved as well as roofing connections. However there is restricted light to communal spaces, economic benefits for the dwellings are minimal and direct access to the parking area is lacking.

Fig. 6.41. C4 Floor Plan 1:500, Image by Author.

Fig. 6.42. C4 Section 1:500, Image by Author.

Fig. 6.43. B4 Physical Model, Image by Author.

Fig. 6.44. B4 Digital Model, Image by Author.

Fig. 6.45. B4 Floor Plan 1:500, Image by Author.

Fig. 6.46. B4 Section 1:500, Image by Author.

B4

This iteration improves on privacy and sunlight access by raising the southern dwellings higher (see fig. 6.43, 6.44, 6.45, 6.46). This elevation also provides a variety of views. Upstairs children's bedrooms are added to conserve space. Detailing considerations start to integrate underfloor heating. However, the spaces do not indicate clear walls, ramp access does not connect with the street, and the structure appears to be four individual plots rather than a comprehensive project of eight.

- UNDERFLOOR HEATING
- STAGGERED PRIVACY
- UPSTAIRS CHILD BEDROOMS
- VIEW VARIETY
- NO RAMP ACCESS

Fig. 6.47. B5 Physical Model, Image by Author.

B5

This stage emphasises CLT as the construction material of choice and adds sun spaces to the north of the dwellings (see fig. 6.47, 6.48, 6.49, 6.50). Ramp access to the street and an elevator to the parking area improve circulation. The structure is holistic while distinguishing between units. Garages, rather than shared parking, prioritise personal storage while additional, movable storage units separate the sharable living areas. However, the units all have a similar size rather than being smaller or larger for different families. Some car parks are too close to the street. The height near the street is overbearing, and the ramp could be integrated better. The common rooms segregate potential users. There is no variation in the courtyards, and they are rather small.

- CLT
- SUNSPACES, ACOUSTICS
- RAMP ACCESS, LIFT
- MOVABLE STORAGE UNITS
- GARAGES

Fig. 6.48. B5 Digital Model, Image by Author.

Fig. 6.49. B5 Floor Plan 1:500, Image by Author.

Fig. 6.50. B5 Section 1:500, Image by Author.

Fig. 6.51. B6 Physical Model, Image by Author.

Fig. 6.52. B6 Digital Model, Image by Author.

Fig. 6.53. B6 Floor Plan 1:500, Image by Author.

Fig. 6.54. B6 Section 1:500, Image by Author.

- PLANTER BALUSTRADES
- INTEGRATED RAMP
- VARIED SIZE OF UNITS
- SLOPED DOWN TO STREET

- NO LIFT

B6

This iteration provided a variation in courtyard size while beginning to integrate the ramps (see fig. 6.51, 6.52, 6.53, 6.54). The reduced street frontage improves perceptions while planter balustrades refine the development.

Fig. 6.55. C5 Physical Model, Image by Author.

- FULL-HEIGHT COURTYARDS, CLT
- SUNSPACES, ACOUSTICS
- INTEGRATED RAMPS
- VARIED SIZE OF UNITS
- SLOPED DOWN TO STREET, GARAGES
- LESS ECONOMICAL
- NO LIFT

C5

This iteration improves light to the communal spaces while raising the units slightly for additional communal space (see fig. 6.55, 6.56, 6.57, 6.58). North-facing sunspaces are enhanced through angled walls, while the reduced height to the street improves perceptions. The form develops to integrate ramps further. The dwellings begin to vary in size. However, removing the elevator option restricts circulation, and economic benefits for the dwellings are minimal. Also, the courtyard is too public.

Fig. 6.56. C5 Digital Model, Image by Author.

Fig. 6.57. C5 Floor Plan 1:500, Image by Author.

Fig. 6.58. C5 Section 1:500, Image by Author.

Fig. 6.59. C6 Physical Model, Image by Author.

- SKYLIGHTS, PLANTER BALUSTRADES
- ECONOMICAL
- LIFT ACCESS FROM GARAGE
- POOL, MOVABLE STORAGE UNITS
- PRIVATE COURTYARD, ROOM PLANS

C6

This stage reduces the public access to the courtyard while improving the economic viability of the dwellings (see fig. 6.59, 6.60, 6.61, 6.62). Reintegration of the elevator and stair access from the parking restores circulation. Movable storage units and potential bedroom space enhance room planning. A swimming pool, skylights and planter balustrades are additional features that advance the ideals of this project.

Fig. 6.60. C6 Digital Model, Image by Author.

Fig. 6.61. C6 Floor Plan 1:500, Image by Author.

Fig. 6.62. C6 Section 1:500, Image by Author.

Fig. 7.1. 1:100 Model from NE, Image by Author.

Fig. 7.2. 1:100 Model from SW, Image by Author.

7. DEVELOPED DESIGN

This chapter explains the final design stage in greater detail, beginning with an explanation of how the objectives are being met (see fig. 7.1, 7.2). Next, particular strengths highlight integrated design principles, followed by various weaknesses being discussed with room for further iterations. The design principles are then briefly summarised. To conclude, several narratives are expressed to provide a snapshot of the development's potential.

Fig. 7.3. Developed Design Overview, Image by Author.

Fig. 7.4. 1:100 Model North Elevation, Image by Author.

This developed design explicitly addresses the objectives through the design generators and contextual parameters (see fig. 7.3). Wellness is integrated through exposed engineered CLT and GLULAM, skylights, planter balustrades, a narrow floor plate with full-height courtyards, white surfaces, tall glazing, and a shared swimming pool (see fig. 7.5). Reciprocity aspects include an economical (side-by-side) layout, reduced acoustics between units, heated flooring to reduce dehydration, gardening

spaces and openable sunspaces that join to the living room (see fig. 7.6). Autonomy features a double, widened accessible ramp at 1:12 and 1:10 gradients, elevator access to the garages, sliding doors and roll-in showers (see fig. 7.4). Interconnectivity includes movable storage units between sharable living areas, varied sizes of dwellings, upstairs child bedrooms, a café for commercial use, a communal lounge and a shared workshop (see fig. 7.7).

Fig. 7.5. Section A, Image by Author.

Fig. 7.6. Section B, Image by Author.

Fig. 7.7. Section C, Image by Author.

Fig. 7.8. West Elevation, Image by Author.

Fig. 7.9. North Elevation, Image by Author.

Site aspects include driveway access - 35m south from the Selwyn Pl. intersection, a private courtyard, a lower façade at the street frontage, raised dwellings for privacy, a variety of views, and individual garages for storage (see fig. 7.8, 7.9). Planting boxes and a grey water system reduce stormwater runoff while engineered timber lightens the structure to withstand earthquakes. Program features include an optimised floor plan layout with living areas each side of central bathrooms, space for additional bedrooms if required, large living rooms, drying areas for laundry and private external areas (see fig. 7.12, 7.13). A secondary yard provides external cooking space, while a view of the preschool enhances connections (see fig. 7.10, 7.11). A shared gym space improves the swimming area, a shared gallery furthers the workshop, a store and library enrich the café, and a kitchen area develops the function room (see fig. 7.14).

Fig. 7.10. Secondary Yard, Image by Author.

Fig. 7.11. Preschool Connections, Image by Author.

Fig. 7.12. Second Floor Plan, Image by Author.

Fig. 7.13. First Floor Plan, Image by Author.

Fig. 7.14. Ground Floor Plan, Image by Author.

Fig. 7.15. Regenerative Principles, Image by Author.

Strengths of the final proposal stand out due to overlapping accomplishments, integrating design principles (see fig. 7.15, 7.16). CLT can be exposed and is suitable for thermal mass, fire safety and earthquake resilience while being produced locally. Openable sunspaces in front of the living rooms create a privacy transition while harnessing the potential for passive solar. Planter boxes are accommodated on roofs

and as balustrades, reducing the stormwater runoff. Further, the integrated ramp, equipped with planter boxes, has also been widened to enhance interaction and reciprocity. Also, mixed-use spaces on the ground floor have improved privacy for the raised housing units while providing for connectivity and reciprocity. Additional findings include movable storage units between dwellings for joinable living

Fig. 7.16. Intergenerational Principles, Image by Author.

areas, full-height glazing and skylights enhance daylight, height changes and staggered balconies advance privacy, and higher acoustic standards reduce relational concerns. These findings suggest that development towards a 'regenerational residence' can readily optimise dwellings for 'ageing in place' as integrated within the community.

Fig. 7.17. Upstairs Balcony sans Ramp, Image by Author.

There are various weaknesses in the project that remain unresolved. A wellness weakness is the amount of natural light penetrating the interior, as earlier designs explored clerestory windows between the habitable flat roof and the sloping roof. These windows were removed due to privacy concerns and were replaced with skylights, but perhaps could have been integrated further through other means such as glass blocks or frosted glazing (see fig. 7.17). A reciprocal weakness is buildability costs for lower-income families. As long-term cost is prioritised, this might create a short-term concern for certain families. Another weakness is the lack of colour; for example, the window framing could be coloured to subtly distinguish each dwelling (see fig. 7.18, 7.19).

Regarding autonomy, it is difficult for mobility-restricted people to inhabit the flat roof areas (see fig. 7.17). Earlier on in the project, the elevator was able to connect to these spaces; however, privacy became more of an issue, and this was removed. The ramp connection to the roof is limited due to the size of the site but could be connectable on a larger site. Further, the bedroom sizes may prove too restrictive as they integrate shelves around the beds. Interconnectivity weaknesses include not specifying a shared laundry space or commercial offices or guest rooms, while the north-facing walls could be perceived as overbearing (see fig. 7.18, 7.20). Each bathroom provides personal laundry areas, yet shared laundry space could also be available beneath the ramp

Fig. 7.18. Dominant North Wall 1, Image by Author.

for interaction. Offices and guest rooms were intended earlier in the process to be above the garages and under the highest dwellings. However, having taller garages instead increases light in these spaces while allowing higher vehicles and more flexibility for additional storage. The overbearing walls could be shorter on a larger site, or perhaps broken up with glazing more frequently. Overall, these weaknesses are relatively minor but could be mitigated through further design iterations or by utilising a larger site.

Fig. 7.19. Potential for Coloured Mullions, Image by Author.

Fig. 7.20. Dominant North Wall 2, Image by Author.

Fig. 7.21. Demographics Diagram Potential, Image by Author.

This developed design emphasises an overlap of design principles for effective accommodation to age in place. Important regenerative principles include exposed engineered timber, solar-facing and openable sunspaces connected to living rooms as well as gardening/plant areas integrated throughout the project. Relevant intergenerational principles include a widened integrated double access ramp, raised bedrooms with stairs for younger residents and movable storage units for dividing the dwellings when desired. Site and programmatic principles feature wide and high garages for accessible parking and storage, staggered dwellings and balconies for privacy and views, as well as variable bedrooms and external areas for extended families. These overlapping principles enhance their appropriateness within the design and indicate the potential for future developments.

The following fictional narratives and renders related to potential demographics suggest a variety of ways this project is appropriate for ageing in place (see fig. 7.21).

Fig. 7.24. Collingwood St. View, Image by Author.

Harold is grateful to be able to live alongside his parents as they are getting older, while still having his privacy. This flexibility enables him to help out easily when needed. His dog, Trev, sleeps contently on the private balcony. The closeness to the city is also useful for his administration job, and he enjoys attending musical events nearby with his parents (see fig. 7.24, 7.25).

Fig. 7.25. Rear Courtyard, Image by Author.

Fig. 7.22. Cafe, Image by Author.

Grandma Shirley sometimes needs her walker to get around, and she likes having the ramp as the main route rather than the difficulty of stairs. She enjoys the proximity to her daughter as they can spend more time together. She likes to read in the café and catch up with friends (see fig. 7.22). She tends to a variety of vegetables on her balcony, as well as herbs alongside the ramp (see fig. 7.23). She walks to the local supermarket regularly for supplies and appreciates the proximity to the medical centre.

Fig. 7.23. Balcony, Image by Author.

Fig. 7.26. Central Courtyard, Image by Author.

Aunt Betsie had high levels of stress at her previous residence as it was sterile and cold. She had an air conditioning unit; however, she avoided its use because the air dehydrated her. Now she is warmer from thermal mass and underfloor heating. She is also calmer through exposed timber, plants and high natural daylight (see fig. 7.26, 7.27). Also, she feels more secure with family help nearby. She has started volunteering at the corner kindergarten and likes walking to the local Queen's Gardens several times each week for refreshment.

Fig. 7.27. Bedroom, Image by Author.

Fig. 7.31. Ramp Access, Image by Author.

Uncle George needs his own space occasionally and likes being able to close off his home from the rest of the family. He appreciates the social interaction that the ramp promotes, as he enjoys teaching his neighbours to repair items in the workshop, especially bikes (see fig. 7.31). When he uses the family vehicle for a large shopping trip, he can take the direct elevator from the garages rather than carrying groceries around and up the main ramp (see fig. 7.32). He had trouble exercising, but now he can improve his mobility through the downstairs gym.

Fig. 7.32. Elevator Access and View, Image by Author.

Fig. 7.28. Upstairs Balcony, Image by Author.

Stanley and Grace used to live in a terrace house and found it difficult to entertain guests, particularly during Christmas. Nowadays, living beside their ageing parents means they can join their living areas for extra space (see fig. 7.29, 7.30). Also, their parents can often babysit their two children when necessary. The private upstairs area is also useful for their children to play (see fig. 7.28). For larger events or celebrations, they appreciate the potential use of the communal lounge downstairs. They also like interacting with neighbours in the central courtyard, especially for the occasional barbecue.

Fig. 7.29. Separated Units, Image by Author.

Fig. 7.30. Joined Dwelling, Image by Author.

Fig. 7.33. Dwelling Entrances to Ramp, Image by Author.

Shona felt overwhelmed raising her four children after their father passed away in a car accident. Moving in alongside her parents has helped her regain stamina. Further, the nearby community provides constant distractions for her children, so now she can find time for herself (see fig. 7.33, 7.34). Accordingly, she has begun a nursing course at the nearby polytechnic as a step towards a dream of hers. Shona has converted the upstairs office/passageway into a bedroom and is planning to do the same with the downstairs lounge in a year or two so the younger two children can have their own room.

Fig. 7.34. Shared Zone off Collingwood St., Image by Author.

8. CONCLUSION

This chapter discusses the results with the original objectives, followed by reflections on the process including insights and constraints. These reflections then inform the potential for future use and further research.

The built environment in NZ, especially the increasing developments of MDH, is not suited for ageing in place; this is particularly problematic with an ageing population. Residences often worsen diseases, provoke burdensome implications, exacerbate functional decline and restrict familial support. Rather, architecture can improve the potential housing stock for ageing by integrating ideas from relevant precedents within an iterative development. This project provides an example of what ageing in place within extended families could look like, through enhancing health, creating opportunities to give back, by prioritising independence while accommodating interaction. These objectives are primarily achieved through exposed timber and natural light, solar-facing living rooms and gardening spaces, ramp access and sharable living areas. Further generators and contextual parameters craft a holistic framework of drivers for integration.

The design process indicates how these drivers can be combined, providing a variety of design principles. A key principle is exposing engineered timber, in particular, CLT at the ceiling and one wall side, and GLULAM for columns and beams. Another principle is for openable sunspaces, to avoid overheating in summer while providing warmth during winter.

Another principle is to provide planter boxes everywhere, particularly integrated as balustrades. One of the more significant principles is to integrate ramps for access and interaction. Further principles include the potential for flexibility such as definable space for extra bedrooms and movable storage units for joinable dwellings.

Additional enhancements include larger garages, staggering spaces for privacy and views, raising bedrooms for mobile residents and low maintenance external areas. Conclusively, combining functions provides an adequate initial response, whereas finding ways to overlap design generators with a particular site and programmatic concerns instigates more relevance into the project. This outcome provided various insights while clarifying constraints, suggesting potential factors for future developments.

This investigation presented a variety of insights. Ageing in place has proved to be an important issue to resolve through design because comparatively there are only gradual enhancements within built projects presently in NZ. The non-interactive methods produced an appropriate response to the objectives, despite avoiding primary engagement with the local ageing community. This exegesis may appear to be attempting too much at once, being too wide for usefulness. However, the scope aims at holistically improving dwellings for ageing in place, and a selected context provides an expression of this. Further, the project can be simplified as combining four distinct precedents within a specific site. The wide framework postulates plenty of potential for future research.

Specific constraints of the project limit its relevance. The MDH focus involves a strict limit of units for the site to match the definition; however, a larger site with a taller development could prove more cost effective for land. A larger site could also enable the integrated ramp to connect with higher areas, making these easier to access. Another constraint is the limited range of European precedents that were selected due to their relative known significance towards each driving influence; however, precedents elsewhere emphasising extended family living

might advance these ideas further. Using the chosen site, in reality, would require combining two distinct lots, necessitating unlikely collaboration between owners as well as approval from the Minister of Education to proceed. These constraints indicate the potential for additional analyses.

There are other potential applications of the outcomes. The proposed double-housing dwelling could be used to provide temporary accommodation for students or Airbnb. However, this would currently fall outside the scope of council regulations about their provision for family dwellings with more than one kitchen: thus indicating a need to adjust these regulations for such situations. Given the wide scope of the project, the core design principles are not limited to MDH, being able to be utilised on other sites through different programs in similar ways to enhance all future dwellings towards ageing in place.

Future research could expand the scope of the project in a multiplicity of ways. Larger and smaller sites could be compared. Extended family precedents from other countries such as Asia could be inspirational. The Living Building Challenge would provoke regenerative design further and suggest improvements. A human-centred design approach involving feedback from ageing residents as to attractiveness and appropriateness of the principles would serve to advance these ideas. Lower short-term costs could be prioritised such as cheaper land in smaller towns with key amenities as well as integrating more economical materials where practicable. Future research could explore more

precise individual client factors with particular difficulties and concerns. A typology on a hillside holds further potential for development as this could tie in well with a ramp. Slightly higher density developments of around four storeys on larger sites may provide better long-term outcomes.

Ultimately, this project has outlined a variety of design principles for future developments. Theoretical research and existing projects support such enhancements. Integrating ideas from this secondary research within a design proposal in Nelson develops these enhancements further. The resulting design principles indicate how to create effective accommodation for ageing in place within NZ.

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- Tamasoft, Pepakura Designer 4
- Trimble, Sketchup Pro

APPENDICES

Fig. 8.1. Environmental Overview, Image by Author.

Fig. 8.2. INSUL Acoustic Analysis, Image by Author.

Fig. 8.3. 3D Detailing, Image by Author.

Fig. 8.4. Structural Elements, Image by Author.

Fig. 8.5. RESIST Model, Image by Author.

Fig. 8.6. Stair Ergonomics, Image by Author.

Fig. 8.7. Presentation Boards, Image by Author.