Circulation, Nature, Connection:
‘Breaking down institutional barriers to biophilic healing’

Masters Thesis Explanatory Document
Scott Foote
Acknowledgments

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Supervisors:
Tony van Raat
Peter McPherson
David Turner

Editors:
Catherine Bish

Chevalier Collective:
Shaun Goddard
Carleone Posala
Tuputau Lelaulu
Mason Rattray
Abstract

This research study is concerned with the how the circulation aspects of a hospital can be intentionally designed to enhance patient care. Natural environments have proven to be beneficial to healing and wellbeing. It is possible that circulation space could be the medium used to connect people back to nature within a hospital setting while continuing to provide for all the other requirements of a functional hospital. How these connections to nature might occur within my design will be a mix of direct and visual strategies. This will give the users of the complex the choice of how they want to occupy such a space. Design will be generated by the dual foci of reducing circulation while also obtaining a connection to nature.

Visits to hospitals around Auckland reveal a lot of long, internal corridors which provide little or no external reference and have a tendency to disorient the visitor or occupier. Circulation systems in hospitals are usually controlled through the necessary connection of different departments, and focus on control of the spread of infectious diseases. Instead, this study attempts to find an in-between point where users could be given more choices, providing new opportunities to pull away from the dense, repetitive and sterile environment that the public currently perceive.

As an example, North Shore Hospital’s circulation is very difficult to “read” for the visitor. The feeling of being locked in corridors with no visual connection or sense of location is very unpleasant. This is a major design problem. This research began with these criticisms, drawing on anecdotal experiences, to develop ideas about how people would prefer to be treated in hospital environments. It is argued by some authorities that nature is beneficial to healing and connection to it can play as important a role in recuperation as the medicine patients receive for their illnesses. This research project focuses on the value of nature to health treatments in the conventional hospital situation and will test different circulation systems and relationships to external landscapes.
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Definitions

-Biophilia: an innate and genetically determined affinity of human beings with the natural world.

-Superstition: Excessively credulous belief in and reverence for the supernatural

-Supernatural: attributed to some force beyond scientific understanding or the laws of nature

-Integration: the act of combining or adding parts to make a unified whole
1.0 Introduction
1.1. Background of the project

Healthcare architecture’s connection to nature is an intriguing and challenging question in regards to its effect on human wellbeing. Hospitals can be seen as machine-like institutions for treating patients in a sterile atmosphere. Since antiquity, the healthcare environment relied heavily on natural elements to aid in healing patients, but this connection was lost in translation through the technology advancements.

This research seeks to explore healthcare institutions and their barriers to biophilic healing, using architecture as a medium for representation.

The areas explored include:
- Nature
- Circulation
- Noise
- Technology
- Scale
1.2. Aims/objectives of the project

The encouraging effects of natural vistas, fresh air and sunlight on the healing process raise the challenge of how, architecturally, to incorporate these beneficial elements into healthcare institutions. Many architectural professionals today are engaging and incorporating nature into the urban fabric. This trend is provoking discussion and raising the awareness of the possibilities of natural elements being incorporated within large buildings and institutions. It is essential to not let their global urban growth disconnect them from the natural world with which civilization has been so intimately involved. This project employs the theory of biophilia\(^1\), and looks at circulation in order to adapt and reconnect it with the environment that we need to sustain our physical and emotional health. Biophilia "is the innately emotional affiliation of human beings to other living organisms". This concept will be explained further within this project.

The research aims to discover how to incorporate natural elements into healthcare institutions on a human scale. The desired outcome from this is to create an environment for healing, to disconnect healthcare designs from being sterile and refocusing on the reconnection to the natural environment.

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2 Ibid. p.3
1.3. **Scope and Limitations**

This work will focus on the interaction of people in healthcare institutions with their environment and how that interaction influences their health and wellbeing, both physical and psychological. Hospital users’ current experiences of this interaction are typically unpleasant and negative. This work will show that there is a tangible healing benefit to the inclusion of natural elements in healthcare architecture.
1.4. Research Question

“How can architecture break down healthcare institutional barriers to create a biophilic healing environment?”
2.0 Existing hospitals
Figure 1: The temple of Asclepius at Epidaurus, Peloponnesus, the shrine of Asklepios, the god of medicine (6th Century BC)
2.1. The Greeks

Since the beginning of recorded history, it has been common practice to segregate unhealthy individuals from the healthy and to create environments dedicated to healing or, at worst, easing the pain of individuals unlikely to recover. Throughout Europe the “sick house” and “death house” evolved as repositories for the disenfranchised, indigent, insane, and terminally ill.7

The earliest documented buildings which in some way resemble our current hospitals were found in ancient Greece. Temples dedicated to Asclepius, the god of medicine and healing, functioned as centres of medical advice, prognosis, and healing.4 Their healing concepts were closely linked with religious rites and rituals, despite which death was understood as inevitable.

Hippocrates of Kos, considered the father of western medicine, was the first to distinguish the existence of medicine separate from philosophy and religion. He believed that physicians must understand the causes of these illnesses, and that diseases could not be healed solely through the healing powers of the Greek gods. He believed that for one to fully understand human health, it was essential to understand the environmental conditions that humans have to deal with. He understood these to be the four seasons, fresh water supplies, site orientation strategies for cities and towns, and the impact of prevailing winds.5 Understanding these factors suggested what diseases to expect throughout the year. Hippocrates’ theory of human health would be the influential push forward for the Greeks to evolve a rational practice of medicine, uninfluenced by superstition and belief in the supernatural. The Greeks put Hippocrates’ theory into practice with the construction of Pergamon in Aeolis with the

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5 Verderber, Innovation in Hospital Architecture.p. 10.
6 Ibid.p. 10.
7 Ibid.p. 13.
Figure 4: Baths of Diocletian, Rome (298-306 AD)
2.2. The Romans

Roman medicine was heavily influenced by Hippocrates’ theories. Roman military hospitals were located on the borders of the Augustinian Empire. These showed some resemblance to current health facilities, particularly in terms of natural ventilation and lighting. It was believed these institutions were to provide resting and healing environments so that the soldiers would return to battle faster. These complexes consisted of small rooms divided by double-loaded central corridors which allowed for natural lighting and ventilation through small windows in each room. This environment not only provided the soldiers with medical treatment to stay alive but with ideas of hygiene and diet. This concept of the “Valetudinarian” was one of the reasons why the Roman military were so healthy and strong compared to others of the era.8

Advances in sanitary systems, the introduction of large aqueducts across the empire and indoor plumbing were significant architectural innovations that contributed to the development of the health sector. The great Baths of Diocletian in Rome were constructed between AD298-306. Roman bathhouses could be distinguished as one of the most interesting innovations in Roman architecture, with most Roman cities having at least one. Bathhouses were used by everyone, and were considered to be very significant in Roman society, “as patrons stayed there for several hours at a time and some patrons went there on a daily basis”.9 They became central to Roman life due to the vast range of civic functions that took place there; personal hygiene, spiritual worship, social interaction, wellness activities and even business transactions.10

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9 Verderber, Innovation in Hospital Architecture, p.16
10 Ibid. p.15
2.3. Fall of the Roman Empire

The fall of the Roman Empire in the fourth century saw a setback in the development of hospitals. Deadly outbreaks of bubonic plague (also known as the Black Death) decimated communities throughout Europe from around 541-700AD, killing off more than ninety percent of the inhabitants.11 To fill the void in healthcare, large monastic hospitals were constructed on the boarders of villages and cities across Europe. Due to the massive demand for healthcare, monasteries soon changed from large open wards to “replicated cross-ward open-plan monastic chapel-wards on a single site”12. This involvement of the Catholic Church led to a diminished architectural emphasis on natural lighting, ventilation and connection to nature. Faith in the healing power of God and Jesus Christ replaced faith in the healing power of nature. Architecturally, as well as spiritually and psychologically, the focus of these buildings turned inwards, to the cross. They were viewed as environments for the diseased, ill, social misfits, the disfigured, and the disabled.13 Although these institutions were repulsive, they did develop self-sufficient environments, growing their own food and producing all necessities for daily life themselves in order to survive such hideous conditions.

The rise of the Catholic Church correlated with the departure of the belief that the connection to nature and the landscape were of any importance in treatment. Belief in god was emphasized as the path to healing. This faith-based healing was known as the “seven works of mercy” and dominated (supposed) healthcare for nearly a thousand years.

11 Ibid. p.17
12 Ibid. p.17
2.4. The Middle East

In the Middle East the first recorded Islamic institution for the sick was founded by Caliph al-Walid in 707 AD. These institutions were well advanced compared to European counterparts during this time. Nearly every Islamic hospital was symmetrically situated around an open courtyard with connections to natural resources; such as rivers and canals. Water was a very significant resource for these institutions, as it was seen as a therapeutic amenity for the sick and diseased. In some buildings, streams would run through the middle of the courtyards to the centre, where a pool would be located. In most respects, these hospitals took the shape of a civic centre by incorporating pharmacies, dispensaries, social spaces, mosques, and spacious courtyards. Unlike their European counterparts these spaces were controlled through the connection between internal and external spaces. The importance of these areas was expressed through the high quality materials used within them. By the 19th century, these institutions were overpowered by Western colonial powers and replaced by westernized medical institutions.

Figure 6: drawing of Ibn Tulun hospital, Cairo (878)

14 Verderber, *Innovation in Hospital Architecture*, p. 19
15 Ibid. p. 19
2.5. The Renaissance

The Renaissance saw a reawakening of interest in classical antiquity as represented in medicine by Hippocratic traditions. The revival of classicism and neo-classicism saw certain architectural elements re-emerging for the treatment of the sick and diseased. These included elements and techniques such as symmetrical configurations, regimented facades and connection to natural environments / landscapes which brought back the therapeutic role within architecture.16

Hospitals in affluent cities throughout Europe were made possible through the charity of wealthy philanthropists and were no longer burdened by religious centres. This didn’t change the social segregation between the wealthy and poor, as private rooms for in-patients were adopted back into the hospital environments but were only available for the use by the wealthy.


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*Figure 7: the Arcispedale di Santo Spirito in Rome (1473-1477)*

*Figure 8: Bernard Poyet (1742 – 1829) in 1785*

*Figure 9: Hôtel-Dieu by Antoine Petit in 1774 envisaged a hospital along radial lines*
Figure 10: Cluny, France (1157)
Figure 11: Historic image of hospital wards
2.6. The Nightingale Movement

Revolutionary developments occurred in hospital architecture due to the devastating fires that took place at Hotel Dieu, Paris, 1772. This event highlighted the atrocious conditions present in hospitals at the time and how far from a healing space they really were. These unhygienic environments were due to the explosive growth within cities. This resulted in the hospitals’ capabilities being overwhelmed. There was a lack of medical knowledge to prevent infections spreading internally in conditions like this. The wealthy continued to receive treatment by private doctors at their homes and thus were able to ignore the unpleasant conditions prevalent in hospitals, which only provided healthcare for those who could not afford better treatment. Massive public criticism resulted in demand for a change in the way these types of institutions were designed.

It was not until the early 19th century that the criticism forced proposals to be taken seriously. Two proposals were notable: the Radial Solution and the Pavilion Solution. These were seen as a revolutionary step in the development of architectural elements within healthcare. This era also saw the separation of health from religion. From this point treatment was based solely on empirical advances through science and technology. This separation helped the new healing environment become known as the first functional building typology in the history of architecture. Already in high demand, institutions adopted the pavilion system (often called Nightingale wards, due to the influence of her barracks hospital during the Crimean War of 1854). Pavilion Hospitals were organised around a central circulation corridor. Long narrow wards were arrayed on either side of this central corridor with garden courtyards in the spaces in between, allowing visual connection to natural environments, natural light and fresh air to filter through the wards’ large windows.

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17 Wagenaar, *The Architecture of Hospitals*. p.29
18 Ibid. p.31
19 Annmarie Adams Reviewed work(s): The Architect and the Pavilion

The realisation that bacteria were significant agents in the spread of disease meant there was no longer any use for the pavilion system, which acted as a wind machine. The abandonment of the pavilion system in the 1920s, brought forth the ‘block’ hospital, which was seen as a more compact type of design. The pavilion system came with many disadvantages, especially the vast and unnecessary distances between facilities. Introducing the more compact hospital was seen as an economic development for the good. With these interventions, the hospital environment soon developed into a “temple of the medical world”, including medical specialists and new medical technology. But such developments saw the hospitals’
original clientele begin to disappear due to the rising costs of treatment. James Gamble Rogers Columbia-Presbyterian Medical Centre (1926-1930) is an example of a block hospital and this transformation from pavilion system to compact hospitals designs that saw the exclusion of nature within the designs as unimportant.

The scientific discovery of bacteria and the invention of the Rontgen (x-ray) machine in the early twentieth century led the next influential revolution within healthcare architecture. From this point, technology and medical science reigned supreme within hospital environments and eventually also revolutionised their social position. From hospitals being known as ‘almshouses’ for the poor, medical institutions have become places, in many countries, where the poorest can no longer afford treatment.

Figure 13: Example of a Nightingale Ward, from notes on hospitals, Florence Nightingale

Figure 14: St Thomas’ Hospital, London, home of the Nightingale Training School for nurses.

Ibid. p.31
2.7. International Style

The international style originates itself from the 1920’s in Europe. This early modernists approach spread immediately following world war II and medical establishments accepted international style modernism as a new direction for the variety of new hospital construction that took place. International style saw dominance for the next forty years in construction of these institutions. The background of these developments in architectural designs was due to the social upheaval of the 1960’s. In the case of hospitals the needs of patients were seen as less important than the “machines housed in within”. \[23\] Troubles during this era was designing hospitals that can adopt to the ever growing technology advancements. Solutions for this issue was to adapt the treatment areas to be located in the lower flat two levels, placing the patient wards above. This solution provided the chance of rebuilding, redesigning areas in the hospital that needed to adapt with new technology, without disturbing the wards. This was the introduction of ‘T-type, K-type designs’ which started to break down three main parts of the hospital:

- Patient wards
- Concentration of facilities for medical treatment of the patients
- Outpatient wards

An early example of hospitals in this era was the St Joseph’s hospital in Burbank, California (1962-64), was designed by Welton Becket and Associates.
Figure 16: J. Gamble Rogers, Medical Center (Presbyterian Hospital), New York, 1930

Figure 17: Coolidge Shepley Bulfinch and Abbott, Cornell Medical Center, New York, 1933
Figure 18: E. & P. Vischer, Hermann Baur & Bräuning, Leu, Dürrig, Bürgerspital, Basel, 1946. At the right the flow chart.

Figure 19: P. Nelson, Hôpital Mémorial France-États-Unis, Saint-Lô, 1956
3.0 Literature Reviews
3.1. Nature

“Implies that we are nature-loving because we are of nature…our brains, our bodies evolved in Nature, and as biological beings we need it to sustain our physical and emotional health” - Stephen Kellert

Biophilia

‘Biophilia’ is a term created by Havard biology Professor E.O Wilson in 1943, and is described as the link between nature and human beings.24

The hospital is an institution that provides patients with treatment through specialised medical interventions. Hosking and Haggard, in the book ‘Healing the Hospital Environment’ says that a place of healing is a place of refuge and recovery, but in some instances the process of healing can be undermined by the sterile, unnatural environments.25 Most hospitals seem to be designed to accommodate medical machines rather than people. Ward location and layout, therefore, are often compromised to fit into this hierarchy. As a result healthcare spaces are usually broken down into sterile boxes and are perceived as hostile.26 Patients in these environments are not treated as individuals but rather as a collection of diseases.

Brian Lawson suggests that “when the body and mind interacts with a space, the surrounding atmosphere evokes the senses consciously and unconsciously.”27 This view on inviting users to interact with a space would fulfils the social, physiological and psychological needs of patients, staff and friends. This involvement would aid to providing a more pleasing and healing environment for the occupier.

Visual connection to nature is an important feature that all healthcare institutions should incorporate in their architectural designs. This is due to the belief that the visual connection to the landscape from a hospital environment provides distractions. These distractions for the occupiers develop a oppositions towards hostile situations that could be occurring. History shows that, “links between landscape and health have been observed for a long time and in many different cultures and societies. There was a sense of belief that vegetation, water and other natural elements can reduce stress and provide beneficial qualities towards patients in healthcare environments. These readings have been dated as far back as the earliest large cities in Persia, China and Greece.”28

Figure 20: Biophilic pathways to urban resilience

24 Beatley, Biophilic Cities: Integrating Nature into Urban Design and Planning, p.2
26 Ibid.
28 Health effects of viewing landscapes – Landscape types in environmental psychology Ma .D. Velardea,, G. Fryb , M. Tveith
Stress and the Environment

The World Health Organisation states that the ideal principle of healthcare should be to establish a “complete physical, mental and social well-being and not merely the absence of disease or infirmity.” Following this principle, the effect of hospital architectural aesthetics on the stress levels and mental well-being of users should be considered as a prime driver in design. Particular focus should be taken into account towards how the human brain is influenced by surrounding built environments, with particular focus on stress levels. There are many proposed healthcare models that architects can use to help develop an environment for the wellbeing of the users (refer to Hospital Precedents studies, chapter 4). One person that has proposed a healthcare model that strives towards an environment that aims to achieve healing potentials within each human being. CEO Patrick Linton based his article on the research done in psychoneuroimmunology, illustrating the science behind a variety of environments’ and its ability to promote good health. He states that “Since the brain, nervous, endocrine and immune system are interrelated, a thought can, in fact, affect an individual’s overall biochemistry. Therefore, a negative emotion can manifest into a physical disease whereas positive emotion can create constructive health traits.” Cancer patients can be used from this study as an example due to the fact that their “exposure to positive emotions has been noted to reduce tumour growth, slow the progression of the disease, increase natural killer- and T-cell activity and increase antibody production.”


Spatial Perception

Waiting is a fundamental part of the healthcare experience. The amount of time a patient may spend waiting during each event for which they require hospital care cannot be quantified, but it can be said that waiting time at a hospital can often be perceived as long, painful, stressful and uneventful. This was expressed in Pruyn and Smidts’ book which describes how the hostile effects on a patient who has to wait in a hospital environment can be decreased through developing or improving aesthetics in these surroundings. One of the most recently constructed hospital buildings, the Royal Melbourne Children’s hospital (2011) has set a benchmark to show how an architect should consider the occupiers’ wellbeing within their designs. It was crucial through the design stage to understand the fundamental needs of the hospital’s users. These were for a hospital that would be suited to a family-centred environment and to have areas that would “translate a child’s fascination with nature into an architectural language.” Other features that were incorporated into the design were a two-storey aquarium, large scale artworks, temporary exhibits of zoo animals in a specially designed environment, a Scienceworks museum and Hoyts movie installations.

EDAC (Evidence-based Design Accreditation and Certification) is an organisation that processes the best possible outcomes for the built environment through the use of credible research. They state that “A large and growing body of evidence attests to the fact that physical environments impact patients’ stress, patient and staff safety, staff effectiveness and quality of care provided in hospitals and other healthcare settings.” This background research supports the idea that incorporating natural environments within healthcare architecture is a simple but effective way of improving the healing qualities and lowering stress levels of staff and patients.

33 “Evidence-Based Design Accreditation and Certification,” https://www.healthdesign.org/edac/about.
Positive Distraction – Nature

There have been many studies that conclude that natural settings possess healing benefits, reduce the amount of stress and promote mental relaxation for patients. Alan Dilani is director of the international academy for design and health (IADH) and states that patients who have undergone a long period of treatment in an institutional setting will require a certain amount of time afterwards recuperating for their healing to produce effective results. He says that for a patient not to be mentally exhausted, they must have a period where their indirect attention is activated. This activation will be more effective in an environment that is aesthetically pleasing. Therefore, incorporating some sort of visual or physical connection to natural surroundings is a straight-forward way to promote a faster, more effective healing process.

Figure 25: Icon Hotel Hong Kong: a vertical garden by Patrick Blanc

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Natural Lighting

Since the 1940’s, artificial lighting has been commonly used in hospitals to supplement natural light. Only recently, since the energy consumption and environmental impact of hospitals has become a concern, has the demand for daylighting been resurrected. The real benefits of natural lighting extend beyond just aesthetics and energy efficiency, however. It has been proven to have significant positive psychological and physiological effects. Use of natural lighting can be “associated with higher productivity, lower absenteeism, fewer errors or defects in products, positive attitudes, reduced fatigue, and reduced eyestrain.” In healthcare the use of natural lighting in the architectural design can be beneficial not just for the patients but for all users who occupy that environment.

36 Ibid. p.3
Healing Environment in hospital designs

Lighting in healthcare is not just a necessity for visibility but for its effect on the human psychological and physiological spectrum. According to Dr. Ott, who did many studies on how light affects the human body said that “nutrient of light affects the metabolic processes” in the human body in a similar way to the nutrients taken from food and water. This type of “nutrition” can be overlooked due to its effects being less quantifiable. But studies have shown that natural lighting benefits the human body by reducing depression, decreasing length of hospital stays, improving sleep and circadian rhythm, lessening agitation and easing pain.

“When we speak about health, balance and physiological regulation, we are referring to the function of the body’s major health keepers; the nervous system and the endocrine system. These major control centres of the body are directly stimulated and regulated by light, to an extent far beyond what modern science….has been willing to accept.”

With all this research providing information that natural lighting is a critical factor in achieving a healing environment for patients, it also suggests that daylight not only impacts the patient outcomes, but that it can also provide benefits to others who spend time in healthcare settings regardless of whether they are there in a work or support capacity. In the healthcare environment, it is not only patients who are in need of healing psychologically and physiologically. Natural lighting promotes a more positive perception for all. A recent survey conducted in 2005 explored the hospital environment and its access to natural light: it claimed that 70% of the medical staff rated increased natural light as having a positive impact on their work life.

39 Torcellini, “A Literature Review of the Effects of Natural Light on Building Occupants.” p.4
40 Haggard, Healing the Hospital Environment: Design, Management, and Maintenance of Healthcare Premises. p.175

Figure 26: creation and perception of an interactive spatial
**Integrating Daylight with design**

Certain areas of healthcare have specific guidelines for lighting in their medical areas. This means that natural light is not always the right type of lighting that is needed for different occasions. When designing a hospital it is essential for the designer to both incorporate natural lighting and artificial lighting to develop this ‘healing environment’. The ability for the users to have control over their environment is essential as everybody is different in their own ways. This factor incorporated in a design will benefit users. An environment which makes good use of natural light will assist occupants in performing their functions, which are a part of hospital life.

“In fact, it has been recognized for many years that light has a significant effect on our circadian rhythm (i.e. biological cycles that repeat 24 hours). Campbell et al. (1988) imply that light is the most important environmental input in controlling bodily function after food (La Grace, 2004). Similarly, CABE (2004) clearly indicate that access to natural light is one of the crucial factors affecting patients’ recovery. The presence of visible light in an indoor environment does influence the physiological responses, mood as well as visual needs (Schweitzer et al., 2004). Most psychiatrists generally agree that seasonal affective disorder (SAD) with symptoms of depression, fatigue and irritability may be triggered by shorter hours of exposure to daylight due to the seasonal change (Morris, 2001, Evans, 2003 and Bower, 2005).”

Information and communication technologies have the potential to provide some solutions for challenges faced by the healthcare industry today. Technological innovations are transforming all industries as well as changing every facet of our personal lives. The amalgamation of technology and medicine can achieve improvement and develop an environment that contributes towards saving lives around the world. The reliance on medical technology by healthcare practitioners is significant and therefore, it is responsible for better diagnosis, surgical procedures, and improved patient care. The use of electronic medical records, telemedicine, and mobile technologies such as tablets and smart phones has enabled healthcare professionals to provide faster service and has improved the patients’ quality of life. Experiencing rapid and constant technological changes within the field of medicine defines the requirements of hospital architecture. The architectural demands are constantly changing as the technology itself evolves, although there are certain major paradigm shifts in technology that can inform healthcare design for the future.

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S. Aripin, “Healing Architecture: Daylight in Hospital Design,” in *Sustainable Building South East Asia* (Malaysia 2007). p.174
3.2. Technology

Telemedicine

Telemedicine is a term used since the 1970s, which literally translated means, “healing at a distance”. It represents the integration of information and communication technologies to improve patient outcomes, thus increasing access to care and medical information. The World Health Organization defines telemedicine as, “The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities.”

Recently, telemedicine has seen steady growth simultaneously with advances in information and communication technologies. The applications of information and communication technology can encourage knowledge and information exchange with a primary goal of improving patient healthcare services. There are various applications of telemedicine that can have an impact on hospital settings. Some of them are:

- Tele-Consultation
- Tele-Expertise
- Tele-Monitoring
- Tele-Training
- Tele-Assistance
- Tele-Administration and Management

Automated Transportation Systems

Technological advances in robotics in recent years have had a significant impact on domestic tasks, surgery, surveillance, and also in security applications such as bomb disposal or handling of hazardous materials. Autonomous mobile robots which assist humans, service equipment and perform other functions have been integrated into almost every industry. Healthcare facilities today are heavily dependent on them and consequently, there is an urgent requirement to improve healthcare staff’s workflow to efficiently meet challenges faced by them. The incorporation of automated guided vehicles can help enhance the productivity of logistics tasks or duties within the hospital, such as collections and deliveries. With improved logistics processes, healthcare personnel can focus their attention on caring for the patients.

Pneumatic tube systems are frequently used in the healthcare sector, although they are limited to delivering goods that weight less than 5 kg. There is a noticeable need for a transportation system that can move heavier and multiple supplies around the hospital in order to eliminate much of the labour that is involved in

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47 Acosta Calderon, Carlos Antonio, Mohan, Elara Rajesh, and Ng, Buck Sin. “Development of a Hospital mobile platform for Logistics Tasks.” Digital Communications and Networks. Accessed April 22, 2015., http://dx.doi.org/10.1016/j.dcan.2015.03.001
In recent times, automated guided vehicle systems (AGVs) are being used in a variety of applications such as warehouses, factory automation, seaport container handling, airport baggage handling, and in hospitals. AGVs are able to transport food, laundry, sterile items, medical equipment, waste, and other items around the facility on driverless wagons 24 hours a day, 7 days a week. They are also able to find their own paths and are able to take elevators on their own. Based on analysis carried out by University of Arkansas at University of Virginia Health Sciences Center, mobile robot solutions are cost effective and can exceed the performance of human-based transportation and distribution systems. The use of pneumatic tubes alongside automated guided vehicles can considerably lower delivery times and further drastically reduces operation costs.

Hospitals are facing major business and technology challenges in this century. They have much to gain from investing in a digital hospital infrastructure. Design and planning can facilitate and enhance the importance of technology within a hospital setting. The incorporation of technology within healthcare does not just alter; rather it dramatically changes our perceptions of hospital architecture. The spatial, planning, and design requirements change completely with the incorporation of digital infrastructure. It enables us to design a more patient-friendly hospital.


Figure 28: Automated machines pick and pack medicines
Figure 29: Robot hospital porters
3.3. Noise

There are a variety of noises that surround a hospital environment, these can range from therapeutic to the stressful and distracting. Physically, there is no difference between sound and noise. Noise is defined as an impurity of unpleasant sounds. This is usually prevalent within the hospital setting. It causes an increased amount of anxiety, sleep loss, and pain perception (Shu-Yen Li 2011).

Different aspects of noise suggest the importance of designing and controlling the environment to prevent transmission of unwanted noise and yet also improve verbal communication between people who need to communicate. Speech audibility is seen as essential, for its inability to communicate between patients and staff or between staff members in the hospital could be fatal.

In a hospital environment, sources of noise are countless. They emanate from alarms and monitors, human conversations, patients and visitors, movement of beds and equipment, and public address systems. These types of noise should be controlled by the building’s design and acoustics, which can include door mechanisms, open plan work areas, and the lack of sound absorption materials. Long term exposure to high levels of noise can have adverse effects on patients including altered memory, increased agitation, less tolerance to pain, aggressive behaviour, and can contribute to falls and confusion, especially with elderly patients. Research have been conducted


and provide information that relates to negative effects of noise on patients and staff in hospital settings. The impact on staff member’s workings long hours in a noisy environments increased their exhaustion, depression, and irritability.

There are many reasons for the noisy environments in the hospital as stated above. These conditions can be controlled also through environmental surfaces such as walls, floors, and ceilings. These contribute as sound sources in a hospital. The presence of hard reflecting surfaces in the hospital tends to aggravate the noise problem in hospitals. These surfaces tend to cause noise to travel long distances down the corridors and into patient rooms, adversely affecting patients and staff over larger areas. The reverberation time of a room is the time it takes for sound to decay by 60 dB once the source of the sound has stopped and is largely dependent on the sound absorbing materials in the room. Use of sound absorbing material can help reduce noise build-up. Incorporating high performance sound absorbing ceiling tiles and panels reduces the noise levels and perceptions of noise. It has a negative effect on other outcomes such as speech intelligibility and reduced perceived work pressure by staff members. Decibel levels are not significantly reduced, but reverberation times and sound propagation are significantly lowered.

Speech intelligibility and speech privacy are extremely important in healthcare settings. The healthcare staff need to comprehend and act on many types of auditory information. A move towards a digital hospital requires automation of many hospitals. Speech recognition systems which can be critical in a functioning digital hospital cannot interpret sound signals in poor acoustic conditions or environments. A poor acoustic environment can lead to errors in automatic transcription, doctors’ notes or automatic dispensing of pharmaceuticals.
In large hospitals, patients are often exposed to situations where they overhear private conversations with or about other patients or even have private information communicated in open areas. Such occurrences often have an impact on patients’ trust and their ability to discuss their health problems. The design of the physical environment evidently impacts matters of patient confidentiality and speech privacy in hospital settings. Breaches in patient confidentiality occur more frequently in multi-bed spaces with curtain partitions, and patients examined in such spaces are more likely to withhold information because of the lack of auditory and visual privacy. There are numerous spaces where private conversations can be overheard such as admission areas, reception areas, waiting rooms, open plan examination areas with curtained cubicles, and multi-occupancy rooms.60 A solution offered by research is establishing a department of sound. It can be aimed at reducing extreme noise levels throughout the hospital and also provide a center for music therapy, hence reducing the level of anxiety for all patients within the healthcare setting.61

Creating healing environments is critical for patient care. Our ambient physical healthcare environment plays an important role. Impure sound becomes noise, which is known to have negative effects on health and healing. Undoubtedly, architectural design solutions can begin to address many of the issues of healthcare settings in terms of patient confidentiality. One of the strong design solutions provided by the research is single patient rooms or rooms enclosed with walls in examination and treatment areas where patients are required to disclose private information.

3.4. Scale

The hospital circulation is a crucial part of the design, not only for the reasons of way fining but for infection control and accommodation of various large amounts of services that a hospital needs to function. In planning for a large scale hospital the architect has to take into account the sheer sizes of these complex’s and how this would affect the occupier’s perception within. Balancing of different parts of the healthcare environment, to create something that functions as a whole, where the structure generates a form that is in agreement with each other, develops the notion that a variety of users can come together and feel safe. In Auckland there are three main hospital, Auckland, North Shore and Middlemore. These all share a common similarity with each other, by neglecting the circulation routes. Many occupiers of these institutes would develop a sense of anxiety and stress from trying to understand where they are located within the mass of concrete their would be situated in.

This type of development and transformation in future healthcare models supports the notion of healthcare being a “place of healing...a place of refuge and recovery…”62.

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4.0 Precedent Study

There are numerous precedents that illustrate the relationship between architecture and nature. This analysis examines the understanding of medical facilities and investigates different architectural means of reconnecting them back to the natural environment. Examples have been selected to demonstrate the wide-ranging influence of theories based on biophilic approaches to hospital design.

The first section explores existing healthcare precedents that have started to venture away from the traditional hospital templates, to focus on the patients themselves and what they need for a healing environment.

The second section explores different typologies of architecture and how they have developed the notion of integrating and connecting their environments with nature to create a better internal environment.
4.1. HOSPITAL PRECEDENT STUDY
Figure 30: Image of the exterior of Lanarkshire, Maggie Centre by Reiach and Hall architects
Maggie's Lanarkshire Cancer Caring Centre opened in 2014 and is one of a series of cancer treatment environmental centers. This series of architecturally pleasing buildings were the legacy of Margaret Keswick Jencks, a terminally ill woman who developed a scheme of drastically improving aesthetic elements of the design of these institutions which resulted in achieving high levels of care for cancer patients with better outcomes. The Lanarkshire Maggie Centre was a building that its architects expressed their desire to fit the design within the surroundings and this was recognised for its success, receiving the ‘Roses Design Awards Proposed Building of the year 2011 Gold’\(^\text{63}\). This was achieved through a low-rise design which helped to stitch it visually into the existing backdrop of trees. The use of various courtyards throughout the design correlated with extensions of landscaped areas that create moments of framed views for the users, both private and open\(^\text{64}\). The most inspiring area is the large central kitchen table, which was inspired by the concept of the common family home. This area is surrounded by large windows and walls that allow the occupiers to connect visually to the outside environment and also represents a distinction between the natural environment and the building. Maggie’s Lanarkshire is a design that encourages the idea of biophilia and detaches itself from the sterile stereotype of the typical institution.


Figure 31: Courtyard view from Khoo Teck Puat Hospital, looking out towards the green courtyard.
Hospitals are perceived by the public as being sterile institutions, usually separated as far from nature as possible. They are perceived as machines for people and are cited as cost driven designs. The Khoo Tect Puat hospital sets a benchmark for healthcare designs as an award-winning scheme that centres its focus on being a patient-friendly hospital. The architects developed a scheme which was significant in its incorporation of nature within its environment. It was named “the hospital in a Garden”, its location playing a huge part in the creation of a humanising design. Its close proximity to Yishun Pond provided a waterscape view for occupiers. Khoo Tect Puat Hospital’s landscaped environment not only delivers a natural healing environment for the well-being of the users of this building, it also created opportunities for the Yishun community for social interaction through the spatial integration of the hospital and external environments. A series of planted terraces located between patient ward towers adds to the overall soothing environment created for the benefit of patients and staff.

Figure 32: Interior View of The Royal Childrens Hospital and its use of colour and artwork to create interesting spaces within.
Melbourne’s Royal Children’s Hospital designed by Bates Smart Architects was designed around a family-centred care model that puts children and their parents at the centre of the facility. The aim of the design of this hospital was to translate a child’s fascination with nature into an architectural language and let nature lead the design process. This hospital design is not like any other hospital, as it has a spectacular collection of child-focused distractions contained within its design. These consist of a two-storey aquarium and large scale artworks. Melbourne zoo, Scienceworks museum, and Hoyts movies have all provided installations within the hospital to distract and engage the imagination of all age groups. The architects wanted users not to feel like they are waiting. This was achieved by incorporating distractions within the architectural language of the building, exploiting the sense of fun and discovery children naturally have. These elements are expressed through different types of materials, forms, textures and colours which provide relief and a psychological sense of healing for occupiers.

69 Ibid.
4.2. COLLECTIVE PRECEDENT STUDY
Figure 33: Elevation of One Central Park building and its vertical green garden.
One Central Park
Ateliers Jean Nouvel
Chippendale, Australia

The 38-penthouse apartment building was named best tall building in the world for 2014 by the Council on Tall Buildings and Urban Habitat. The building also gained a five-star green star rating from the Green Building Council Australia. Most apartments seen around the world are weighed down by the pristine tower of glass and steel. Architects Ateliers Jean Nouvel transformed the way apartments should be treated with the incorporation of a vertical garden. This garden wraps both the north and east faces of each tower with indigenous and exotic plants. The public park plays focal attention as it transforms and attaches itself to the side of the building, which derives the idea of organic growth. The growth begins at the lower ground level and demonstrates an organic merged of vegetation generating a live façade. ‘Vines and leafy foliage spring out between floors and provide the perfect frame for Sydney’s skyline.’

The series of gardens spread out through this building provide its occupiers an area of ‘lush tranquil meeting place’ for friends and family. Activities such as open-air cinema, chessboard, occasional markets and music festivals provide the chance for social, community interaction. Other features are the large cantilevered heliostats that reflects natural light into the internal garden between the towers.

From a negative point of view it can be seen that attaching this large cantilevered heliostat is more of a marketing sense of promoting this biophilic idea. In cross-section it is apparent the architects would have been able to achieve the same amount of light in the internal courtyard without this large device.

Figure 35: Perceptive view of Salk Institute,
The design of Salk Institute for Biological Studies by world-renowned architect Louis Kahn’s, was established in the 1960’s. It was Louis Kahn’s design abilities that ushered him in for designing an environment that could be spacious with unobstructed laboratory spaces, that was also able to adapt to ever developing needs for science. This building’s design is a good reference when thinking about hospital designs due to the fact that there are 29 separate structures joined together to form as one institute. Its use simple, durable, strong, and maintenance-free building materials provide a creation that sit so elegantly on site. The importance of natural light and use of space is spread throughout the design. From the internal conditions being flooded with natural light to the central courtyard that is directed towards the natural ocean view. This design has been stated in ‘Architectural Digest’ as a design that fuses art and science together.

Figure 36: Exterior image of Commerzbank
The scheme for the Frankfurt Commerzbank, completed 1997 by Foster + Partners, was a fifty-three story office tower and was the tallest building in Europe at the time. The project explores the incorporation of office life and natural environment within one building. The integration of ecological systems with working patterns saw conceptual ideas reliant on natural systems of lighting and ventilation. Large sky gardens are spread throughout the design, providing a diverse ecological system that supported the idea of informal break out spaces with external visual connection to the city.

The triangular plan was conceived as a representation of a flower. The three ‘petals’ of the flower spring from a central ‘stem’ which is formed by a full-height central atrium. Each ‘petal’ consists of four-storey clusters of office floors, interspersed with green, four-storey atriums. The foliage-filled atrium spaces are the central visual and social focus of each four-storey office cluster. This triangular design of the building and the central atrium generate a zone of negative pressure, which drives the natural ventilation throughout the building.

The focus in the context of this research is the attempt to create a civic realm. The towers have a very distinctive presence in the skyline of Frankfurt but it was also stated by the architects that it has been ‘anchored into the lower-scale city fabric, through restoration and sensitive rebuilding of the perimeter structures to reinforce the original scale of the block.'

Figure 37: Cross-section of Commerzbank, showing the internal environment

Commerzbank
Foster + Partners
Frankfurt | Germany

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4.3. Conclusion for Precedent Studies

This projects precedents study has examined the present hospital institutions and collective architectural designs that can contribute towards the areas of focus I want my design to explore. What I have understood from these examples are that integrating and connecting natural qualities and visual links towards nature within an architectural design, provide more beneficial attributes other than aesthetics. The ability of nature to create a soothing healing environment is what I want to take from these precedent, and this will be achieve by providing various opportunities of space that users can interact with the nature environment, by providing various views that connect the design to the surroundings, and by exploring how one design can interact nature into the actual architecture itself.
5.0 Programme
5.1. Medical Program: Hospital Wards

The project is a proposal for an extension to the proposed plans of north shore hospital by Jasmax. The programme of this extension will be focusing around the wards of the hospital and its integration of natural elements being a major influence in its design. This proposed hospital extension will be located to the northern side of Northshore hospital and will be attached to the proposed design given by Jasmax. Its aims reactivation healthcare architecture to contribute towards its healing for occupiers by reintroducing the physical and visual; connection to nature. It is also a piece of architecture that responds to re-imaging hospitals as place of healing as well as providing additional resources for the community to activate.

This hospital extension will aim to provide:
- Individual rooms in the wards that are designed to help connect the patients to the natural surrounding
- Courtyards that can be activated by additional resources such as sports, markets, community activities.
- Façades that helps reduce the sterile environment, reflects positively towards the hospital relationship with the natural surroundings and contributes to the overall healing ambition.
- To produce a hospital that reflects the ambition of being able to help heal patients through the building's architecture.
5.2. Spatial Requirements

This section outlines the spatial and functional requirements essential for the design of a general hospital. The basic form of a hospital is based on its functions:

- Bed-related inpatient functions
- Outpatient-related functions
- Diagnostic and treatment functions
- Administrative functions
- Service functions (Food, supply)
- Research and teaching functions

The outlined functional design requirements have been extracted from VA Office of Construction & Facility Management (CFM):

- VA Design Guide Inpatient Nursing Units
- VA Design Guide Outpatient Clinic
- VA Design Guide Supply, Processing & Distribution
- VA Design Guide Ambulatory Care
Inpatient Nursing Units

Inpatient care units provide patients who are recovering from surgical procedures or have medical conditions with a place to stay overnight. Its units are typically for male and female patients of various ages with different levels of acuity and special requirements for isolation.75 The length of a patient stay - until discharged or transferred to a different facility - is determined by patients’ acuity of their medical condition. Care in these units may be provided by physicians, nurses, physician assistants, nurses’ assistants, dieticians, physical and occupational therapists, respiratory therapists and social workers, among others.76 Education and research programs are additional systems incorporated into these areas of hospitals.

The spatial organization of inpatient care units can be categorized into two functional areas, dependent on the patients’ levels of acuity: Medical / Surgical (M/S) and Intensive Care Units (ICU). The treatment planning requirements for patients in M/S units are lower than that of ICUs. Typically, there would only be one nurse assigned to monitor four to five patients.

ICUs are designed for critical care that accommodates patients with life-threatening conditions. These types of units house medical equipment such as invasive cardiovascular machines, respiratory monitoring and mechanical ventilation that assists artificial life support. Nurses in these areas of the hospital are assigned two patients each.77

The functional organization of inpatient units can be divided into two categories: 1. Medical / surgical Inpatient units and 2. Intensive Care Nursing Units. These areas are predicated on five functional areas. These areas are the Reception Area, Patient Area, Support Area, Education Area and Staff and Administration Areas. “The functionality of each individual room within the department, as well as the department as a whole, can greatly impact the delivery of patient care, department efficiency, staff satisfaction and patient satisfaction.”78

Reception Area

Spatial requirements within this functional area are:
- Waiting area
- Family lounge / family pantry
- Public toilets
- Consult room
- Patient education / resource kiosk
- Discharge lounge

The reception area must be in a location that is easily accessible to the main public entrance. Nursing staff must be able to see everything within the spaces noted above at a glance, apart from discharge lounge.

Patient Area

Spatial requirements within this functional area are:
- Patient room with patient bathroom
- Patient room, airborne infection isolation with anteroom and patient bathroom
- Patient room, protective environment with anteroom and patient bathroom
- Patient room, bariatric and bathroom, bariatric / physical disabilities
- Exam room

Fundamental in all design and spatial layouts for an inpatient room is staff access to equipment.\textsuperscript{79} All patient rooms must include hand washing located close to the entry, provide work space close to the patient, and a patient care zone and family zone located at the far area of the patient, parallel to the work space. VA (Vertian Affair – Office of Design and Construction Information) design guide states “all patient bedrooms shall be located on the perimeter of the floor and shall have access to natural light from windows to the outside or to day lit atrium space.”\textsuperscript{80} The functional organization of these spaces result in an overall efficiency for staff and patients.

**Support Areas**

Spatial requirements within this functional area are:

- Nurse station
- Telemetry alcove
- Medication rooms and nourishment stations
- Nurse and team workrooms
- Clean and soiled utility rooms / clean linen room
- Equipment and medical gas storage rooms
- Multipurpose specialty storage rooms and environmental management storage

**Staff and Administration Areas**

Spatial requirements within this functional area detail:

- Offices as authorized for physicians and physician assistants, nurse leaders, social worker, dietician, clinical pharmacist, clinical researcher, and consultant
- Cubicles as authorized for unit administrators
- Recycling room as authorized
- Staff lounge
- Staff locker rooms
- Staff toilet

The nursing station requires offices for the nursing managers and nurse supervisors. Other offices for staff should be located in close proximity but not in the centre of the nursing station. This is to allow these spaces to be shared by other inpatient units. By allowing this it helps reduce the amount of traffic occurring within each unit. Nursing break areas should be located away from their work stations as it is important for staff to be able to detach from the units’ activity in order to reduce fatigue and lower stress levels.

**Education Areas**

Spatial requirements within this functional area are:

- Office for residency program director
- Office for patient instructor
- Cubicles for interns, residents, and fellows
- Conference/classroom
- Library

Educational areas should be located in close proximity to the patient area but not so close that it would affect the traffic within the units.

Materials and finishes should provide an interior environment that accommodates healing of the patients’ minds and bodies. Key functional and design considerations for these elements are that they have a durable, timeless quality, in both the materials and colour, and are easy to clean.


Windows at the end of corridors enable way finding and bring natural light into the core.

Locate support space doors in cross corridors off stage of main corridors to reduce traffic and limit noise in patient corridors.

Separate public entry points from patient and service access.

Locate nurse station or communication center adjacent to entrance to the unit.

Decentralise nurse stations on larger units to increase patient visibility and reduce nurse travel distances.

Decentralise support functions to reduce hunt and gathering by staff.

Locate staff support close to unit but away from patient rooms for staff respite and to reduce noise on unit.

Suggested locations for patient isolation room.

Staff / Service
Visitor
Inpatient

Figure 38: Functional diagram of general wards in hospitals (Author's diagram)
Ambulatory Care

Ambulatory Care units are hospital-based patient care centers that focus on providing scheduled and unscheduled examinations and treatment services to a variety of different patient types. These units have relationships with and provide treatments to both inpatients and outpatients, eliminating duplication of. Ambulatory care centers are commonly connected to existing hospitals structures. The types of activities that occur in this environment are surgery, sophisticated imaging systems, and both invasive and non-invasive diagnostic and therapeutic procedures. One of the most important design considerations is the location. Ease of access and circulation for both outpatients and their families is essential due to the high levels of anxiety one may experience in such environments.

Spatial requirements within this functional area are:
- Air quality / natural ventilation
- Noise abatement
- Environmental / use of artwork, music, and plants
- Accessibility / ease of access
- Daylighting / natural light potential
- Application of colour, textures, and finishes
- Infection control / operational protocol

Outlined in Veterans Affairs document they have underlined the importance for ambulatory care centres and how these areas in the hospital should be designed as a healing environment that allows the architecture itself to develop a sense of therapy for the occupiers. Patient privacy (visual and acoustic) is accommodated without sacrificing facility utilization.82


Figure 39: Functional diagram of an Emergency department (Author’s diagram)
5.3. Project brief

The design is intended to use the investigation from historic context of the hospital, and how the integration with therapeutic elements can be implemented into an architectural building design. The issues of sterile environments, alienation towards natural elements, are results of architecture not producing an environment for the occupiers for healing like they should be. This project aims to focus on exploiting this isolation to nature, and adapting a new architectural design that incorporates elements to provide healing qualities. In doing so, the following architectural questions are to be addressed:

- What elements of nature can be seen as important?
- How can these natural elements contribute towards the environment?
- How could the site interact with architecturally into building design?
- With the hospital being so bounded to function, how can this incorporation of nature be flexible with the overall environment?
Figure 41: Satellite image of Auckland, New Zealand, with location of North Shore Hospital
6.0 Physical Context

6.1. Site Selection

An appropriate site for this research project was to select a hospital within Auckland, which was undergoing future development. Jasmax has pointed out that North Shore hospital will be undergoing future development to improve the overall services and architectural elements of their facilities. Any hospital would be an appropriate setting to develop a healing environment, but using an existing hospital that has major acknowledged defects within its facilities provides an opportunity to show how, architecturally, existing hospitals can be developed into healing environments in the future.

The selected site is an active hospital located on the North Shore in Auckland. The proximity of the existing hospital campus to Lake Pupuke, a natural asset which is not exploited in the current campus layout, provides further opportunities in terms of creating relationships between the institution and nature. This site was obtained by North Shore hospital in 1958 and has had various developments and growth. It currently provides medical services for the wider regions of Auckland that include approximately 560,000 residents of North Shore.

The aim of this project is to modify the proposed Jasmax design scheme, with a focus on improving the environment of the hospital ward and developing it into a space that will be experienced as a healing one by all users. Ward development and redevelopment should not be driven solely by cost but should be tempered by an understanding of how patients should be treated to achieve the best healing outcomes and how we would like to be treated ourselves if we were in their situation.
Figure 44: Perceptive photo looking across Lake Pupuke at North Shore Hospital site.
6.2. Site Analysis

In order integrate a healing environment into the hospital, an analytical investigation of the site conditions and the surrounding context is required to understand what approach is appropriate.

The existing site of North Shore hospital is situated on Shakespeare Road and Shea Terrace. The Eastern side of the hospital site is adjacent to Lake Pupuke. In its current iteration, the hospital does not take advantage of or even acknowledge the lake: it is not facing Lake Pupuke, nor does it interact with it in any way.

There is currently no distinct access to the water’s edge, even though the hospital is situated in such close proximity to the lake. There is certainly no way wheelchair-bound patients would be able to access it. The creation of an interaction with the water’s edge is vital. The lake edge is described in the book *Pattern Language* as “irreplaceable and precious”\(^\text{83}\), so to ignore the benefits that could be derived from this natural sanctuary would be a mistake, especially for a healthcare institution.

In its existing state, the hospital interacts with the community only in its role as a provider of medical treatment and to the extent that it creates local traffic congestion and creates a barrier between the community and the lake.

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Figure 49: Photograph on Shakespeare Road, looking towards access point to site.

Figure 50: Photograph on Shea Terrace, looking at access point to site.
6.3. Pedestrian/Vehicular activity

The public access route through North Shore hospital runs between two entry points, Shakespeare Road and Shea Terrace. The site currently has no direct connection to the lake itself but opens up the opportunity for hospital design to create a thoroughfare for pedestrians. The neighbouring buildings on site currently relate to the main hospital function but don’t interact architecturally with pedestrian routes crossing the main access roads. These entry points currently cut the site in half, and provide the main thoroughfare to the hospital. This correlates with the large six story concrete car park building being located adjacent to the main hospital. It provides parking for staff and patients in the hospital.

Figure 51: Existing perspex mass model of north shore hospital
Figure 52: Jasmax proposed perspex mass for new development to North Shore Hospital
Figure 53: Exploded axonometric drawing of site conditions
Figure 54: Photograph from on top of carpark building looking out towards Lake Pupuke and Rangitoto Island.
Figure 55: Photograph looking at North Shore Hospital from across Lake Pupuke
7.0 Design
7.1. Design Methodology

What methodologies should be used to incorporate nature within our medical institutions? For most of human history people have lived in environments totally and intimately involved with natural systems. A hospital designed solely around medical advancements but which neglects the contextual environment is not justifiable. But this is not to say that the function of these institutions should ignore the natural environment. There are certain functional areas within hospitals which are inflexible and have certain requirements in order for everything to work. For this research project, the regulations and design guidelines around these required and largely inflexible elements have been noted, but are not the main design driver. The focal point for this project is relationships with and connection to nature. Vastly improved therapeutic environments can be achieved by modifying the stereotypical sterile, maze-like, 20th Century hospital. Through the incorporation of natural elements, the hospital can potentially be developed into a symbiotic environment that actually regenerates patients physically and psychologically through its architecture, as well as medically treating the ill. How this can be done will be explored through the investigation of relationships between nature, social and circulation space elements.

Figure 56: Diagrammatic illustration showing the focus of this project
7.2. Site Constraints and Opportunities

1. Visual connection to Natural elements on North Shores Hospital
2. The site location of the main hospital is situated at the back of the whole site. The sites location means that it has direct connection to Lake Pupuke.
3. The dual access point to the site, Shakespeare Road and Shea Terrace, provide potential for multiple entry points
4. The topography and level change at the rear of the site, provide the opportunity for the architecture design of this institution that can adapt new landscape possibilities
5. Potential of Hospital wards having multiply views out towards natural surroundings, such as: Rangitoto Island, Lake Pupuke, Auckland CBD, the Waitakeres
6. Main access road cutting through the middle of the hospital site, possibilities of axis views from entry points to Lake Pupuke
7. Replacing the Lake Pupuke hospital land mark with something that could be seen as an architectural attribute for the surrounding areas
8. Existing North Shore Hospitals functional grid system and the connection to new proposed hospital design

Figure 57: Photograph of site opportunities to connect with nature
7.3. Connection to Nature

The heart of this research is to discover how architecture can contribute to healing. The researches exploration of hospital designs and their functionality, has tried to incorporate natural elements into the design palette, both visually and physically. The typical hospital design is based on a functional grid, to achieve maximum cost-efficiency. The natural beauty of the site is such that it suggests a deviation from the standard grid in order to maximize the benefit that can be derived from the location.

Green areas cannot typically be accessed within standard hospital design, unless patients and their visitors are able to leave the hospital buildings themselves. This is an insurmountable barrier to many patients, who are room-bound. To overcome this, green pockets have been created within the vertical volume in this design in order to take advantage of the natural surroundings. This was so that occupiers of the hospital could easily access environments that would help in their healing. These areas will be opened up to the virtues of landscape views that include the Waitakere, Auckland City and Lake Pupuke.

Within individual rooms in the wards themselves, the positioning of the beds play a huge part in the patient’s connection to the natural surroundings. This idea of connecting the patient to nature has to be achieved within the rooms as well as the environment of the hospital. Through the next few chapters there will be an exploration of layout of rooms and positioning of items within them to achieve the desired connection to nature.

Other areas of focus within the design included:
- Interaction with Lake Pupuke at ground level
- Opportunity for physical connection to nature at ground level within the hospital building itself through green courtyards

Figure 58: Exploration of how patient rooms could connect to nature
**Figure 59:** Exploration of vertical green pocket design
Figure 60: Drawing showing the vertical green spaces within proposed design.
Figure 61: Internal drawing of Inpatients room looking out towards Lake Pupuke
7.4. Vertical study

The issue of connection between private and public areas within a hospital environment usually only occurs within the first two floors of a hospital. The idea of developing a vertical connection through a central void develops a new notion of design which does not disconnect the medical world from the public. The potential of this void to dissect the hospital’s mass opens up the opportunity to create social spaces on each floor. This concept enables the creation of breakout spaces for occupiers to use along with visiting family members and staff. Dissecting the large hospital mass also exposes the building’s program and function. This allows for visual connection to the natural surroundings and the penetration of sunlight into the internal environment. A common experience for those trying to find their way within a standard cubic, horizontally-oriented hospital is confusion. Departments may work well in themselves, but circulation is often an afterthought, squeezed in around and between departments. There is often no visual connection to the outside world. Often there is no connection to the spaces that are being circumnavigated, which results in disorientation and increased stress levels. Occupiers within this space feel as if they have been placed in a maze.

An exploration of vertical organization was made to reduce circulation and ensure an optimally functional environment. To this end the bulk of the hospital would be punctuated with green breakout spaces. Each area would be connected through the main central void and visually differentiated for not only the patients but for visitors also. Providing large public areas, with pockets of activities, breaks down circulation. Enclosed areas would be situated at the ends of the wards, and open spaces with natural elements incorporated would give the occupiers an inviting distraction from...
the ward environment.\textsuperscript{85} It can also be seen as a way to encourage movement through the building, creating a healthier daily routine for patients and staff. These activities in and around the hospital will help to soften the dehumanising hospital environment.

The inclusion of a central void within the hospital mass develops an internal perspective for patients and staff. It is also circulation friendly, enabling functions to be organized spatially around it. Breaking up the building in this way also emphasises the three axial directions of visual focus for the hospital: Lake Pupuke, the Waitakere’s and the city.

Mixed-use programs within the hospital can be organized by locating them in specific areas with reference to the void to help with the notion of way finding.

The exploration of vertical organization for North Shore Hospital created a disconnection from the concepts central to this thesis. The reasons for this disconnection were increased verticality produced increased physical distance from nature which created a physical barrier for the majority users. This meant it was no better than what would commonly be found in hospital designs. The standard requirements for various spaces dictated a form that resembled a hotel - an environment disconnected from its surroundings - more than a biophilic structure for healing.

\textsuperscript{85} Alexander, \textit{A Pattern Language}, Pockets of activity
Figure 64: Photograph study of perspex models exploring verticality
Figure 65: Exploration of cutting voids into common hospital mass building

Figure 66: Sketch of three winged hospital design
7.5. Horizontal study

Pursuing the idea of a dispersed layout allows for a grounding connection to the natural surroundings. However, doing this would mean abandoning the secondary ambition of reducing circulation space. The impact the increased amount of space dedicated to circulation may be compensated by means of technology. Automated transportation can be employed for the transport of medical supplies and equipment, while each ward be serviced by lifts.

To achieve an environment that is healing for its users, this project focuses on restricting the height of the hospital in order to maintain physical and visual connections to nature. The incorporation of courtyards of a variety of sizes embedded both horizontally and vertically throughout the hospital, develops visual references for wayfinding and helps break down the sterile environment of the hospital. These courtyard spaces provide the opportunity for activities outside hospital functions to take place. This would allow the site to be activated as an additional resource for the community as well as hospital occupiers, providing an new potential venue for markets, sports and community activities. The interaction of Lake Pupuke with the hospital site provides additional design opportunities. The hospital follows the contour of the slope down to the lake; likewise a pathway follows the contours of the hospital towards the lake. An arm of the hospital extends past the waters’ edge, heightening the hospital’s relationship with the lake and placing emphasis on water’s ability to calm, heal and soothe the mind and body. The creation of this new connection removes the hospital from its previous isolation with respect to both the lake and the community. The public, as well as hospital users, are now provided with a path to the water; people within this wing of the hospital not only have an increased visual and physical proximity to the lake, but they are visually and emotionally more connected with community activities that may take place outside.
Figure 68: Proposed location for extension to North Shore Hospital
Figure 69: Various perspex mass models exploring different ward layouts

Figure 70: Sketch exploring different hospital layouts

Figure 71: Sketch of proposed idea
Figure 75: Site Plan of proposed hospital design
Figure 76: Initial Design proposal of Inpatient ward rooms
7.6. Connection Mixed used and Social Spaces

On the lower levels of the hospital, the design provides grounded courtyard spaces that provide smooth transitions between social and medical spaces. Within these courtyards a variety of vegetation is embedded into the landscape to help create a barrier between the different wards internally facing the central courtyard. These internal spaces create a greater connection between the hospital occupants and the community by its activation as a potential location for markets, sports and community activities. Courtyards are provided also in the areas of the hospital that would commonly be massed with internal circulation. The hospital becomes more permeable to the external world. Patients are provided with these courtyards enable them to sit and relax in green spaces while remaining, technically, in a hospital environment. These spaces will accommodate vegetation that will allow patients to be able to sit under cover or for occupiers to reside around. The locations of these internal courtyards provide thresholds within the design that are easily accessible to all occupiers.

The vertical green breakout spaces punctuated within the circulation of the hospital provide private pockets of green spaces where patients and occupiers of the hospital will be able to venture away from the internal ward environment. These enclosed areas have the potential to provide a location for calming activities, or simply be places to relax, drink coffee and help distract users from medical or work-related stresses.

The roof gardens within this hospital design follow the landscaped contours of the hospital site. These additional areas are located for occupiers of the hospital to venture away from the internal hospital condition and provide views of Lake Pupuke, Auckland city and the Waitakerees.
Figure 77: Sectional perspective of proposed design.
7.7. Connection through Facades

The issue of connection to nature within a hospital design provides the opportunity to explore and create a façade that can provide visual connection to the outside while also maintaining the occupiers’ privacy and other functional requirements for an internal environment such as controlling sunshine and reducing glare. The external form of the hospital design allows helps shape dynamic and playful views out towards the natural surroundings, connecting itself back to the context. The exterior of the building is based around a series of radial axis that helps detach itself from the usual hospital sterile box. This thin curved radial design helps break open the internal environment to allow the external natural quality in. The main façade is offset from the building by one metre that allows for a service walkway to be placed for maintenance purposes. The outer layer of the façade consists of timber louvered panels that direct out towards the natural surroundings but also controlling the daylight. These louvers are fixed onto perforated black stainless steel framing that creates a contrast between the two materials. Where the façade meets the vertical green breakout spaces the vertical timbered louvered system stops allowing the green vegetation overtake the stainless steel structure. From the external these area exposes the circulation, movement and busy hospital nature.

At the lower levels, the façade dissolves into the black stain steel structure with the glazing of the building offset 1m back. This helps create transparency and defines the entry points at a pedestrian’s level. The structure of the façade on both areas are free for vegetation growth to spread organically throughout the façade system. This approach allows for a realistic natural environment to be part of the architecture at a human level.

Figure 78: 3d printed developments exploring facade designs
Figure 80: Sectional Perspective of entrance to hospital and the vertical green pockets
Figure 81: Cross Section of proposed hospital design
7.8. Hybrid Program

**Solar Panel**

Solar power is a significant energy source in New Zealand, and will be used in this project to supplement other energy usage. Solar water heating in 3.0m x 5.0m panels is a contributing element, estimated at 20% in the summer and 10% in the winter months, supplied by roof-mounted vacuum tube systems to a central water heating exchange unit. Similar water heating panels could also be used for a low temperature warm water under-floor heating system for background heat throughout the year, but would need to be tested for economic effectiveness before being built in to the environmental system for the building as a whole. Both these systems have been used in Australian hotel developments and have proved to be economic.

**Heat Exchanger**

Natural ventilation is unlikely to be practical in the sterile environment required, but a stack system in the atrium circulation spaces will include vents at the top which will recover excess heat through a heat exchanger to recycle some otherwise lost energy; this will be transferred by a closed water system to supplement hot water supplies in locally-positioned tanks, and in summer months is expected to contribute between 10 – 15% of heat required. The heat recovery system costs off-set cooling costs throughout the year to reduce total energy consumption; partial natural ventilation also adds to the sense of a less artificial building environment.
8.0 Design Outcomes

The purpose of this project was to investigate how elements of nature could break down the institutional sterility of North Shore Hospital, making it into a more welcoming space for the community and a more holistic healing environment for hospital users. This concept of incorporating nature back into the hospital environment was driven by research that explored the current knowledge of the benefits of the natural environment and its impact on people, as well as developments within technology. This research suggested natural elements should be incorporated within the design of a hospital in order to assist with the treatment of people.

Prior to this research, it was important to understand the revolutions in medical architecture that have taken place over the years. The majority of this research showed that right from the beginning of the hospital as an architectural typology, there were connections to nature that were employed for their healing and stress relief. As hospitals have evolved they have developed into complex institutions that are controlled by bureaucracies, whose design is restricted as much by the requirements of medical technology as by regulations. This established a type of architecture that was no longer patient friendly.

**Vertical study**

The focus of this project in the early stages was driven by the ambition of reducing circulation. Given the fact that circulation could be perceived as an afterthought in the design of North Shore Hospital, the vision was to try to shrink the circulation footprint in order to make more direct, logically pathways from department to department. This would be achieved by a design with a core central hub that would perform all circulation needs for the users. The hospital departments would be arrayed around this hub with visual connection to the outdoors. The aim in this was to introduce a better system for way-finding. However, developing the project in this direction lead to a design which create new physical barriers to connection with nature due to strict hospital functional requirements. This led to the adoption of a new approach, which reflected the grounding of the hospital in its natural surroundings.
Horizontal study

The conflicting ideas of nature and its connection to the hospital environment brought about a change in focus to a horizontal layout, as this would emphasise its grounding both physically and visually. The design of the façade focused on this notion of keeping the hospital design grounded, with the incorporation of organic growth to the outer edges of the fixed timber louvres. The louvres are designed both to reduce direct sun and glare to the façade, to provide an aesthetic reference to the surrounding landscape, and are also angled to provide minimal interruption to the visual connection to the outdoors. The façade forms a second skin for the hospital, composed of a structure in black stainless steel to which the louvres are fixed, emphasizing the contrasting materials of black metal and warm wood. This second skin sits one metre off the face of the hospital building, providing space for a walkway for maintenance access and also contributes to the control of the internal environmental conditions.

The current design of North Shore Hospital originated in the standard 20th century hospital grid form, ideal for satisfying the functional medical requirements of patients, while at the same time neglecting their psychological and emotional needs. Surfaces in wards, hallways, and their lighting all reflect the functional nature of the environment. It is a space that is made up of hard, easy to clean surfaces, harsh reflections, glaring artificially lit hallways, and dull, repetitive white rooms. The sterile nature of the hospital along with copious time spent waiting - for diagnosis, for treatment, for recovery; the lack of visual connection to the outside world and the physical isolation from fresh air, sunlight and greenery all combine to create a stressful, hostile environment for all hospital users.

The aim of the design was explore how the walls of the current institution could be dissolved, in order to introduce some of the natural advantages of the site into the body of the hospital. The introduction of vertical green pockets situated at intervals throughout the design helps develop this notion of breaking up the institutional barriers of the hospital. The proposal suggests restricting the design to six levels to help keep in close contact with its natural surroundings in order to maintain both lines of sight and physical access. Staggered roof levels follow the natural contours of the landscape and also allow the hospital to have green roofs that can be used by hospital patients, visitors and staff. These green roof areas are placed to be readily accessible for relaxation, eating, and socialising.
9.0 Conclusion

The core question posed in this research paper was how architecture can break down healthcare institutional barriers to create a biophilic healing environment.

After an exploration of different hospital layouts, the conclusion was reached that restricting the height of the hospital would play an important part in creating a tangible connection to nature.

Being kept in physical or at least visual contact with natural things like green grass, plants and trees, fresh air, sunlight, and the sight or sound of natural bodies of water like Lake Pupuke has been shown to speed up the recuperation of hospital patients and improve the environment for all users. This research paper explored how North Shore Hospital can be architecturally connected to its exceptional natural surroundings in order to benefit the health and wellbeing of its users.

Instead of shutting out the local community, the design opens up the hospital grounds for public access, inviting interaction with the lake. One of the hoped-for results of this is improving the local perception of the hospital by providing spaces that can be occupied by hospital users, as well as people from outside the hospital, for things such as markets and sports events, as well as more permanent businesses such as cafés.
10.0 Bibliography


Shabde, E. M. Strehle and N. “One Hundred Years of Telemedicine: Does This New Technology Have a Place in Paediatrics.” Archives of Disease in Childhood (2006).


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<th>Figure</th>
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<td>High Rise configuration taken from The Modern Hospital (1913) - reproduced from Cor Wagenaar book ‘The architecture of hospitals’ (accessed April 2015).</td>
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<td>16</td>
<td>J. Gamble Rogers, Medical Center (Presbyterian Hospital), New York, 1930 (accessed April 2015).</td>
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<td>17</td>
<td>Coolidge Shepley Bullfinch and Abbott, Cornell Medical Center, New York, 1933 (accessed April 2015).</td>
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<td>20</td>
<td>Biophilic pathways to urban resilience (accessed April 2015).</td>
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11.0 Final design
UNDERGROUND FLOOR PLAN:
1. RECEPTION
2. SURGICAL THEATRE
3. DOCTORS OFFICE
4. PUBLIC LIFT
5. HOSPITAL LIFT
6. WAITING
7. COURTYARD
8. RECOVERY
9. STAFF SUPPORT
10. GENERAL CLINICS
11. TREATMENT CONSULTATION
12. MILD UNIT
13. MEETING ROOMS
14. CT SCANNER
15. WORK STATIONS
16. CAFÉ
17. FAMILY WAITING
18. SINGLE ROOM
19. DIRTY UTILITY STORE
20. NURSES STATION
21. ATRIUM
22. TOILET
23. VERTICAL GREEN SPACES
24. BRIDGE WALKWAY
25. STAIRS
26. ROOF GARDENS