PERMANENCE IN ARCHITECTURE:
IS IT RELEVANT?
HOW IS RELATIVE PERMANENCE ATTAINABLE NOW?

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ABSTRACT

The typical New Zealand dwelling, which is built in timber and often lightly anchored to site, arguably appears impermanent. This research reviews the idea and relevance of permanence in architecture. It considers symbolic persistence, the durability of architecture on thought and memory, permanence of function and space, architecture as event, reification and sustainability as they relate to permanence.

Permanence is related to durability and durability is explored in terms of resistance to decay, and also its value to the user. It looks in particular at mass, materials and detail; and additionally at the requirement for flexibility in design to achieve durability of use.

Case studies of buildings displaying differing aspirations to permanence are reviewed in terms of durability and analysed using the three components of durability - mass, material and detail.

This thesis tests permanence through the design of a dwelling to last and be relevant for 400 years. It finds constructing dwellings for relative permanence as a relevant, sustainable and entirely possible option.

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INTRODUCTION

The typical New Zealand dwelling, which is built in timber and often lightly anchored to site, arguably appears impermanent. This research will review the idea and ongoing relevance of permanence in architecture today as a way to investigate quality, sustainable residential architecture.

This thesis will first examine definitions of (relative and absolute) permanence and how advances in mathematics and science have caused a new understanding of time and fundamentally altered our understanding of permanence. Chapter one explores new theories and writing about the ongoing relevance of permanence and durability in architecture put forward by Sola-Mirales, Tuow, Ford, Isenstadt and others. These include the influence of time, reification, the idea of architecture as event, and permanence as a continuum.

The next chapter examines the concept of durability, and how mass, materials and detail contribute to durable architecture. It will also look into the necessity of buildings to be flexible in order to have durability of use. Mass is investigated to see if it is necessary for durability. The influence of materials on durability is discussed. Detail is also discussed in terms of its role in enhancing durability.

Chapter three examines three case studies of buildings that display differing aspects of permanence. The case studies are analysed in terms of the concepts explored in the literature review, and the main physical components for relative permanence- mass, materials and detail. Each case study has different aspirations to permanence and these aspirations influence the design outcome. Flexibility of use which is crucial for durability of use is also discussed for each case study.

The themes of this thesis (permanence and durability) are obviously not restricted to New Zealand. Nevertheless the site for testing the design is in New Zealand -therefore chapter four starts by examining the historic context of residential dwelling construction in New Zealand. It also explains the process of site selection for the design, as clearly site selection plays a fundamental part in any design aspiring to relative permanence.

Chapter four goes on to explain the design of a dwelling in Wellington as a means of testing the research findings. The aim was to design a residential dwelling to last, and still be useful in, 400 years. Mass, materials and detail are tested throughout the design of the dwelling from its position on the site and its form through to its lighting. Additionally flexibility of use is designed for, tested and discussed.

CHAPTER ONE PERMANENCE

This chapter explores notions of permanence and more specifically, absolute and relative permanence. It will first look at the concept of permanence and how our understanding of permanence has changed over time, then explore some new ways of thinking about permanence and how different societal values can impact on permanence. Finally the case for the ongoing relevance of permanence to architecture will be argued for.

1 What is permanence?

Like the notion of God, permanence appears to be a concept readily understood at an emotional level by human beings, but difficult to define. Permanence means different things to different people and societies and changes over time. Webster's dictionary is perhaps as good a starting point as any: it defines "permanent" as *lasting or intended to last indefinitely without change*, and *lasting a relatively long time*. This definition draws a distinction between lasting 'indefinitely' and 'lasting a relatively long time' which is of fundamental concern when examining the meaning of permanence, as it recognises that permanence can be both absolute and relative.

2 Absolute permanence

In Western architecture, Vitruvius' *Ten Books on Architecture*¹ contains what is considered to be the original writing on permanence. Many modern writers discussing the theory of permanence associate 'absolute' permanence with the Vitruvian notion of 'firmitas'²:

*"All these must be built with due to reference to durability, convenience and beauty. Durability will be assured when foundations are carried down to the solid ground and materials wisely and liberally selected:..."*³

The words 'Durability will be assured' imply absolute or ongoing permanence by assuring endurance. In a quote discussing the construction of walls Vitruvius writes:

"In the thickness there should be set a very close succession of ties made of charred olive wood, binding the two faces of the wall together like pins, to give it lasting endurance. For that is a material which neither decay, nor the

1 Vitruvius (1960). *Vitruvius: The Ten Books on Architecture*. New York, Dover Publications.

2 Touw at pg 7, Ignasi de Sola-Morales at Pg 103,

3 Vitruvius (1960). *Vitruvius: The Ten Books on Architecture*. New York, Dover Publications. Book I chapter III 2.

weather, nor time can harm, but even though buried in the earth or set in water it keeps sound and useful forever.”⁴

This discussion takes an absolute view of permanence. A material that time cannot harm and will be useful forever would be absolutely permanent, eternal.

However, it is clear that Vitruvius was aware of the distinction between architecture that will “endure to eternity” and relatively less permanent architecture. In a continuation of the quote discussing the construction of walls Vitruvius writes:

“And so not only to city walls but substructures in general and all walls that require a thickness like that of a city wall, will be long in falling to decay if tied in this manner.”⁵

This latter part of the same paragraph takes a more relative view of the longevity of the wall by use of the words ‘long in falling to decay’ (i.e. acknowledges relative permanence).

3 The influence of time and relativity on ideas of permanence

Society’s ideas of space and time have radically changed since Vitruvius’ time. It was once believed that time began in 4000 BC. After the geologists of the nineteenth century, it was estimated that the earth began 24 to 400 million years ago. The discovery of radioactivity dating subsequently caused a backwards revision to this so that it is now estimated that the earth began billions of years ago. The next leap in the time perspective was due to Einstein’s theory of relativity at the beginning of last century. Einstein showed that time is relative to acceleration and gravity. Mass curves space-time.⁶

Gregory Benford is a professor of physics and writes of the modern scientific theories of time:

“Modern science reveals that time is supple, changeable and even enigmatic. Further, we stand in a small slice of it, anchored in a moving moment that is an infinitesimal wedge compared with what has gone before, or will come

⁴ Vitruvius (1960). *Vitruvius: The Ten Books on Architecture*. New York, Dover Publications. . Book I chapter III 2.

⁵ Ibid Book I chapter V 3.

⁶ Benford, G (2010). *Time: The Winged Chariot*. In *Seeing Further: The Story of Science & the Royal Society*. London, Harper press Pg 446-455

Figure 1 Fireplace and chimney in a padock in Tikokino, Hawkes Bay. All that remains of a dwelling is the permanent element.

after us. Our telescopes tell us of immensities of space, but other sciences – geology, biology, cosmology – speak of even grander scales of time.”⁷

This modern view of time is in contrast to what Benford says is the western tradition of a constant timeline which is consistent with the Vitruvian view of tradition and time. Since Einstein’s theory of relativity we understand that time is no longer simply linear. In the Vitruvian era, permanence in all things built was largely absolute permanence (or at least, his society considered absolute permanence was attainable). Absolute permanence is no longer considered by our modern society to be attainable in architecture. Sola-Mirales expresses this eloquently when he says:

“Space was no longer perceived as an initial datum, an a priori starting point upon which the architect’s work intervened; instead, space itself resulted from an architectonic proposition.”⁸

Today, even if a structure was built to rival the most durable or monumental of structures of Egyptian or Greek times, it would not be conceived as permanent by visitors and critics in the same way that the actual monumental structures of ancient Egypt and Greece were at the time they were built (or even within a few centuries of being built). Societies’ collective perception of permanence has shifted from the absolute to the relative due to the new and wider perspective we now have on time:

“The Places of present-day architecture can not repeat the permanences produced by the force of the Vitruvian firmatas. The effects of duration, stability and defiance of time’s passing are now irrelevant.”⁹

From the foregoing paragraphs it can be seen that the concept of permanence (whether related to architecture or not) is also heavily influenced on the view taken by society of time. Modern thinking is that architecture can only aspire to relative permanence (if at all), as no known construction will last indefinitely in time. So if we as a society no longer believe in absolute permanence of architecture, how can we conceive and categorise architecture in relation to time in a way which makes sense to us with our new scientific knowledge of time? The following paragraphs explore different ways of thinking about

7 Benford, G (2010). *Time: The Winged Chariot*. In *Seeing Further: The Story of Science & the Royal Society*. London, Harper press. Pg 449

8 Solá-Morales, I (1996) *Differences- Topographies of Contemporary Architecture*, Massachusetts Institute of Technology, U.S.A. Pg 95

9 Ibid. Pg 103

time and architecture advanced by modern academics.

4 Absolute permanence through reification

Tuow argues that absolute permanence can only be achieved in modern times through reification¹⁰, which can be defined as the act of representing an idea or concept as a physical thing.¹¹ Her argument is that the physical thing can be constructed and re constructed time and time again, and throughout these processes it is the idea or concept which remains and is the permanent.

An example of this idea of reification can be seen at work in the Ise Shinto shrine (Ise Jungū), part of a compound of shrines in the city of Ise, in Japan. This collection of small sacred buildings have for a millennium or longer been under the protection of imperial rulers and are constructed in timber in a forest of cedar. Two of these are rebuilt every 20 years. The Shinto followers believe in the “*death and renewal of nature and the impermanence of all things (wabi-sabi)*”¹² and this is why the shrines are rebuilt. The change then is constant but not the idea, which has existed since at least the seventh century. There are two additional reasons why those buildings exist today. Firstly Ise Jungū is in a cedar forest and its beauty is partly due to this landscape and no doubt the affinity of the buildings with the forest. Secondly its’ longevity is also due in no small part to the sacredness and political protection. This will be further discussed below when exploring the effect of the symbolic economy on permanence.

There is a certain paradox, to the Western mind, in the permanence being manifest in the impermanent. However the Ise complex can be used as a different lens through which to view longevity, durability and absolute permanence. Tuow argues that that absolute permanence can or could be achieved where there is a continuity of will or idea through reification despite the durability, or otherwise, of the material. I suggest that although an idea may persist longer than materials, nevertheless an idea can only achieve permanence within a society that shares the idea (i.e. still only relative permanence). My own view is that architecture embodying reification is likely to have longer relative permanence than other forms of architecture.

10 Tuow, K. (2006). *Firmitas re-visited: Permanence in Contemporary Architecture*. Architecture. Waterloo, University of Waterloo. Master of Architecture: 93. Pg 8

11 Concise English Oxford Dictionary

12 http://en.m.wikipedia.org/wiki/Ise_Grand_Shrine

5. Architecture as event

Ignatio Solá-Morales in his article 'Differences- Topographies of Contemporary Architecture'¹³ advances the theory that the production of place within this modern construct of space and time is an architectonic event: *"From a thousand different sites the production of place continues to be possible. Not as the revelation of something existing in permanence, but as the production of an event."*¹⁴ This consideration of architecture as an 'event' considers any new architecture as discrete in the sense that it is not connected as part of a constant time line and also that it is influenced by human perceptions and interactions within it. Solá-Morales talks of a media culture which envelops the world, and where images can be sent and downloaded anywhere instantaneously. He argues that this *"constant generation of new stimuli ... has also produced feelings of profound estrangement"*¹⁵ and that in this new modern world the focus has turned to a *"philosophy of personal commitment."*¹⁶ His theory is that the more we become a global village, the more we tend to retreat to individualism, resistance and nihilism.

Solá-Morales concludes that a better way of understanding place or time is as a cultural event. *"Place is, rather a conjectural foundation, a ritual of and in time, capable of fixing a point of particular intensity in the universal chaos of our metropolitan civilisation."*¹⁷ So place is not part of the fixed linear continuum that was our understanding of time but it exists and exerts control in chaos. He explicitly disclaims using his theory as a justification for impermanence and argues that there is still a need for architectural places. In Solá-Morales view architecture does not occupy absolute (or even relative) permanence but is still a point or 'event' in a constantly accelerating and chaotic world.

I suggest that, while this view of contemporary architecture assists us with understanding time and the role of architecture and place within it, and is useful in understanding architecture that has a profound impact upon a particular society (for example, Corbusier's Villa Savoye) it is an extreme view and essentially dismisses permanence as an outmoded irrelevance. This theory argues that nothing (including architecture) is permanent; all

13 Solá-Morales, I (1996) *Differences- Topographies of Contemporary Architecture*, Massachusetts Institute of Technology, U.S.A.

14 Ibid Pg 104

15 Ibid. Pg 99

16 Ibid. Pg 97

17 Ibid. Pg 104

Figure 2 Ise Shinto shrine (Ise Jungū) Ise Japan

that can be said is that it exists at a moment in time. Although Solá-Morales argues that this need not lead to ephemeral architecture, in my view this is the logical consequence if permanence is irrelevant. This theory is perhaps technically correct in its explanation of time but in denying any sort of permanence or continuity, fails to address or relate to modern concepts of sustainability, and does not address the fundamental human need identified by Tuow and Ford to believe in permanence.

6 Permanence as a continuum

Unlike Solá-Morales, Tuow argues that permanence is important to our society, but that to remain relevant and useful in today's society, absolute and relative permanence should be synthesised and seen as a continuum:

*"If the permanence of substantive matter is perceived as being cyclical rather than linear it is possible to speak of the absolute permanence of substantive matter in a relative sense. In this sense, then, permanence might be thought of or measured as the interval between successive cycles- the longer the interval, the more permanent or durable the object or 'human artifice' is."*¹⁸

This concept of permanence as a continuum aligns with Frampton's view of *"an agrarian, cyclical concept of time,"*¹⁹. This is a concept which acknowledges that a material is constantly returning to its original form. It applies to a material which wears down in the absence of maintenance and returns to the state from which it came. Frampton cites mud houses as an example. The matter is not destroyed over time but its form and properties are altered. This cyclical concept of time can also describe a material which can constantly be reused, or a process of cyclical maintenance. My own view is that this 'cyclical' view of permanence assists in that it is compatible with Western society's current understanding of non-linear time and relative permanence. It has value in assisting society to remain realistic as to the relativity of permanence, the role that maintenance and materials have to play in relative permanence, and is consistent with modern concepts of sustainability.

Nevertheless the question remains as to whether permanence has ongoing relevance

¹⁸ Tuow, K. (2006). *Firmitas re-visited: Permanence in Contemporary Architecture*. Architecture. Waterloo, University of Waterloo. Master of Architecture: 93. Pg 11.

¹⁹ Frampton, K. *Intimations of Durability: Notes on Architecture and the Theme of Time*, Harvard Design Magazine Fall 1997

today. Each society has different drivers and values that cause it to have differing views on the relevance of permanence. The next paragraph explores the impact of society's values on the relative permanence of architecture. Then I will argue the case for the ongoing relevance of permanence today.

7. Symbolic and material economies and their influence on permanence

*"Our houses will last less time than we do, and every generation will have to make its own"*²⁰ This quote dates from the 1914 *Future Manifesto of Architecture* by Antonio Sant'Elia²¹. Now almost 100 years old, the words have proven to be very accurate. The way we live our lives is constantly changing.

Luis Fernandez-Galiano uses the terms 'symbolic economy' and 'material economy'²² to describe why some buildings last (relatively) longer than others. In the realm of the symbolic economy *"if a building becomes a revered icon, society will ensure its endurance, continuously repairing the ravages of time so that it always appears fresh and newly born."*²³ This can be seen to occur where a building survives despite the high cost of maintaining it or substantially rebuilding it as in the Parthenon, the Villa Savoye or the Pompidou centre²⁴. According to Fernandez-Galiano, in the material economy *"durability depends on such mechanisms as rates of interest and returns on investment; the higher the rates, the faster the return and the flimsier the construction."*²⁵ Permanence and durability are undermined by these underlying economic imperatives.

Tokyo is an excellent example of the effect of the material economy on permanence. In his article *What goes up must come down*²⁶, Bognar discusses the constant remaking of Tokyo. The economic forces on property cause rapid change in the cityscape where *"land is scarce and notoriously expensive."*²⁷ Bognar cites a number of Tokyo buildings of architectural significance which no longer exist such as Toyo Ito's Nomad Restaurant and Bar (existed for three years before demolition), House by Kazuo Shinohara (existed

20 Frampton, K. *Intimations of Durability: Notes on Architecture and the Theme of Time*, Harvard Design Magazine Fall 1997 Pg 28

21 Braham W W, Hale J A, and Sadar J S Ed's. *Rethinking technology : a reader in architectural theory*, New York, NY : Routledge, 2007

22 Fernandez-Galiano, L. *Architecture and the Symbolic economy*, Harvard Design Magazine Fall 1997

23 Ibid. Pg 44

24 Ford, E. *The Theory and Practice of Permanence*, Harvard Design magazine Fall 1997 Pg. 15

25 Fernandez-Galiano, L. *Architecture and the Symbolic economy*, Harvard Design Magazine Fall 1997 Pg 44

26 Bognar, B *What Goes Up, Must Come Down*, Harvard Design Magazine Fall 1997

27 Ibid. Pg 34

for ten years before demolition) and Tokyo City Hall by Kenzo Tange (existed for thirty five years before demolition). He speculates that perhaps these buildings would have survived in other cities with lesser economic imperatives or in Western cities where there is a greater attachment to the idea of permanence. Bognar gets to the heart of the issue when quoting Nyozeikan Hasegawa. Bognar writes that

*"...the importance of tradition in Japan 'lies not so much in preserving the cultural properties of the past as giving shape to contemporary culture.'"*²⁸

Bognar's article on Tokyo, written in 1997, quotes a staggering statistic from 1993: *"more than 30% of all [its] structures... has been built since 1985."*²⁹ Thirty percent of Tokyo's buildings were built in eight years between 1985 and 1993. In 2011 a further 18 years have passed. One wonders if there is anything left from the periods pre 1985 at all. This city would seem to be the antithesis of permanent and yet it is one of the most modern and influential cities in the world. We must therefore acknowledge that permanence at least in the medium term has not been a necessary condition of a modern city. Clearly in a city like Tokyo where economic imperatives are extremely high, even great architectural works are not symbolic enough. They can become outdated before they become dilapidated (to use Bognar's description).

In this scenario of the modern city we can look at the medium term as being twenty to forty years and the long term being a minimum of two to four hundred years. If permanence is not a necessary condition for a city in the medium term, as illustrated by Bognar's Tokyo, then the relevance of permanence must belong in the longer term. Such are the scale of our cities now that it is surely unsustainable for any city to rebuild itself time and again. There are insufficient resources to perform this type of reconstruction on the scale of Tokyo city in perpetuity. In the long term then there must be a place for permanence in dwellings as much as in public buildings.

I agree that the material economy and (to a much lesser extent) the symbolic economy are important drivers behind the relative permanence of individual buildings and examining these drivers assists in our understanding of the impact of societal values upon the relevance of relative permanence to that society. Tokyo is an example of a society whose values align more closely with the concept of architecture as an event and thus does not value relative permanence. Nevertheless I do consider that relative

²⁸ Bognar, B *What Goes Up, Must Come Down*, Harvard Design Magazine Fall 1997. Pg 37

²⁹ Ibid. Pg 34

Figure 3 U-House in Nakano, Tokyo, 1976 by Toyo Ito. Demolished 1997

permanence is relevant today. The next paragraphs of this chapter argue the case for the ongoing relevance of permanence .

8 Permanence fulfilling a human need

Despite the fact that it is perceived to be impossible, a number of prominent theorists suggest that our (Western) society still clings to and needs the concept of permanence. Hannah Arendt in her book *The Human Condition* argues that this human need persists from Greek times:

“By their capacity for the immortal deed, by their ability to leave non-perishable traces behind, men, their individual mortality notwithstanding, attain an immortality of their own and prove themselves to be of a ‘divine’ nature.”³⁰

While perhaps today this need to attain immortality is more subconscious than in previous times, Ford argues that *“the idea that important buildings should be not only durable but also permanent is so integral with the Western idea of architecture as to escape notice, except by those critical of Western civilisation as a whole.”³¹* He questions how, given the amount of maintenance and replacement conducted on traditional architecture such as the Parthenon and Venice, we can as a society widely perceive them to be original. He argues that

“The ...numerous reconstructions of the Parthenon have been universally suppressed by common consent, subject to a kind of collective amnesia in which the modern replacement is treated as the original.”³²

Similarly, Tuow argues that *“pre-relativity perspectives are lingering and merging, or rather conflicting, with relative perspectives, to the detriment of material durability.”³³* She is suggesting that while modern society understands time is relative, when we talk about permanence we often discuss it in absolute terms. This can lead to confusion where there is an expectation of absolute permanence in materials which can only ever be relatively permanent. She argues that absolute permanence is still a powerful myth

30 Arendt, H *The Human Condition*, The University of Chicago Press, London (1998) Pg 19

31 Ford, E *The Theory and Practice of Impermanence*, Harvard Design magazine, Fall 1997 Pg 14

32 Ibid. Pg 3

33 Tuow, K. (2006). *Firmitas re-visited: Permanence in Contemporary Architecture*. *Architecture*. Waterloo, University of Waterloo. Master of Architecture: 93. Pg 7

Figure 4 Vietnam War memorial Designed by Maya Lin 1982 Washington DC. An example of symbolic persistence inspiring interpretation.

within our society³⁴ which is bound with ideas of immortality and answers a fundamental human need.

9 Durable architecture and its contribution to memory and thought.

In her article *Architecture and the Perfectibility of Memory*³⁵, Sandy Isenstadt argues that architecture endures in two senses. The first (more prosaic) sense of endurance is that architecture is generally constructed of hard and typically more durable materials. This is consistent with the traditional ideas of durability and relative permanence. The second sense in which architecture endures she calls *symbolic persistence* and is the power of architecture to remain meaningful by '*its ability to prompt interpretation for generations beyond its creation.*'³⁶ Architecture, she says:

*"...improves memory by recasting it in materials more permanent than itself so that persons, events, and thoughts will endure. In this sense durability in architecture is more than merely material fact; it is a philosophical and epistemological proposition. Truth, or at least veracity, is based on the faith that the past can be made external and objective. Things that endure – time honoured, timeless, everlasting – seem somehow to contain more truth than do ephemera. Durability at some point becomes a kind of validity."*³⁷

Isenstadt discusses this in relation to war memorials in Washington. One example she gives is the Vietnam War memorial, a long stone wall with the names of all the American soldiers killed in the war engraved on it. It is set down below normal ground level at what Isenstadt calls the '*space of the dead*'³⁸ Its power is to '*compels us with its power to keep alive the memory of the dead.*'³⁹

In one sense these ideas can be seen as explaining what Fernandez-Galiano saw as the role of the symbolic economy in terms of its contribution to, and effect on, architecture. However Isenstadt is actually discussing the reverse situation; the contribution of architecture to the durability of memory, ideas and thought of society rather than the

34 Tuow, K. (2006). *Firmitas re-visited: Permanence in Contemporary Architecture*. *Architecture*. Waterloo, University of Waterloo. Master of Architecture: 93. Pg 8

35 Isenstadt, S. *The Interpretative Imperative- Architecture and the Perfectibility of Memory*. Harvard Design Magazine, Fall 1997

36 Ibid.

37 Ibid. Pg 58

38 Ibid. Pg 61

39 Ibid. Pg 61

contribution of societal values to the durability of the physical architecture. Further to this Isenstadt writes:

“Architecture’s contribution to the durability of thought differs not in degree from that of a book or a hard drive but rather in kind. It is a medium less for conveying information than for provoking commitment. By doing so, by creating conviction, architecture helps determine what will be remembered... Because it persists locally in space and time, and substance, architecture inspires us, in unique fashion, to remember.”⁴⁰

Symbolic persistence in architecture then, is less a matter of architecture reflecting societal values than of architecture continuing to inspire interpretation and durability of memory of thought by society. The interpretative imperative is architecture’s contribution to remembrance in an age of imperfect memory. This idea differs from reification in that architecture that inspires interpretation is not a reflection of one universal idea; more that it is capable of inspiring multiple ideas and thoughts to different people.

I certainly agree with Isenstadt that great architecture contributes to society’s durability of thought. This is one of the ways in which architecture responds to fundamental human needs, and in my view is another reason why relative permanence in architecture is still relevant and worth aspiring to today. The longer the relative permanence of architecture, the greater its contribution to societal memory and durability of thought. If we view architecture as an ‘event’ whose primary virtue is productive shock rather than its value in prompting ongoing questioning, interpretation and thought, then a deeper level of emotion and thought may very well be lost.

10 Conclusion

In this chapter we saw that permanence can be viewed in both absolute and relative terms. Although Western societies often discuss architecture in terms of absolute permanence (implicitly or explicitly), this conflicts with our modern understanding of space and time which leads us to understand that architecture is only relatively permanent. This confusion contributes to what Ford describes as the collective amnesia under which we continue to regard old buildings such as the Parthenon as original despite the constant rebuilding. Societal values (expressed by Galiano-Fernandez as the

⁴⁰ Isenstadt, S. *The Interpretative Imperative- Architecture and the Perfectibility of Memory*. Harvard Design Magazine, Fall 1997. Pg 62

material and symbolic economies) clearly have an influence on the relative permanence of individual buildings and the relevance of permanence to that society.

Although Sola-Mirales view of 'architecture as event' in essence dismisses permanence as irrelevant to our society, others argue that it is inherent within Western society and that it does have ongoing relevance. Viewing permanence as a continuum and as part of an ongoing cycle of production, as argued by Tuow, may well assist permanence to become a more useful concept in modern society.

My own view is that permanence is still relevant today. Material and economic drivers of society that have over the past century increasingly made relative permanence as irrelevant are changing, worldwide. I argue that aspiring to relative permanence in architecture facilitates, over time, the dialogue between the architecture and society that Isenstadt calls the "interpretative imperative". This allows built architecture to contribute in a deeper and richer way to society's thoughts and memories over time than ephemeral architecture. Surely this is the fundamental function of great architecture?

In the next chapter we will look into how relative permanence can be equated with the concept of durability and how mass, materials and detail all contribute to durability.

CHAPTER TWO DURABILITY

In the previous chapter we discussed that in our modern society, the concept of absolute permanence is no longer thought attainable in practice, and that architecture can only ever be relatively permanent. Durability can be equated to relative permanence. It is self-evident that the period for which an object (or piece of architecture) resists wear and decay incorporates the concept of “relative” permanence, which measures permanence in relation to time. The longer the period an object can resist wear and decay, the greater its relative permanence. In this chapter I will look further into the concept of durability, and the physical aspects of architecture that relate to it (namely, mass, material and detail).

1 Concept of durability

The Concise Oxford English dictionary defines ‘durable’ as *“capable of lasting, not transitory; (of goods) remaining useful for a period, not immediately consumed; resisting wear, decay etc”*.

It is important to note however that durability is also linked to usefulness or value to the user as well as time. Petroski makes this point when talking about kitchens and bathrooms, which although they have hardly worn are no longer fashionable: *“Durability does not equal long-lasting serviceability”*.⁴¹

Societal and economic values, which were discussed in chapter 1 as being relevant to the relative permanence achieved by architecture, are also relevant to the concept of durability. Petroski uses a comparison between books, bridges and buildings to illustrate the effect of societal and technological values on durability. We do not expect some things, such as books, to endure as long as others such as bridges and buildings. He adds that *“over time, societal... values change, and even when created with the best of materials, things once held in high regard can fall from grace.”*⁴². He uses books as a metaphor. Where books were once highly valued and kept for future generations, now the availability of copiers, CD-ROM and the internet have devalued these. This devaluation has been going on since the first book was copied, through the invention of the Caxton Press until today. The implied parallel is that the faster and cheaper we

⁴¹ Petroski, H. *The Gamble of New Technologies* Harvard Design Magazine Fall 1997 Pg 21

⁴² Ibid. Pg 19

can make houses the less we value them, as the easier they are to replace. In this way durability is directly connected to the values we as a society have for both architecture and the materials used in it.

Bognar's discussion of the influences on Japanese society in the way the Japanese value durability, make for fascinating reading. He argues that

"... complex conditions and powerful sources challenge any simple understanding about "normal" courses of aging, and necessitate a substantial reinterpretation of the issue of "durability" in architecture and the built environment".⁴³

Bognar cites a number of diverse influences (both historic and current) which have essentially lead to the huge rate of destruction and construction of architecture in Tokyo relative to the rest of the world: a long history of natural disasters (primarily earthquakes and fires); expensive land prices relative to construction; substantial annual real estate and inheritance taxes; the influence of Buddhist teachings; the tremendously skilled, innovative and capable workforce; the competitive nature of commercialism; a culture of impermanence and with no individuation or objectification; and a culture which viewed human dwellings as only temporary shelters.

Bognar argues that all these influences have created a notion of impermanence in Japanese culture. He concludes that

"Contemporary design in Japan is characterised by lightness, surface, fragmentation, and dissolution, often with a 'ruinous' quality, a sense of temporality, imageability, sensuousness, and, finally, a spectacular phenomenalism- all attributes of the ephemeral...it favours ambiguity, transparency and perceptual instability".⁴⁴

This is a society which does not value durability as a concept; thus architects and owners expect their buildings will only last a few years. Or to put it another way, the period of durability expected in Japanese culture (as measured by its value to the user) is far shorter than in traditional Western culture.

Western countries (both historically, and to a lesser extent today) tend to value more

⁴³ Bognar, B *What Goes Up, Must Come Down*, Harvard Design Magazine Fall 1997 Pg 34

⁴⁴ Ibid. Pg 40

Figure 5 The Parthenon, the acropolis Athens 2004

The durable elements attain relative permanence.

highly the concept of durability and expect a relatively longer period of durability. According to Ford, in traditional theory durability and permanence were expected of public architecture, and that this expectation still persists today. Ford points to a number of monumental buildings which survive because they have largely been rebuilt:

*“there is ample evidence that we do have a deep-seated need to believe in the permanence of traditional buildings, and we have developed a tendency to overlook these instances when these works fail to meet our expectations”.*⁴⁵

In his book *The Secret Lives of Buildings*⁴⁶ Edward Hollis reviews the lives of the Parthenon. It was originally built to be a magnificent temple for Athene. The Parthenon has now, he explains, been built a number of times. It was first ruined when it was changed from a temple into a Christian church. It was ruined secondly in 1867 when a shell hit a magazine of gunpowder stored in the Parthenon during a siege and destroyed the whole of its centre. It was dismantled around 1834 in order to rebuild it as close to the original as possible with the remains, from centuries of abuse, which lay on the ground around it. In 1894 an earthquake destroyed a large part of the almost-complete reconstruction. The latest reconstruction (in which again every stone was again removed and rebuilt) was itself caused by rapid deterioration due to corrosion caused by acid rain acting on the steel added in the previous reconstruction. The corrosion and expansion of the steel was breaking the marble. When I visited and photographed the building in 2004 an almost complete structure in stone was visible behind the scaffolding. No timber no steel and no terracotta tiles were to be seen-only white marble. The durable and massive parts of this building have endured for more than two thousand years. The latest reconstruction was due for completion in 2010 when the Parthenon will be 2,443 years old.

The Parthenon has therefore been threatened with destruction by a combination of new elements (acid rain and steel inserts) just as surely as it was by siege and war. It is only through the constant rebuilding that the building has survived. Hollis says *“One day, all that will be left of the Parthenon will be fragments imprisoned in museums;”*⁴⁷ Interestingly in the last sentence Hollis introduces the idea of reification (that was previously discussed in chapter 1): *“Then, liberated from physical being, the Parthenon*

45 Ford, E. *The Theory and Practice of Impermanence* Harvard Design Magazine, Fall 1997, Pg 2

46 Hollis, E. *The Secret Lives of Buildings* Metropolitan books, New York, 2009

47 Ibid. Pg 35

will have become nothing but an idea, and at last it will be perfect.”⁴⁸

Although there are many Western architects that take a similar view to the Japanese, there are others that still see durability as valuable and relevant. Thomas J. Campanella argues that Western consumers are experiencing a cult of durability:

“The appearance of durability and ruggedness in our accessories comforts us. It appeals to us as we age, and we are an ageing population. It is almost as if we project upon the artifactual world our own desires for longevity and immortality. Durability also appeals to our sense of nostalgia, for many of us recall childhood appliances, toys and other artifacts which were “made of iron”.”⁴⁹

I therefore define durability as being a period which is the lesser of the object’s resistance to wear and decay, and its value to the user/ owner. I will next discuss the relevance of mass, materiality and detail on durability.

2 Mass

One major component of durability is mass- mass of materials, and mass of architecture. This section will discuss briefly mass of materials and then the effect of the mass of an architectural form on its durability.

Mass of materials

Materials with greater mass are generally more durable. The denser a material is, the more resistant it is to deterioration caused by water and decay. For example stone, even more than concrete, has “a high gross density, great strength, great surface hardness and high thermal conductivity”.⁵⁰ Stone for this reason (as well as because it has been used for centuries) is associated with “stability, authority and tradition”.⁵¹

Mass of architecture

Traditionally in Western architecture there has been an idea that “architecture is the expression of permanence through solidity and mass.”⁵² Proponents of this idea

48 Hollis, E. *The Secret Lives of Buildings* Metropolitan books, New York, 2009 Pg 35

49 Thomas J Campanella *Mythologies of the Sport Utility Vehicle*, Harvard Design Magazine, Fall 1997 Pg 30

50 Hegger et al *Basics Materials* Birkhauser, Basel 2009 Pg 39

51 Ibid. Pg 39

52 Ford, E. *The Theory and Practice of Permanence*, Harvard Design magazine Fall 1997 Pg 15

inherently link mass with the idea of monumentality and durability.

One such theorist was James Fergusson. He was a great proponent of massiveness in architecture, primarily on the grounds that size was a prerequisite to architectural grandeur.⁵³ He viewed mass as the first principle of architectural grandeur, believing that, when all other things were equal, larger was more imposing; and not just a little better but better by the amount of the ratio of relative sizes. Twice as large equalled twice as grand or effective.

Fergusson suggested strength was the next most important element of architectural grandeur. He wrote:

*"By this is meant, not merely the strength required to support the roof or to resist the various thrusts and pressures, but that excess strength over mere mechanical requirement which is necessary thoroughly to satisfy the mind, and to give to the building a monumental character, with an appearance that it could resist the shocks of time or the violence of man for ages to come."*⁵⁴

According to this view of 'more is proportionally better', excess of mass or strength is to be desired.

Durability to Fergusson is the compliment to stability, i.e. the two concepts are interlinked. He also clearly links mass to durability, but also acknowledges that this is an impression of durability rather than an outcome. *"Sculpture and painting, when allied to architecture, may endure as long, but their aim is not to convey to the mind the impression of durability which is so strongly felt in the presence of the more massive works of architectural art."*⁵⁵ Even as a proponent of great mass in architecture, Fergusson was aware of enough great buildings in ruin to acknowledge they did not last forever. Nevertheless he insists that great architecture is required to give the impression of durability via mass:

"In this respect the great art of the architect consists in obtaining the greatest possible amount of unencumbered space internally, consistent in the first place with the requisite amount of permanent mechanical stability, and next with such an appearance of superfluity of strength as shall satisfy the mind that the building is perfectly secure and calculated to last for

53 Fergusson, J. Third edition *History of Architecture in All Countries* John Murray London 1893 Pg 16

54 Fergusson, J. Third edition *History of Architecture in All Countries* John Murray London 1893 Pg 17

55 Ibid. Pg 19

Figure 6 Blue Mosque Istanbul 2004, exterior. Slender minarets belie the mass of the mosque

Figure 7 Blue Mosque Istanbul 2004 Interior. Massive scale decorated with tiles.

ages.”

This idea of the ‘art’ of architecture being inextricably linked to mass is far less popular today amongst theorists. It is hard to defend the promotion of more structure than is required in a time when we recognise the responsible use of limited resources. The influences of the ‘material economy’ as argued by Fernandez-Galiano have made the idea of using unnecessary mass and materials to convey an impression of strength and durability a rarity and a luxury. Similarly much light must be sacrificed for massive structures in the way Fergusson proposes. Buildings like the Parthenon and the Pantheon have a satisfying imposing effect of mass and stability, but perhaps their air of permanence is less to do with their mass than the fact that they *have* survived for centuries.

In this century, modern architectural thinking is moving further away from this concept of mass as a necessary prerequisite to durability in architecture, and indeed away from permanence towards ideas of beauty from economy, weightlessness and ephemeral architecture. Although it is argued in chapter three that there is still a case for the concept of permanence and durability in architecture, the idea that this must necessarily include large mass is in my view an outmoded one.

3 Materials

It is self-evident that durability in built architecture is inextricably bound with the materials used and the maintenance of those materials. By equating relative permanence with materials position permanence can be positioned with durability as previously discussed. Tuow points out that as Shadi Nazarin writes “[O]ur conception of permanence is intimately linked to our conception of both time and matter.”⁵⁶ If matter deteriorates, it marks time. As materials all have limited durability they can be only relatively permanent. Relative permanence relies on, and is inherent in, any particular material - whether it is a teak or it is granite.

What is the durability or degree of permanence that can be expected from materials? Henry Petroski writes that it depends on the inherent quality of the relevant materials and the workmanship. He also discusses two other factors which affect ageing of material.

⁵⁶ Tuow, K. (2006). *Firmitas re-visited: Permanence in Contemporary Architecture*. Architecture. Waterloo, University of Waterloo. Master of Architecture: 93. Pg

These are “*the intentions of the owner, designer; and constructor;... and the quality of maintenance.*”⁵⁷ This section will first discuss the inherent qualities of material, the effects of weathering, maintenance, and lastly the impact of societal and technological values on durability of materials.

Inherent qualities of material

All materials have unique qualities which lend that material to certain uses. It is the art and the science of the architect to select the best material for each part of a building, which selection in turn depends on “*the intentions of the owner, designer; and constructor*” for durability as identified by Petroski. Concrete makes for a durable floor, timber for rafters, glass for windows. What then are the inherent properties which assist the architect to determine where a material can best be used to achieve the required durability?

These are firstly the substance and the surface of a material. The appearance of the surface is important but so is the substance- for example when many natural materials are cut, planed or polished the appearance changes in the cross section. The end grain of timber is different from the face, and in natural materials, the face changes with every layer which is planed off of it. Strength (in tension, compression and shear), ductility and formability, transparency, hardness, water resistance, heat transfer, resistance to decay are some on the scientific side.

In addition to the inherent physical qualities of each material the architect may also consider what Hegger et al⁵⁸ refer to as an “associative material quality”. This is the symbolism attached to some materials. Due to societal values these associations may have great influence in a material’s selection. Marble can be associated with wealth and timber with economy. But what happens when we use glass for a stair? There are many opportunities for an architect to engage people and challenge their perceptions by taking one particular quality of a material and using it in a novel way.

Weathering and Maintenance

Weathering is time played out on a material. It generally affects the surface first, then the core of the material. The appearance of weathering is obvious and must be taken

57 Petroski, H. *The Gamble of New Technologies* Harvard Design Magazine Fall 1997 Pg 19

58 Hegger et al *Basics Materials* Birkhauser, Basel 2009

into account at the design stage. A building is only new once, and for the rest of its life its appearance is subject to weathering.

Maintenance and the degree to which it is undertaken, will impact on the durability of materials (and hence the architecture). This is where the intentions of the owner (as identified by Petroski) become relevant to durability. Given that there is no known material that endures to absolute permanence, architecture must be maintained in order to fulfil the owner's intentions of durability (if this is a relatively long period). The alternative to maintenance is replacement, or simply allowing architecture to decay.

Ford argues that given the increasingly technical nature of our construction materials, if we continue to equate architecture with durability (or relative permanence) then society's expectations of maintenance need to increase:

*"The obvious solution to the altered nature of modern construction is to alter the nature of construction methodology: to recognise the need for sophisticated long-term maintenance and for the replacement of parts, to acknowledge that, whatever its imagery, a Modern building is a complex piece of equipment and must be treated accordingly, and to place architect, contractor and user in a long-term relationship"*⁵⁹.

Nevertheless he does not argue that implementing this will be easy.

Influence of society and technology on materials and craftsmanship

Technology and science have given us new materials to design with such as ACM (Aluminium Composite Material) and connection details which rely on sealants. Demetrios Porphrios with others such as Ford argue that over time our society has come to over-rely on technology, leading to a separation of the practitioner from the practice, turning a building contractor from a craftsman into an assembler of parts. Demitrios Porphyrios cites this as a reason for what appears to be an increasing incidence of construction failure:

*"Building materials have become mere technological products; that is, they make no demand upon our skill, knowledge or attention. Their properties, their functioning and their constructional behaviour... are all today concealed."*⁶⁰

The implications of this, he explains, are that knowledge of properties of materials are

59 Ford, E. *The Theory and Practice of Impermanence*, Harvard Design magazine Fall 1997 Pg 7
 60 Porphyrios, D. *High Tech and Such Misnomers*, Harvard Design Magazine Fall 1997 Pg 66

not required; contractors and architects are distanced from the craft of building and “... *skill is replaced by incompetence.*”⁶¹

Petroski points out that new materials are often put into the market for use promising a serviceable life that is longer than these materials have existed. “*Durability tests, when conducted, are accelerated; the effects of time and the elements are extrapolated rather than interpolated.*”⁶² The same can be said of untried construction techniques. These new materials and new techniques are best used on buildings designed for impermanence, designed for limited life spans, until they have over time built up a proven record.

The influence of society and technology can be seen not just in the durability of new materials, but in new ways of using old materials. In 2002 Leatherbarrow and Mostafavi wrote that rather than materials being ‘of our time’ the future of materials is important. Technological developments in materials provide us with new properties “... *which play an important role in constructing unprecedented architectural and spatial effects.*”⁶³ Glass is a material which has been used for thousands of years but it is only in the last 100 years that industrial processes have been developed to allow it to be manufactured as a flat sheet. Further and continuing development has meant there are many different properties available for many different uses.⁶⁴

Today architects deal in large panes of high tech glass, extruded aluminium, stainless steel and reinforced concrete in modern architecture. These are the materials with which we distinguish the new from the old. They allow spans greater than ever before, transparency, strength, openness and light filled spaces like never before, and versatility that belongs to this age and not the age of stone and timber.⁶⁵ From these new materials, and those which are being developed currently, we are able to make new forms which mark our time.

Therefore it can be seen that materials and maintenance remain of fundamental importance in achieving the intentions of the owner, designer and constructor as to

61 Porphyrios, D. *High Tech and Such Misnomers*, Harvard Design Magazine Fall 1997 Pg 66

62 Petroski, H. *The Gamble of New Technologies* Harvard Design Magazine Fall 1997 Pg 21

63 Leatherbarrow, D & Mostafavi, M. *Surface Architecture* Massachusetts, MIT Press 2002 Pg 214

64 T. Conder *Materials* BRANZ Porirua New Zealand 2008 Pg 25-56

65 Frampton, K. *Intimations of Durability: Notes on Architecture and the Theme of Time*, Harvard Design Magazine Fall 1997

durability. Petroski argues that because of the new materials being produced

*“the challenge today in achieving durability is not so much to appreciate its value but to find the budget, materials and product that can deliver that value over time”.*⁶⁶

4 Detail

Having discussed the relevance of mass and materials to durability the effect of detail on durability will be examined. Firstly I will discuss what detail is, then how it affects durability, and finally how new technological materials and ideas in architecture are impacting on the importance that detailing plays in durability.

What is detail? Detail is a joint. It is an intersection of materials. Detail occurs where different materials meet, at the end of an element, a change in plane or the connection to another material to address a specific condition. It is in layering, opening and finishing. For something as simple as a door in a wall, detail is present where the architrave bridges the tolerance or gap between wall and door frame. It also helps express the opening and it keeps the weather out.

Detail works for architecture on several levels. It resolves issues of connection, change in materials and of the direction of materials; it enhances design; and it is of fundamental importance in determining the durability of buildings.

Detail is the answer to problematic environmental conditions, thermal bridging, and it can delay the impact of weathering. It can express structure or it can cover it. Detail can be used to give (or take) line, direction, shadow, texture, depth and meaning from materials. And it can be positive or negative. Detail can be ornament and it can be covered by ornament.

Detail can articulate the general design or even contradict it. As Ford says

“A detail is considered articulated to the extent to which it expresses and demonstrates the resolution of the problems of weight, material, connection and assembly. When it expresses the opposite – absence of weight, an indifference to material, a lack of apparent connection, and an

⁶⁶ Petroski, H. *The Gamble of New Technologies* Harvard Design Magazine Fall 1997 Pg 21

Figure 8 Glenn Murcutt hand drawn details elegantly resolving a change in direction along a deck

apparent disregard for the elements- it is seen as abstract. Another means of abstraction is the degree to which the building is an ideal form perceived as a whole and not as a series of parts.”⁶⁷

Detail properly put together will enhance durability. A simple drip edge constructed correctly can ensure a much extended life to materials exposed to rain.

“The term ‘weathering’ was, in fact, originally defined as that part of a building that projected beyond the surface of any external wall and served as a ‘drip,’ in order to throw off rainwater.”⁶⁸

And incorrectly designed, detail can deliver water onto a material thereby accelerating its deterioration and decreasing its durability. This has been the subject of much damage and rewriting of building codes in New Zealand in recent times, for example the Hunn Report to the Building Industry Authority 2002⁶⁹.

Many architects and theorists are concerned with our increasing over-reliance on technology, as mentioned by Porphyrios, and whether there is *“something inherently flawed in the practices of modern construction”⁷⁰*, as evidenced by many recent high-profile failures which appear to be the result of failures of both building contractor and architect. Glen Murcutt is an architect who pays close attention to detailing. In the book *Glenn Murcutt: a Singular Architectural Practice*, he laments the lack of focus in architectural education on observing natural phenomena and our over-reliance on technology. His view is that understanding natural forms, structures and, studying constructed forms is learning to design from nature. An exercise he was required to conduct as a student was detailing a south-facing doorway, which brought to the fore all the design issues of access and weatherproofing.⁷¹

Ford argues that increasing amounts of different building components and environmental controls required by clients have pushed...

“modern construction techniques away from the solid and monolithic wall toward the layered and veneered... While failures of these veneered systems

67 Ford, E. *Five Houses Ten Details*, 2009, Pg 11

68 Leatherbarrow, D & Mostafavi, M. *Surface Architecture* Massachusetts, MIT Press 2002 Pg 33

69 Hunn D, Bond, I, Kernohan, D. *Report of the Overview Group on the Weather tightness of Buildings to the Building Industry Authority*, 2002.

70 Ford, E. *The Theory and Practice of Impermanence*, Harvard Design magazine Fall 1997 Pg 17

71 Beck, H & Cooper J. Glen Murcutt: *A Singular Architectural Practice*. 2002 Pg 15-16

are not uncommon there is likewise no shortage of successfully installed and maintained examples of these same assemblies. They are quite obviously dependant on proper detailing and installation in ways other assemblies are not”⁷².

In other words detailing is becoming increasingly more critical to durability in modern times than ever before because of the complexity of modern materials and construction techniques.

And yet at least one prominent modern architect argues that *“Details should disappear - they are old architecture”*.⁷³ Ed Melet in his book *The architectural detail: Dutch architects visualise their concepts* argues that this plea from Rem Koolhaas stems from his desire to give priority to the concept in his architecture instead of trying to give it an inviolable, perfect look. This new approach is termed ‘NO-Details’ and is described by Melet as follows:

*“The purest form of NO-Details is the detail at which the material seems to be juxtaposed without any interventions.”*⁷⁴

The NO-Detail can best be seen in monolithic materials such as concrete which can be continuously poured through floors, up walls and around corners, avoiding joints and bypassing the usual change of direction issues in facades. This NO-Detail approach would seem to be a useful one in detailing for large mass. However, as Melet makes clear, the NO-Details approach

“are part of the danger that Koolhaas deliberately integrates into his buildings. That something will go wrong during building is accepted to a certain extent because it sometimes leads to new experiences in the building which could not have been anticipated in advance”.

5 Designing for durability: catering for flexibility

It was concluded above that one essential component in durability is the value of the object (or architecture) to the user/ owner. Many buildings (and some of our oldest examples) have endured as a result of changing the functionality of the space within

72 Ford, E. *The Theory and Practice of Impermanence*, Harvard Design magazine Fall 1997 Pg 17

73 Rem Koolhaas SMLXL, Rotterdam 1995

74 Melet, E. *The architectural detail: Dutch architects visualise their concepts*, Pg 15

it. Some good examples include the Pantheon in Rome, which has survived by being reused. The Villa Savoye has survived through its symbolic importance to society but continues to survive now through its change of use into a museum visited by architects and students. Change of use is helpful if not strictly speaking necessary for permanence.

One architect who has considered the issue of relative permanence (or durability) in architecture in depth and how to increase the value to the user over a relatively long period of time is Bernard Leupen in his book *Frame and Generic Space*⁷⁵. In his introduction Leupen lays out the essential problem of designing permanent architecture:

*"The average lifespan of a dwelling lies somewhere around 100 years... House designers are faced with the task of giving form to the enclosure that, for those 100 or so years, is to provide shelter for dwelling, and activity that is continually subject to change. Many mutations in household make-up and the associated spatial rituals occur in the course of time. Flexibility and changeability are the keywords when faced with the unpredictable."*⁷⁶

Leupen talks above about a 100 year lifespan. Therefore we can put his work in the category of relative permanence as described in the previous chapter. This 100 years he considers is a long enough period to encompass change which cannot reasonably be predicted. This thesis by design considers how a domestic dwelling might still be relevant in 200 to 400 years. The difference between 100 and 400 years may only be one of technical and material competency for the architect and one of maintenance for the owners. This is because if the building can allow for the space within the frame to change sufficiently to satisfy the needs of the users (as Leupen suggests) then the problem of longevity becomes one of durability rather than permanence alone.

*"If a dwelling is to stand the test of time it has to be able to accommodate every imaginable kind of inhabitation and use."*⁷⁷

Here Leupen is suggesting by the words "habitation and use" two different ways to stand the test of time. One is an acknowledgment of the changing ways we inhabit spaces through use of the word *habitation*. And the second suggests that the *use* may change within a building and this also needs to be accommodated.

⁷⁵ Leupen, B. (2006). *Frame and generic space* Rotterdam: 010 Publishers

⁷⁶ Ibid. Pg 9

⁷⁷ Ibid. Pg 19

Leupen analyses buildings with a view to separating each into two different conceptual parts. These are the *frame* and the *generic space*. The frame is the permanent part, the more durable component.

Leupen writes

*“This present study takes not the changeable but the permanent as its departure-point. This I hope will open up new perspectives. The permanent, meaning the more durable component of the house, constitutes the frame within which change can take place.”*⁷⁸

Leupen proposes that this frame concept could be used as a design tool ⁷⁹.

Looking at his methodology for analysing five case study buildings. Leupen breaks down the buildings into five categories. Each one of these categories can be considered to be the frame. That is, each one can be the frame of the building in the sense that the frame is the *permanent* part. Therefore the other parts of the building can be freely altered - they are free to be impermanent.

These are

- Structure - columns beams, load bearing walls etc,
- Skin - the cladding for facade base and roof,
- Scenery - internal cladding, internal doors and walls finishes of floors, walls and ceilings,
- Access - stairs corridors lifts and galleries,
- Services - pipes and cables appliances and special amenities⁸⁰.

78 Leupen, B. (2006). *Frame and generic space* Rotterdam: 010 Publishers. Pg 9

79 Ibid. Pg 10

80 Ibid. Pg 32

6 Conclusion

This chapter discussed the concept of durability, and noted that by equating permanence with materials we can position permanence with durability. It was argued that durability can be defined as a period which is the lesser of the object's resistance to wear or decay, and its value to the user/ owner. It examined whether mass in architecture was a necessary component of durability and concluded that it was not, although it visually referenced permanence. The influence of materials, maintenance and detailing on durability was discussed. It is clear that societal values (incorporating economic values) and new technologies are impacting now perhaps more than ever on durability itself, in particular via the materials being produced and used in architecture, new ways that traditional materials are being used and that they are also underscoring the fundamental importance of detailing and maintenance. Chapter three will examine three case studies which illustrate different ideas and aspects of permanence and durability explored in chapter one and in this chapter.

Figure 9 Villa Savoye, abandoned weathering and deteriorating 1959

Figure 10 Villa Savoye, renovated 2003

CHAPTER THREE CASE STUDIES

This chapter will look at three case studies of buildings, each of which has been chosen to illustrate different aspects of the literature review on permanence which were outlined in chapter 1. The first (Rafael Moneo's cathedral of Our Lady of the Angels) is an international non residential project. The second (Le Corbusier's Villa Savoye) is an international residential dwelling and the third (Pip Cheshire's Congreve house) is a local residential dwelling. This chapter will show how the case studies relate to aspirations to relative permanence, symbolic persistence and the durability of architecture on thought and memory, permanence of function and space, architecture as event and reification. In addition each case study will investigate durability and analyse the architecture using the three main components of durability (mass, material and detail).

CASE STUDY 1

Cathedral of our Lady of the Angels- Los Angeles (Rafael Moneo)

The Roman Catholic cathedral of Our Lady of the Angels is located in the archdiocese of Los Angeles, California. The cathedral is a large and prominent building located in an area known for significant and regular earthquakes. The new cathedral was designed to replace the previous one damaged in the 1994 earthquake, magnitude 6.7.⁸¹

The brief required that the cathedral:

- Last five hundred years,
- Survive a major earthquake,
- Be a place of refuge in time of disaster.⁸²

Rafael Moneo was selected for this project through a design competition. His philosophy and approach show he is ideally suited to the long-term vision of this cathedral. As William J R Curtis writes *“He continues to be committed to the notion that architecture is there to endure; that it should crystallize values and conserve them.”*⁸³ This is consistent with the aims of the client for durability and for creating a sacred space that embodies the values of the Catholic Church. In an interview (including discussion on the cathedral) he confirmed his personal commitment to architecture and permanence:

*“Today there are those who wish to think of architecture only in relation to instantaneity and action. But in my opinion architecture can and should aspire to a certain endurance.”*⁸⁴

81 http://en.wikipedia.org/wiki/1994_Northridge_earthquake#Damage_and_fatalities

82 N. W. Roberts 2003 Design as materials research: building a cathedral to last 500 years Arq 7 3 April 2003

83 El Croquis 98 *Rafael Moneo 1995–2000*. 2000 Pg 41

84 Ibid. Pg 27

Figure 11 exterior of cathedral

Figure 12 cathedral, detail of concrete bell tower

Absolute and relative permanence

This building is the clearest example encountered of modern architecture that aspires to relative permanence. Although the architect has a personal philosophy that architecture should aspire to a certain endurance, it is doubtful that the cathedral would have been designed and constructed with such a degree of relative permanence had it not been for the brief (in particular, the requirement of the brief that the cathedral last 500 years). This *“design life was unheard of in the Southern California construction landscape, known for its rapid obsolescence and ephemeral structures.”*⁸⁵ The brief has caused the architect, the executive architects and the technical teams to carefully consider the design and in particular the materials to fulfil this brief as much as was technically, practically and economically feasible within budget.

This kind of relative permanence (combined with the size and mass of the cathedral) requires the confidence to aspire to a high degree of relative permanence. This degree of investment in the cathedral, as well as the sacred nature fulfilled by the architecture, should mean that the cathedral is relatively permanent (even if that is less than the 500 years required by the brief).

The cathedral is highly visible and occupies a prominent site in downtown Los Angeles. Because of its site, aspirations to permanence, massive scale and function as a cathedral, it should contribute considerably to the ‘durability of thought’ in both the communities it serves and the community it occupies. In Isenstadt’s terms, the cathedral has, and should continue to have, a high degree of symbolic persistence. It should continue to provoke interpretation, conviction, commitment and remembrance. Certainly this was what the architect intended:

*“I envision a cathedral that is a prominent part of the urban landscape, a permanent reminder of God’s presence in our midst. It will be visible from many points to many people.”*⁸⁶

No doubt because of the client, the cathedral harbours no aspirations towards flexibility of function but has accommodated to the extent possible flexibility of use within the scope of religious worship. The design of the cathedral

“refers back to the history of the Church in its Latin cross plan, orientation

85 N. W. Roberts 2003 Design as materials research: building a cathedral to last 500 years Arq 7 3 April 2003, Pg 336

86 Moneo, R A *Cathedral of, and for, Los Angeles* Los Angeles Times 22 September 1996

and iconography, but is also designed to accommodate future developments. Large areas of flexible seating allow for a range of liturgies around the altar and font, infrastructure is designed for new technology, and nine of the eleven chapels will be completed in the future...⁸⁷.

Durability

The cathedral has a high degree of durability in terms of the built architecture. As will be explored below, considerable time, effort and money was expended ensuring that the cathedral can resist decay and wear for hundreds of years. The architect also devoted considerable time and attention to ensure the cathedral fulfilled the needs of the Catholic Church, the parish and (as far as possible) future worship, in other words the value to the user/ owner. The main reason the cathedral was built to accommodate 3,000 worshippers was because of the 4,000,000 Catholics in Los Angeles and because the old parish cathedral with seating for 1,200 had regularly been packed to capacity for special ceremonies and liturgies.

Mass

The cathedral is an extremely massive building. Early on, the Church realised that the site of the church it was built to replace was inadequate and selected the new site, which now also needed to encompass the Cardinal's residence, the Parish Centre, a car park and a public square or plaza. The architect noted that the effect of the new large (around 39,000m) site, *"allowed me to think of the whole thing as a sort of compound settled on a platform."* The end result is a cathedral that is 99m long and 36.5m high, has a 5,574m² footprint and has a total seating capacity of 3,000. In addition to its size, its sheer mass of concrete (around 42,000 m²) adds to its overall feeling of mass, solidity and permanence.

Materials

The materials selected to achieve this durability requirement of 500 years were;

- Concrete, which in some cases was reinforced with stainless steel,
- Glass,
- Alabaster for glazing,
- Limestone floor paving stones,

- Copper roof,
- Bronze doors.⁸⁸

Inherent qualities of material

The bulk of the building is constructed in architectural concrete (there are 18,825 cubic yards⁸⁹ of concrete used). This is used for lateral bracing, for carrying vertical loads, and for floor diaphragms.

When interviewed about the materiality and specifically the concrete of the cathedral the architect said:

*"Thinking of the direct use of stone in churches of the past, I was against using cladding. I wanted the material and substance of the building to be seen from the beginning... You could relate this consistency of the material to some of the Ruskinian 'Lamps'! I am thinking precisely of what Ruskin calls the 'lamp of sacrifice'. It is a way of recognising the dignity of the building itself."*⁹⁰

In other words, it was important to Moneo that the means of supporting the building and the finished materials should be what they appear to be, not an applied veneer over a concealed structure.⁹¹

Twenty-gauge copper was chosen for roofing. Lead was dismissed on the basis of cost and safety reasons. This material could easily last 100 if not 200 years.

Moneo chose to use alabaster for glazing because, although relatively opaque compared to glass, it filters light into the building during the day and at night the building glows. The warm colour generated can be seen for miles due to the large expanse of glazing (2500m²) and the building's elevation. It was also a requirement of the brief that the cathedral should be a beacon of light at night. Alabaster's durability can be assured in its natural environment due to its inherent properties. Examples are still extant of alabaster used in Roman tombs. However the environment high up in a wall of the cathedral in Los Angeles is not similar to its natural environment in the quarry in Zaragoza, Spain.

88 M.-C. Durkin *A short Tour of The Cathedral of Our Lady of the Angles* Los Angeles, 2004 Strasbourg, France, Editions de Signe Pg 6

89 N. W. Roberts 2003 *Design as materials research: building a cathedral to last 500 years* Arq Vol 7 No 3 4 April 2003 Pg 336

90 El Croquis 98 *Rafael Moneo 1995–2000*. 2000 Pg 26-27

91 N. W. Roberts 2003 *Design as materials research: building a cathedral to last 500 years* Arq 7 3 April 2003 Pg 337

Figure 13 Cathedral interior showing alabaster window

Figure 14 cathedral interior view

Accordingly a curtain wall of laminated glass was required to keep the alabaster sufficiently cool for it to remain translucent and protect it from the effects of prolonged cleaning, projectiles from the street, smog and acid rain and seismic forces.

It is important to note that the design and construction process allowed for exceptional research and testing on each material to ensure it could meet the brief both in terms of the required permanence and functionality testing of these materials. This is because the construction contractor had been appointed at an early stage and had accepted a Guaranteed Maximum Price contract. In trying to build for exceptional durability, either new ways must be explored, or traditional 'tried and true' principles must be used. In this case, as the architect and technical teams proposed to use new materials or forms or combinations, this needed to be tested at the 1:1 scale as the contractor did.

Weathering and Maintenance

As would be expected of a building designed to last 500 years, significant attention was paid to the effect of weathering. Materials were specifically selected for their resistance to weathering, and all materials were stress tested to ascertain how they would perform in various conditions (e.g. seismic events, heat). The building programme specifically included assumptions regarding maintenance, including a regular programme of cleaning and sealing the building, and incorporated elements into the design to facilitate maintenance, such as a bosun's chair inside the curtain wall for the alabaster, allowing for the replacement of services, and allowing for flexibility to add services via a service tunnel and crawl space.

Influence of society and technology on materials and craftsmanship

The cathedral has been highly influenced by technology in respect of both materials and craftsmanship. Considerable technology was employed to ensure that, as far as is currently possible, the materials selected would be durable for as long as possible. The craftsmanship with respect to the poured-in-place concrete in particular, was considerable. Experts in the fields of acoustics, concrete, lighting, base isolation and stress testing laboratories were all employed in addition to the usual engineers, architects and executive architects.

Detail

This building has been rigorously detailed after significant research and testing to cope with weathering, seismic events and replacement of parts. As would be expected, significant detailing and testing was conducted on the concrete so as to meet the architectural and structural design, and extend its durability as far as possible:

- An extra one inch of concrete cover over the reinforcement, or where this was not possible, stainless steel rebar;
- Using a penetrating breathable silane sealant;
- Rigorous specification of the concrete and its preparation and pouring to achieve a dense and impervious concrete that had a low hydration heat.

The copper roof was detailed with a flashing that drained to the interior so that rain would not wash pollutants down the face of the building. The curtain wall protecting the alabaster was also significantly detailed.

Given the history of earthquakes in the region, the size and frequency of earthquakes needed to be taken into account in the design and engineering. The building was designed with base isolation to separate and isolate it from the predicted ground movement. The system incorporates 149 high damping rubber isolators and 47 stainless steel slider bearings. It also incorporates four friction pendulum isolators for the bell tower. These support the 55, 800 tons of the building. A full 685mm of lateral movement can be tolerated with the system. Therefore when the ground moves suddenly the building does not.

Allowance for replacement of services was an important principle if the building was to remain fully functional immediately after a significant seismic event. It is likely (despite the base isolation system) that there will be some damage after a large earthquake, particularly to services. By incorporating space around the services in the sub floor these service lines can be accessed for repair if necessary. The ability to rapidly effect repairs allows the building to continue to fulfil its brief and function for hundreds of years after a significant seismic event.

It is also feasible that some of the base isolation foundations will be damaged during a seismic event. Allowance has been made to replace the isolators. Room has been made for removal of the bearings below the foundations. Additionally the building has in

place lifting devices adjacent to each isolator for raising the building enough to replace a damaged bearing.⁹² As with the services, the ability to replace such significant parts of the building is designed to allow the cathedral to continue to serve its purpose for hundreds of years after an earthquake.

Similarly the building systems are also designed for replacement, recognising that they will not last the life of the building. For example, ducts for ventilation are located in the attic space and the crypt where they can be accessed. Where ducts penetrate the concrete structure the duct is formed in the concrete itself. Ball joints connect piped services to the building at the point where they cross the plane of isolation.⁹³

These are some of the ways the building has been explicitly designed and detailed to ensure it is extremely durable, has a useful life beyond a significant earthquake and also beyond changes in systems. Allowance for replacement of parts (whether due to changes in available technologies or due to earthquake damage) is key to the long term survival of any building. It is also key to the long term survival of the community who use the cathedral.

Conclusion

It is clear that permanence and durability have both been fundamental drivers for the cathedral, and that exceptional effort and thought has gone into designing the cathedral for both, as well fulfilling the rest of the functions required by the brief (cathedral, parish meeting place, cardinal's residence). The architect's preoccupation with form and material is also evident, and the mass of the cathedral adds to the air of endurance. The cathedral does not appear to have flexibility of function in mind, no doubt given the client's stated aim for the cathedral to be in use as such for the next 500 years.

92 N. W. Roberts 2003 Design as materials research: building a cathedral to last 500 years Arq 7 3 April 2003 Pg 342

93 Ibid. Pg 347

CASE STUDY 2

Villa Savoye, Poissy, Yvelines (Le Corbusier)

This dwelling has been selected as a case study because of its importance in the history of architecture (being an early and exemplary example of modern architecture) and primarily by way of contrast to the other two case studies due to its recorded deterioration. This house is significant because it has achieved its relative permanence to date not so much through its mass, materiality or durability but because of its symbolic persistence, or through the influence of the symbolic economy, which was discussed in chapter 1.

According to Le Corbusier, the architect, the clients (a Parisian insurance broker, Pierre Savoye, and his wife) had *'no preconceived ideas whatsoever: neither modern nor old-fashioned'*.⁹⁴ However Morel-Journel points out that they contacted him after seeing his completed Ville-d' Avray. Although the brief was detailed, Corbusier saw their programme as straight forward:

*"They had a magnificent park consisting of meadows surrounded by forest; they wanted to live in the country; they were 30 kilometres from Paris. This meant being able to arrive at the door of the house by car, and it is the minimum arc of curvature of a turning car that determines the size of the house itself."*⁹⁵

Absolute and relative permanence

Le Corbusier was uninterested in permanence (whether absolute or permanent) as a concept. His whole objective with this house was to realise his ideas on new concepts underpinning modern architecture. This is clear from his views on the future of the Villa Savoye at the time when it was dilapidated and its future insecure:

*"One of the objectives of the Maison Savoye will be to serve as a point of departure in the Western hemisphere for an alternative means of research (other than academic) into architectural development from ancient times to the modern day"*⁹⁶.

The greatest contributor to the relative permanence of the Villa Savoye is its value to

94 Morel-Journel, G. *Le Corbusier's Villa Savoye*, Editions du Patrimoine, Paris 2000 Pg 6

95 Ibid. Pg 6

96 Sbriglio, *Le Corbusier The Villa Savoye*, Berlin 2008, Pg 114

the symbolic economy, rather than its mass, detailing, materiality or durability. It has *symbolic persistence*, to use Isendstadt's term. This villa is an icon of modern architecture and it remains, as any monument does, to remind people what it stands for. Because it stands today it can be seen and experienced by a new generation who have the chance to reinterpret it for themselves. The storm of protest at the building's possible destruction and its subsequent establishment as a listed public building attest to the value of the building to society. The saving of the building was called for by French, British, Brazilian and U.S. architects in 1958.⁹⁷

The Villa Savoye is also an excellent example of 'architecture as an event'. In July 1931 when the building was first completed, it resulted "*from the force of projective mechanisms capable of promoting intense, productive shock*"⁹⁸. It did in fact achieve (although not immediately) precisely that intense productive shock within architectural circles and wider culture. It is for precisely this reason that its preservation was ultimately assured: if it had not been such a revolutionary building, society would not have valued it sufficiently highly to invest in such a costly renovation, thus assuring its future and relative permanence (compared with its otherwise imminent demise).

The Villa Savoye can also be seen as embodying the concept of reification where "*The physical thing can be constructed and re constructed time and time again, and throughout this it is the representation or concept which remains and is the permanent*". The dwelling was worked on for restoration or maintenance purposes in the years 1963-1967; 1977; 1983-1985; 1985-1992; and 1997. This building is maintained and restored to illustrate Modern architecture in the 20th century. It is considered a landmark⁹⁹ and the best example of Le Corbusier's idea of a "machine for living" and his five basic points of a new architecture.¹⁰⁰ It now has government protection as a listed monument and this ought to assure its maintenance and survival for many years to come.

The Villa Savoye can be said to have relative permanence of function in that the house, which was to be a country retreat for a Parisian couple with one child, is now a museum. It is possible that this private dwelling could have achieved permanence of

97 Time Art: Stompin' on the Savoye, Mar. 23, 1959

98 Sola-Morales *Topographies of Contemporary Architecture* Pg 104

99 Time Art: Stompin' on the Savoye Monday, Mar. 23, 1959

100 Morel-Journel, G. *Le Corbusier's Villa Savoye*, Editions du Patrimoine, Paris 2000 Pg 38

Figure 15 Courtyard of Villa Savoye in an advanced stage of degradation.

Figure 16 Courtyard of Villa Savoye 2003

space through adapting to the changing requirements of consecutive private owners, if its durability had not been such an issue. For example, the servant quarters could have become family or guest bedrooms once servants became too expensive to keep (as Corbusier had already foreseen). Much is written about the 'free plan' of the house whereby internal space is free to be used in infinite ways due to the structure being independent from the walls. This allows for non load bearing walls to be moved and adapted relatively easily. In theory, this free plan admits of many uses and therefore permanence of function. Indeed, the house was proposed to be used during the process before the major restoration variously as a museum, teacher's lodgings or as a head office for a girl's school. However it is interesting to note that Corbusier wanted the house restored exactly to its original plan: *"I think I am right in following the path of truth, that is, returning the construction to its original state."*¹⁰¹ My own view is that altering the interior layout or the function of the Villa Savoye too far from its initial function (i.e. a private dwelling) would destroy the very reason for which the building has symbolic persistence. The building's permanence of space/ function, and its impact on the symbolic economy are therefore inextricably entwined.

Durability

Soon after the house was completed (1931) it was discovered that it leaked. Morel-Journel points out that the first restoration project began at this time and he notes the architect *"seems to have taken little interest in the proceedings!"* This house never kept out the rain and the architect and contractors could not fix the problems. The owners visited the house little after 1938 and soon abandoned it, as it was found to be uncomfortable and exacerbated their son's health problems. We do not know if there was ever any specified length of time that this house was expected to last but it is fair to conclude the clients' expectations would have been for longer than the nine years before it was abandoned, especially given its expense.

101 Sbriglio, *Le Corbusier The Villa Savoye*, Berlin 2008, Pg 122

In 1940 German soldiers took it over, occupied it and looted it.¹⁰² By 1958, when 27 years old, the Villa Savoye was a ruin, it was expropriated and there were plans to build a school on the site. The dwelling had deteriorated fast because of its abandonment and the war (in addition to its inherent waterproofing issues) and in these states there was no maintenance undertaken. We cannot conclude this was a durable building by any means. Judging the villa by the Oxford dictionary definition of durable as “remaining useful” the dwelling can be said to be useless, a complete failure.

Mass

The dwelling is constructed mainly of reinforced concrete and concrete masonry with a plaster coating inside and out. All posts, beams and floors are constructed in concrete cast on site. These are materials with mass. However, although constructed mainly in concrete and externally plastered and painted all in one colour, the building does not project as much mass as it might. There are a number of reasons for this. One reason for this is the stark white colour, which does not convey gravity and mass. However the main reason for its apparent lightness is the elevation of the main volume of the building up to the first floor and over slender round columns. This dwelling, although connected to the land through the ground floor and its basement cellar, appears to float. This floating image is helped by the solid part of the ground floor being set back from the first floor on all sides and in shadow or, painted a darker more recessive colour. Another factor is the placement of the window openings in the exterior walls. These extend almost the full width of all four elevations showing the first floor wall to be a façade and not a solid form because you can see through them to the open interior. Conversely it is the thin walls of the solarium which are curved and appear the most solid and massive because they appear to enclose a volume without openings.

Le Corbusier was a master architect and every move was a deliberate one. As previously noted it was not his intention to convey the idea of permanence through mass and solidity in this building or he would not have raised it on slender columns. Corbusier was looking forward towards a new architecture.

“The pilotis carry the immeasurable weight of the house above the ground, up in the air....The centre of gravity of the architectural composition has been raised; it is no longer that of the old masonry architectures, which

102 Time Art: *Stompin' on the Savoye* Monday, Mar. 23, 1959

implied a certain optical relationship to the ground.”¹⁰³

Refer to figure 10.

Materials

Inherent qualities of materials

As noted above, the structure of the villa was in reinforced concrete, the floors in concrete of lost-tile construction, and the external walls of two layers of concrete masonry and all rendered inside and out. The plaster system used was a high quality with a “*specialised worker brought over expressly from Switzerland to apply the exterior rendering*”.¹⁰⁴ These materials are inherently durable and it appears there was much consideration given to getting the outer layer of waterproofing and finish just right with the selected render.

The new modern architecture required new materials, or materials used in new ways, which had for example, smooth and continuous surfaces consistent with the desired aesthetic. This is what Hegger et al refer to as “associative material quality” and is achieved in the white smooth and flat render to the box form of the villa. The symbolism in this external cladding is consistent with the modern and new architecture promoted by Le Corbusier at the time.

Weathering and Maintenance

Photographs taken of the building when it was in an advanced state of degradation show that the plaster render had largely fallen off, exposing the reinforced concrete structure and infill concrete masonry walls. Some of this concrete is rough looking and the concrete masonry exhibits porous faces. These naked walls allow for accelerated rates of water ingress without a protective render. They are the result of weathering and no maintenance. It is the abandonment which prevented any maintenance (painting and repairs) which allowed water to penetrate the plaster and push it off the concrete.

We can see in Figure 9 the “cyclical concept of time” which Frampton discussed, returning the constituent parts of the building to their original form. The steel reinforcing, for example, where exposed is beginning to rust away, expanding and breaking the concrete which in turn falls and breaks into smaller parts.

103 Sbriglio, J. *Le Corbusier :the Villa Savoye* Birkhauser 2008 Pg 45

104 Ibid. Pg 104

Figure 17 Villa Savoye, detail of window joinery

Influence of society and technology on materials and craftsmanship

In chapter two I noted that materials and maintenance remain fundamental to achieving durability, and the values of society have a fundamental impact on both materials, attitudes to maintenance and durability.

The durability of the Villa Savoye was impacted profoundly by new societal values being advanced by Le Corbusier- specifically, the complex construction due to the radically different design and on-site construction of the elements required to achieve it, and the lack of maintenance. As Sbriglio notes:

*"Given that Le Corbusier was experimenting with new concepts on both a functional and formal level, it is understandable that he found himself faced with such a thorny construction process. In addition, the situation was hardly alleviated by the fact that, in the late twenties, building firms were still entrenched in traditional skills and techniques and were consequently out of step with the requirements of modern architecture."*¹⁰⁵

The lack of maintenance of the Villa Savoye was due to the abandonment of the owner (which in turn had been caused by the constant and unresolved weatherproofing defects of the dwelling since it was first occupied), and the interruption of WWII. This allowed the materials to weather significantly quicker than might have been the case if regular maintenance had been undertaken. In the case of the Villa the first priority of maintenance was to address the leaks and it appears that this was never done satisfactorily. Secondly with the building abandoned, routine repainting would not have been undertaken and water would have penetrated the render and in a relative short period of time caused the render to break away from the substrate. These materials used were however relatively inherently durable and perhaps because of this the building did not suffer complete collapse.

Detail

Edward Ford posits that

"Few would describe Le Corbusier as a great detailer. He lacked the patience, the eye for precision and perhaps even the technical knowledge... However he was able to develop detailing systems that reproduced, on a small scale,

105 Sbriglio, J. *Le Corbusier :the Villa Savoye* Birkhauser 2008 Pg 103

*the organisational ideas of the buildings themselves".*¹⁰⁶

Le Corbusier and Pierre Jeanneret were aware of some good detailing practices as can be seen in the drawings of the exterior windows of the elevations at the first floor. These provide for proper weathering (drip edges) at both the head and sill. His timber joinery details show an understanding of movement in timber and how to cope with this. These particular detailing issues of the drip edge and timber movement due to temperature and moisture, however, would have been known about resolved and refined over hundreds of years. The areas where the building failed immediately were different to these.

Sbriglio writes that the

*"...villa's complexity ...resides in the fact that the dwellings various spaces - notably the vertical sections - are interwoven rather than juxtaposed... This reasoning called for intricate construction details, fusing enclosed, covered zones with non-enclosed yet covered areas and other spaces which are veritable open air rooms... It is... easy to understand why waterproofing problems would ensue from the fully or semi-transparent walls whose frames were of different types. Indeed, the water seepage suffered by the villa as of its earliest days stemmed from insufficient waterproofing of the various roof terraces, skylights, glazed roof sections and planters."*¹⁰⁷

And yet, rather than fully detail and resolve these issues before commencing construction, Le Corbusier's approach was to never strictly finalise tender documents and estimates so as to keep solutions open, and rely on a trusted pool of construction companies¹⁰⁸. This is not only costly; it also no doubt contributed to the lack of weatherproofing that eventuated, with disastrous consequences. The building is now watertight. This suggests that details and practices over time have caught up with the complexity of the ideas Le Corbusier was attempting to explore.

106 Edward R Ford *The details of Modern Architecture* 1990 Japan Pg 241

107 Sbriglio, J. *Le Corbusier :the Villa Savoye* Birkhauser 2008 Pg 100-103

108 Ibid. Pg 96

Conclusion

There is no evidence that the Villa Savoye was designed with any kind of permanence in mind. Its architect was at the time instead committed to exploring new ideas in architecture. Le Corbusier was however keen to see this house preserved and devoted considerable effort later in life to ensuring this would be the case *"Houses can die as well as men, but if there's a way of saving them, so much the better."*¹⁰⁹

The Villa Savoye has achieved relative permanence precisely because of its location within time as an exemplar of modern architecture. Whether this house achieves a state of relative permanence will be determined by the continuing significance of this house to architecture and wider society, given its history of deterioration and poor detailing.

109 Time Art: *Stompin' on the Savoye* Monday, Mar. 23, 1959

CASE STUDY 3

Congreve House, Takapuna (Pip Cheshire)

Absolute and relative permanence

This house is a significant departure from the more usual timber framed houses built in New Zealand. Although concrete houses are not new in New Zealand, this house is deliberately massive and it is constructed almost entirely in concrete. Furthermore it wears its concrete proudly, demonstrating it is unashamedly massive and therefore different.

The clients for this house wanted *“a serious piece of architecture”*.¹¹⁰ According to Erica Congreve *“We wanted to break the mould of traditional New Zealand architecture,”* *“That tradition was usually to build in wood...”*.¹¹¹ The architect of the Congreve house said:

*“In the design process there was a preoccupation from the outset with an architecture of massiveness, permanence, and ‘bruteness’, to mark a change which has to do with a country now more certain about its place in the world.”*¹¹²

The architect and client wished to mark a change in the certainty of the country about its *“multiple heritages, strong landforms and clear convictions. Once a permanent occupation of the land becomes conceivable, then so too does architecture as a conscious exercise in object-making”*.¹¹³

It would be easy to speculate that this house will be relatively permanent because this is the impression the house deliberately conveys through its mass and materiality. The house was constructed in 1993 and so insufficient time has passed to comment in terms of relative permanence with any degree of conviction.

This house is a product of the material economy- it was built for a wealthy couple and it was rumoured to be extremely expensive to build. It remains to be seen whether this house becomes part of the symbolic economy. The house has been recently sold and only time will tell if this house survives the process of change.

110 P. Neville. The House That Art Built *NZ house & garden*, Oct 2006; n.146: Pg 24

111 Ibid. Pg 24

112 Jasmax, editor Stratford Pg 242

113 Hunt, J. Architecture without disguise: *Architecture New Zealand* 1994 Pg 28

Although the client did not specify the period of time that this house is expected to endure for (permanence of space) we can nevertheless consider whether there is permanence of function. The house was for a couple with adult children. It has four bedrooms. The house is very large by New Zealand standards at 1000m². It has accommodated 180 people for an Opera recital. But how would it respond to more people living in it? It does not appear to have any flexibility in planning other than the open plan nature of the living/dining and kitchen spaces. Given that the internal structure is also concrete, it would also appear that spaces cannot be easily rearranged to accommodate different ways of using the house. Given its massive concrete construction and lack of standard tolerances in the detailing, it appears extremely unlikely that the house could be made smaller or larger without significant demolition. Therefore it would appear that the Congreve house lacks flexibility of function. This could be a very limiting factor in the durability of the house, i.e. its value to the owner/ user.

Durability

This ought to be a low maintenance building. The materials should not require replacement as they are not affected by the wind and rain and claddings do not rely on painting to be kept up. In time the roof membrane will need to be replaced. If this is not done, the whole of the structure could eventually be undermined through water ingress and consequent corrosion of the steel reinforcing. Steel window frames will need repainting regularly, particularly given the coastal location and the susceptibility of steel to corrosion due to salt.

The construction of the exterior walls contributes significantly to the relative permanence of the structure. The same material (concrete masonry) is used inside and out. The inner skin is structural because it is hollow and in the process of construction is filled with concrete reinforced with steel. The outer surface is a brick veneer of solid concrete masonry separated from the structure by a cavity and insulation. The concrete masonry is a porous material taking in moisture (rain) which can be driven through by wind. The lower course of the veneer is set below the floor level and there are gaps in the mortar between some of the units. The purpose of the cavity is to recognise that wind driven moisture penetrates this material and it allows this water to run down the surface and out through the gaps (weep holes). The cavity allows the external veneer to act as a rain screen sheltering and buffering the structure. Ford considers the 'rain screen' principle

Figure 18 Congreve House view from driveway

Figure 19 Congreve House entry detail

of building significantly superior to monolithic walls¹¹⁴.

The Congreve house has no base isolation system which will always limit its longevity if a large earthquake occurs.

However, as previously discussed, there is a significant question concerning the durability of this house, when considering its ongoing flexibility and use to the owner/ user.

Mass

The house *“explores ‘bigness’ through mass, complexity within apparent simplicity and richness through the use of variations within a limited range of materials,”*¹¹⁵ says Cheshire. This house is all grey and weighs in at 22, 000 tonnes. The massiveness of the grey concrete is enhanced by the squared-off modern and box-like form. Even the roundness of the wall at the entry and porte cochere canopy confirm the house is a solid mass and not just a wall or veneer. The house is large enough not to be intimidated by its position. The scale is deceptive though. It does not look like 1000m² of house, perhaps this is because a fair portion of it is underground. Building below ground can be seen as a strategy for anchoring the dwelling.

From the entry to the site the view is all of concrete masonry of one or two stories. The curved roof canopy over the poolside pavilion accentuates the height of these walls.

The interior exposes the mass no less than the exterior with its interior walls of the same concrete and concrete masonry. The first floor slab is exposed, demonstrating the monolithic form to its best effect. There is little doubt that the Congreve house, through its enormous mass, conveys an impression of durability and permanence.

Materials

The bulk of the house is constructed in concrete. The basement, ground floor, first floor and roof are all cast-in-place reinforced concrete slabs. Cast elements also include the columns to the covered walkway, the four large (800x800mm) columns of the “room within a room” that is the living room,¹¹⁶ the columns to the eastern exterior canopy and the suspended reflecting pool.

114 Ford, E. *The Theory and Practice of Permanence*, Harvard Design magazine Fall 1997 Pg 17 - 18

115 Hunt, J. *Architecture without disguise: Architecture New Zealand* 1994 Pg 27-34

116 Ibid. Pg 31

Figure 20 Congreve House, parapet detail

Figure 21 Congreve House, bedroom interior

The walls are of concrete masonry shells solid filled with steel reinforced concrete to form the structure. These are faced on the exterior with concrete masonry bricks as a veneer or a rain screen. These are the same height and width as the structural blocks and so the walls read as a monolithic element inside and out.

The concrete masonry units are a non standard module developed specifically for this project. This fact alone distorts the scale of the building. The blocks used in the Congreve house being smaller than the typical concrete block module.

Roof flashings which weather the building (in the original sense of projecting from the face of the building) are lead. This is a material which has a long history of use in this way because it is easily manipulated by hand to follow complex forms. It returns quickly to a dull grey colour which is consistent with the concrete. Floors are parquet timber laid in a herring bone pattern. Parquet is seldom used in New Zealand private houses.

Weathering and Maintenance

This building is too young to have weathered significantly and be showing signs of aging. The materials are durable and low maintenance. The house sits on the coastline and is subject to salt spray. Original drawings have the roof flashings made of copper but these were changed to lead. The copper would have leached over time causing staining on the concrete. This was avoided by using lead instead and shows little sign of weathering.

Detail

At first site there does not appear to be a lot of detail in this house. This is deceptive. Where do the services, fixtures and fittings run and sit when there is no ceiling cavity or timber wall framing? They must all be accommodated within the floor slabs and concealed wall spaces. There are no facings or architraves where the simple and minimal steel windows butt into the masonry openings. When the services, fittings and fixtures require replacement, it is far from clear that they can be easily reached and replaced. This could be a significant factor in the durability and relative permanence of the house.

There are no standard tolerances that a timber framed house might accommodate within the width of facings etc. In this way the fine proportion of the steel window frame contrasts with the concrete reveal each showing the other up for its massiveness or fineness through the contrast. This lack of standard tolerance will also not easily admit

of changes to the structure, as there is no place to hide any joins or insertions.

Conclusion

The Congreve house is unusual in New Zealand because of its exuberance of size and mass, and the exploration of the idea of permanence in the design and selection of materials. The scale of the building is both appropriate and deceptive. It is appropriate in that it sits on top of a cliff looking east across the bay to Rangitoto island. It is an elevated site with an impressive view. The house is large enough not to be intimidated by its position. The scale is deceptive though. It does not look like 1000m² of house, perhaps this is because a fair portion of it is underground.

Given its mass, its form and its predominance of visible concrete this house looks like it is there to stay. It has durability of materials and appears to be appropriately constructed of reinforced concrete with a rain screen and cavity. It should also be a low maintenance house because of the materials selected. Left alone (but with some maintenance) this house could easily last 100 to 200 years unless an earthquake occurs which is larger than the house was designed to withstand. However there is a significant question mark over the longevity of the Congreve house due to its lack of flexibility. This is a house not easily demolished, but if its planning and internal spaces cannot keep pace with changes in the way future occupants live then it is far less likely to survive.

Conclusion for case studies

Each of the three case studies can be seen on a continuum in terms of their aspirations to permanence. The cathedral of Our Lady of the Angels has clear and unambiguous aspirations to relative permanence (500 years), the Congreve house has far more modest aspirations to mass, solidity and endurance, and the Villa Savoye had no aspirations towards permanence at all. Very few clients have the confidence to aspire to, or the necessary means to fund, relative permanence on the scale and for the length of time that the Catholic Church has for the cathedral of Our Lady of the Angels. The Congreves had no specific aspirations to relative permanence but were certainly aspiring to quality architecture that was massive, sculptural and durable and marked a change in the certainty of the country about its heritage, landscape and convictions. Perhaps New Zealand is too young a country for its citizens to aspire so clearly to relative permanence in the same way as in other parts of the world. Ironically, the Villa Savoye, which had no aspirations towards permanence (rather, towards a new ideas of architecture) has achieved a degree of relative permanence only through sheer force of the ideas that sit behind it.

The cathedral of Our Lady of the Angles and the Villa Savoye are good examples of both the influence of the symbolic economy on the relative permanence of architecture and the interpretive imperative argued for by Sandy Isenstadt. Both concepts deal with the interaction of architecture with societal values, ideas and memory. The cathedral is a relatively new building, but because of its function, its size and mass and the prominence of its location, it should endure as a landmark on the cityscape and through its longevity contribute to its community's memory, durability of thought and representation of collective belief. One of its roles is to invite visitors to question their religious convictions and commitments. The Villa Savoye on the other hand owes its survival to its value to the symbolic economy, where it has become in Fernandez-Galliano's terms a revered icon such that *"society will ensure its endurance, continuously repairing the ravages of time so that it always appears fresh and newly born"*¹¹⁷. The Villa Savoye, as an icon of modern architecture, invites a new generation of visitors to reinterpret the role of architecture in life ('a machine for living in') and question the ideas sitting behind the house (industrialised building systems applicable to all types of buildings).

117 Fernandez-Galiano, L. *Architecture and the Symbolic economy*, Harvard Design Magazine, Fall 1997 Pg 44

The Villa Savoye is an excellent example of the idea of architecture as an “event”. This dwelling was explicitly designed to represent ideas that would cause an intense productive shock to society. Certainly Le Corbusier had no aspirations to permanence and if it had not had such an impact on society the Villa Savoye would have in reality amounted to relatively ephemeral architecture (due to disastrous detailing and lack of maintenance).

The Villa Savoye also can be seen as an embodiment of the writings about reification, in that the number of restorations required to make and keep the building watertight have essentially meant that little is retained of the original except the ideas. The ideas behind this building are of paramount importance, are the reason for the building’s current relative permanence, and may very well endure beyond the building itself. The number of restorations and the amount of maintenance also attests to the illusion of durability that Ford refers to.

All of the case studies show in different ways the effect of societal values and technology on their permanence in terms of materials, detailing and maintenance. In the case of the cathedral, societal and technological values have impacted on the materials of the building obviously in terms of intensely technical uses (e.g. the protection of alabaster by a laminated glass curtain wall), by durability testing, rigorous detailing and the extensive use of technical experts and by the intensely collaborative approach taken by them. The Congreve house wears its expansiveness (and its expense) proudly- a large house for wealthy owners. The technology used in this house is considerably more conventional than the other two case studies, but nevertheless shows in the non-standard concrete masonry units, rigorous standard of workmanship for the concrete in particular, and the exacting nature of the detailing admitting of no standard tolerances. The Villa Savoye was clearly an experimental house whose ideas far outstripped the technological advances of the time. The decisions of Le Corbusier to use a monolithic form, long horizontal fenestration, using white painted rendered concrete, were all based on his ideas of industrialised building systems and the architecture that the new modern society should aspire to. The abandonment of the Villa by the owners (and the advent of World War II) also impacted significantly on the durability of the house and its materials.

None of the case studies selected show any attention has been paid by the architect to achieving permanence of space, in other words flexibility of function. None of the

case studies readily admit of other uses, which may be a limiting factor in their actual durability or relative permanence. However the Villa Savoye has shown some limited flexibility of function by changing its use to a museum from a private dwelling.

Clearly there are factors other than mass, materials and detailing which impact on relative permanence and durability. Some of these can not be designed for, or if designed for, can not be guaranteed for example the ideas behind the design may become symbolic as in the case of the Villa Savoye. The next chapter explores the New Zealand historic context for dwellings and how this impacts on our aspirations for relative permanence. It also documents the selection of a Wellington site for the design. The last chapter takes the lessons of these case studies and develops them in the design of a single dwelling to test permanence through mass, materials and detail in the Wellington context.

CHAPTER FOUR

DESIGN - THE LAST SITE SOUTH

This chapter discusses the design of a permanent house to be located on the south coast of Wellington, New Zealand. This chapter includes analysis of the site, discusses the design strategies and decisions and how the theories and ideas from the previous chapters and the case studies were tested in the design.

1 A brief history of permanence and earthquakes in NZ

Early construction in New Zealand to today

Pre-European Māori built in raupo and timber, which was a natural fit with their tradition and available technology.

The oldest remaining dwelling in New Zealand is a timber one. The Kemp house in Kerikeri was constructed in 1821 of timber (kauri, totara and puriri) on concrete piles.¹¹⁸ This type of house with its simple plan and form, its verandah, hipped roof and rear lean-to was used and developed in the following 170 years in New Zealand¹¹⁹. It is interesting that concrete piles were used instead of timber.

One of the oldest buildings in New Zealand (and the oldest and first stone building) is the Stone Store in Kerekeri, built between 1832 and 1835 for the Church Missionary Society (CMS) and located adjacent to Kemp House. The building is constructed of local stone generally, with some imported stone. The Stone Store is significant as the earliest intact stone building in New Zealand and demonstrates colonial adaptation to the use of local basalt, with sandstone imported from Australia for lintels, corner stones and real quoins.¹²⁰ Fowler and van de Voort refer to the 'fireproof store'¹²¹ which would be sufficient justification for the construction technique given the importance of the warehouse building in holding stores from Australia and England and as an integral part of the CMS supply network.¹²²

There were also a number of stone cottages built in the early days of European settlement

118 Fowler, M and van de Voort, R. *The New Zealand House*. Lansdowne Press: Auckland, 1983

119 Ibid.

120 Cochran, C. *Historic Buildings of new Zealand North Island*. Edited by Frances Porter. Methuen: New Zealand, 1979.

121 Fowler, M and van de Voort, R. *The New Zealand House*. Lansdowne Press: Auckland, 1983 Pg 16

122 Jones, Martin. *Stone store, Brief History*, New Zealand Historic Places Trust Pouhere Taonga <http://www.historic.org.nz/TheRegister/RegisterSearch/RegisterResults.aspx?RID=5>

in New Zealand. These were thought to be preferable to timber. However, as Salmond notes, in 1885 *The Yearbook of New Zealand* recorded that stone, like brickwork, was expensive and vulnerable to earthquakes:

*"In 1858, of the 12,812 houses in New Zealand almost eighty percent were made of wood, 2^{1/2} percent of brick or stone, and the rest of other materials including earth, raupo, and canvas"*¹²³

Residential concrete construction was used in New Zealand in the 1800's with a couple of houses from the 1860's still surviving.¹²⁴ Eleven houses are still standing from the 1870's. Geoffrey Thornton relays an account from 1852 of a small cottage in Lyttleton as being built of concrete and also notes imports of cement from England into Wellington from 1843¹²⁵. He suggests these imports were most likely to have been used for small engineering or military purposes.

Although a number of houses were constructed in concrete, and bricks were made in Wellington from the first year it was settled,¹²⁶ the great majority of residential dwellings constructed in New Zealand were timber. Di Stewart writes that *"Timber milling and processing was the country's biggest industry in the late nineteenth and early twentieth century. Turn of the century Auckland was a town largely built of kauri"*¹²⁷. This focus on timber milling and processing was largely fuelled by the local demand for timber villas¹²⁸.

According to Salmond, foundations of New Zealand houses were timber piles of puriri or totara *"although after 1900 square sawn totara blocks were common, or brick piers..."*. Concrete piles did become common for foundations around 1920. Since the early 1970's there has been a shift from the predominance of suspended timber floors in residential construction to concrete-slab-on-ground. This marks the start of a rise in the use of concrete and concrete masonry in residential construction in New Zealand.

Statistics are not kept in New Zealand for the percentage of houses built of permanent materials (concrete etc) as opposed to those built of impermanent materials (timber

123 Salmond, J. (1986). *Old New Zealand Houses 1800-1960*. Auckland, Methuen. Pg 60

124 Thornton, G. *Cast in Concrete: Concrete Construction in New Zealand 1850-1939*, Reed, Auckland, 1996

125 Ibid. Pg 11

126 Salmond, J. (1986). *Old New Zealand Houses 1800-1960*. Auckland, Methuen. Pg 100

127 Stewart, D. *The New Zealand Villa Past and Present*. 1992 Auckland, Penguin. Pg 22

128 Ibid. Pg 23

etc.). However the amount of concrete produced in New Zealand is rising and this could indicate an increasing amount of residential construction is being undertaken in more permanent materials. Recent statistics for concrete use in new stand-alone houses (to the year ending in March 2010) show 84.6% of the total floor area of houses was constructed in concrete. That is a rapid rise since the 1970's. However, concrete block walls make up only 4.2% of all wall frames compared to 89.8% for timber.

The rationale for timber construction in New Zealand

Typical residential dwellings in New Zealand are timber framed, light-weight houses. Often they sit above the ground on short timber piles. They are cold, damp, expensive to maintain and not designed to last longer than 50 years¹²⁹. These timber framed dwellings therefore demonstrate a lack of permanence/durability in their construction.

What are the reasons for the lack of permanence in dwellings in New Zealand and Wellington? What are the reasons for most of our buildings being constructed in timber rather than concrete or concrete masonry? A literature review suggests there are primarily two reasons for this. The pattern we see today of relatively impermanent construction was set at the very beginning of the colonisation of New Zealand. It is firstly, because of the ready availability and economics of timber for construction. The Government Buildings in Wellington (now a part of Victoria University of Wellington campus), are illustrative of the economic influence influencing timber construction over concrete construction at the time. Tenders for the building in 1873, were for £40,900 to construct Government House in concrete and £29,975 to construct it in timber.¹³⁰ Cochrane points out that in addition to these cost tags, the successful tender did not *'take any risk against earth shakes...Nor with regard to time'*.¹³¹

Secondly, the frequency and size of earthquakes which occurred early in Wellington's history demonstrated the structural superiority of timber construction in earthquake conditions. There were major earthquakes in New Zealand in 1848 and 1855. In both instances, timber buildings fared better than the permanent brick and plaster ones. This caused an adjustment to the dominant line of thought on construction and materials.

129 New Zealand Building Code Clause B2 Durability

130 Cochran, C. *Historic Buildings of new Zealand North Island*. Edited by Frances Porter. Methuen: New Zealand, 1979 Pg 239

131 Ibid. Pg 239

Figure 22 The Wellington Club, 1987

Where immigrants from Europe might naturally have expected to be housed in permanent accommodation of brick or stone (materials of mass and durability) they instead found themselves in timber dwellings. It was these timber dwellings which had proven to be better in the case of earthquakes.¹³²

According to Salmond *“Bricks were in great demand in Wellington following a disastrous fire in 1842 where more than 40 raupo and timber houses were destroyed....Wellington people soon learned, however, that brickwork was a poor risk in an earthquake...”*¹³³

Such was the shift in thinking around timber construction that the buildings of importance such as the Old Government House, built for the Governor of New Zealand in 1855-1856 and now part of the University of Auckland campus; and Government Buildings, Wellington, 1876¹³⁴ were constructed in timber with faux stone quoin work- timber dressed up as stone. The impermanent dressed up as permanent. On at least one level, the colony was not totally comfortable with timber construction. Where one might most want to portray the permanence and continuity of the system of governance, the perception of impermanence inherent in timber construction would not convey this, hence the quoins.

A modern example of permanent construction in New Zealand

In 1973 a relatively small commercial building was constructed in Wellington’s central business district for the Wellington club. The Wellington club is a conservative businessmen’s club founded in 1841. It owns and occupies a property on the Terrace in the heart of the Wellington CBD. The Wellington Club building¹³⁵ was designed by Roger Walker who was then working for Calder, Fowler and Styles. The building was described as occupying *“a pivotal position in the recent history of New Zealand architecture”*¹³⁶ and *“the first regional expression of the human face in commercial architecture in this country.”*¹³⁷ A significant component of the building was the concrete structural members

132 Skinner, R. *Representations of Architecture and New Zealand in London 1841-1860*, PhD Diss., University of Auckland, 2007

133 Salmond, J. *Old New Zealand Houses 1800-1960* (1986) Auckland, Methuen Pg 47

134 Cochran, C. *Historic Buildings of new Zealand North Island*. Edited by Frances Porter. Methuen: New Zealand, 1979

135 *NZ Architect* No. 4 1984 Pg 9

136 *Ibid.* Pg 9

137 Walden, R. *NZ Architect* No. 5 1984 Pg 21

Figure 23 View to south from site

supporting the building, which were massively oversized for the loads, as if to stand up to the surrounding tower blocks at least in mass if not in height.

Despite being built of “permanent materials”¹³⁸ and lauded as a significant piece of New Zealand architecture in a time when there was very little ‘New Zealandness’ in local architecture, the building was demolished in 1987 aged 14 years. The building’s demise preceded the stock market crash of 1987 by a matter of months. The number of buildings on the site (three) is indicative of the increasing value of the land and consequent increase in rates on that land. These factors seem to have driven the changes to larger buildings returning greater rents.

138 Walker, R. *NZ Architect* No. 5 1985 Pg 22

2 Selection of site for design

The Wellington Club shows how difficult it can be to achieve an enduring or relatively permanent dwelling in an urban area that is itself young such as the city of Wellington. Constant upward pressure on land prices causes demolition and redevelopment of one site many times over as economic imperatives determine land use. For this reason the strategy in selecting a site to design a permanent dwelling on, has been to select a site outside the central Wellington CBD area.

Site selection recognises also cognisant of the urban/suburban condition that exists in Wellington. The chosen site is a suburban one. With a programme to build a dwelling to last for up to four hundred years, certain assumptions need to be made around the way we will live in the future. Whereas we can accept that change is constant, so too we must accept the pace of change is accelerating. Will we still have suburbia in 400 years? Will we still need to commute, will the city expand to swallow up suburbia? The answer to these questions cannot be known. This thesis presumes that we will still need an infrastructure and transport routes in 400 years time. We will still have cars even if they are not petroleum fuelled. Population may well have increased, putting pressure on suburban density. The economics of a single dwelling on this selected site may cause it to be reused in another way for a purpose other than dwelling. Therefore flexibility of function will be an important aspect of the design.

Figure 24 view of site from beach

Figure 25 view of site from beach

Figure 26 view of site from beach

Figure 27 view of site from beach

Figure 28 view of site from beach

Figure 29 view of site from beach

Figure 30 Preliminary plaster model of section through underground round sleeping area

Figure 31 and 32 Secondary model of south elevation (left) and section through structure (right).

3 Brief

The brief calls for a dwelling with a life span of 400 years in order to explore and test ideas of permanence through the design of the dwelling. Appendix i sets out a number of assumption made in the design of this dwelling.

Figure 33 Enclosing walls and service tower - permanent and masive elements. Plan view

Figure 34 Permanent elements (exterior walls & Services tower) anchored into the site. Plan view

Figure 35 Permanent elements anchored into the site connecting the permanence of the site itself with the dwelling. Section view

4 Site Analysis and Location of Dwelling

Appendix ii sets out the detailed site analysis undertaken, the environmental factors considered and the schemes considered when deciding on the location of the dwelling. Appendix iii shows part of the sun study undertaken for the site.

Figure 36

Services tower vertically anchors
the dwelling to the ground

The dwelling is anchored
into the site thereby
connecting it to the
permanence of the land.

Figure 37

Figure 38 Lightweight internal partition walls are demountable and relocateable providing for flexibility of use over time. Some possible alternative bedroom and bathroom options are illustrated.

5 Building Form

Early in the design process it was decided to use simple geometric forms for the building. Simple geometric shapes are timeless and by association make connections to some ancient architecture. From the geometry of the three pyramids of the ancient Giza Necropolis and the hemisphere dome of the Pantheon being half the height of the building (allowing for a whole sphere to fit perfectly inside the building) mathematicians and architects have used simple forms for the most significant buildings. Pythagoras, Plato, Vitruvius, Palladio and le Corbusier have all tried to relate buildings through geometry to mathematics and ultimately to truth¹³⁹. Architects have also used geometry to symbolise man, the earth, and the cosmos, and the relations between these. By deliberately using a simple geometric form, the square, on the one complete elevation I want to draw attention to the importance of this dwelling to its local environs. Primarily though, the use of this geometry is a visual device to link to older monumental buildings (such as the pyramids) which have mass and which have achieved relative permanence.

The best form for the building was devised through the same analysis used to determine the location of the building on the site. Several forms are explored and described in appendix ii.

139 Calter, P A. *Squaring the Circle Geometry in Art and Architecture*, Key College Publishing, 2008.

Figure 39

Figure 40

Figure 41

Figure 42

Figure43

Figure 44

Figure 45

Figure 46

6 Structure

The structure of the design has largely been driven by the earthquake mitigation strategy and the cantilever, which is outlined below. Firstly I will discuss the earthquake strategy and then secondly describe the details of the designed structure.

Earthquake Mitigation Strategy

The Last Site South has already been subjected to seismic events. The greatest one in recent memory occurred in 1855 and was magnitude 8.2. During this event it is estimated by Geological and Nuclear Sciences (GNS) the whole site rose in excess of 1.0m¹⁴⁰. I considered two different structural schemes to allow the building to survive a major earthquake and so to achieve the brief of relative permanence. Scheme (i) Permanence through base isolation Scheme, and scheme (ii) Permanence through massive rigid structure. Refer to appendix iv where each of these is elaborated on below.

Both structural strategies can deliver a building which ought to remain functional for 400 years including through a large seismic event. Ultimately the second strategy was favoured because it better visually expressed the notions of permanence, as it allows the building to be anchored to the site and become part of, and grow out of, the site. This structure uses the ground above it and around it to hold it in place in an earthquake so that the building does not move independently of the land. By using the dwelling, through its structural envelope, to generate permanence the concept becomes inherent in, and a requirement of, the dwelling.

Given that It was decided in favour of a massive rigid structure, reinforced concrete wall/ beams with composite walls, roof and floors form the basic elements of this construction. The structural concept is one of a box beam extruded and tapering as it cantilevers. The walls form the webs of the beam while the floor and roof are the flanges. The extrusion is anchored within the landscape by virtue of being dug into the slope with earth laid over the roof. Its tapered form is another way of anchoring into the hill side, working like a wedge to resist moving. The weight of the structure and the weight of the earth over it

¹⁴⁰ <http://www.gns.cri.nz/Home/Learning/Science-Topics/Earthquakes/New-Zealand-Earthquakes/Where-were-NZs-largest-earthquakes>

and around it (creating friction and resistance to removal) anchor it metaphorically and physically to the site.

The walls are effectively 6.0m deep beams with a cantilever of only 20 metres. Walls, floor and the roof are composed of reinforced concrete inner and outer layers. Within the inner concrete core is a steel truss frame. This steel is encased in concrete. Ribs between the inner and outer skins located at the steel floor and roof beams form portal frames. The upper and lower concrete floor and roof layers span between the walls.

In an earthquake the floor, and roof to a lesser extent, which are the flanges of the box beam, act as diaphragms which transfer the forces back into the ground. The tapering in plan toward the end of the cantilever reduces the mass and the load while the depth of the webs or walls remains constant.

The cantilever demonstrates the structure. It is the depth of the walls which determine the span of the cantilever and more than half of the length of the building is on or in solid ground. The balance is in favour of the anchored part of the building. The structure is very rigid. The cantilever supported by the tower at mid span and in turn it prevents the tower from bending. Connecting the tower (column) to the box beam reduces the span of the cantilever by 50%. Crucially, the cantilever visibly also questions permanence. A cantilever appears to defy gravity which is a permanent law of physics. Visitors to the site would not be able to see how far into the land the structure is anchored, so will look at what and question the building's relative permanence in relation to the absolute permanence of the laws of gravity.

The services tower is designed to lean out from vertical by 4 degrees to the south east. It does this to help express the cantilever. The lean of the tower throws into doubt the structural integrity of the whole. This would cause observers to question the structure and decide for themselves if it is capable of relative permanence. Refer to appendix v for additional structural information.

Figure 47 Last Site South, cross section

Figure 48 Last Site South, cross section

Figure 49 Last Site South, cross section

Figure 50 Last Site South, cross sections. Consecutive cross sections through the building reveal the procession of the building from anchored in the mass of the land through to the cantilevered public rooms which rely on their own mass for permanence.

Figure 51 Last Site South, longitudinal section looking west

Figure 52 Last Site South, longitudinal section looking east

Figure 53 Red rock from earlier geological age at site

7 Mass

Mass is perhaps the element most easily visually associated with relative permanence and durability. It was central to the case studies of the cathedral of Our Lady of the Angels and the Congreve house. In chapter two the western idea that '*architecture is the expression of permanence through solidity and mass*' was discussed. In my design, solidity and mass is used not just to express permanence but to generate permanence. Although James Fergusson's view that equated massiveness directly with architectural grandeur and monumental character has been discredited, in this case there is a place for mass that is consistent with and enhances the architectural programme.

Mass is evident in the shell of the building due to the choice of reinforced concrete as the material for the structure, and the long narrow form with its cantilever increases the visibility of the mass. This dwelling is in contrast to the Villa Savoye where the slender piloti and walls with continuous horizontal windows were used in a deliberate strategy to usurp visual mass. Here the services tower which supports the cantilever contrasts with the slender piloti through its substantial size. The Congreve house cleverly uses the same material inside and out with the exterior forming a rain screen. Ford argues this rain screen principal is superior to a monolithic wall for durability. This may often be true but the rain screen of the Congreve house does no structural work. The Parthenon's marble columns which remain are monolithic and have no cavity or rain screen. The choice of a solid and monolithic wall, floor and roof over layered and veneered systems (as suggested by Ford) is one which is likely to require much less maintenance, is less complicated to assemble, and therefore has every chance of being more durable.

Concrete has a lot of mass. Its mass, strength and its durability are enhanced when the density of the material is increased. The walls, roof and floor are all 1.0m thick. Creating wall, floor and roof elements which are concrete interior and exterior with an interlayer of up to 500mm of insulation, have made a composite wall with obvious mass but with reduced weight due to the insulation voids.

The Congreve house has a scale due to its block module which is difficult to read because this module size is different to the normal New Zealand block module. The scale of the building I have designed is similarly difficult to read but due to the opposite effect, namely that the whole of the dwelling is one unit or module. Visitors will need to be

PERMANENCE IN ARCHITECTURE

Figure 54 VERTICAL SECTION

Figure 55

MATERIALS FORMS AND FINISHES

up close to the building or to see it against neighbouring houses to fully appreciate its relative size.

8 Materials

As stated in chapter two, it is self evident that durability is inextricably bound with the materials used and the maintenance of those materials. For the exterior of the building at the Last Site South, extreme durability is required to achieve relative permanence. Hardness, weather resistance and the ability to withstand earthquakes and storms were the main material requirements. The two main materials considered were stone and reinforced concrete. The Villa Savoye is an excellent reminder that using new materials or materials in new ways carries risk, so materials with a long history of use and relative durability only were considered.

Reinforced concrete with a highly polished finish, glass windows and small amounts of timber was chosen. Weathering of the surface of concrete can undermine its appearance, strength and lifespan. A ground and polished finish will improve durability by reducing concrete pore size in the surface and reducing the chance for salts to cling to the building and water to ingress. This finish can be sealed and re-sealed over time. It is intended the concrete of the dwelling will be cast in place layer upon layer in a continuous pour. In this way each of the three main forms becomes a piece of monumental structure. There will be indications in the surfaces where different batches have slightly different characteristics and horizontal joint lines from this process which will tell of the stages of the process.

This choice of reinforced concrete is consistent with two of the case studies (and in particular, the two with aspirations to permanence). The Congreve house is also in a coastal location 100 metres above sea level but the environment is less extreme than the last site south. Potential corrosion is addressed in that house with the use of a concrete masonry veneer and lead and stainless steel to the exterior of the building. The cathedral of our Lady of the Angels is not in a marine environment but nevertheless deals with a polluted environment through careful material selection, and through a regime of maintenance. Moneo chose concrete because of its resistance to weathering and because he wanted the material and substance to be clear. As noted in the case

Figure 56 South east perspective

Figure 57 East perspective

study he saw it as a way of '*recognising the dignity of the building itself*'.¹⁴¹ Additional protection was given to the cathedral concrete and can be included here, through new technologies such as using breathable silane sealant. New technologies and research allow for more dense and impervious (and therefore more durable) concrete as was used in the cathedral.

By choosing to use glass for the enclosure I was conscious of selecting a material with a proven history of use in excess of the required lifespan of the building. Weathering of the surface of glass is almost non-existent.

Timber is to be used for opening ventilation flaps and the main entry door. Timber is obviously not so durable but it is only sparingly used and only where it can be accessed easily. If properly maintained, it will not compromise the durability of the rest of the dwelling.

The interior finish is of concrete and this is a material with longevity and one that is plastic and formable. Careful consideration was given to the interior finish in terms of tactility, colour reflectance, maintenance and adaptability. One issue with materials which are dense and have a lot of mass is that they are cold to touch. To avoid this the interior of the concrete would be skim-coated with Gypsum plaster directly on to the concrete. This can cover all permanent walls and ceilings. This is a material which will adapt to ambient room temperatures and will create a warmer atmosphere than bare concrete. It is a natural warm colour with good sound absorbing properties. Additionally it can be easily repaired and will seamlessly cover alterations to services where these penetrate through walls, ceilings and floors. Gypsum plaster that is hand screeded will add a trace of craftsmanship to the interior shell of the dwelling.

Parquet flooring as used in the Congreve house will also be used in the dwelling as its small module size contrasts with the height and volume of the interior spaces, thereby reinforcing their monumentality.

141 El Croquis 98 *Rafael Moneo 1995–2000*. 2000 Pg 27

Figure 58 View at entry door across courtyard to coastline

Figure 59

9 Detail

The interior and exterior faces of the structure will have different detailing as these need to address different environments and requirements.

Monolithic structure, 'NO-detail'

The most significant design detail in this permanent dwelling is the 'NO-detail' approach taken to the exterior (and structure) of the building. The continuous use of one material for the structure of the whole creates a monumental structure. It seamlessly merges the elements of tower and light shaft with the horizontal cantilevered form. Different finishes assigned to vertical and horizontal elements articulate the three main elements of the dwelling and these meet without any conflict. Potential conflict is resolved because the different finishes always meet at different angles. Unlike the OMA approach discussed in chapter two which talks about an increased risk to permanence where two materials meet, here we are meeting concrete with concrete and there is no issue with resolving different materials meeting. This one material 'NO-detail' works for the design in a number of ways. Primarily it expresses the mass of the cantilevered building through the continuity of the form in one material. The one material continues indefinitely into the landscape where it is enclosed by the land (as shown visually by the presence of the oval light shaft). Visually the material also continues in the way the form reaches out to the horizon. The metaphor of continuity (in time) can be related to permanence.

The Villa Savoye structure was compromised by complicated detailing of joining surfaces beyond the capabilities of the craftsmen and the selected materials. I have mitigated this risk in my design through the continuous use of one material - concrete.

Within this 'one material' approach to detailing, the fenestration is either flush with the exterior (for fixed glazing) or recessed for opening windows or panels. The flush glazing reinforces the continuity of form by removing any digression in the surface. The polished surface and the polished glass face will be read as one element in some light conditions. The few deep recessed openings articulate the thickness of the walls at areas of ventilation. The deep recess is in itself significant protection from the weather.

Slope of walls

Sloping the walls a little encourages rainfall to run down them and wash off the salt

Figure 60

Figure 61

spray, which is expected to also reduce the requirement for exterior cleaning. This is similar to (but with the opposite effect to) the function of the parapets at the cathedral of Our Lady of the Angels which fall inwards to reduce the quantity of pollutants in the rain from running down the face of that building.

Drip edge

The plastic nature of concrete allows that timeless and essential detail, the common drip edge, to be formed as part of the monolithic whole. In this way not only is continuity achieved but other potential issues are designed out which might otherwise be required to affix a drip edge, such as material compatibility and replacement, sealants and fixing and connection details.

Floor and wall junction

Consistent with the sharp drip edge detail to the perimeter and the “No-detail” design is the interior detail where the wall meets the floor and the ceiling. Here the plastic form of the concrete lends itself to a continuous and seamless curve to again convey and reinforce the idea of continuity of time through continuity of surface.

Entry

The entry procession starts on the flat part of the site where stairs, under the cantilevered dwelling high above, lead directly to and then around the tower form. The stair is narrowed with a concrete wall on one side where the tower leans out over the stairs. This creates a sense of drama and anxiety likely to cause one to question whether to continue on but this point also reveals the rest of the stair to the entry. Stairs which are cast out of the ground are coloured a dull red to relate to the red rocks from which the area takes its name.

The procession goes from exterior public part of the site through the entry to interior/ exterior space that is the courtyard, and then to the interior public space (kitchen, dining, living) or, the interior private space (bedrooms and bathrooms).

The entry door is located near the centre of the dwelling just out from the point where the ground and floor levels meet. Entry from the wind buffeted exterior is across a narrow gap between the dwelling and the landing. This landing platform is extruded from and is an extension of the stairs. This marks a threshold and does not interrupt

Different lighting solutions developed for permanent and impermanent situations

Figure 62 Section details of permanent and impermanent lighting.

Figure 63 Section /detail through permanent and impermanent bathroom lighting.

the continuity of the dwelling. The opening into the wall is 500mm deep to the face of the door and it cuts back sharply to provide protection to the edge of the door from the weather. This angle also works to align the entry opening with the view across the courtyard and out through the opening in the courtyard wall opposite to the horizon where the land meets the sea.

The door is 4m high and 1.9m wide but pivots on an axis some way in from the edge to reduce the opening significantly. Only one person can enter at a time. At 100mm thick the door is monolithic and yet still recessed more than 400mm from the interior face. The door also overlaps the wall at its leading and trailing edges to allow for significant weathering cover for durability. Opening the door reveals its full size and further makes the one-person-wide opening appear as a restriction and threshold to the entry.

Entry through a monolithic wall and into an open or glazed and sheltered courtyard will be unexpected, as there are no clues to the presence of this courtyard from the approach. Once inside the covered part of the courtyard, a deliberate choice has to be made whether to go to the open public parts of the building towards which the angled opening lends itself, or to turn towards the private quarters which are underground.

Light shaft

The light shaft over the bedrooms is oval in form, the same shape as the tower. It is rotated about the building's axis to provide light into the hall and deep into bedroom areas. Formed of reinforced concrete with a timber finish to the exterior, it has gypsum plaster on the interior to reflect light.

This light shaft allows the building to be anchored without being a dark cave. It allows for habitable underground spaces. This in turn allows the building to be anchored and it is through this anchoring that it can cantilever.

The light shaft and tower are reminiscent of Le Corbusier's monastery of La Tourette 1953-60. At La Tourette there are three altars to one side of the main chapel which bring in light in a very controlled way. The light is overhead in these small spaces. In this way the individual is not distracted by windows and views.

The bathrooms are enclosed by the thick floor walls and roof without any direct light.

INTERIOR VIEW OF TOWER LIGHTING AT CEILING

Figure 64

PLAN OF FLOOR LEVEL LIGHTS AT TOWER

Figure 65

It was necessary to slice through the walls to let in some light. The requirement for the bathrooms is for light but not for views. Here, where the walls are cut, coloured glass admits light without views. This is reminiscent of the chapel at Ronchamp also by Le Corbusier, where thick walls are penetrated with tapering rectangular shafts. At the Ronchamp chapel, coloured painted glass on the exterior filters exquisite light to the dark interior. This technique is used to provide light into the bathrooms where clear glass would provide unwanted views into what would otherwise be a dull and dark internal space. The coloured glass can be placed on both faces of the wall, with additional lighting between, keeping both surfaces flush and continuous. From the exterior at night these will glow subtly while the interior will be lifted by the infusion of softly coloured light.

Services

An important lesson can be learned from the cathedral where allowing for replacement of services and providing flexibility to change services was an important part of the strategy for relative permanence. Services need to allow for change if a building is to adapt, plus they will need to be repaired and replaced over the intended lifespan of the building. Refer to appendix vi which sets out the strategies considered for flexibility of services.

A number of ways were tested to find the best way to provide for flexibility in services.

I selected scheme 5 (all services in a cavity within the walls, floor and roof) appendix vi, because the voids in the floor, roof and walls created by the double skin box frame structural system are ideal for the purpose. Access through the interior skin is required and enables services to be accessed easily. Services are therefore protected from the elements. The same strong structure which protects the building, protects the services.

10 Permanence of space verses permanence of function

When architects are designing for relative permanence, the function of a building or room within that building must also be considered and allowed for, including the function of the building in the last fifty years of its 400 year life. This is essentially designing for the unknown, which is an impossible task. The appropriate strategy is therefore to design for flexibility and adaptability.

'In the quest for permanence, the provision of a prolonged existence may

Figure 66 Off site modular interior as assembled off site and as transported to site

Figure 67 modular interior assembled and in situ

be defined as the capability to change, as opposed to inflexible solidity. In architecture which is itself initially a process of transforming, longevity can be achieved by incorporating the means of further transformation. Therefore we should conceive architecture with generosity and ample opportunity to accept change.”¹⁴²

The ideas put forward by Leupen are tested to see how permanence can be made relevant in the architecture of domestic dwellings. Also explored are ways to make a building useful beyond the occupation of the original owners or inhabitants.

Occupants

Determining how many people may use the dwelling at any one time over its 400 year life, or what the optimum number of occupants to design for is difficult at best. History tells us that the make up of family groups in single dwellings is not constant. In the past, houses have accommodated multiple generations and large families of ten or more children. More recently in New Zealand many single family homes are trending towards having fewer residents with the average number being 2.67 usual residents per household.¹⁴³

The dwelling plan provides three bedrooms with beds shown for two couples and three individuals. This number of occupants is indicative only, and it is not the intention to restrict the usefulness of this dwelling to seven persons.

Flexibility of internal space

In order to cater for permanence and durability of use, the design of the internal space needs to be flexible. The Congreve house was criticized in chapter three for its lack of flexibility because of its four concrete walled bedrooms. These would not easily be changed. Le Corbusier anticipated change. He expected servants would become too expensive to keep and their quarters would need to be adapted. This could be done at the Villa Savoye as the thin internal walls were not load bearing.

The whole of the northern part of the dwelling is given over to private functions. This

142 Sahin, E. Master of Architecture thesis, Virginia State Polytechnic Institute and State University 2001 Pg 66

143 Government Statistician. Statistics New Zealand 2001 Census of Population and Dwellings – Housing, Household Composition and Number of Usual Residents, 2002. Statistics New Zealand. Pg 13

space is shown as bedrooms, bathrooms and a study. In order to allow for future and different arrangements of these rooms to suit many different future requirements, the internal walls here are all demountable lightweight structures. This allows for them to be easily, quickly and inexpensively altered. They are timber or metal framed walls with thin sheet linings fixed to each face. In contrast to the exterior permanent walls these are only nominally 100mm thick, one tenth of the exterior wall thickness. In this way internal walls can be simply and quickly altered to suit changes in use.

The solution for lighting the permanent and impermanent walls demonstrates and enhances their respective purposes. The bathrooms are lit (as described above) through the exterior permanent walls. They are also lit with white light through the interior demountable wall. One side of this wall lights the interior, the other is coloured to match the interior and to light the hall with soft coloured light. The colour matches the particular bathroom and also indicates occupancy. The drawings below show the impermanent walls which can be changed as functions of spaces change or as fashion dictates.

The bathroom windows are narrow on the inside face of the wall so as not to limit the positions of the internal demountable walls. It is acknowledged that as there will always be requirements for bathrooms they could be rearranged as necessary in the same area.

The lighting to the interior of the services tower illustrates two strategies for dealing with permanent walls and roof and an impermanent timber floor scenario.

The location of the oval light shaft is aligned with the positions of the bedrooms. Alternative layouts would need to work around this if daylight and/or a view to the sky was required.

The southern part of the dwelling is given over to public functions. The drawings below show in another way how the interior can be changed as functions of spaces change or as fashion dictates. These drawings propose that a new interior for each space can be constructed off site and lifted into the dwelling. This can be done by removing the window in the south elevation. In this way the new interior (scenery) can be prefabricated. A lightweight frame (steel) strong enough to be lifted, is framed out and then lined (for example with plasterboard or stone facings) and fittings installed all

in the workshop. Lights for example can be fitted with wiring run through the framing ready to be connected into the wiring below the access hatch.

Coupled with flexibility in service provision these strategies provide flexibility and adaptability in order to cater for permanence and durability of use.

This design has resulted from testing ideas of flexibility within the inflexibility of mass and structure. The generous size of the dwelling (257m² internally) allows for one occupant or up to as many as can be fitted in the 80m² of bedroom space and as can be catered for in the large kitchen. A smaller building could become redundant as a dwelling should large families again become the norm, whereas a large dwelling will not be redundant with only one or two occupants.

It is expected (but cannot be known) that the building will always be used as a dwelling. This thesis is concerned with dwellings and the chosen site is located in a residential area away from commercial or retail activity, making it less likely the dwelling will find other uses. It is designed with flexibility of space to support its continuing use as a dwelling. It is not specifically designed for flexibility of purpose however it could function with other uses e.g. as a small office or an observatory.

Using Leupens theory of *frame and generic space* we can define the Last Site South in his terms. The skin and the structure become the frame (permanent elements) of the dwelling. The design process has led to a box beam reinforced concrete structure which is also the external cladding to all faces. These two functions are combined into one material rather than having a separate cladding or structure. The generic spaces are the access, scenery and services. Services which are discussed above have been made generic through the cavity in the structure. The scenery (internal finishes) are generic to allow for flexibility of space. These have been suggested as a modular insert or demountable partition that can be removed and replaced in order to suit the rearrangement of internal spaces. Access into the building is fixed to one point, however throughout the interior, circulation can be arranged in almost any way because of the flexibility of the services and scenery.

While the structure of this dwelling at the Last Site South is fixed and permanent, the interior is almost entirely open flexible space with only one permanent internal wall.

This wall north of the entry, distinguishes between private and public internal spaces. The walls shown around the bedrooms and bathrooms are all easily demountable for relocation and revised subdivision as may be required. The layout shown suggests only one of many possible configurations. For example this layout of bedrooms may support three generations e.g. parents with three children and one set of grandparents in relatively large spaces.

Similarly the dining and living areas are easily interchangeable as they are open spaces. The kitchen, with its additional plumbing and drainage services, can also be relocated as necessary. The flexibility provided for by the structural voids throughout means that locations of kitchens and even bathrooms can also be altered to suit changing requirements over time.

The courtyard is an indoor and an outdoor room. The predominantly cool local climate and shading of the site along with the 45 degree slope mean the provision of an outdoor space at the same level and sheltered from the predominant cold wind is an essential asset. This space is open to the sky or covered over with double glazed sliding panels. Additionally it can be open to or closed off from the living areas and/or the bedroom spaces. This is done with doors which slide to the outside of the building. Refer to appendix vii for courtyard information.

The purpose of the courtyard in this plan is to provide:

- An outdoor living space at the same level at the house, overcoming the slope of the site;
- Ventilation;
- Light to the centre of the house;
- engagement with the moon and stars and their patterns of movement
- shelter from the wind;
- a modified climate for living in and for plants;
- Privacy; and
- Solar gain.

The courtyard therefore deals with the permanent characteristics of the site. The sun, wind, orientation, slope and general cool climate are all addressed.

11 Conclusion

It is impossible to know if this design would be successful for 400 years without waiting for 400 years to pass. That is because although we design for flexibility of use we are still designing within our expectations of what that flexibility will encompass. By looking back 400 years and seeing how dwellings have changed we can project this forward and design to encompass all these alternatives. However even 50 years ago architects were not predicting the changes which the internet would bring and so there is a limit to the flexibility which is included in this design.

It is more straight forward to design for the tangible environmental issues and constraints.

The site has had a great influence on the design due to its steep contours, its (southern hemisphere) south facing aspect, the history of seismic activity in the area, and the predominant and strong cold southerly winds coming off the sea. Much of the form of the building is in response to these.

The dwelling is also influenced by the requirement for durability in this environment. This has led to the thick walls, floor and roof which give a massive and monolithic appearance to the dwelling. This appearance certainly provides a metaphor for stability. It is beneficial that the relative permanence of the dwelling is questioned and discussed. This is achieved through the cantilever. The massive dwelling is still cantilevered and hanging in space and one can not tell how far it is anchored into the site.

FIVE CONCLUSION

It is clear from modern understanding of time that absolute permanence (whether in architecture or otherwise) is unattainable and only relative permanence is achievable. Time is not linear. This new understanding of time has caused some academics and practitioners to abandon any consideration of permanence as relevant to architecture today. There are however some writers that consider permanence is or could be still relevant to today's architecture: nevertheless all of these writers acknowledge that for permanence to remain relevant there will need to be a shift in our thinking about permanence. Tuow argues that absolute and relative permanence should be synthesised and seen as a cyclical continuum- the greater the cycle, the greater the degree of permanence and durability. This thinking accords with our intuitive understanding of the underlying degradation of the substance materials. Ford argues that in the future if society continues to equate architecture with permanence then all those involved in architecture (builder, architect and client) will need to explicitly accept and recognise the increased need for maintenance given our increasingly technical construction and materials.

Modern Western society appears to accept dwellings with no aspirations to permanence at all. This acceptance has, at least in part, been based on societal and economic drivers such as relatively economic construction costs, a highly skilled construction workforce and the constant adaption that has been necessary to adapt to societal changes from the industrial revolution to the internet. In my view this constant rebuilding is not sustainable. A change in attitude is required to consider the sustainability of architecture practices. One aspect of sustainable architecture is to consider the projected lifespan of the materials and design and to maximise these to the extent that economics allow.

Architecture that aspires to relative permanence also maximises the possibility of what Isenstadt calls "symbolic persistence". The longer the relative permanence of architecture, the greater its contribution to societal memory, interpretation and thought. The Parthenon and Pantheon are prime examples of great architecture that over time have contributed tremendous symbolic persistence to various societies. Architecture that does not aspire to relative permanence or considers it worthless, in my view, cannot contribute the richer appreciation, emotion and interpretation that comes with time. This is the fundamental function of great architecture and that permanence therefore remains relevant in architecture today.

Chapter two examined the concept of durability, mass, materials and detail and examined the role that they each played in the actual relative permanence of architecture. It was argued

that durability can be seen as the lesser of an object's resistance to wear and decay, and its value to the user. It is self-evident that durability depends on the selected materials, as evidenced by the Parthenon's marble columns. Petroski wrote of the inherent qualities of materials- namely the surface and substance of the materials and the "associative material qualities"- i.e. the societal and economic values associated with those materials. I selected exterior materials for the design that were plastic, extremely dense and durable- namely concrete and glass. However by also considering the value to the user it can be seen that durability is directly connected to societal and economic values as well as the materials selected.

This thesis also argued that it is an outmoded idea that mass is necessary to achieve relative permanence in architecture. However mass can clearly be used to assist in achieving relative permanence, and certainly can be a visual metaphor speaking the language of permanence. In terms of maintenance and durability (over the 400 year time frame examined in this design) massive materials rather than other more complicated layered systems relying on new unproven technology, were chosen which had a better chance of lasting for the designed timeframe. To achieve even relative permanence the detail and materials selected for the design have to be aligned with this aim.

The writings of Ford and Petroski and examples such as the Villa Savoye, also strongly advocate that relative permanence is directly related to the mundane practices of detailing and maintenance. Complicated construction systems most especially rely on good craftsmanship and regular maintenance. Detailing operates to extend the life of materials by delaying the impact of weathering. The design therefore attempted to eliminate the requirement for regular maintenance as much as possible by selecting monolithic materials for the exterior. It does recognise and allows for maintenance of services as these will need to change and be maintained over the selected lifetime of the dwelling.

In order to achieve relative permanence, the literature review and case studies make it clear that architecture needs to aim for flexibility. The architecture needs to contain relevant and useable spaces throughout its intended life to achieve any sort of permanence. Relative permanence in modern western society is attainable if we are clever enough to design spaces as adaptable as they are durable. Leupen allows us to understand ways in which we can make a dwelling adaptable to change of use by making

parts of the building flexible, such as services and internal walls. In the design therefore, having overcome issues of durability of materials and environmental factors such as earthquakes and tsunamis, future proofing by designing for flexibility and adaptability was crucial.

The case studies were instructive as they each had different aspirations to relative permanence and each show in different ways the effect of societal values and technology in terms of materials, detail and maintenance. The Villa Savoye had no aspirations to relative permanence whatsoever, but has survived due to its iconic design and constant maintenance. The Congreve house has more modest aims of solidity and durability, and runs proudly counter to the traditional timber dwelling in New Zealand. The cathedral however aspires to relative permanence of 500 years. Its approach to the design underscored the importance of careful material selection, detailing and planning for maintenance (e.g. by replacing services) to my design. The mass and form of the cathedral adds to its air of endurance. None of the case studies showed much attention to flexibility of future use, and in the case of the Congreve house in particular may impact heavily on the actual degree of relative permanence achieved. However all three very clearly express the architect's ideas.

Chapter four explored the history of building in timber in Wellington due to its availability and its ability to survive earthquakes. In the design using timber was considered, but not chosen due to its lack of durability over the designed timeframe and the fact that in modern times structural solutions have been developed in earthquake design that allow for rigid structures. Architects today can build for permanence with materials much more durable than timber.

Dwellings may be able to be built to withstand the environmental conditions a 400 year life will require, even in hostile environments like the south coast of Wellington. This is impossible to prove in New Zealand when there are no examples of 400 year-old buildings to learn from yet. Nevertheless throughout Europe and elsewhere examples are extant of buildings lasting this long. However, by designing with materials capable of lasting the designed timeframe (as materials are ever only relatively permanent) and designing for flexibility we can at least aspire to achieve relative permanence.

The dwelling, as designed, could survive the 400 years required by the brief. But a flatter

site, less prone to severe earthquakes, tsunamis and wind driven salt would be easier. It would result in a different dwelling and probably a less dramatic one. This dwelling is very much a response to this particular site.

The plan is not completely flexible despite the aim. It presumes the best place for the bathrooms and bedrooms is in the north part of the dwelling and hence the fenestration is designed for this.

What has been learnt

One significant lesson learnt through the literature review was the importance of designing for flexibility. That careful selection of materials and detailing is required for any architecture aspiring to relative permanence was self-evident. Flexibility is fundamental to architecture that aspires to relative permanence because it is impossible to predict how society will evolve (larger or smaller family groups) and how the dwelling will be used ahead of say the next 100 years. Flexibility of function enhances durability (and therefore relative permanence) by extending the value of the architecture to the user.

With our modern understanding of time, we no longer believe that absolute permanence is attainable in architecture, whereas there are many examples of buildings achieving relative permanence. Some societies and leading architectural theorists consider striving for relative permanence is an outmoded idea, inconsistent with society's values and lifestyles.

Nevertheless aspiring to relative permanence still has meaning and is worthwhile. Sustainability increasingly will become part of our lives. This argues against 'throwaway' architecture and that as a way forward, we can and should strive for relative permanence in our buildings. By designing for flexibility and with mass, durable materials and appropriate detailing it is possible to aspire to and achieve a level of relative permanence, thus contributing to sustainability in a way that resource-hungry, ephemeral architecture cannot.

Buildings that achieve relative permanence can also contribute to society through what Isenstadt calls the "interpretive imperative" by virtue of its symbolic persistence. Architecture can over time improve society's memory by prompting interpretation and

questioning. Great architecture definitely does this. My view is that buildings that achieve a degree of relative permanence are more likely to contribute in this way to a greater extent than those with a shorter life-span. Further development of this thesis could look into symbolic persistence and how a building might be designed to persist by continuing to inspire interpretation.

APPENDICES

Appendix i

Assumptions

1. That should sea level rise to the level where the road is no longer able to serve the residents alternative access to the houses will be provided across non residential land to the north of the site.
2. Services currently being supplied to the site will continue to be supplied by the local authorities or government bodies or utility companies. These include electricity, potable water, phone/internet data lines, storm water, sewerage drains, and rubbish collection. Notwithstanding this rainwater will be collected on site for use as a back up system and stored in a bladder in the services tower below floor level. Solar energy will be harnessed through the top of the services tower to battery storage. Improvements in technology may one day allow for all electrical need to be provided for through this method.
3. Heating will be provided via a ground source heat pump system heating water, or similar liquid, run through pipes to radiators. It is expected that over time new technologies will develop more efficient heating systems and it will be advantageous to be able to adapt to use these.
4. Geology is suitable. The ground in the area is typically greywacke rock.
5. Site analysis section drawings show storm surge level at approximately 5.0m above mean sea level. This is an estimate of the highest (spring) tide (when the sun, earth and moon align) with the addition of a large swell caused by strong winds.
6. Seal level rise predicted due to global warming over 400 years is predicted to be 0.59m to the year 2100 with an additional 0.2m added for safety. Beyond this an allowance of 10mm/year is made. Mean sea level datum in Wellington is 0.44m (1953 correction).
7. Tsunami Height data. Like the earthquakes which cause them we can not predict the height of a tsunami wave. Greater Wellington regional Council through Wellington Region Emergency Management considers the effects of three scenarios; 1.0m, 4-5.0m and 10m high tsunami. Note that because the site is forward on a spur of land water will move around the spur and up the valleys to either side. A surge which would take the wave higher than its crest height would only occur where land forms a valley.

8. The views to the south west and east will remain an important aspect of the site.
9. There will be no private development of the public land to the west of the site. This property will remain the last site on the western end of the south coast.
10. The next large earthquake will raise the land of the site again relative to sea level. This rise will not be factored in as it may not occur. A conservative approach is taken assuming sea level rise and placing the proposed dwelling above this level while not counting on ground level rise.
11. Electricity will be available although how it is generated may change.
12. The number of people occupying the dwelling will change and the relationships of these groups may also change. For example the site could be occupied by a single person or a couple, it could be occupied by four generations of one family or a large group in an extended family.
13. The methods of communications with people outside the site can not be predicted as this function has changed most dramatically in the last 100 years and continues to change at an ever increasing rate. It is assumed that this can continue to develop with less dependence on the provision of hard wired services within the dwelling.
14. The dwelling will have sufficient mass to take in heat and release it slowly maintaining an even diurnal temperature range.
15. Water is essential for drinking cooking and cleaning. Bathrooms, water supply and drainage, will always be required. Their positions within the building will not be permanent and replacement, relocation and maintenance of these services is allowed for.

Appendix ii

Site Analysis and Location of Dwelling

This appendix sets out the detailed site analysis undertaken, the environmental factors considered and the schemes considered when deciding on the location of the dwelling.

Analysis of the site was undertaken to understand the implications of the following:

- Orientation
- Figure ground
- Potential sea level rise
- Contours
- Sun and wind direction
- Shading
- Views
- Environmental factors
- Geology.

Refer to appendix for detailed site analysis.

Orientation, sun, wind, views and contours

The site is one of the very southernmost sites in Wellington. It is also the last residential site at the end of the coastal road around wellington heading south and west. Hence I have called it the Last Site South. This site was chosen because it is a residential lot that has real constraints which require robust solutions. It sits in the iconic landscape of the south coast on the edge between the constantly shifting sea and the more rigid land. From the site it is possible to perspective on relative permanence, in a way that would not be apparent in a flat inland suburban site, by observing the effects of the natural process of coastal erosion. Views to the south are into the Cook Strait, a large open body of ocean stretching to the South Island and as far as the eye can see. The sea here is subject to frequent and dramatic storms, with high winds and cold weather. There are spectacular views to the east and west of the hills running into the sea. The design solution will be very much influenced by the site.

The site runs from relatively flat at the south end (where there is road and beach access) to steep (about 45 degrees) to the north, making it a difficult site to get winter sun. The

low flat part of the site is between five and six metres above sea level and constitutes about 40% of the site. The remainder rises to the north to 35m above sea level. The site is rectangular and aligned 6 degrees off north, with the east and west boundaries being about four times as long as the north and south boundaries.

Shading

As stated above, it is a difficult site to get winter sun, hence minimising shade was an important design consideration. New development in neighbouring lots cannot be predicted and if they occur they may block some views or cause shading. This is best addressed by being conscious of future development along the eastern boundary, especially in the placement of windows.

Geology

The general area is known locally as 'red rocks' with a large outcrop of dark red rock being present on the coast line two bays to the west. Red rocks are scattered in the area and pebbles of the same colour can be gathered from the beach in front of the site. These are a sign of the action of the two tectonic plates (the Australian and the Pacific) nearby which gave rise to the earthquake of 1855. The red rock is an older basalt deposit embedded in a younger greywacke as part of the process of subduction.

The immediate site is made up of typical greywacke rock covered with a screed of loose material to a depth of up to 2.0m on the slope. Good bearing can be found on greywacke rock. Additionally the screed of loose material can be compacted to good ground.

Environmental factors

To fulfil the brief, the location of the building on the site required analysis of environmental factors which may impact on the site over the next 400 years. These factors and the sun path will determine the form and position of the building within the site. Refer to appendix iii for sun path analysis. Environmental factors considered were the likely recurrence of earthquakes and tsunamis as well as sea level rise which may occur due to global warming. Sea level rise is predicted to change significantly over the next 400 years¹⁴⁴. To account for this, a conservative design approach has been taken when locating

144 <http://www.climatechange.govt.nz/emissions-trading-scheme/building/groups/climate-change-leadership->

the building by extrapolating the worst case sea level rise for 400 years. By locating the building on a site where predicted change in sea level will have such a dramatic effect we can test if relative permanence can be attained in the face of climate change.

Schemes for locating the building on the site

After analysis of the site, a picture emerged which allowed analysis of the best location of the dwelling within the site. The overriding strategy was to design a dwelling with relative permanence and durability.

Schemes A-J in which both the form of the building and its location on the site are tested. Schemes generally look to position the dwelling above the projected sea level rise to ensure the building and its foundations are not subjected to the corrosion, wave and tidal forces caused by sea water. Scheme B investigates building within the projected sea level rise. This could be achieved with a bridge access to the part of the site above sea level. However I decided against this scheme because in this position, a dwelling would be subjected to extreme weathering which is neither necessary nor prudent. Refer to *Scheme B location plan analysis* and *Scheme B location section analysis* diagrams.

Comparing Scheme B with F it is clear that the further south the building is located on the site, the more sun it will receive. Scheme F locates the dwelling at the rear of the site which makes for quite a climb or drive up from the current access of the road. However, if sea levels rise to a height where the current coastal road is no longer feasible access for the property then alternative access to the site from above is possible and anticipated.

Schemes E, F, G and J locate the dwelling to the western part of the site. The benefit of this is that more western (afternoon) sun falls on this part of the site. However, due to the steep rise of the site to the north significant shading occurs, particularly in the winter months where there is only afternoon sun from 2pm. Refer to sun study images in the appendices. In order to gain maximum sunlight the building would either need to be tall, located to the south (scheme B), or to the west, or all three of these.

When evaluating the relative merits of the schemes I considered that:

- if a tsunami occurred, any scheme higher up the site will be better protected;
- in response to the predominant southerly wind, a narrow southern elevation will be best;
- to build in worst-case predicted sea level rise, schemes above the 9.0m contour will be best;
- to gain best sun the building should be located to the west and south as much as possible; and
- good views are available from any part of the site although they could potentially be built out along the east boundary.

Therefore scheme G was chosen because it combined the best of all analysed options. It is above anticipated tsunami wave height, and sea level rise, presents a low profile to the wind, is located for afternoon sun and will be away from neighbours to the east. This means the dwelling has every chance of long term survival.

The best form for the building was devised through the same analysis used to determine the location of the building on the site. Several forms were explored. Scheme A shows a dynamic irregular form which presents a wide face exposed to the predominant cold southerly wind. It also presents elevations to the east and west where there are great views of the coastline.

Cylindrical forms are common to Schemes B and C above. This shape presents a narrow, curved and resistant face to the predominant wind. Cylindrical dwelling forms have a long history. Any tower is a timeless simple and geometric form which conjures up thoughts of safe medieval castles and robust lighthouses. By extruding the form deep into the ground the tower form can be anchored to the site. Similarly the cathedral of our Lady of the Angels acts as a beacon of light through its mission, its position alongside a motorway, and by its size with its large areas of glass. It is not necessary for this dwelling to act as a beacon to any one other than the occupants but it is necessary that it conveys a degree of permanence and signals home. The tall cylindrical form is a motif for a stake in the ground. It says 'this is where I dwell.'

Scheme D proposes a tower in a 'V' form. Refer to plan and section analysis of D. The height given by a tower is necessary to fit in all the accommodation where the footprint of the building is small. This form also presents a broad and exposed face to the south. Views are available in a number of directions but these are not aligned with the walls. Similarly Scheme E which is square in plan would need to be a tower, to provide all the accommodation required with a small plan and would be physically and metaphorically anchored into the ground. Scheme F is similar to E but rotated 45 degrees. The benefit of this orientation is that it provides a narrow face to the wind. This diamond shaped plan allows for views in all directions.

Schemes G, H and J are cantilevered forms. All align the dwelling with the proportions of the site and indicate that the northern part is buried into the slope. Cantilevering the building horizontally allows it to be all on one level while being anchored into the site and, if sea level rises sufficiently, extending out over the sea. *Scheme G location section analysis* indicates a dramatic form but shows up two practical issues. Firstly the rooms buried into the site have no natural light and secondly the cantilever looks weak in response to the actions of an earthquake.

Schemes A and I explore using the width of the site. This option would put windows on the eastern boundary with the neighbours and over 400 years they may be shaded or blocked. *Scheme D location section analysis* shows how this is feasible but hardly dramatic or responsive to the site.

This analysis led me to the form shown in scheme G. This is because the cantilever allows for all the accommodation to be on one level while providing a narrow elevation to the wind. It also allows for a good sense of anchoring as it runs back into the slope. The tower forms were attractive as they draw on images of safe permanent buildings while being also a marker of a place. Hence the services came to be vertically integrated and accommodated in an oval tower. In addition it was a deliberate strategy to have the south elevation read as a framed 4m square. The south elevation glazing is simply one large (triple glazed) piece. While allowing uninterrupted views from the interior it presents to the public an exterior form which is timeless.

There are three ovals in the building. Two are positive in the form of the services tower and the light shaft while the third is a negative being the opening in the west side of the courtyard wall. This opening can be read, due to the thickness of the wall, as being pointed to the place where the land meets the sea on the horizon when viewed from the entry and courtyard. It relieves the courtyard of its internal focus and gives connection to the landscape immediately outside and to the wider view. This will be glazed.

Appendix iii

Site Sun Studies

Images are generated at 1 hour intervals from sunrise to sunset. The site is shown as an extruded box, light in colour, the full size of the site boundaries. This generates shadows which can be read on the large scale which is necessary to show the hill that is casting the shadow over the site.

Site sun study for the last site south at equinox.

Appendix iv**Earthquake Mitigation Strategy***Strategy 1 Permanence through base isolation*

This strategy uses relatively new but proven technology to separate the dwelling from the land and provide a slip plane along which the dwelling can move independently from the ground, thereby reducing the forces on the building. This allows for a less rigid and therefore smaller structure. Base isolation is one of the earthquake design strategies used in the cathedral of Our Lady of the Angels. A building is not metaphorically nor physically anchored in this scenario. It does not allow for the building to be literally a cave with the earth covering the roof. In a steep site such as the one I selected, significant earthworks also would be required to stabilise the slope above the dwelling. This method could allow a dwelling to be designed to survive seismic events for 400 years without being a massive structure. Additionally repairs can be made where the building can be accessed. Two building forms (schemes *i and iii*) are drawn to illustrate the consequences of this strategy:

Strategy 2 Permanence through massive rigid structure

This second strategy requires a much more rigid and more massive structure in order to withstand the forces resulting from an earthquake. This could allow the earth to be laid back over the roof after construction and show minimum intervention of the building on the site. The dwelling would be connected to the ground on all faces including the roof. The shape of the plan would be influenced by this approach, as an irregular plan may not respond well to movement. It is essential the rigid building moves at one with the ground so as not to break up. Two building forms (schemes *ii and iv*) are drawn to illustrate this.

Appendix v**Structural Engineering Notes**Site

Erosion of this hill side over time is an ongoing process. This existing process is shown by the scarps on the hillside being evidence of past slips in the face. There is an existing layer of screed 1.0 to 2.0m deep over greywacke rock. The foot of the slope will need to be protected to prevent erosion from undermining the loose material.

Design

In order to allow for a 400 year return period we must use different parameters for structural design than the usual 50 year design parameters. Detailed structural engineering design will need to design for a higher return period perhaps as much as 1:4000 year earthquake. This may mean an increase of 30 to 100% to current codes. The current code only allows for 1:2000 year return period for wind. Similarly the earthquake code does not allow for 400 year return period.

Foundations

The foundations for the cantilevered elements are concrete walls or pads set into rock. Piles below these increase the connection into the ground. The tower needs a large slab foundation with piles into good ground. A leading edge to the foundation needs to be provided in the direction of the lean.

Foundations for the dwelling in the slope are slab on good ground (greywacke). It will be necessary to backfill behind the foundation wall.

Cantilever

The tower supports the cantilever (on one side only) as does the foundation wall running east to west. The action of the box beam cantilevering wants to twist the tower. This is resisted by two rigid portal frames at the tower. This twisting is not helped by the opening in the roof above the courtyard.

A web in the tower at plant room level for shear will help with the cantilever. Walls need to be struts and ties which can be in the form of a steel truss with steel ties and concrete struts. Apart from the tower the dwelling cantilevers from a foundation wall below the

courtyard. The further forward this the less stress there is. There is more torsion if the cantilever is supported from further back. Detailed design will be needed to determine the final position of the foundation wall supporting the cantilever.

Lateral Support

It is necessary to lock the building into the sloping land at the north. It may be necessary to provide pin piles down at back in an east-west line. This will give good resistance in one direction. Rock anchors only work in tension and one direction only but these can also be used if necessary to further key the building into the hillside.

There will be pressure sideways at rear of the building in the ground. It is necessary for the building to be a regular (box) shape here to allow for the pressure forces to run around both sides and flow on.

The building will also need to be tight into the ground. This will assist the pressure (both sideways and from above) to pass around the building. To do this the building walls can be cast against the excavated ground. Backfilling over the roof will also be necessary between the excavated ground above and the building.

Two slabs with diaphragm with holes to reduce weight: Concrete rib with holes for services and to reduce weight. Design the slabs to span from wall to wall and so do not need ribs. For stiffness the structure will need portal/ ribs running across box (fewer and chunkier ribs). It will also need trimming beams at openings in roof. Concrete of 40 Mpa or greater should be used as this will not only increase strength but also durability through its increased density and surface hardness and reduced voids.

Steel Truss and Walls

The walls are 6m deep primarily to support the cantilever. In the design these are made of steel RHS truss and cast in concrete. The steel is galvanised before encasing in the concrete inner skin. Provide FRP reinforcing bars in a grid form to the exterior skin. Steel truss cast in concrete to last 400 yr. There are advantages to using the steel truss in erecting a working platform and no need to scaffold. Tension ties in steel and compression struts in concrete. Openings are located within the design to clear struts and ties.

Cladding

Cladding the building in stone which is hard, dense and has a long record of service was considered. This would have involved fixing systems and joins between sheets which create details to be resolved that rely on sealants, grouts and glues. These fixing systems require more maintenance than concrete to be effective as they rely on glues and grouts or mechanical fixings and cavities. Therefore they are less suitable as a long term solution. Cavities for water drainage also undermine the monolithic appearance of any building.

Reinforcing

Options include :

- Galvanised (50yr durability) or
- Epoxy coating (100yr durability possibly) or
- Stainless steel or
- Fiber-reinforced plastic (FRP)

The best option is FRP reinforcement and is a composite material made from a polymer matrix which is reinforced with fibers. The fibers are usually fiberglass, carbon, or aramid, while the polymer is an epoxy, vinylester or polyester thermosetting plastic. FRP is used in industries including aerospace and construction.¹⁴⁵ Because it is inert there are no rusting issues with FRP and its use is likely to contribute to the durability. It is proposed to use inert FRP rods for reinforcing. The steel truss frame will be within the inner skin and so at worst over 500mm from the exterior of the building offering significant protection from the weather.

New Zealand building codes only presume a design life of 50 years. As the dwelling is located in a coastal zone with wind driven salt being a constant of the site, additional concrete cover, along with finer and denser concrete will be necessary to ensure the durability and relative permanence of the dwelling. Durability in concrete construction increases with the depth of cover of concrete over steel. This was identified and provided for in the cathedral of Our Lady of the Angels and it also consequently increases mass.

Construction Method

Due the steep slope and presence of scree on the site, the construction method will be critical to the feasibility. Following is a suggested method.

¹⁴⁵ http://en.wikipedia.org/wiki/Fibre-reinforced_plastic

- Tunnel into the hillside,
- Construct series of portals to tunnel safely as excavation progresses,
- Rock bolt into good ground overhead as temporary support,
- Spray the tunnel with concrete,
- Remove temporary portal,
- Apply waterproof membrane,
- Install steel truss,
- Cast concrete walls against the membrane and around the steel truss.

Appendix vi

Flexibility of Services

This appendix sets out the strategies considered for flexibility of services. Flexibility is necessary for durability of use as discussed in chapter two.

I tested a number of ways to find the best way to provide for flexibility in services.

- *Scheme 1 services strategy* accommodates permanence by providing a crawl space or access tunnel under the building around the foundations. The provision of a services space allows for access to make changes (relocation or extension, running new services or repairs) without cutting into the building itself. Scheme 1 (below) shows how this might work with base isolation. This was the strategy used in the cathedral of Our Lady of the Angels by Rafael Moneo.
- *Scheme 2 services strategy* provides access tunnels below the concrete floor slab. These are more restricted access than scheme 1, but do allow for changes and maintenance. This strategy would work where slab on ground foundations were used.
- *Scheme 3 services strategy* places all services outside the building where they can be easily accessed. This has a precedent in the Pompidou Centre in Paris and is common for many building services in New Zealand. However this strategy would be difficult with a building buried in the ground and would be difficult to access in a tower. In addition, all external services would need protection from the environment.
- *Scheme 4 services strategy* accepts that cost is involved in changing services and allows for alterations to the building to relocate services as and where necessary. This may involve significant work if the structure is concrete or stone or may require services to be expressed internally or externally where minor changes would otherwise require major work.
- *Scheme 5 services strategy* puts all services in a cavity within the walls, floor and roof with regular access to these. In this way flexibility and access is maintained without external services. It will require a larger structure. A variation of this which is common in commercial high rise buildings is to run services under a raised floor, usually only electrical and communications services.

All piped and cable services run to and from the tower with the tower forming a plant room at ground level. Here all pumps, distribution boards, batteries, potable hot and cold water storage, etc. can be accessed. This integrates with the photovoltaic solar energy collection above and the rain water storage below. Within the tower is also the soil water pipes taking waste to ground level. As a hollow section the tower can easily be accessed to make changes or to run new services. For example should technology and cost allow, the tower may in the future support a wind-powered turbine to generate electricity on site.

Ventilation shafts are cast into the concrete skin and form part of the permanent structure.

Heating

Permanence in heating services through one system or product is difficult to achieve, as new technology continues to offer new ways which are less expensive and more efficient. Recent history has shown changes from coal and kerosene to electric heating systems such as heat pumps. Even the timeless wood burning open fire is becoming outlawed in some places. Nonetheless good use can be made of new technology and constant and permanent natural systems.

The first part of the heating strategy involves using a ground source pump which is accessible from the tower. Within a couple of metres of the earth surface below ground the temperature becomes a constant 10 to 12 degrees Celsius. By using a ground source heat pump these 10 to 12 degrees of heat can be extracted and used. The second part of the heating strategy is to pump heated liquid to radiant heating unit(s) in every room or space, which each have thermostatic control and are run from a central system. Radiators have proven to be a good way to heat spaces. It may be that over time, other liquid mediums may be substituted in that system that are more efficient to heat than water. Also the source of the heat can be substituted as necessary should the ground source heat pump be superseded in efficiency or cost. The system itself can be changed through the service cavities.

Appendix vii**Courtyard houses: modifying hostile climates**

Traditional courtyard houses were developed as a response to hot climates. An opening in the centre of a house lets sun light in in measured amounts while maintaining shaded areas. Heated buoyant air rises from the centre and forces ventilation in through small windows on the perimeter. This air movement is cooling.

In order to deal with the heat and light, houses in hot climates have thick walls, small windows and use a combination of shutters over openings and tiled and hard dense surfaces. Towers at corners can trap and direct wind and aid natural ventilation. There is often more wind higher up.

In a cool or temperate climate such as Wellington has, the courtyard works a little differently. Here it provides shelter from the wind. It is not so tall and narrow so it lets in more sunlight. This sunlight, direct or indirect, can penetrate deep into the plan. It also creates a modified climate which allows for heat gain in cool months when the glass roof is covered. This will allow for planting to grow better and for different species to grow here. Planting could include ornamental or fragrant plants or citrus or fruit trees or vegetables and herbs.

In combination with the sliding doors the glazed roof works for many climatic situations.

Like the traditional courtyard houses of hot climates, the thick walls of the design for the Last Site South provide security. They are also inward looking and provide privacy while excluding noise.

In cosmological terms the courtyard was not open but roofed by the stars and sky. The courtyard (as do the bedrooms through the light shaft) engages with the moon and stars and their cycles and becomes a positive void.

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