THE NATURE OF HEALING

Living Architecture for Long Term Care & Rehabilitation Hospitals

By
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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis including any required final revisions, as accepted by my exminers.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

Healthcare interiors are perceived as stressful and isolating spaces; endured during times of vulnerability causing stress for patients, visitors and staff. This thesis examines studies, which prove that this psychological stress is intensified by the overly artificial and sterile conditions typical to medical environments. Further studies collected, reveal that this stress worsens the sensation of symptoms, causing increase in medication dosage and overall hinders the immune system and recovery outcomes. The paradox of the sterile healing environment is that nature, the adversary, is essential to healing processes. This thesis concentrates on research proving that not only do people generally prefer natural environments, as supported by the theory of *Biophilia* (see definition), but that exposure to elements of natural landscapes in healthcare spaces, greatly improves the holistic health of patients, visitors and staff.

This thesis examines the historical and contemporary factors influencing the design of hospitals. In the past few decades, healthcare design has progressed by integrating therapeutic design, through these strategies discussed, *Evidence-Based Design* and *Biophilic Design* (see definitions). However, through experience as a patient, visitor and designer in healthcare architecture, it is evident that there are still confines limiting the evolution of therapeutic design in hospitals. This thesis questions why healthcare standards prohibit the integration of living (plant) systems into more interior spaces, past the atrium. In seeking these answers it became clear that further innovation is necessary for architectural design to synthesize the qualities of sterile and therapeutic healing environments, to achieve healthcare homeostasis.

Various types of living systems are examined for exterior and interior application, including comparisons with artificial biophilic design strategies. The design intervention proposed in this thesis integrates living systems into typical architectural assemblies, and is referred to as Living Architecture. Living Architecture expands the threshold between healthcare interiors and horticultural therapy, to bring long-term plants closer to long-term patients. This is done by exploring the design possibilities for healthcare architecture to integrate spaces for patients to physically engage with living systems, year-round in various locations inside and outside the hospital. The challenge of this design study is meeting healthcare requirements for infection control, accessibility, maintenance and the financial limitations for public healthcare in Canada today. There is an opportunity to redefine health care architecture to suit the transformative nature of complex continuing care and rehabilitation hospitals. This progression could then influence other health care typologies to bring down the barriers between nature and medicine, by integrating living systems as the new standard approach to health care architecture.

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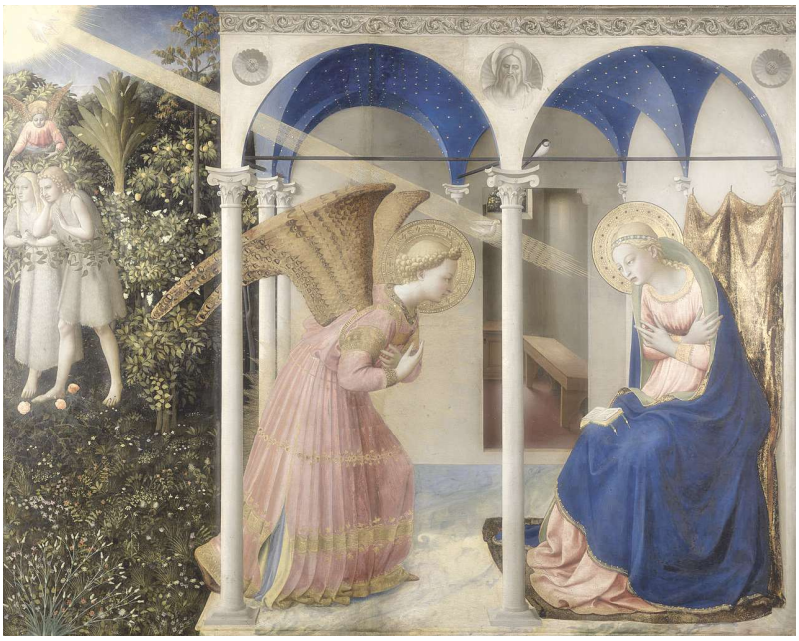

Fig. i The Annunciation, tempera on panel by Fra Angelico. Vicchio di Mugello, Florence, 1395 - Rome, 1455.

"The Nordic climate, which requires a sharp differentiation between the warm interior and the surroundings, has become a stumbling block for architects, and has given rise to defects in proportions on both sides of the demarcation line...I have chosen Fra Angelic's Annunciation [shown above]...The picture provides an ideal example of "entering a room". The trinity of human being, room and garden shown make it an unattainable ideal image of the home...The garden wall is the real external wall of the home" -Alvar Aalto, 1926.

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INTRODUCTION

The Problem

This thesis, the *Nature of Healing,* dissects the issue of the hostility and stress people experience in hospital environments and their affects on long-term health. Research reveals that the artificial environments created to support medical processes produce environmental stressors that cause discomfort and stress on the patients, visitors and staff. This stress is proven to directly harm the immune system and hinder recovery processes. In this state of stress and discomfort patients perceive pain more sensitively and develop long term traumatic effects from their hospital experience. Contact with natural landscapes greatly reduces this stress through the placebo effect, by psychologically providing comfort through therapeutic stimulations. The isolation the patient has from the outside realm; from nature, natural processes, sense of duty and social relationships, is the root of the issue. This thesis examines why natural elements and living systems are restricted from hospitals in areas beyond the atrium, even if contact with them is proven so valuable. Have design professionals exhausted all efforts to strategize new ways of bringing natural systems in without compromising the strict standards of cleanliness? This research examines which hospital environments are restricted more severely and which could be granted more contact with natural and living systems. An important question is why are all varieties of health care architecture designed under the same blanket hospital design model?

The Response

This thesis aims to propose design strategies for long term rehabilitation and complex care hospitals. It is common knowledge that long-term care has less people for longer periods, which reduces the exposure to new viruses, relative to acute care with many people, with many viruses being introduced daily. Therefore, infection control requirements are relatively less strict for long-term care, allowing more flexibility and less sterility in design. Complex continuing care patients suffer from chronic conditions, injuries or multi-system diseases that require rehabilitation for loss of functions. The long term rigorous nature of their recovery requires a different design response than short term care. This research examines the differences between design qualities essential for short term versus long term care. Outlining what is currently being applied to long term care design that is not

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beneficial and finding what is missing that could be beneficial. The specific hospital typology for this amalgamation of complex care specialties is relatively new and is increasing in demand. In prospective development, this is the perfect time to define the unique design requirements for this type of hospital that will differ from the standard model and this thesis proposes that interior living systems is essential.

For the purposes of experimental design for this proposal, an existing and newly purpose-built hospital of this typology was selected as the basis to realistically sample the designs with. This hospital is the state-of-the-art rehabilitation hospital in Toronto, Bridgepoint Active Healthcare, opened in 2013 and produced by Stantec Architecture, KPMB Architects, Diamond Schmitt Architects and HDR Architecture[1]. This hospital is unique in that it had an extensive Post-Occupancy Evaluation report[2] (POE) conducted, which reveals areas of the new hospital design that improved patient wellbeing and recovery outcomes, and areas that did not meet their intended potential. This POE was used to assess areas of weakness, which were then marked as areas to apply the Living Architecture design interventions to.

The research presented explores green technology systems that allow plants to grow indoors in various modes of interactivity, maintenance and cleanliness. The design process strategizes three differing methods for living (horticultural) systems to be intervened within the three focus areas pulled from the POE, and common to long term care hospitals: the exterior balcony, the physiotherapy gym and the patient floor lounges. Each of the three designs differ and increase in levels of patient interactivity relative to their interposition from exterior to interior.

The Outline

This thesis is structured into three sections beginning with the qualities of space essential to the healing process, followed by the parameters that define hospital architecture in the past continuing to current practice, and lastly the provocation of synthesizing the desirable qualities with the restricting parameters to harmonize natural systems within hospital spaces.

Part One: The Nature of Healing establishes the qualitative parameters for the design of a conceptual place of healing to improve quality

1 Atkinson, Cheryl. "Healthy Outcomes: A major pre- an post-occupancy study of a new Toronto hospital provides evidence for design's impact of qualitative aspects of wellness." *Canadian Architect.* October 28, 2016, https://www.canadianarchitect.com/features/healthy-outcomes/.

2 Alvaro, C., Kostovski, D., Wilkinson, A. & Gardner, P. Design and Evaluation: The Path to Better Outcomes. The Final Report on the Bridgepoint Active Healthcare Pre and Post Occupancy Evaluation. Report prepared for the Health Capital Investment Branch, Ontario Ministry of Health and Long Term Care, March 2015.

of life for patients and caregivers. This chapter examines historic characteristics of healing places that prioritize patient comfort and connection to nature. Drawing from precedents such as medieval monasteries, Alvar Aalto's tuberculosis sanitoria, Maggie Jencks' cancer centres, and the Holland Bloorview Kid's Rehabilitation Hospital in Toronto, Canada. These precedents exemplify health care architecture that prioritizes: sense of place, connection with nature, creativity and social support. Research is provided on the negative psychological effects of environmental stressors on the immune system and consequently, a patient's capacity to recover. Including evidence-based design research based on the theory of *biophilia*, revealing the positive outcomes that natural or *biophilic design* features in sterile medical environments provide to patients, visitors, caregivers and staff in medical facilities.

Part Two: The Nature of Hospitals examines the evolution of western hospital designs and the conditions in hospitals which contribute to the stress patients experience during their stays and what determining factors generate such hostile environments. This thesis research derives these conditions from, what the author of this thesis is referring to as, the "IPAC (Infection Prevention and Control) Paradox". The IPAC Paradox is, that the sterile environments developed to protect patients and the public from spread of infectious disease, become the cause of the increase in stress, which consequently increases pain medication dependency and traumatic psychological barriers which hinder long-term recovery. An interview with an IPAC specialist provides insight into the circumstances that restrict design innovations in medical spaces. This section briefly outlines the dialectic history between infection control and it's restraint on therapeutic design in western hospitals; as termed by Charles Jencks as "antiseptic architecture"[3]. By examining IPAC and Ministry of Health design requirements this information is then dissected to differentiate short-term versus long-term care parameters. The endeavor of reimagining long term complex rehabilitation hospitals as a unique typology, is done to break down the design barriers and promote innovation. The goal is for these interventions is to change perspectives on the limitations of other hospital typologies, and thus have these interventions spread or adapt into strategies that could cross platforms and meet types of short-term health care architecture. Finally, this section examines the

3 Jencks, Charles. *The Architecture of Hope: Maggie's Cancer Caring Centres,* edited by Heathcote, Edwin. 1st Frances Lincoln ed. London: Frances Lincoln, 2010, 7.

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POE for Bridgepoint Active Healthcare as the prime precedent that the design interventions are based off of, with the intention for these designs to be adaptable to any long-term care centre.

Part Three: Nature in Hospitals begins by presenting architectural precedents of health care or institutional buildings with interior living systems or exterior healing gardens and the benefits and issues they cause. This section divulges the design process of researching and selecting various living systems that could be suitable for application in hospital interiors, such as: hydroponic, aquaponic and traditional growing systems. These systems are then further developed into three modular Living Architecture design interventions for three typical locations within a long-term care and rehabilitation hospital, as applied to Bridgepoint Active Healthcare. The designs draw from biophilic design principles and precedents to inspire blurring the threshold between horticulture and health care architecture. All of the research leading up to this section contributes to the design parameters outlined for the three designs. The designs experiment with the synthesis of living systems at three levels of immersion into the hospital, whilst simultaneously intervening into the rehabilitation program at three levels of contact and interactivity.

Design Objective

The goal of this thesis is to influence other health care typologies to integrate Living Architecture at the onset (rather than the afterthought), as a new standard approach to health care design. This thesis observes the necessity to draw from the past and propose an alteration to the current ideology of medicine-versus-nature, because environments disconnected from nature do not support homeostasis. In long-term care and rehabilitation, some patients do not "rehabilitate" or recover to a former state of being, but rather transform to an altered state of being, with altered abilities or chronic conditions. In this transition phase, patients face the early development of their adaptation and acceptance of their changes. Change is essential to life's natural processes, and the design of a rehabilitation hospital must reflect natural processes of transformation; to not only facilitate and comfort patients, but to also transform collectively with them.

DEFINITIONS

BIOPHILIA

a hypothetical human tendency to interact or be closely associated with other forms of life in nature

"Biophilia is the inherent human inclination to affiliate with nature that even in the modern world continues to be critical to people's physical and mental health and wellbeing" *(Kellert, 2015) - Summarized by Stephen Kellert and notably defined by Edward Wilson.*

BIOPHILIC DESIGN

is the methodology of varying design strategies that draw from the principles, experiences and attributes of nature and apply them to the built environment.

(Kellert, 2015) - Summarized by Stephen Kellert and Elizabeth Calabrese.

EVIDENCE-BASED DESIGN

a field of research developed by environmental psychologists that directly influences healthcare design.

"Evidence-Based Design is research-informed and its results not only affect patient clinical outcomes, but also staff recruitment and retention, and facility operational efficiency and productivity. It looks at building design not only as physical space, but included total sensory environment of sight, sound, touch, and smell." *(Malkin, 2006) - Summarized by Jain Malkin.*

Part 1: The Nature of Healing provides research from environmental psychologists and architects on the benefits of natural and comforting design elements and connections to natural landscapes, have on patient healing outcomes. This research is effective in making the argument to healthcare administrations managing project budgets, that accessible exterior gardens, commissioned art installations and other therapeutic design initiatives are cost-beneficial. Examples of healthcare facilities that excel in therapeutic design initiatives are presented in this section for long-term care and rehabilitation hospital and cancer care centres.

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Fig. 1.1 Mushroom Painting

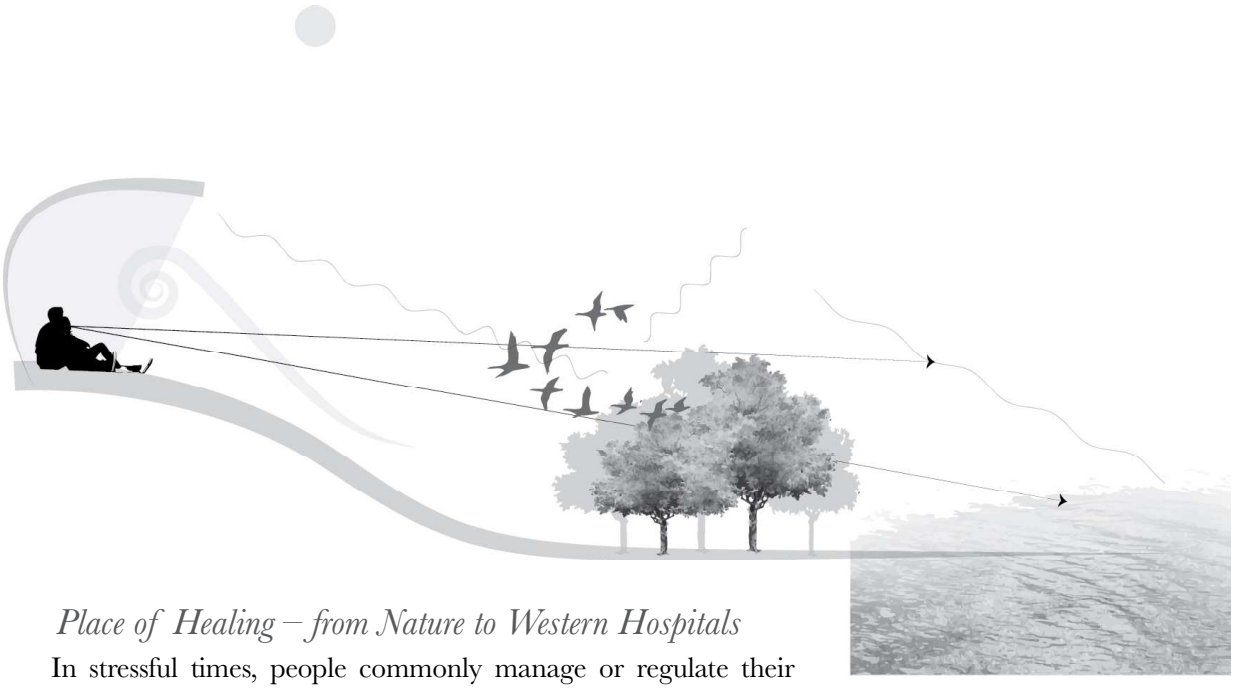

Fig. 1.2 Sketch of Therapeutic Elements in Natural Surroundings.

Place of Healing – from Nature to Western Hospitals

In stressful times, people commonly manage or regulate their stress by following these instructions: to pause, close their eyes, imagine a serene place, perceive the sensory experiences of such a place, take a deep breath and exhale. This imaginary place for seeking serenity could be considered as the ideal concept of a healing place. This environment provides universal therapeutic design qualities such as: immersion in a natural landscape, a position of security with outwards vantage, access to social support and lastly, the ability to have a tranquil and temporal sensory experience of a natural process, as discovered by surveys by Anita Rui Olds[1]. (as illustrated in *Fig. 1.3*). Imaginary healing places are comforting, private or communal and connect with natural landscapes, as per further surveys initiated by Clare Cooper Marcus[2]. The theory of *Biophilia* (See definition) acknowledges humans' innate desire to interact with nature, as defined by Edward Wilson[3]. The inversion of this conceptual healing place is one that causes stress, isolation, and lifeless stagnation. The latter more accurately describes the common perceptions people have of the interior spaces of today's hospitals in Canada.

Clare Cooper Marcus, a professor of Architecture and Landscape Architecture at the University of California, Berkeley, has numerous publications on the subjects of environmental psychology and healing gardens in hospitals. On the topic healing places, Marcus remarks

[DEFINITION] Biophilia :

"Biophilia is the inherent human inclincation to affiliate with nature that even in the modern world continues to be critical to people's physical and mental health and wellbeing" - Summarized by Stephen Kellert and termed by Edward Wilson.

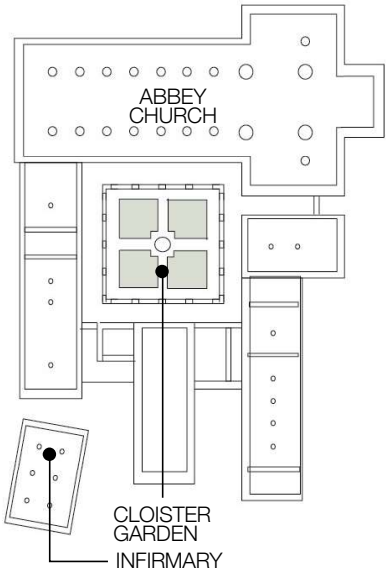

Fig. 1.3 Sketch of Monastery Plan

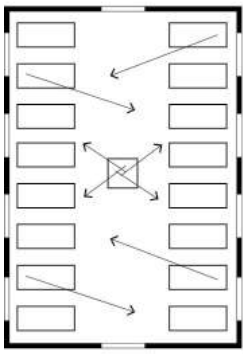

Fig. 1.4 Diagram of Internalized Military Hopsital Layouts

on the location and characteristics of healing places since ancient cultures. Such places were situated within similar unique sites in nature with a captivating temporal quality, such as "a healing spring" with the purist water infinitely carried through the layers of the earth, "a sacred grove" where a ray of sunlight momentarily illuminates a clearing in the forest, like glimpse of the presence of a higher power, or in "a cave"[4], a safe haven carved into the impenetrable cliff by the powerful forces of nature over thousands of years. These examples all reflect the same qualities of the imaginary healing place, which people still virtually visit today. Marcus describes how a natural landscape, sunlight and fresh air were all essential qualities to ancient healing practices[5]. According to Marcus, these qualities were first integrated into Western health care architecture in the monastic infirmaries in medieval times. The complex contains infirmary buildings (for patients) with views out and access to an internal courtyard, the cloistered garden with a healing fountain at the center[6] (Refer to Fig. 1.4). Ensuing the advancement in technology and scientific medicine, Marcus believes, "A separation occurred between attention to body *and spirit*"[7]. Consequently, hospitals were stripped of religion, ornament and connections to nature, as the Military-style hospital influenced the design of hospital buildings between the 17th and 18th centuries[8]. This hospital model restricts patients to rooms without access to nature, not even views. Healing the body was the only obligation for medical services; therapeutic design not deemed necessary to heal the mind or spirit of the patients.

Sense of Place – Environmental Psychology

Esther Sternberg, a medical researcher of the interactions of the brain, the immune system and the effects of stress on health[9], specifics the power of the Placebo Effect on pain management. She discusses the negative assumption the general public has with the term "placebo effect" as if it is something falsely perceived without any effective qualities[10]. However, since the 1980s neuroscientists have been collecting data from trials proving that the placebo effect causes actual neurological changes in people, which in term relieve people of suffering from physical ailments such as pain. Pharmaceutical researchers confirm the effectiveness of the placebo effect by accounting it for over 30% of recorded changes from clinical

drug trials in combination with the intended effects of the asserted chemicals[11]. Levine and Fields at the University of California focused their research on endorphins, self-produced morphine-like molecules amid our "brain's reward pathways", which was a recent discovery at the time[12]. They produced a drug that blocked the brain from sensing endorphins, called naloxone, and conducted trials where patients in pain from a recent surgery were given either morphine, saline (the placebo) or the naloxone. The results reveal that patients who received the placebo drug experienced some pain relief and those who received the naloxone experience intensified pain; proving that endorphins are the brain's self-medicating painkiller. Further research using PET scans has produced imagery showing that when a person is given a placebo drug (that they acknowledged as actual pain medication) more endorphins were released when the person began experiencing pain relief[13]. These tests all prove that when a patient believes their placebo treatment is real and produces expectations of reward, then to meet these expectations, their brain simultaneously produces more

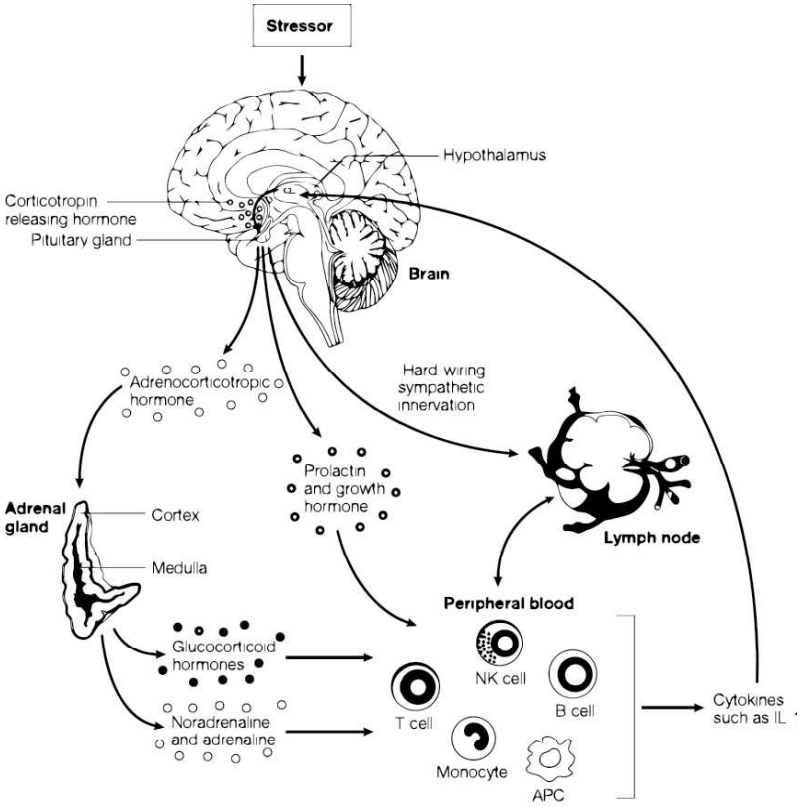

Fig. 1.5 Stress-associated modulation of the hormone response by the central nervous system.

rewarding nerve chemicals, which relieve symptoms of depression and pain, as Sternberg summarizes:

> "The pathways of belief and expectation thus include the endogenous opioid pathways, important in controlling pain, and the dopamine reward pathways, involved in addiction and desire. In the case of a placebo, it is the expectation of healing that triggers the reward cascade. The greater the expectation, the greater the quantity of nerve chemicals released, and the greater the nerve-cell activity in the brain's reward centers."[14]

She states that placebo effects are based on the claim of each individual's expectations and like any type of expectations they are based on peoples unique experiences that have shaped their beliefs. "The placebo effect is a big part of any healthcare professional's relationship with a patient, and is essential to the healing process."[15] This positive association with medicine can also be attested to a place. Research conducted with animals prove that sensing a singular element from a place where a reward was previously experienced will cause the same degree of effect as experiencing the entirety of that place again[16].

Roger Ulrich is a behavioral scientist, whom conducted experiments in the late 1990s surveying these negative effects of environmental stressors on the mental and physical wellbeing of patients and staff in hospitals; these theories then influenced the field of *Evidence-Based Design*[17]. This research greatly altered the perceptions of the medical society and led the advancment of hospital design standards prioritizing comfort and *wellness*. The collaboration of Janice Kiecolt-Glaser, a clinical research psychologist, and Ron Glaser, a researcher in virology and immunology[18], advanced this research, producing hard evidence linking stress and its effects on the immune system progressing the new field, defined as *Psychoneuroimmunology*[19]. Marcus contests that in medical care, patients are vulnerable to developing an anxious emotional state, caused by deprivation, isolation and loss of control from the regimented medical procedures and the environmental stressors produced by the environmental conditions in health care[20]. In this state and environment, like in the depths of the 'concrete jungle' of the city, people yearn for the distraction and stimulation of nature and life's natural processes. The state of confinement, isolation and deprivation patients face in contrast,

Fig. 1.6 Diagram of Patient Senses

enhances their sense of *biophilia*[21] and desire to be connected to life and natural surroundings. A successful and popular example of the theory of *biophilia* was experimented by Ulrich in testing the effects patients having a view of a brick wall versus natural scenery, and the results proved the patients with the natural view required less pain medication than the other patients[22]. Stephen Kellert, a researcher and professor of social ecology, further expanded this research by identifying the essential qualities of *biophilic design*[23]. This design strategy was formally referred to by Ulrich as *ecological health* for patients. Ulrich and these other design researchers, like Maggie Keswick Jencks, the co-founder of the Maggie's Cancer Caring Centres[24], came to the same conclusion that even after the environmental stressors are removed from health care spaces, there is still an imminent need for designers to strive to further to enhance comfort and care in healing environments[25], to tend to the spiritual and social needs of patents[26].

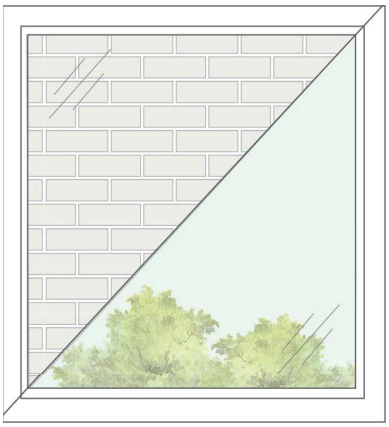

Fig. 1.7 Window View of Brick Wall vs Natural Scenery

Precedent – Holland Bloorview Kids Rehabilitation Hospital

Terry Montgomery, a founding and principal architect of Montgomery Sisam Architects Inc., discusses the design conception of the Holland Bloorview Kids Rehabilitation (HBKR) Hospital in Toronto, in his presentation for the 6th World Congress International Academy for Design and Health in Singapore, 2009; with the fitting title "Cultivating a Sense of Place". He emphasizes the importance for the architecture of children's care environments, for long term rehabilitation and complex continuing care, to foster a connection and interactive presence within the neighbourhood community and the "everyday fabric of the city"[27]. Montgomery expresses that this connection is necessary to contest the dire sense of isolation that patients face in typical long-term care buildings built in the 1960's and 1970's, that "internalized" space for clinical efficiency and disregarded the patients sense of well-being[28]. This hospital is unique for combining pediatric rehabilitation with a complex continuing care teaching hospital and is the largest in Canada. This merger offers the diverse, community-based activities of rehabilitation to the inpatient children in "stark' and "drab" institutional, clinical care spaces[29]. Together the community children, outpatients and inpatients are united for the integrated school, creative arts, recreational and therapeutic programmes. The heart of this architectural design is the

Fig. 1.8 Holland Bloorview Kids Rehabilitation - Cafeteria

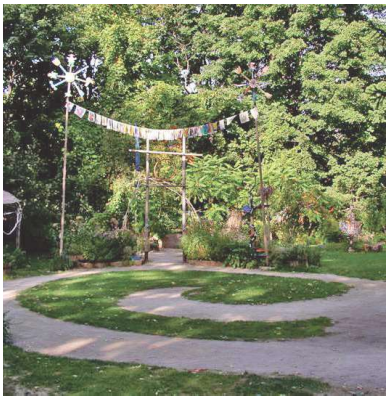

Fig. 1.9 Former Holland Bloorview Hospital Spiral Garden

Fig. 1.10 Example of the "Disney Approach" A recent renovation to the Pediatrics at St Josephs Hospital, Toronto.

use of public space to uphold a sense of wellbeing, orient the interior of the building, connect interior with exterior by providing views of the ravine, natural light and integrating exterior spaces with the overall therapeutic environment. The design team commissioned art installations for the building and site to further enhance and contest the clinical requirements for health care design. The creative art programs from the former facilities with an integral outdoor Spiral Garden, which promoted summer camps, greatly influenced the design team, as Montgomery acknowledges "These garden settings left a powerful impression on us…. Why could we not aim to achieve this kind of quality in the new building?"[30]. "These programs engendered a huge, creative commitment to enrich the lives of patients and in many ways, they inspired us to think differently about the design for the new building"[31]. The design team took the necessary steps of visiting similar and exemplar hospitals in the U.S (*list of hospitals referred to in appendix*). They conducted critical analysis of what made certain hospital interiors too clinical and others comforting.

The opposing approach to reforming health care spaces is the "'Disney' approach"[32] for children's environments which is criticized as a strategy causing instantaneous stimulating distraction but is short lived and does not provide the calmness that medical spaces should provide. Through this design team's hospital visits and design charrette, they devised nine design guidelines[33]:

- Reflect the needs of the children, youth and their families
- Provide safe, secure, accessible and supportive spaces
- Create space that allows the staff to work with the most success
- Ensure flexibility to accommodate programmatic changes in a creative and cost-effective manner
- Fully utilize space
- Facilitate broad community support and linkages
- Maintain respect for local community and environment
- Foster innovation and to maximize connections between interior and exterior

Fig. 1.11 Exterior of Holland Bloorview Kids Rehab. Hospital

There are outdoor terraces carved into the sloping building form which provide relief and social opportunities for inpatients, staff and visitors. The cafeteria is an important "social centre"[34] that is aligned along a long axis of glazing that provides views to the gardens and the ravine. This space is described by Montgomery as the "interior 'porch'"[35] to the gardens and ravine. According to the hospital's website, The Creative Arts Studio is a double height space that facilitates arts and crafts and even gardening activities during the winter months, as intended by the architect. The success of this children's hospital design is generated by the design team's emphasis on embedding inspirational public space with public art that, as Montgomery describes, "can nurture a sense of engagement and ownership among children, staff and families and foster a process of local culture-making and healing"[36]. The theme of the art reflects the design themes for the hospital, as transformation and discovery of the natural world[37]. This theme relates to the history of healing places and their direct link to nature and special temporal conditions, as outlined previously.

The design team's dedication to the process of place making, successfully created meaningful opportunities for the patients, family and staff to engage with the architecture, nature, the community and the city. Similarly to this theme of linking health care to the natural world, Michael Hough's theorizes the synthesis of ecological processes with urban environments, he outlines the importance of "Making visible the processes that sustain life" ... "Much of our daily existence is spent in surroundings designed to conceal the processes that sustain life and which contribute, possibly more than any other factor, to the acute sensory impoverishment of our living environment."[38] This provocation of exposing life's processes to an artificial environment influences the design strategy to revitalize hospitals, to assimilate qualities essential to "restorative environments" or "spiritual sanctuaries"[39] to cultivate such healing places discussed previously.

Fig 1.12 Holland Bloorview's Creative Arts Studio

Fig 1.13 Holland Bloorview's Creative Arts Studio

Fig 1.14 Foster and Partners Manchester Maggie's Centre

Precedent – Maggie's Cancer Caring Centres

A successful example of architectural design influencing change in the quality of health care environments for the sake of patient comfort and wellbeing, are the Maggie's Cancer Caring Centres. These centres are designed by world renowned architects following the criteria that

Fig. 1.15 Gehry's Maggie's Centre

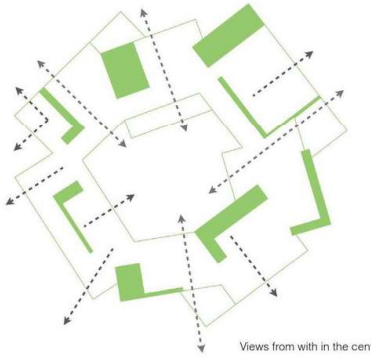

Fig. 1.16 Parti Diagram for Views Koolhaas' Gartnavel Maggie's Centre

Fig. 1.17 Interior View from Koolhaas' Gartnavel Maggie's Centre

Maggie Keswick Jencks and Charles Jencks codeveloped as a way to use architecture to provoke change in response to the health care activities and environments related to the forbidding medical processes that people suffering with cancer endure in typical clinical facilities. This concept was initiated by Maggie, who was diagnosed with cancer and together, led the architecturally trained couple to experience and criticize the grim and hidden system of cancer care. C.Jencks elaborates on the bond between architecture and health care in the article, "Maggie's Architecture: The Deep Affinities between Architecture and Health", as he depicts the significance of metaphors in the design intentions, "This little iconic building type can be minimalist and understated, or highly expressive. Either way a Maggie's Centre is a mixed metaphor that must both welcome in visitors and take creative risks. My late wife Maggie mentioned such varied attitudes as typical with cancer, as one fluctuates between preparing to die and fighting to live, oscillating between fear and tentative hope…"[40] This design intention provokes debate on the issue of how directly architectural intervention can affect the healing process of individuals and reflect the complexity of volatile emotional states. Charles Jencks and Edwin Heathcote, in *the Architecture of Hope*, a collection of a decade of Maggie's Centres projects, state that, "Architecture cannot change society, … but it can underwrite and enhance the basic activities of those who work in it. For cancer sufferers this impetus is significant, for the architecture acknowledges their plight and affirms their worth, a recognition rare in a culture where cancer is usually hidden."[41] The design criteria for these centres is about supporting the cancer patients sense of agency and to encourage their caregivers as well, as C. Jencks describes, "they present a face that is welcoming, risk-taking, aesthetic and spiritual; and with their commitment to the other arts, including landscape, they bring in the full panoply of constructive means."[42] The Maggie's Centres provoke architectural design, synthesizing the arts and the healing environment. The Maggie's Centres reflect the current trend and design response of relying on art initiatives to improve health care environments, as C.Jencks expresses, "Art and architecture are important allies in the perennial struggle with cancer, and this also leads to the basic metaphor: *the architecture of hope*. As patients walk into a Maggie's Centre after a diagnosis, or enervating treatment…they enter another world. This place, set apart from

the hospital with a friendly atmosphere and art, acknowledges their importance; it gives expressive recognition to a human condition…"[43] Jencks and Heathcote examine the past influences on health care architecture and the significance that metaphors play, for instance, "The war on cancer", a metaphor declared by President Nixon in 1971, that Modern hospital design responded to with the 'antiseptic architecture' that remains today[44]. Here, they are commenting on the misconception that the condition of cancer had developed in society, former to the Maggie's Centres influence. Formerly, and still typically today, it is conceived as a hopeless disease that was to be immensely feared by all and kept out of sight, like a warzone, aligning with the oppressive metaphor 'war on cancer'. This is very similar to the negative representation of healing spaces, which are architecturally depicted within the health care system as desolate, overly sterile, containment systems that must be kept segregated from the public. Hence, as Jencks and Heathcote believe, is why 20th century hospitals fail to sustain a meaningful connection with the city. Heathcote pays tribute to the medieval and Renaissance hospitals, which provided civic and spiritual value to their cities, unlike Modern hospitals[45]. The authors believe the Maggie's Centres are a "partial alternative" as a hybrid health care building responding to the city and the human condition, "such a hybrid could bridge the divide between the purely functional and the symbolic and give back to the institution a civic architecture of meaning."[46].

Similar to the previous precedent: the Holland Bloorview Kids Rehabilitation Hospital, there is a discovered need for both projects to connect care to community support, nature and the city, as Jencks observes, "When you are faced with cancer, a life-threatening disease based on rogue-life, you are likely to orient yourself to nature…The 'architecture of hope' is correspondingly one big orientation outwards; and twenty little foci on secondary therapies, inwards…"[47] Lastly, Jencks remarks on the important lesson that architecture cannot heal people directly, but it can stimulate the type of care one receives, as he reveals, "Architecture helps create the virtuous circle of the caring cycle but it is only an indirect aid, not a substitute for the ethos and commitment of those who work and play inside the building."[48]

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Part 2: The Nature of Hospitals outlines a brief Western history of how hospitals became stressful and overly sterile and what reforms have occured to promote therapeutic design initiatives. This research reveals that infection control measures have significant influence on healthcare design outcomes. This thesis points out the paradox, that the infection control requirement to protect patients against spread of illness, in-turn creates the harsh, artificial environments that cause patients stress and hinder their innume-systems. An interview with a medical labratory technologist for IPAC and a healthcare architect outline the restrictions and limitations of healthcare design. Lastly, this part of the thesis details the hospital typology, long-term care and rehabilitation, which is more appropriate for these proposed design interventions. An existing & contemporary hospital of this typology is selected as the basis for testing these design interventions.

THE NATURE OF HOSPITALS 2

Fig. 2.18 Photo Collage

Late 19th C. – Nature-centric Hospitals

Hospital architecture today epitomizes the discord between nature and medicine. This thesis addresses the current state of health care architecture by examining the historical evolution of hospital design strategies and the reoccurring estrangement of nature from medicine and health care architecture. The first reform to let nature into hospitals was in the late nineteenth century. Florence Nightingale, a nurse and activist writer, influenced a public health reform to simply allow patient quarters access to natural sunlight, views to outside and fresh air to improve patient recovery outcomes. Her theories and observations influenced the design of the Pavilion-style hospital typology, which altered the design of specialized care facilities such as: asylums and sanitoria[1]. The Pavilion-style plan is also referred to as the Nightingale Plan[2]. These hospitals included open span rooms, with cross ventilation from large operable windows or balconies to access sunlight, fresh air and views. In the early twentieth century, the International Style of modern architecture sterilized any therapeutic or natural interventions in health care environments[3] and shifted the focus to clean, functional and affordable design[4]. The era of hospitals kept windows in patient rooms as a standard requirement, but then stripped their therapeutic value by raising them up into high-rise towers. Hospitals became corporate, isolated, monumental machines that prioritized advancing efficiencies and medical technology. Cor Wagenaar, a Dutch architectural historian and author of the project and book, *the Architecture of Hospitals* describes this shift leading to the early twentieth century, "the natural environment ceased to be a factor in hospital design, the only exception being the tuberculosis hospitals, for instance Alvar Aalto's sanitorium in Paimo, Finland. In all other hospitals, science and technology reigned supreme. . . Nature was reduced to the view from the bedroom windows"[5].

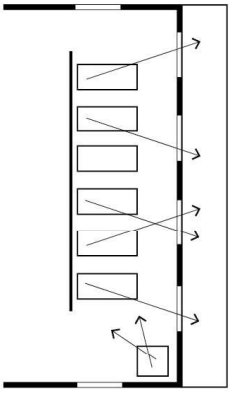

Fig. 2.19 Diagram of Sanitorium Externalized Layout

Mid-20th C. – Patient-centric Hospitals

In the nineteen-fifties and 'sixties the postwar and post-modern critics raised awareness for patient-centered care movements[6]. Rather than patients traveling to various wards to see various doctors in the hospital, this reform succeeded in centralizing care around the patient, bringing the various doctors' to one patient ward. Architecturally, this paradigm shift decentralized doctors quarters from a central patient

Fig. 2.20 Aalto's Sanitorium - Roof Terrace View

ward. This shift eliminated redundancies of patient wards, minimizing the overall hospital area and was able to adopt to Regional-style architecture, as low-rise hospitals integrated into the urban fabric. Building layouts became organized as the "T,H and K types" depicting heavy central wards with narrower wings. With great efforts to please every individual patient, the aspired aesthetics of health care became the infamous and unexpressive "*as neutral as possible*"[7].

Late-20th C. – Machine-centric Hospitals

However, by the nineteen-eighties and nineties, there was an expressive renaissance, as hospitals became designed as commercial entities, like hotels and shopping malls, with large atriums ad street-like corridors. Annmarie Adams, of Social Studies of Medicine within the Faculty of Medicine at McGill University, with a background of architecture and art history, has numerous publications on the relationship between medicine and architecture. In the article, "Decoding Modern Hospitals: An Architectural History", she outlines the evolution of hospital design over the past century, from prioritizing modern efficiency in the "postwar tower hospital" to the "less-institutional" shopping mall hospital model that catered to patient and family experience[8]. Adams refers to the Atrium in the Hospital for Sick Children (SickKids) by Zeidler Roberts Partnership Architects in Toronto, Ontario, built in 1993, as an example of the "Mall-style hospital", where playful accents of colour and plants (mostly artificial) returned to health care interiors, as facilitated by the atrium space[9]. Adams continues to explain how the design strategies for patient-wayfinding were influenced by city streets, using sight lines and landmarks like fountains or art installations, as she describes:

Fig. 2.21 Zeidler's Hospital for Sick Children - Atrium

> "[The] hospital-as-city metaphor was often explicit, with corridors even masquerading as streets, as if outside, with 'street' lighting and benches, giving the hospital an aura of being public, no matter what its pedigree. Massive skylights augmented the illusion that interior space was outside. Multistorey atriums meant users could see where they were going across levels, giving them an unprecedented sense of control."[10]

Contesting this praise, Adams discloses that these generous architectural gestures were "just a veneer" and "cheery decoration"

and that this façade of modern health care was covering up the real medical miracle of the era, the systems – computer, technical equipment and communications. She refers to the computational and mechanical systems as the "backstage architecture" which fashioned the innovation of "interstitial floors, where an entire level of the hospital was given over to mechanical equipment"[11]. She refers to the popular example, the McMaster University Health Sciences Centre in Hamilton, Ontario, built in 1972. As impressive as interstitial mechanical levels is, Adams concludes that, "Healthcare architecture advances when architects embrace medical technology and landscape as inspiration, rather than as constraints or things to be disguised."[12]

21st C. – Garden-centric Hospitals

With this management focus on patient satisfaction in the late twentieth century, surveys began to support the theory that access to nature enhanced the patients experience and provided benefits for medical outcomes and shorter stays[13]. This led to the 1994 first Post-Occupancy Evaluation of hospital gardens in the U.S. that compared various types of exterior garden designs and surveyed the usage demographics, effects on sense of symptoms, and sense of wellness[14]. The growing interest on this subject was further attested by Ulrich's Theory of Supportive Garden Design outlining the healing garden design components that patients respond positively to[15].

Michael Hough, in *Cities and Natural Process*, compares the natural processes in ecosystems with the urban environment. This comparison of the city as an ecosystem is relative to the idea of a hospital as an ecosystem, as Hough insists, "The quality of life implies, among other things, being able to choose between one place and another, between one lifestyle and another. It implies interest, pleasure, stimulated senses and varied landscapes."[16] This subject of stimulated senses is essential for health care design, especially the need for multi-sensory environments for long-term care patients to occupy their attention to during strenuous medical or rehabilitation procedures. The art of designing distraction can create powerful benefits in confined clinical spaces.

The IPAC Paradox

The medical interiors of hospitals are designed with strict sensitivity to immediate public-health safety requirements, operational standards and functional efficiencies with respect to medical processes; ensuring the patient's visit is a safe, efficient, and respectful process, as outlined by Ontario's Ministry of Health and Long-Term Care[17]. Too often though, these functional design requirements (within the initial functional program) supersede qualitative strategies, manifesting health care environments into overly sterile and hostile places. The paradox in health care design today, is that research by Infection Prevention and Control (IPAC), a national association with chapters of Provincial Infectious Diseases Advisory Committee[s] (PIDAC), proves that sterile conditions are successful at protecting the immune system from immediate infection[18]. Though, evidence-based research by environmental psychologists proves that these stark, sterile environments cause psychological stress, which hinders the immediate immune system, long term wellness and recovery outcomes[19]. This evidence proves that therapeutic design is just as critical to health care in protecting immune systems from environmental stressors[20].

In response to this discovery, recent health care reforms have reoriented patient rooms to prioritize views to the outdoors and implemented interior design strategies to post-naturalize these hostile spaces. These strategies apply antiseptic, artificial representations of nature, such as scenic artwork, laminated wood-like graphics and floral fabrics; this strategy is an "indirect experience of nature" as framed by *biophilic design* methodology[21]. Since, this design approach only employs the aesthetics of nature to improve comfort conditions in health care, editors of the *Imperfect Health*, Giovanna Borasi and Mirko Zardini, refer to it as "placebo architecture"[22], as an effective yet, fake or indirect remedy. To contest this current-day design response, this thesis explores the potential of replacing placebo nature with living systems, with the efforts to design a health care environment that provides more than visual sensory stimulation. To immerse patients into healing environments which support horticultural therapy, to help calm and motivate the mind, body and soul during the healing process.

This argument to resuscitate clinical interiors, is in response

to the critique of the mid-twentieth century, international style of modern hospital architecture[23], which still exist today, continuing to haunt and influence the architecture of institutional buildings. Esther Sternberg observes how the design of modern hospitals has resolved the issues of infection and contamination by stripping all ornament, colour, materials and surfaces that would foster bacteria growth, by replacing them with resilient, solid surfaces that undesirably reflect acoustics[24]. She argues that throughout history, "as hospitals became cleaner, they became colder, noisier, and less comforting. 'Sterile' became a negative term."[25] Charles Jencks and Edwin Heathcote, in *The Architecture of Hope: Maggie's Cancer Caring Centres*, have a similar critique of the modern era's intentions for health care architecture as: "*antiseptic architecture*", a "*medical machine*", a "hygienic structure stripped of aesthetics" which fails to sustain a meaningful connection with the city or as the "*industrial megastructure*" that "remain[s] immune to architecture"[26].

IPAC-Informed Design

This thesis engages the design threshold between horticulture and health care architecture, with the endeavor to take nature indoors, past the atrium and deeper within the maze, that is the hospital. Natural systems should be integral components to health care interiors, as per the supporting evidence outlined in this thesis. In opposition to this stance, today's current architectural standards for health care projects in Canada, associate natural materials and systems as being prohibited by IPAC. IPAC informs design by providing consultation to organizations such as, the Public Health Agency of Canada, the Canadian Standards Association and the Canadian Hospital Association[27]. Exposed natural materials, such as untreated wood, do not meet IPAC approval due to their surface porosity, which absorbs moisture, fostering microbial growth, and therefore are cumbersome to hospital processes of disinfection[28]. Natural systems like interior landscaping, consisting of vertical living walls or planters do exist in hospitals today, but only in public spaces, like atria. These systems are either out-of-reach due to a high guard or are placed behind glass. Unfortunately, they are commonly perceived as a burden of additional cost, maintenance and safety liability[29]. These disadvantages for bringing nature indoors could be countered

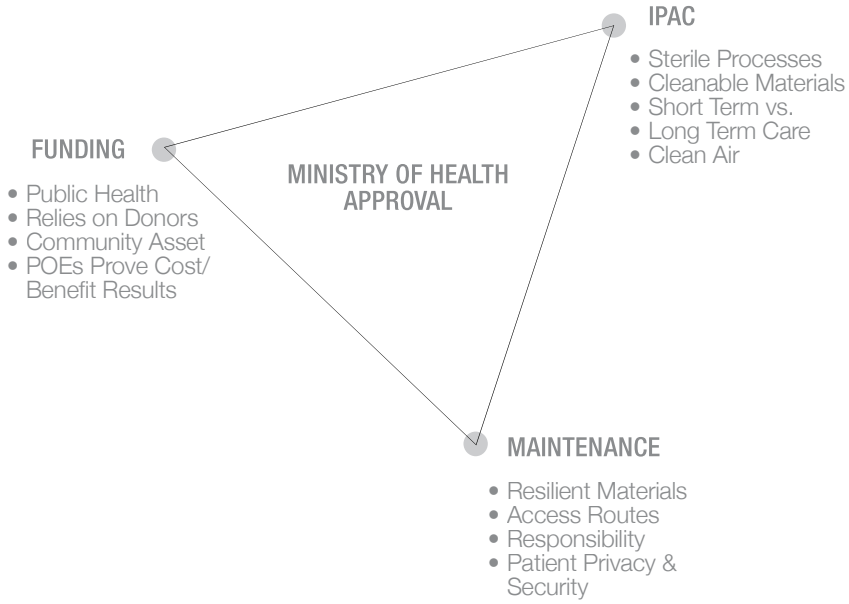

Fig. 2.22 Healthcare Design Limitations and Restrictions Diagram

by the advantages that are currently progressing with the support of advancing green technologies. Though without precedent, the design community requires extensive research and development to be able to challenge and attain approval of this strategy from the complex bureaucracy of public health care in Canada. Without awareness of the potential advantages and innovative capabilities of bringing nature into hospitals, the health care system condones this strategy, with limited to no tolerance.

A discussion with a health care architect and a medical laboratory technologist certified in infection control within IPAC, together posed apprehensions about bringing living systems into hospitals from their professional experience (refer to Addendix for interview questions). They described the processes in which a designer could propose new design strategies and the necessary steps, such as, initially contacting the local IPAC office to review proposed materials and systems. For new construction or future expansion of an existing hospital, these living systems designs need to be proposed in the functional program and master plan for review and approval by the Ministry of Health. For interior planting systems, major concerns were: maintenance access and plant care, accessibility, the amount of unprogrammed physical contact patients would have with plants and therefore, being able to control the interactivity, the plant species and risk of plant pathogens,

poisonous or common allergic species, the irrigation system and risk of producing and spreading legionella bacteria, and lastly the cost of these systems[30]. Two recent trends in shifting the standards of hospital design today were discussed and both are directly influenced by IPAC. The first is the new necessity for single patient rooms rather than double or group sharing rooms. This was a result of research proving that sick patients should not share toilets. The second was the recent increase in restrictions in place by IPAC, caused by outbreaks such as SARS. The documents proving design standards for hospitals is the 'Generic Output Specifications' document, which led to the CSA Z8000 standards for design.

A shift in long-term geriatric care design based on the Edin Principle, encouraged the use of plants, animals and children for improving quality of life for elderly[31]. Plants are strictly restricted from intensive care units. It was suggested that the plants must be a part of a program for patients to ensure care and hand hygiene protocols are overseen. Possible suitable locations for living systems design are common areas. Water quality of the irrigation system will require constant monitoring to ensure bacteria is not forming anywhere, with risk of outbreak of legionnaires disease; for this reason the irrigation system must be a drip system, as aerated filters cause risk and are prohibited in CSA's Z8000 standards[32]. There must be design considerations for insect and pest control for these systems. Risk assessment must prove that the benefits of these systems outweigh the risks they cause. The final advice that was provided was that the factors that will determine the restrictions for the design proposal are based initially on the nature of the hospital that it is being applied to[33].

Long Term VS Short Term Care & Real VS Artificial Plants

A further understanding of infection control and it's impact on health care design led to the reasoning that short-term health care environments requires stricter adherence to IPAC-informed design strategies. This is because more people with weakened immune systems and contagious infections are occupying these spaces, therefore, exposed living systems are not suitable for the nature of short-term hospital departments. However, these living systems could be implemented, if installed within reach they will require a glass barrier to avoid contact and transference of bacteria. Anywhere

"The funny thing about sustainability... is that you have to sustain it."

- Ron Finley
Guerilla Gardener, CA.

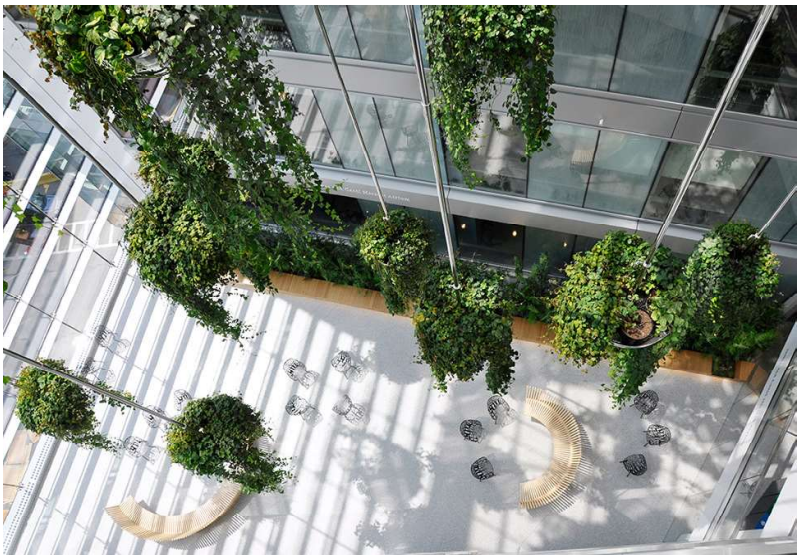

Fig. 2.23 Artificial plant suspended over main atrium at Massachusetts General Hospital, Lunder Building, Boston.

above reaching distance, e.g., above seven feet, such as ceiling space, is a suitable location for exposed living systems design. The IPAC specialist explained that wall art and ceiling materials that do not make contact with patients can be made of porous materials and do not need to be sterilized[34].

A study published in the Journal of Physiological Anthropology in 2013 by a researcher and graduate student of the Graduate School of Horticulture at the Chiba University in Japan, survey the psychological and physiological effects that people get from touching plant foliage[35]. The study shows the comparison of tactile stimuli from touching a real plant (pothos leaf), artificial plant, a piece of metal and a piece of fabric (see chart of results*). The results of this study prove under these circumstances that tactile stimuli between real and artificial plants cause nearly identical psychological impressions[36]. However, when testing the physiological responses, such as stress response, through measuring cerebral blood flow through sensors, that touching a real plant leaf causes greater physical calming or stress relief than artificial plants do[37].

Artificial plants are then an excellent alternative to provide a sense of comfort in short-term care hospital spaces. Artificial plants can be sterilized or easily replaced and do not require maintenance. In long-term healing environments, this thesis argues that real plants

are necessary rather than the artificial. This is because, long term care patients face more than an immediate sense of stress, they endure long-term grief and physical chronic pain. These patients require more intense therapeutic strategies to cope with their long-term pain, stress and overall life-altering changes that they are struggling to adapt to. Real plants provide a long-term, evolving beauty and a symbolic reflection of transformation. The act of gardening provides horticultural therapy and supports mobility. Gardening can assist with exercising of fine motor functions. The act of gardening supports independence as well as strengthening social relationships. There are opportunities to gain and share knowledge, to develop skills, as well as abilities and by redirecting care to something else, enables a sense of purpose. The process of healing is reflected by the process of gardening.

Bridgepoint Active Healthcare

The outcome from the discussion with the IPAC specialist and the hospital architect led to grounding this living systems design specifically to the hospital typology of long term complex care and rehabilitation. Long-term care has less strict IPAC requirements because there are less patients for longer durations and with stronger immune-systems, relative to acute care. Therefore, I was advised that the design interventions for this thesis are more convincing if specified for long-term care. Rehabilitation was selected due to being able to tie horticultural therapy activites to rehabilitation activities, to make these designs integral to the care programming. This typology is a recent amalgamation of previously disconnected care centres. A specific hospital of this typology was selected, toured and studied, as a basis to apply the design interventions proposed in this thesis (presented in Part 3: Nature in Hospitals).

Bridgepoint Active Healthcare opened in 2013, in Toronto and was developed by Stantec Architecture with KPMB Architects for planning, design and compliance and HDR Architecture with Diamond Schmitt Architects for managing and realizing this *Design, Build, Finance and Maintain* project[38]. This building replaced the former hospital on the same site, as it was overpopulated and still supported group-patient rooms. The intent for the new hospital was to maximize single-patient rooms, diverse amenity space, and amalgamate facilities

for complex chronic care and rehabilitation. Cheryl Atkinson, architect and professor of Architectural Science at Ryerson University, worked with Dr. Celeste Alvaro, an experimental social psychologist and others to produce the Bridgepoint Active Healthcare Pre and Post Occupancy Evaluation[39]. According to Atkinson, this evaluation compares the architectural design of the old hospital building with the new state-of-the-art building, and links this data with carefully collected qualitative data of the perceptions of both hospitals. Together this data reveals the psychological impacts that architectural design has on patients and staff[40].

This thesis draws from this Post-Occupancy Evaluation (POE) report revealing the great successes that this innovative "healing architecture" caused on reducing patient stays by 30%[41]. The POE does highlight areas of weakness in the design that have room for further improvement. The results reveal the patients' impressions of these areas, and some of the occurring themes relate to the lack of space for people watching, lack of colour and comforting aesthetics, and issues with environmental stressors in these areas. These issues all coincide with the research presented in this thesis on health care design.

These gathered issues reveal that even the newest and most highly rated health care buildings today in Canada are still perceived as overly sterile and artificial. In conclusion, this thesis is using these three spaces at Bridgepoint Active Healthcare, to develop the living systems designs. The results from the POE for these three areas is presented in Part 3. These spaces are essential typologies for the future of long term rehabilitation care hospitals and therefore, the designs are to be regarded as adaptable to future hospitals of this nature.

Fig. 2.24 Bridgepoint Active Healthcare.

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34 Ibid, Interview.

35 Iwasaki, Yutaka and Kazuko Koga. "Psychological and physiological effect in humans of touching plant foliage - using the semantic differential method and cerebral activity as indicators." Journal of Physiological Anthropology 32, no. 7 (2013): 1.

36 Ibid, 6: Figure 4.

37 Ibid, 7.

ENDNOTES

38 Atkinson, Cheryl. "Healthy Outcomes: A major pre- an post-occupancy study of a new Toronto hospital provides evidence for design's impact on qualitative aspects of wellness." Canadian Architect. October 2016. Accessed June 2018. https://www.canadianarchitect.com/features/healthy-outcomes/

39 Alvaro, Celeste, Deyen Kostovski, Andrea Wilkinson and Paula Gardner. "Design and Evaluation: The Path to Better Outcomes: The Final Report on the Bridgepoint Active Healthcare Pre and Post Occupancy Evaluation." Report prepared for the Health Capital Investment Branch, Ontario Ministry of Health and Long Term Care, 2015.

40 Atkinson, Cheryl. "Healthy Outcomes: A major pre- an post-occupancy study of a new Toronto hospital provides evidence for design's impact on qualitative aspects of wellness." Canadian Architect. October 2016. Accessed June 2018. https://www.canadianarchitect.com/features/healthy-outcomes/

41 Disrupting Design, episode 3, "Bridgepoint Healthcare Centre," commentated by Grey Colucci of Diamond Schmitt Architects, aired March, 20, 2016 on CBC player, https://www.cbc.ca/player/play/2685625557.

NOTE All interviews were conducted in confidentiality, and the names of interviewees are withheld by mutual agreement.

Part 3: Nature in Hospitals briefly summarizes examples of natural landscapes currently being associated with healing environments, such as exterior and interior healing gardens, labyrinths and medicine wheel gardens. The author attended a Healthy Hospitals Tour and Biophilic Design Workshop in Toronto and the findings from this research is presented. Research on various living systems technologies and systems are examined to find suitable applications for the design proposal. Lastly, the three design interventions are proposed and convey aspects absorbed from all the research examined in this thesis.

Fig. 3.25 Diagram of typical hospital corridor.

NATURE IN HOSPITALS 3

Fig. 3.26 Diagram of hospital corridor with *Living Systems* interventions.

Fig. 3.27 Monastic Cloister Garden

Elements & Qualities of Places Chosen by University Students When Feeling Stressed

Opportunity for Exploration

Opportunity for Movement

Urban Milieu

Expansive Vantage Point

Privacy / Solitude

Evokes Safety / Comfort

Sensory Stimuli

Natural Elements

Fig. 3.28 Table 1-3 Survey results by Francis and Cooper Marcus, 1992.

Clare Cooper Marcus claims the first hospitals in Western history were the monastic infirmaries in the medieval times. She focuses on the cloister gardens at the center of the monasteries, which provide healing herbs for the patients[1]. Along with the garden's medicinal purpose, the design promotes experiential activities such as strolling and for moments of pause, for prayer and reflection at the central fountain. This courtyard surrounded by arcaded walkways exemplifies a human scale garden, with semi-enclosure providing a sense of security. Marcus presents a survey of features people expect in a therapeutic setting, many of which can be experienced in a monastic cloister garden (refer to *Fig.3.33*)[2].

Marcus defines *healing* as "a beneficial process that promotes overall well-being."[3] She ties the word *therapeutic* to *healing* for their shared goal to enhance well-being. Well-being is achieved in medical environments by supporting three aspects of the healing process that Marcus identifies as: "relief from physical symptoms or awareness of those symptoms", "stress reduction and increased levels of comfort" and "improvement of overall sense of well-being and hopefulness"[4]. She concludes that Healing Gardens support all of these therapeutic factors essential to the healing process.

Similar in formal arrangment to the monastic cloister garden is the indiginous Medicine Wheel garden. Both gardens are circular and contain a central sacred space for reflection. The layout is governed by a circle of stones with four cardinal aisles leading to a central stone

Fig. 3.29 Indiginous Medicine Wheel Garden

representing the Spirit or Creator[5]. The wheel represents the circle of life. By entering the garden, walking its pathways in meditation (based on a labyrinth) and sitting within it, you actively invite "all of life"[6] to sit with you, in council. Each aisle is a phase or season of life that you travel through to evoking a ceremonial meeting with the Spirit or the Creator at the center[7]. The elements of nature found in the garden, the animals, medicinal herbs or personified stones all provide support to someone seeking healing and they restore a sense of connection within the great circle of life.

Roger Ulrich's Theory of Supportive Garden Design outlines the design components of healing gardens that patients respond positively to, such as designing[8]:

- Opportunities for exercise
- Opportunities to make choices
- Seek privacy and experience a sense of control
- Reinforce sense of control and sense of autonomy
- Reinforce social support through areas to gather and interact
- Opportunities to engage with nature as a positive distraction from physical and mental symptoms
- Maintain visibility and be easy to find
- Have accessibility and mobility for all ages and disabilities
- Be familiar or domestic with homelike furnishings
- It must be quiet as unwanted sounds are one of the greatest environmental stressors for patients

- Must be comfortable by being located nearby with choices to sit or walk be alone in privacy or socialize with others
- Enjoy sun or shade
- Multiple viewpoints
- Various routes or shortcuts
- Provides security and shelter
- Unambiguous positive art as the emotional state changes sensitivities and perception of surroundings and misinterpretations of art can be perceived as threatening.

This evidence-based research influenced the application of outdoor gardens coupled to hospitals at the end of the twentieth century and continues today. Speaking with professionals working in complex care and rehabilitation hospitals, outdoor gardens have their disadvantages that these studies do not discuss. Some issues are poor air quality and humidity conditions in the summer in most urban locations. Another disadvantage is that in colder climate regions these outdoor gardens can only be enjoyed partially throughout the year and do not carry their benefits through the winter season.

An example of an interior healing garden with natural finishes, living plants and a water feature, is found at Juravinski Cancer Centre in Hamilton, Ontario *(refer to Fig. 3.35)*. This design was achieved by Perkins + Will architects and landscape architect, Virginia Burt. Another example is the Crown Sky Garden in Chicago, *(refer to Fig. 3.36)*. This enclosed rooftop garden integrates digital technologies with garden planters in a versitle layout.

Fig. 3.30 Juravinski Cancer Centre, Hamilton Health Sciences interior garden.

Fig. 3.31 Crown Sky Garden - Lurie Children's Hospital, Chicago

[Endnotes]

1 Marcus, Clare Cooper and Marni Barnes. ***Healing Gardens: Therapeutic Benefits and Design Recommendations***. New York; Toronto: Wiley, 1999, 1.

2 Ibid, 7: Table 1-3.

3 Ibid, 3.

4 Ibid, 3.

5 Kavasch, E. Barrie. ***The Medicine Wheel Garden: Creating Sacred Space for Healing, Celebration, and Tranquillity***. Bantam; 2008, 3.

6 Buhner, Stephen Harrod. ***Sacred plant medicine: The wisdom in Native American herbalism***. Simon and Schuster; 2006, Part 9.

7 Ibid, Pt. 9.

8 Ulrich, Roger. "Effects of Gardens on Health Outcomes: Theory and Research." In ***Healing Gardens: Therapeutic Benefits and Design Recommendations***, edited by Marcus, Clare Cooper and Marni Barnes. New York; Toronto: Wiley, 1999, 36.

HEALTHY HOSPITALS TOUR

BIOPHILIC DESIGN

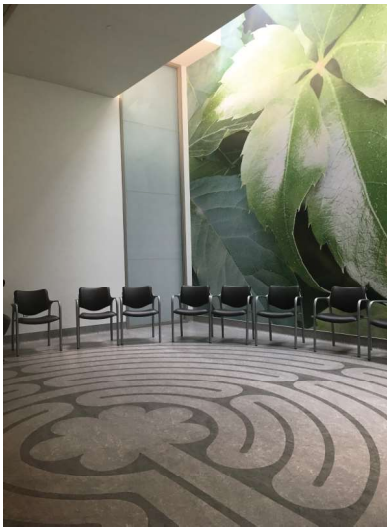


Fig. 3.32 Labyrinth Meditation Room at Womens' College, Toronto.

For this thesis the author participated in the "Healthy Hospitals Tour" in Toronto, as a segment of the *From Grey to Green Conference*, organized by Green Roofs for Healthy Cities[1]. A Biophilic Design Workshop was led by Elizabeth Calabrese, she presented the recent research by herself and the late, Stephen Kellert on *The Practice of Biophilic Design*[2]. This research summarized the various strategies for implementing *Biophilic Design* in the built-environment. These strategies can be applied to spaces to stimulate a familiar comfort within humans, due to the conditioning of *Biophilia*[3]. This design strategy is useful to interior spaces that are perceived as too artificial and sensory-deprived, such the negative characteristics that are common to dense, open-plan offices and hospital interiors, as discussed in Part 1 of this thesis. The summary of "Experiences and Attributes of Biophilic Design" are shown in the table below, *Fig. 3.37*. They are categorized by direct and indirect attributes of nature, as tools to design with, and the last category is the experiences that humans find comforting or stimulating in nature that should effect the spatial qualities of Biophilic Designs.

An example of Indirect Nature or artificial Biophilic Design, is the Meditation Room at Womens College in Toronto *(refer to Fig. 3.38)*. The plant graphics on the wall with downlighting create a sense of being in a garden with the sunlight beaming down. The labrynth on the floor captivates the viewer for a period of time to extend time spent in the room.

[Endnotes]

1 For more information: https://greytogreenconference.org/

2 Kellert, S. and Elizabeth Calabrese. " *The Practice of Biophilic Design. www.biophilic-design.com, 2015.*

3 Wilson, E. *Biophilia: The Human Bond with Other Species.* Cambridge: Harvard University Press; 1986.

DIRECT NATURE	VS	INDIRECT NATURE	+	SPACE & PLACE
Sunlight		Images of Nature		Prospect & Refuge
Fresh Air		Natural Materials		Organized Complexity
Water		Natural Colours		Integration of Parts to the Whole
Plants		Simulating Natural Light & Air		Transitional Spaces
Animals		Naturalistic Shapes & Forms		Mobility & Wayfinding
Weather		Evoking Nature		Cultural & Ecological Attachment to Place
Natural Landscapes & Ecosystems		Information Richness		
Fire		Age, Change & the Petina of Time		
		Natural Geometries		
		Biomimicry		

Fig. 3.33 Experiences and Attributes of Biophilic Design

Fig. 3.34 Pothos Vines

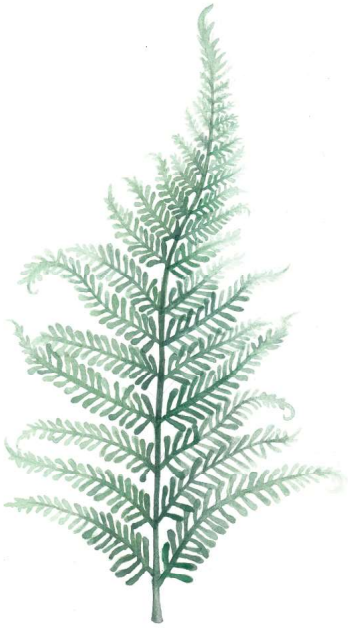


Fig. 3.35 Fern Stem

Fig. 3.36 Ivy Vines

Fig. 3.37 Aloe

Fig. 3.38 Dragon Tree

Fig. 3.39 Dracaen Janet Craig

RESEARCH

INTERIOR LIVING SYSTEMS

For the past 30-40 years living system designs and technologies, have allowed plants to grow vertically without soil, on rooftops and indoors with artificial lighting. Plant species have been tested for their capabilities at improving indoor air quality and led to recent technologies developing interior living walls as biofilters, assisting mechanical air systems. A popular system for commercial plant and fish growing operations is the development of aquaponics, which is a closed-loop process recircuting water between plants and fish to benefit both species.

According to the 1989 NASA Report, "Interior landscape plants for indoor air pollution abatement." Low-light houseplants coupled with activated carbon plant filters improve indoor air quality by removing volatile organic chemicals (VOCs) as air pollutants from energy-efficient buildings. This study was conducted in response to sick building syndrome, an issue with air-tight buildings trapping off-gasing chemicals from various furnishing and finishes. The plant root-soil zone is identified as the most effective area for removing VOCs. The findings proved that maximizing air exposure to the plant root-soil area enhances filtration. This experiment influenced the design of living walls and the significance of the cavities exposing the roots to drip-water supply and air circulation.

LIVING SYSTEMS

VERTICAL GARDEN BY PATRICK BLANC

Patrick Blanc is a botonist who spent years researching plant species in tropical rainforests worldwide, specifically plants which grow vertically, without soil and on the rocks of waterfalls. In the 1980s he developed the hydroponic vertical garden using these perfectly paired plant species. This system was used initially on the exterior of existing buildings. Due to the light substrate of felt layers rather than soil, this allowed the system to be supported by light metal framing. The wall is supplied with nutrient-rich water through a drip-irrigation system by an array of pipes. The plants are arranged accordingly to those requiring more water or more sunlight.[1]

1 Blanc, Patrick. *The vertical garden: From nature to the city*. WW Norton & Company, 2008.

Fig. 3.40 Quai Branly Museum

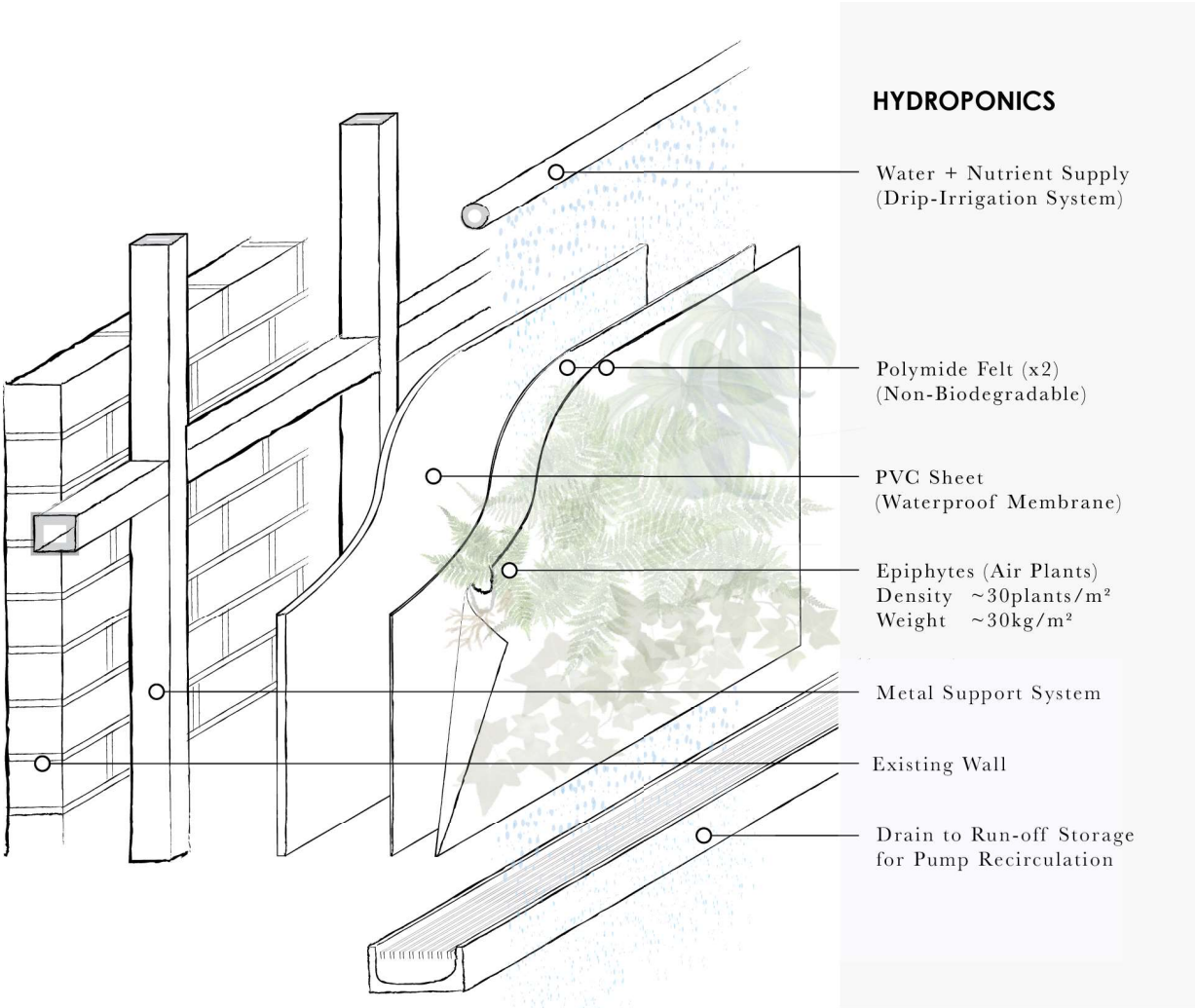


Fig. 3.41 Peal away axonometic drawing of Patrick Blanc's Vertical Garden system[1].

LIVING SYSTEMS

BIOWALL BY NEDLAW

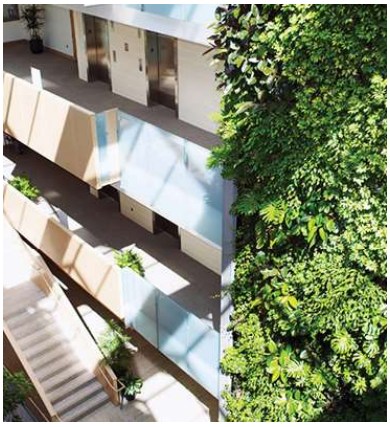


Fig. 3.42 Cambridge Civic Centre

Nedlaw Living Walls is founded by Dr. Alan Darlington, PhD. This company spent decades of lab research in collaboration with architecture firms such as Diamond and Schmitt Architects to develop the Biowall, the hydroponic indoor air biofilter. These walls use closed-loop systems for water and air. The wall has plenums behind the growing media that drive air through the walls and are forced through air intake to be recirculated in the space. This is the biofiltration process. The other cycle is the drip-irrigation system which collects run-off water in a basin and recirculates it to the top to be re-supplied.[1]

1 Darlington, Dr. Alan. Cleaning Indoor Air with Nedlaw Living Wall Biofilters. URL: www.nedlawlivingwalls.

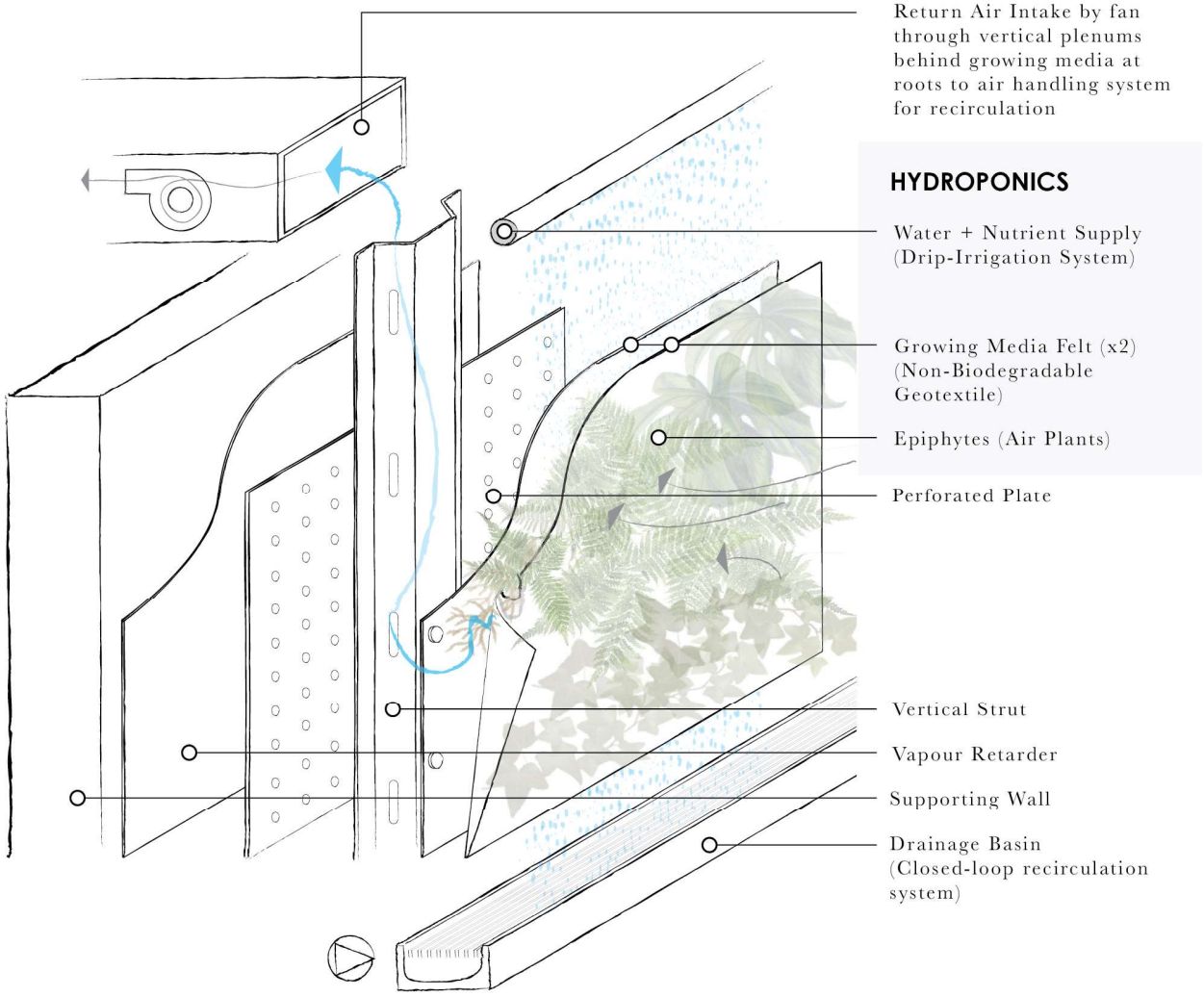


Fig. 3.43 Peal away axonometic drawing of Nedlaw's Vertical Biowall system[1].

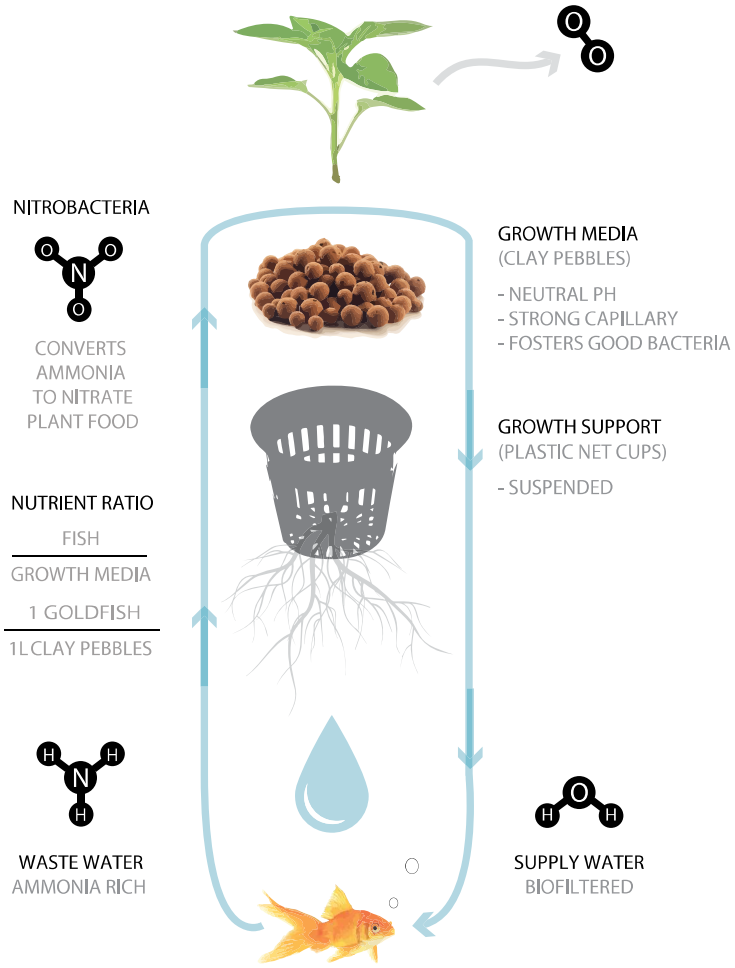


Fig. 3.44 Diagram of Aquaponic Biofiltration of Nitrogen Cycle

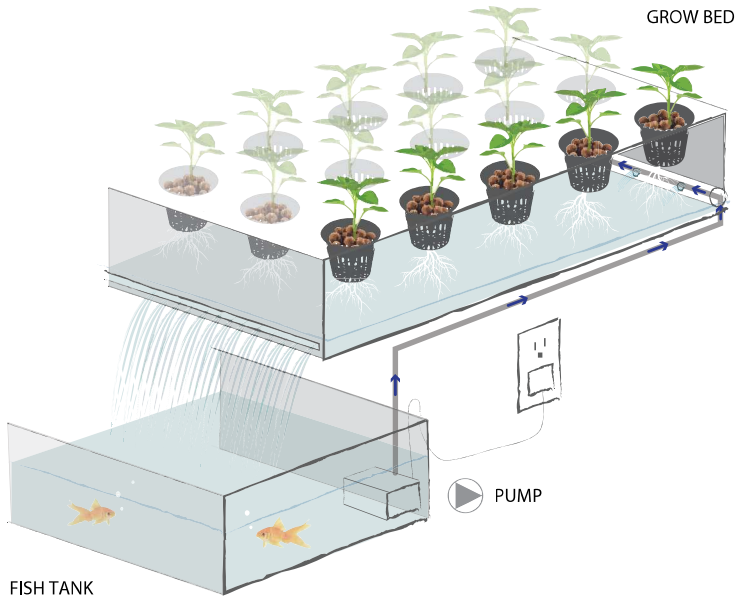


Fig. 3.45 Diagram of Stacked Aquaponic System

Plants require sunlight, air, water, growth support and nutrients. The waste water produced by fish is ammonia rich. At the growth media threshold, where the roots begin, this is where good bacteria flourishes. This bacteria takes the ammonia rich waste water and coverts it into nitrates. In this process the plant asborbs the nitrate as plant nutrients, releases the excess oxygen molecules into the air and supplies fresh water back to the fish. This system requires consistant PH testing to ensure the ratio of fish-to-growth media is correct. If not, the plants will not absorb enough ammonia and acidic water will be re-supplied, harming the health of the fish.[1]

This system uses suspended net cups (typically on styrofoam trays) growth media such as clay pebbles or synthetic batt insulation. The tray is angled and allows for nutrient-rich water to flow at the base of the cups on an automatic timer throughout the day. The water is pumped electronically to cirulate through the system. This system is only good for nurseries.[2]

1 Bernstein, S. *Aquaponic gardening: a step-by-step guide to raising vegetables and fish together*. New society publishers, 2011, 183.
2 Ibid, 63.

Fig. 3.46 Labyrinth at Bridgepoint Active Healthcare

LONG-TERM CARE & REHABILITATION

BRIDGEPOINT ACTIVE HEALTHCARE

BRIDGEPOINT ACTIVE HEALTHCARE

AREAS OF FOCUS

The three areas of focus selected from Bridgepoint Active Healthcare's POE report, are the exterior terrace, floor physiotherapy gyms and floor patient lounges. These areas are common to long-term care and rehabilitation hospitals. The POE revealed that all of these areas excel in design excellence compared to the former building, but that there were still drawbacks in the design qualities, from the post-occupancy survey from patients and staff. These findings are presented and examined in the following pages. Reoccurring themes from all the areas is lack of colour, comforting design, issues with noise and smells, accessibility issues, mono-functional spaces lack stimulation[1].

The rooftop garden was visited during the Healthy Hospital tour. It has a no maintenance green roof and raised, mobile planters for popularly used for seasonal gardening sessions. This rooftop terrace is open to the public. This space is proving successful in enhancing patient wellbeing and inviting the community inside the hospital. The POE outlines that issues with this area are based on accessibility, as the entrance is not easy to locate, the transition from interior to exterior is a hassle and there is a long ramp that causes strain for patients with mobility issues[2]. Studying this space separately influenced the proposed design options.

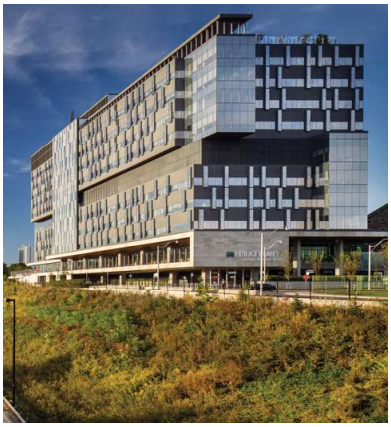


Fig. 3.47 Bridgepoint Active Healthcare View from Gerrard St.

1,2 Alvaro, Celeste, Deyen Kostovski, Andrea Wilkinson and Paula Gardner. "Design and Evaluation: The Path to Better Outcomes: The Final Report on the Bridgepoint Active Healthcare Pre and Post Occupancy Evaluation." Report prepared for the Health Capital Investment Branch, Ontario Ministry of Health and Long Term Care, 2015.

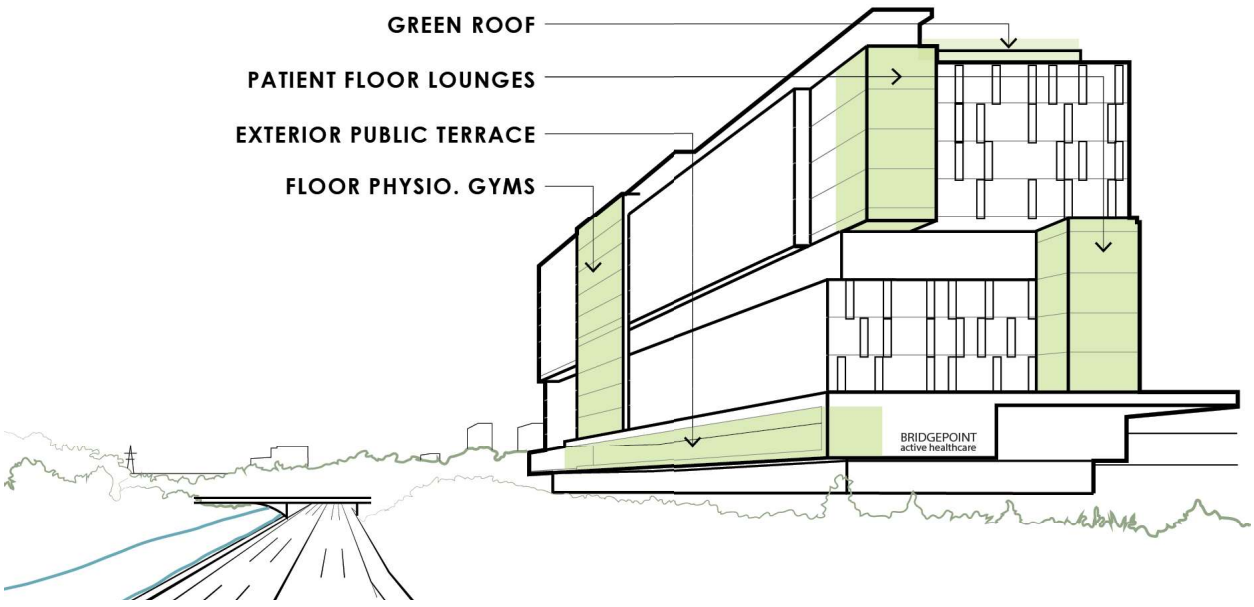


Fig. 3.48 Bridgepoint Area of Focus Callout Diagram

BRIDGEPOINT ACTIVE HEALTHCARE

EXTERIOR TERRACE

Fig. 3.49 West Terrace exterior view

Fig. 3.50 West Terrace south view

Fig. 3.51 Cafeteria to Terrace View

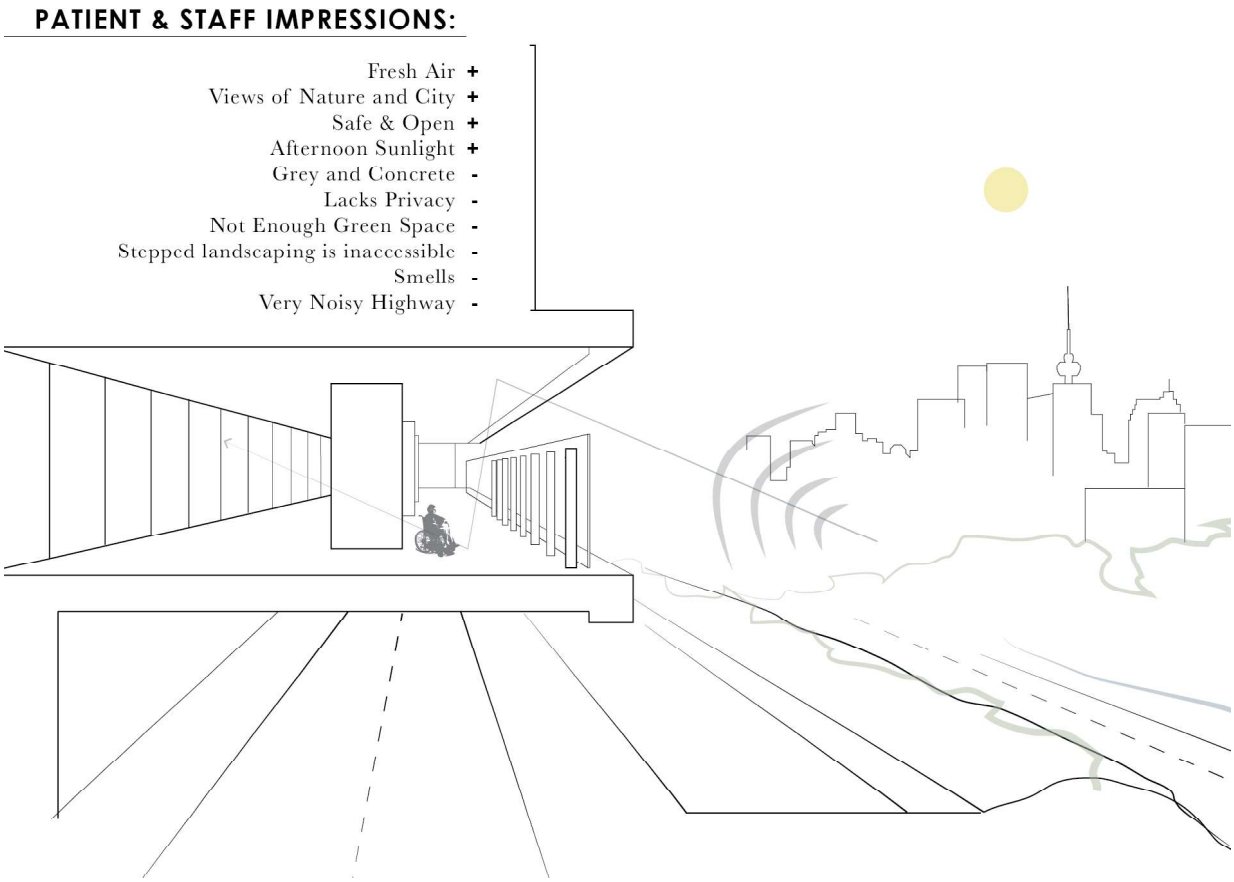


Fig. 3.52 Diagram: West Terrace illustrating Bridgepoint POE report feedback

BRIDGEPOINT ACTIVE HEALTHCARE

PATIENT FLOOR PHYSIOTHERAPY GYMS

Fig. 3.53 Physiotherapy Gyms per all pateint floors - view to the west

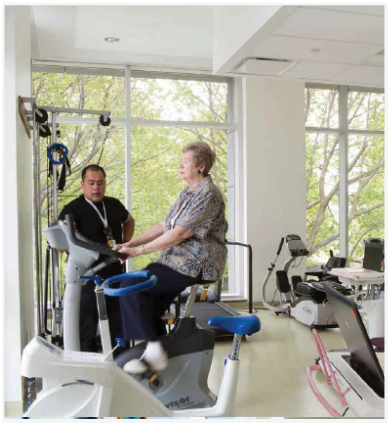


Fig. 3.54 Ground floor gym

PATIENT & STAFF IMPRESSIONS:

+ Lots of Windows & Natural Lighting
+ Views of Nature and City
+ Spacious Room
- Lack of Colour
- Need Longer Parallel Bars for Physiotherapy

Fig. 3.55 Diagram: Typical Physiotherapy Gym illustrating Bridgepoint POE report feedback

Fig. 3.56 Patient floor lounges South view

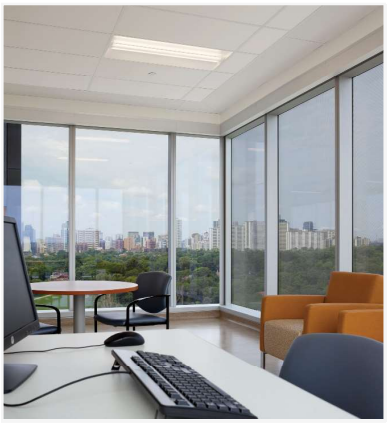


Fig. 3.57 Patient lounge East view

PATIENT & STAFF IMPRESSIONS:

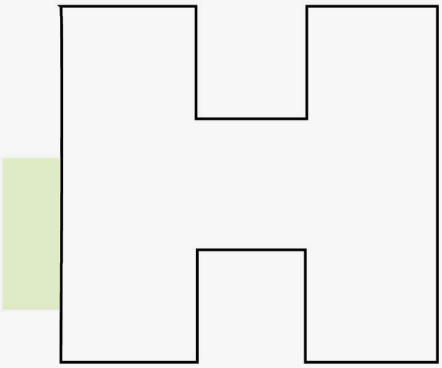
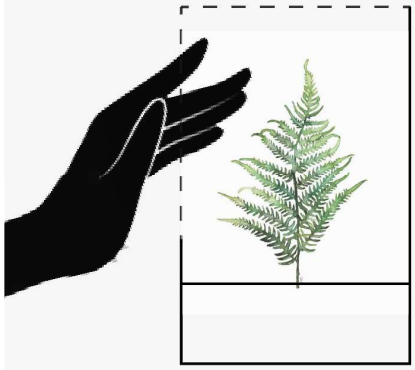
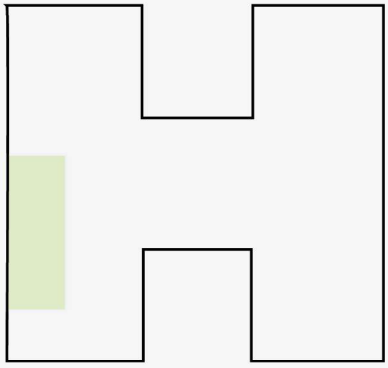
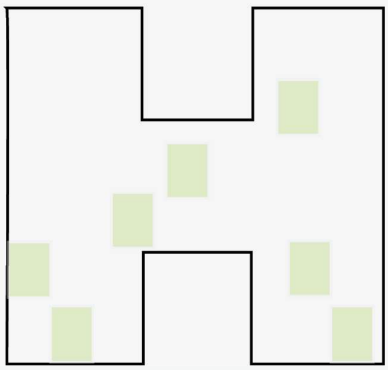
+ Lots of Windows & Natural Lighting
+ Views of Nature and City (Night Lights)
+ TV
+ Comfortable

- Noisy
- Furniture is bad for people with mobility issues
- Underused, wasted space
- Prefer large animated social spaces

Fig. 3.58 Diagram: Typical Patient Floor Lounge illustrating Bridgepoint POE report feedback

DESIGN STRATEGY

Fig. 3.59 Interactivity : Immersion Diagram

INTERACTIVITY	HOSPITAL IMMERSION	
 No Contact	 Exterior Appendage	This is the most IPAC restrictive strategy, intended for high-use, public spaces. Plant Interactivity Level: The living systems are behind glass screen to avoid any contact. Location within hospital: This strategy is designed as an exterior appendage to a terrace.
 Limited Contact	 Interior at Perimeter	This is the semi-IPAC restrictive strategy, intended for mid-use, semi-public spaces. Plant Interactivity Level: The living systems are behind glass screens but during propogation sessions are accessible. Location within hospital: Along interior span of exterior glazing.
 Full Contact	 Interior & Migratory	This is the least IPAC restrictive strategy, intended for individual use, semi-private spaces. Plant Interactivity Level: Living systems are fully exposed & accessible for tending. Location within hospital: Free for migration around patient levels or docked in lounges.

DESIGN INTERVENTION

LIVING ARCHITECTURE

This section presents the three design interventions proposed for the three areas of focus selected from Bridgepoint Active Healthcare's POE. These three designs range from least to most interactive for patients. In unison with interactivity, these design range from least to most immersive in location within the hospital interior spaces. The intention for the designs aesthetically, was to add colour and light play, diversity in textures, changes over time, and to make them look as if they could already exist in hospitals. The goal was to make these designs adaptive to any hospital with these typical areas, the terrace, gym & lounge, this was achieved through modularity. Affordability and maintenance plays a significant role in all designs to reduce servicing needs and consider patient privacy.

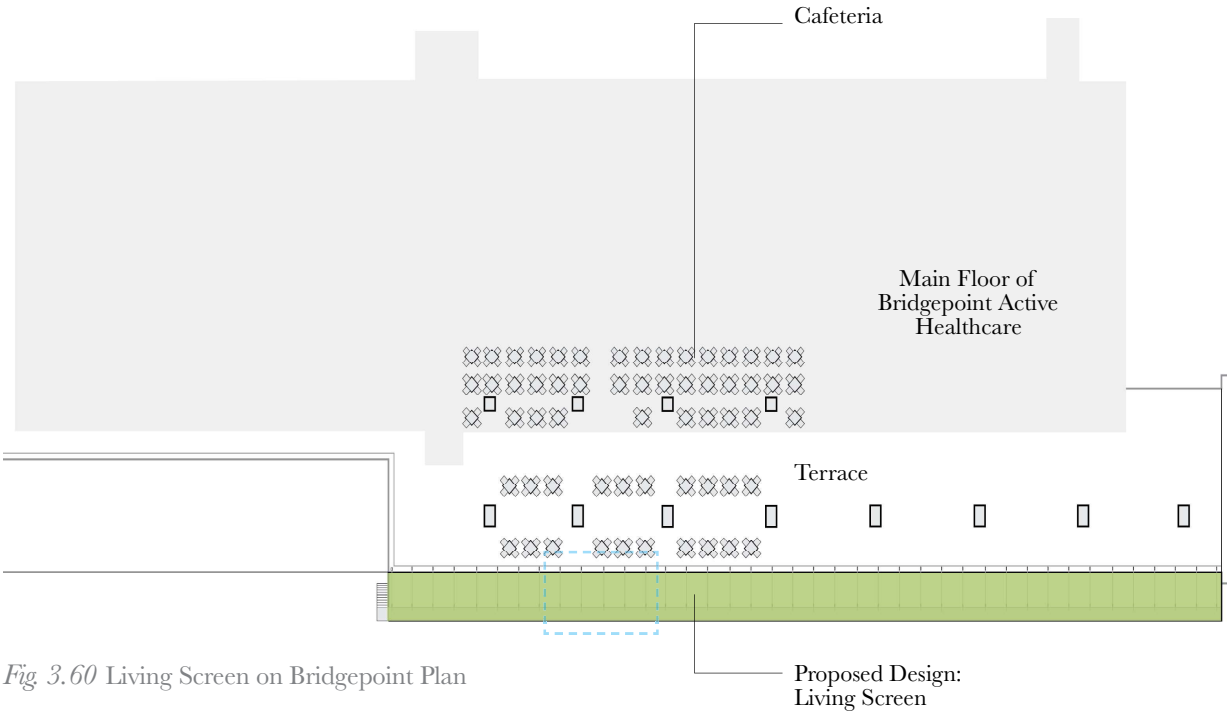


Fig. 3.60 Living Screen on Bridgepoint Plan

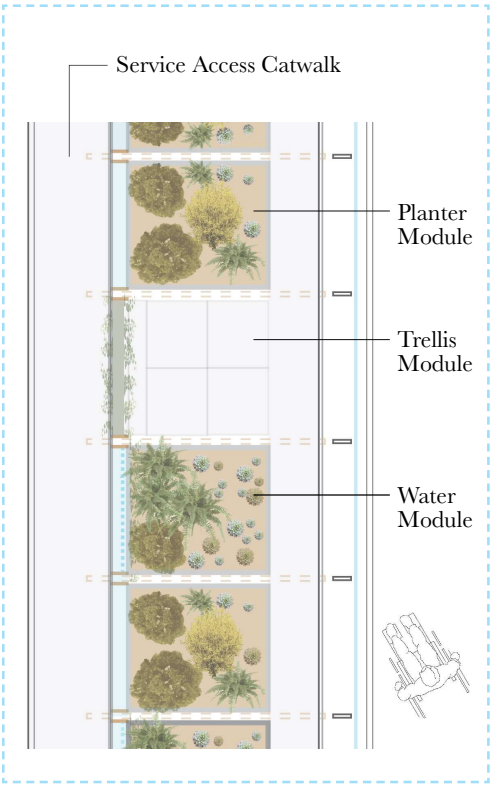


Fig. 3.61 Living Screen Enlarged Plan

This system is the most restrictive in interactivity and the most construction intensive of the three designs proposed, as it requires substantial structural support to cantilever the planters with integral cisterns. The largest size of this planter is two meters (or five feet) to accommodate various depths of soil and space for various natural plantings. The access walkway adds another meter to the cantilever, but this is lightweight steel grate. This system could be narrower with plants that require less space and soil depth. The base of the module is proposed as steel construction to reduce weight and columns are of treated wood framing to promote a natural aesthetic. The plants are selected for the garden as a whole, to look aesthetically pleasing year-round. The advantages of this system are the collection and reuse of rainwater, that reduces irrigation costs.

DESIGN INTERVENTION 1

LIVING SCREEN

Fig. 3.62 West Terrace Proposed *Living Architecture* Intervention

DESIGN INTERVENTION

LIVING SCREEN

– Rooted –

Exterior System – The Living Screen at Terrace

This design intervention is intended for exterior terraces that require a screen for privacy, partial shade and sound absorption. The design is modular to permit customization and adaptability per new and existing buildings. It has three types of modules: the cantilevered planter, the trellis and the water module. The level of interactivity with this design is primarily limited to visual. The water module is intended to provide auditory therapy, whilst cancelling out stressful background noise. The planter module contains four-season natural plantings that transition throughout all seasons and are catered to attract butterflies and birds for animation. Each module is self-sufficient by means of water collection, containment, circulation and drainage, though electricity is supplied from the building. In winter, the irrigation system will be shut-off, drained and small pumps removed and stored. A steel grate access walkway and stair is attached to the modules creating a hidden maintenance corridor. The Living Screen is to be installed behind a glass guard for safety, a handrail and unfixed seating is to be provided to support viewing by those with mobility issues.

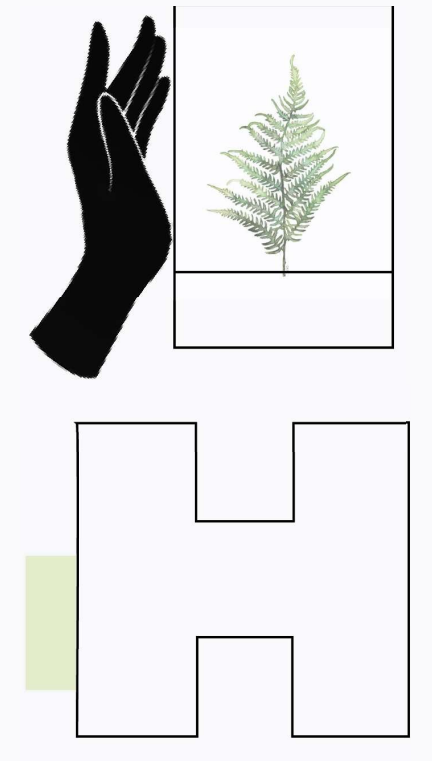


Fig. 3.63 Interactivity & Immersion: No Contact at Exterior

DESIGN INTERVENTION

LIVING SCREEN

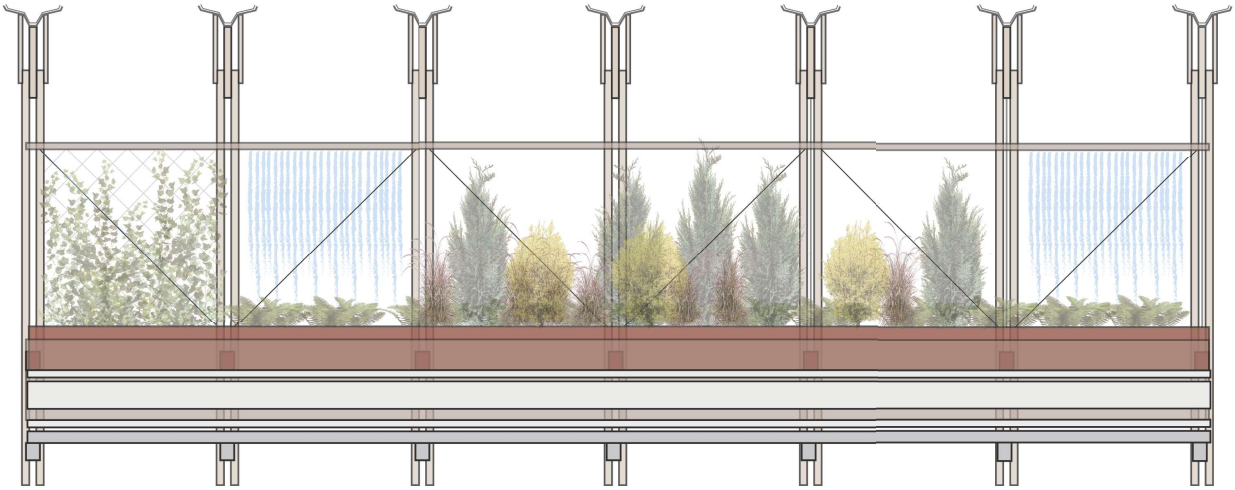


Fig. 3.64 Elevation of Living Screen System

Fig. 3.65 Image (a)

Fig. 3.66 Image (b)

Left: This example shows inspiration for the hanging vines creating light shadows for the Trellis Module.

Right: This is an example of natural gardens proposed for the Planter Module, with a variety of texture, heights, colour and all-season plantings.

Fig. 3.68 Image (c)

Fig. 3.67 Image (d)

Left: This example shows inspiration for the lightly cascading water feature for the Water Module.

Right: This is another example of natural gardens, with a variety of texture, heights, colour and all-season plantings. These plant species shown are also drought resistant.

LIVING SCREEN

PLANTER MODULE

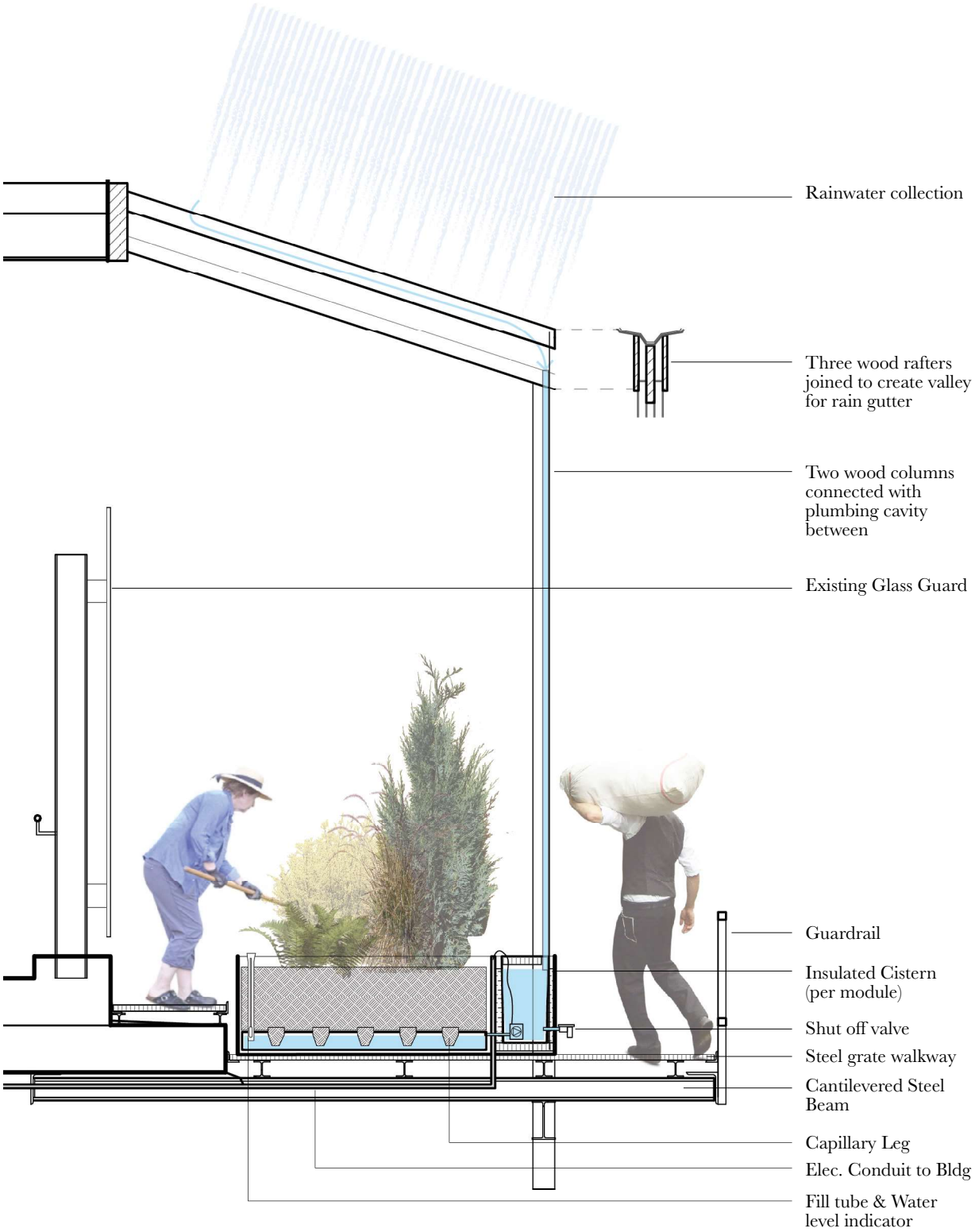


Fig. 3.70 Section: Planter Module

LIVING SCREEN

WATER + TRELLIS MODULES

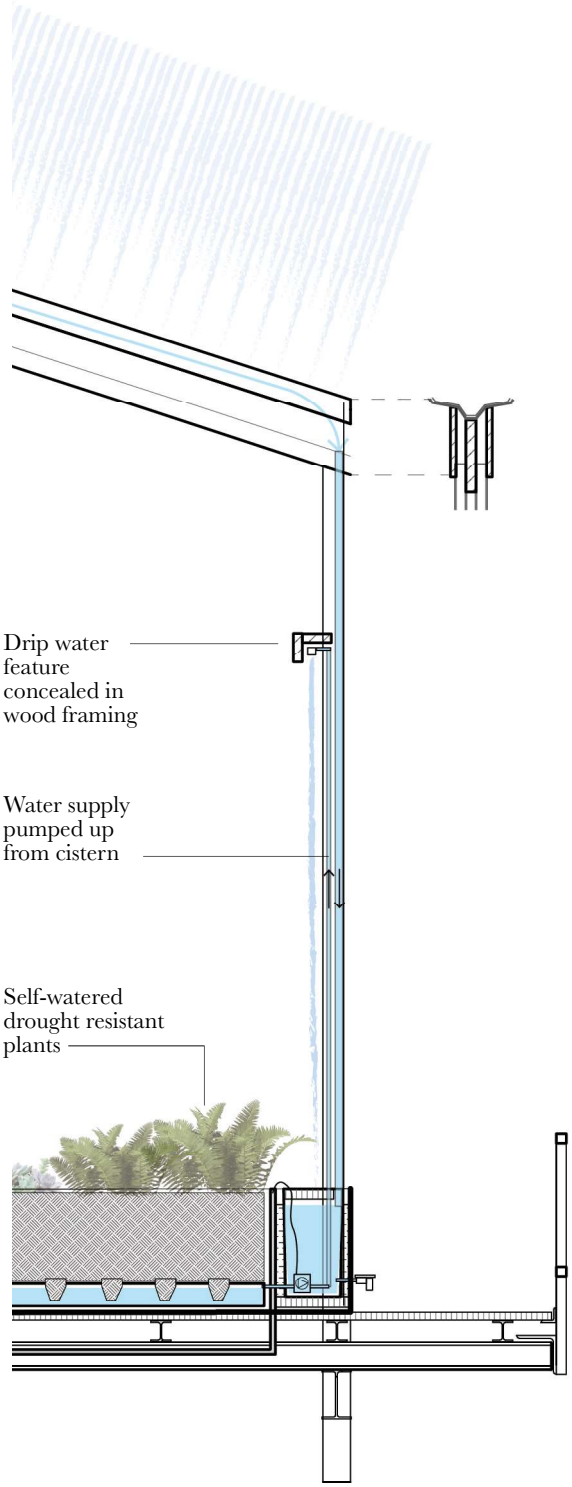


Fig. 3.71 Secion: Water Module

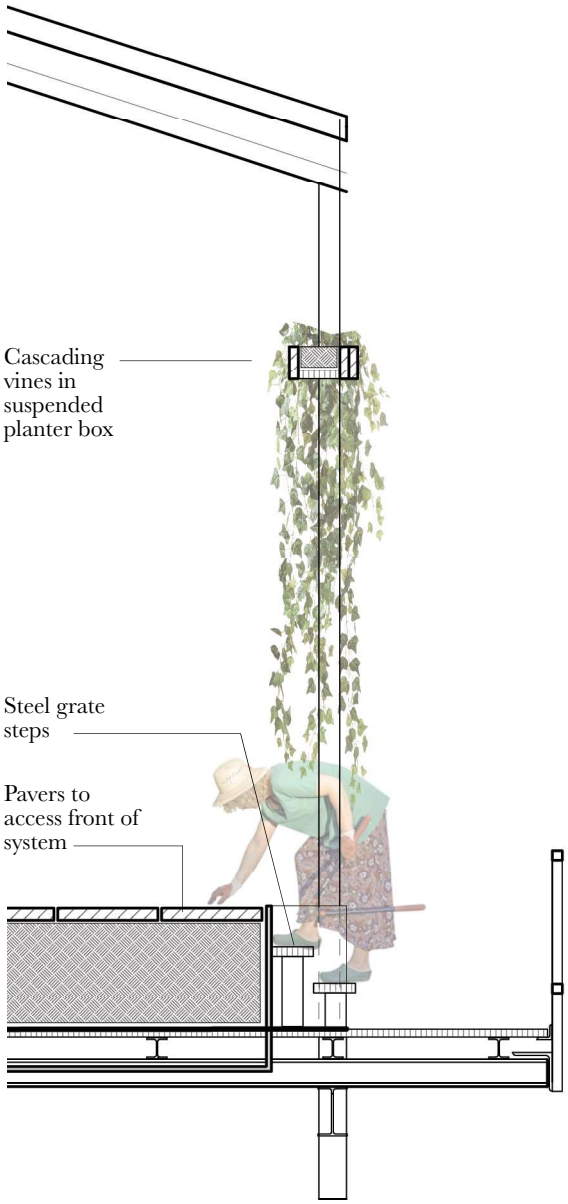
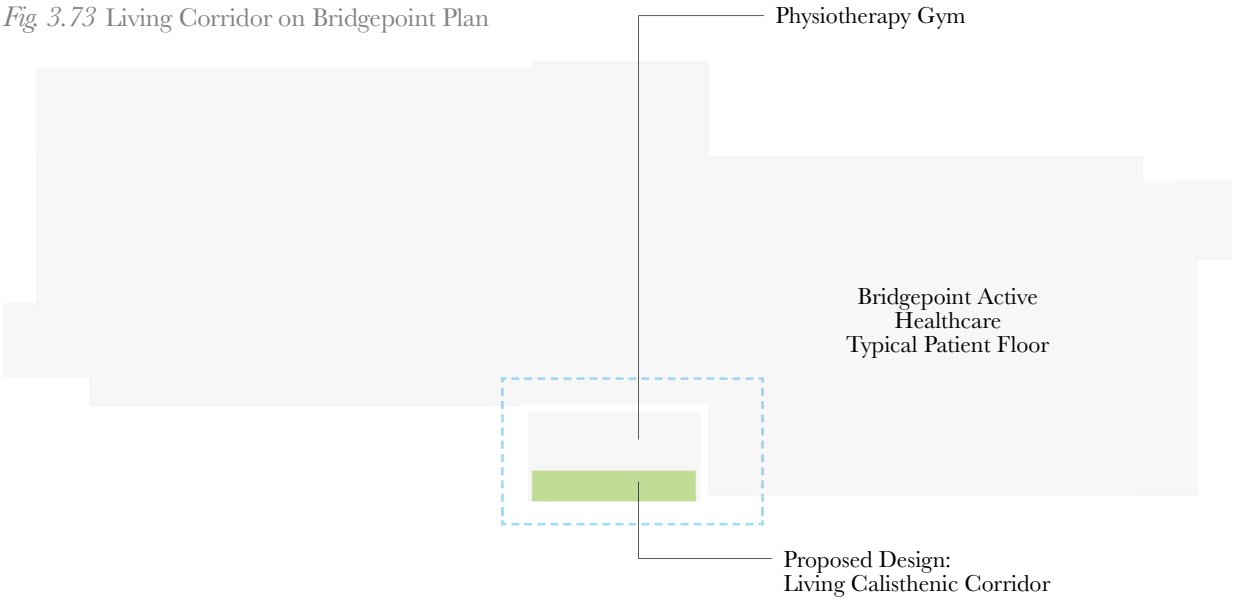


Fig. 3.72 Section: Plant Screen Module

Fig. 3.73 Living Corridor on Bridgepoint Plan



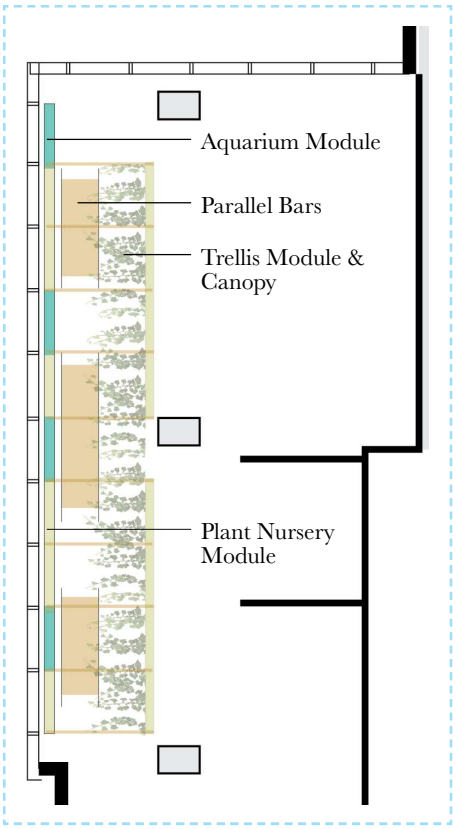


Fig. 3.74 Living Corridor Enlarged Plan

The modularity and light wood framing of this intervention makes this design the most affordable. The proportions of this design are intended for the use of physiotherapy bariatric parallel bars, with wheelchair access and support staff space. The system is intended as a corridor with two sides and a ceiling trellis, but could be installed with only one wall of nursery and aquarium modules (as they are paired for the quasi-aquaponic system - *refer to Fig3.78*), and omit the side and top trellis modules. The plants are kept behind glass screens to limit unmonitored contact by patients. The frames are to be of wax-treated wood. This material choice will require convincing of IPAC, as wood is frowned upon in such an actively used space, however there are hospice precedents such as the Juravinski Cancer Centre in Hamilton (*refer to Fig.3.35*) that have wood framing and benches in an interior garden.

DESIGN INTERVENTION 2

LIVING CALISTHENIC CORRIDOR

Fig. 3.75 Proposed design intervention: Living Calisthenic Corridor & Plant Nursery

DESIGN INTERVENTION

LIVING CALISTHENIC CORRDIOR

– Threshold –

Interstitial System – The Living Calisthenic Corridor in Gyms

This design intervention is to be placed inside exterior glazed walls. This design is outfitted for parallel bars used for *calisthenics*. A generous pathway aligns the parallel bars for support staff and wheelchair access. It creates an aisle of modular living systems with three types of modules: the plant nursery, the aquarium and the trellis module as a privacy screen. The interactivity of this system is primarily viewing. Occasionally, during programmed propagation or transplant sessions, the patients will fully interact with the nursery plants, by planting the seedlings and transferring the maturing growth to patient lounges. These sessions directly support rehab physiotherapy as they exercise fine motor functions. Sunlight is blocked from the aquariums, but can pass through the violet coloured glass of the nursery modules. The intention is to add colour to physio-gyms to liven the environment and motivate patients.

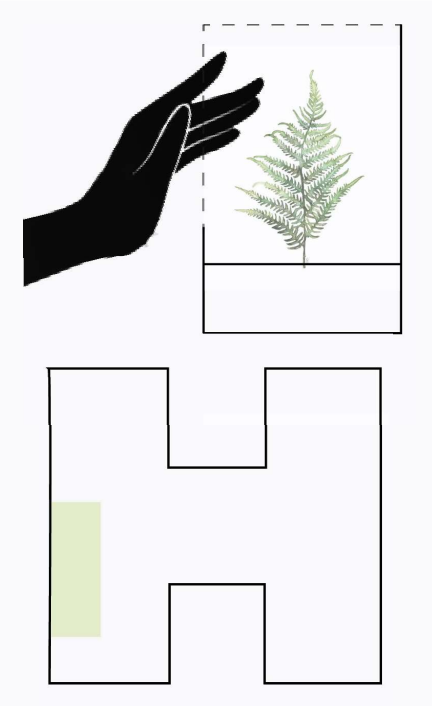


Fig. 3.76 Interactivity & Immersion: Limited Contact at Perimeter

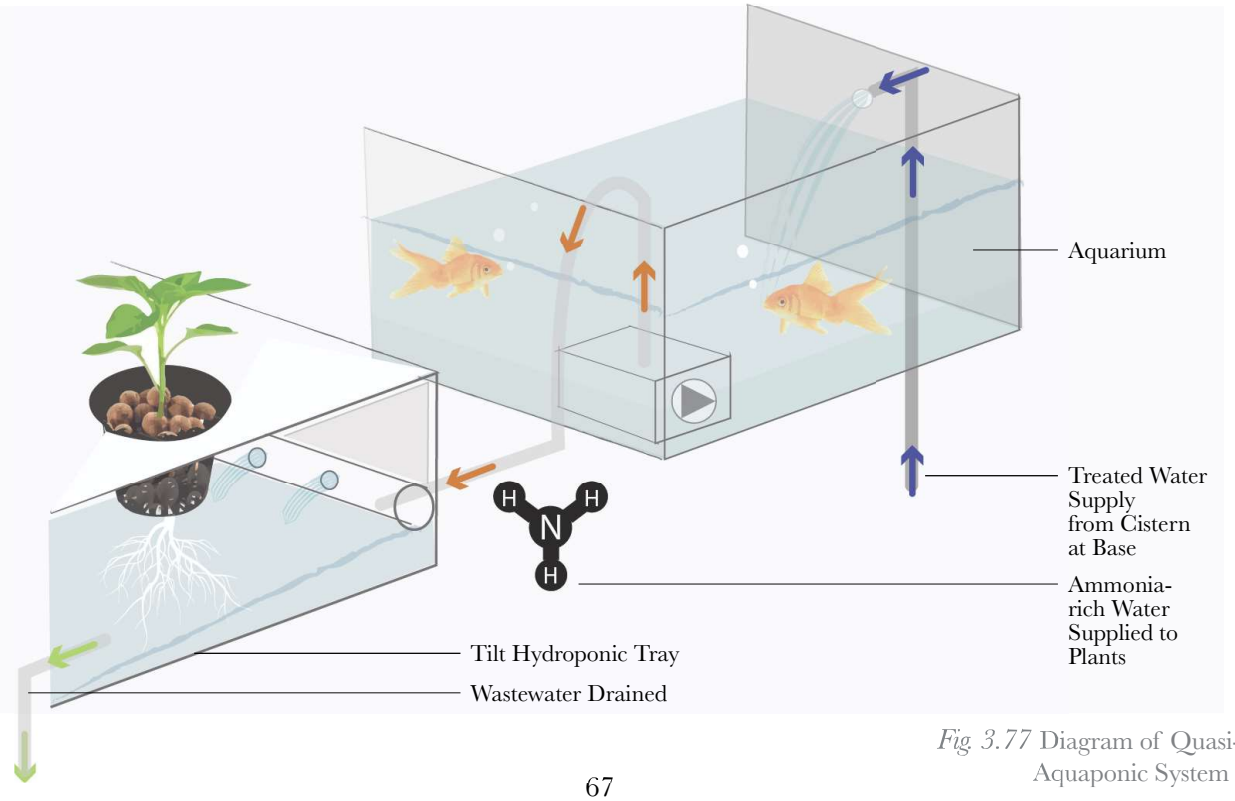


Fig. 3.77 Diagram of Quasi-Aquaponic System

LIVING CALISTHENIC CORRIDOR

PLANT NURSERY MODULE

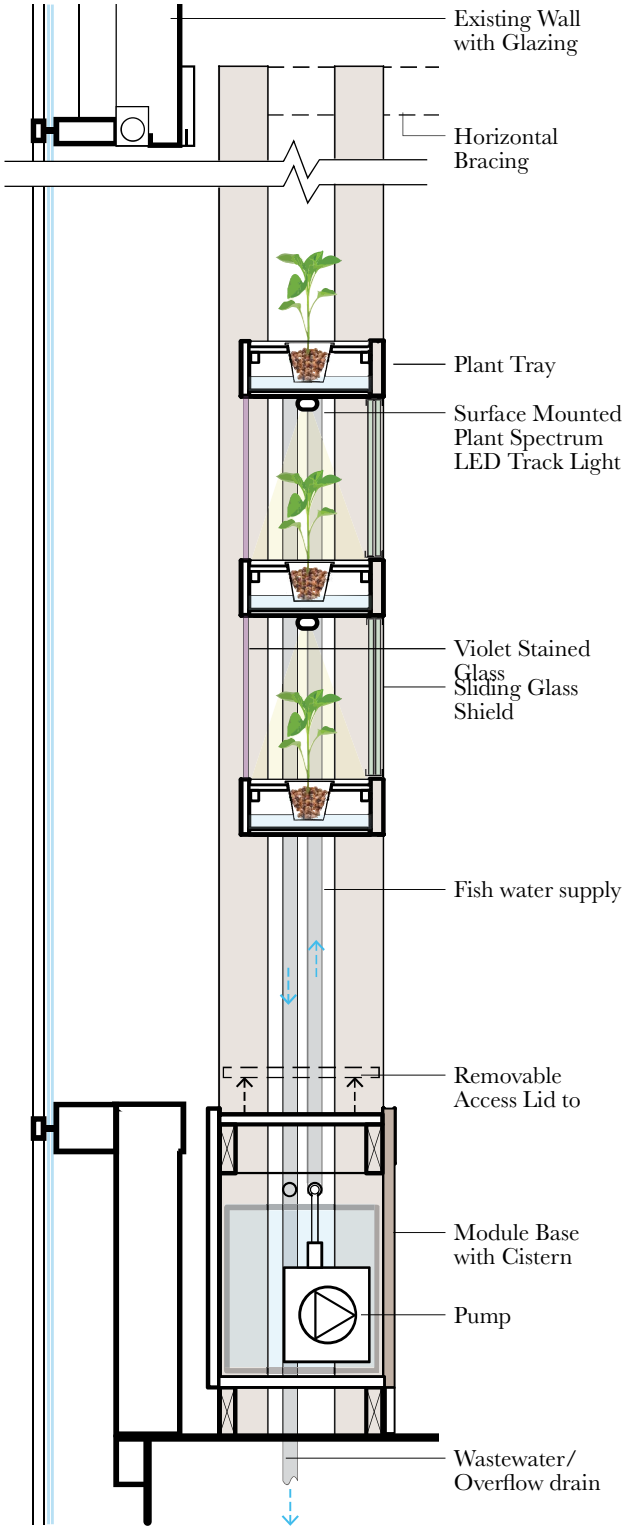


Fig. 3.79 Section: Plant Nursery Module coupled to curtain wall for support.

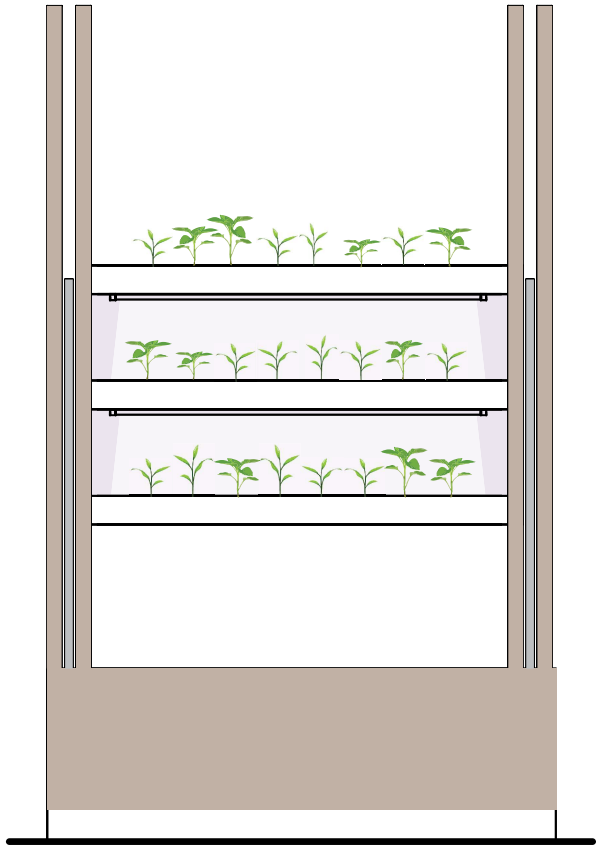


Fig. 3.78 Elevation: Plant Nursery Module

This module is paired with the aquarium module to reuse the nutrient rich water from the fish tank as plant food for the plants *(refer to Fig..3.78)*. The nursery trays use a horizontal hydroponic *Nutrient Film Technique*. This water is drained from the paired fish tank and stored in the cistern at the base of the module. This water is then pumped on an automatic timer, up to all trays, irrigate the roots and base clay pebbles. At the base of the growth media is where the ammonia rich fish water is absorbed as plant nutrients. The waste water from the plant trays is drained as the building's wastewater. These system will require monthly maintenance to clean & check trays for clogging.

LIVING CALISTHENIC CORRIDOR

AQUARIUM MODULE

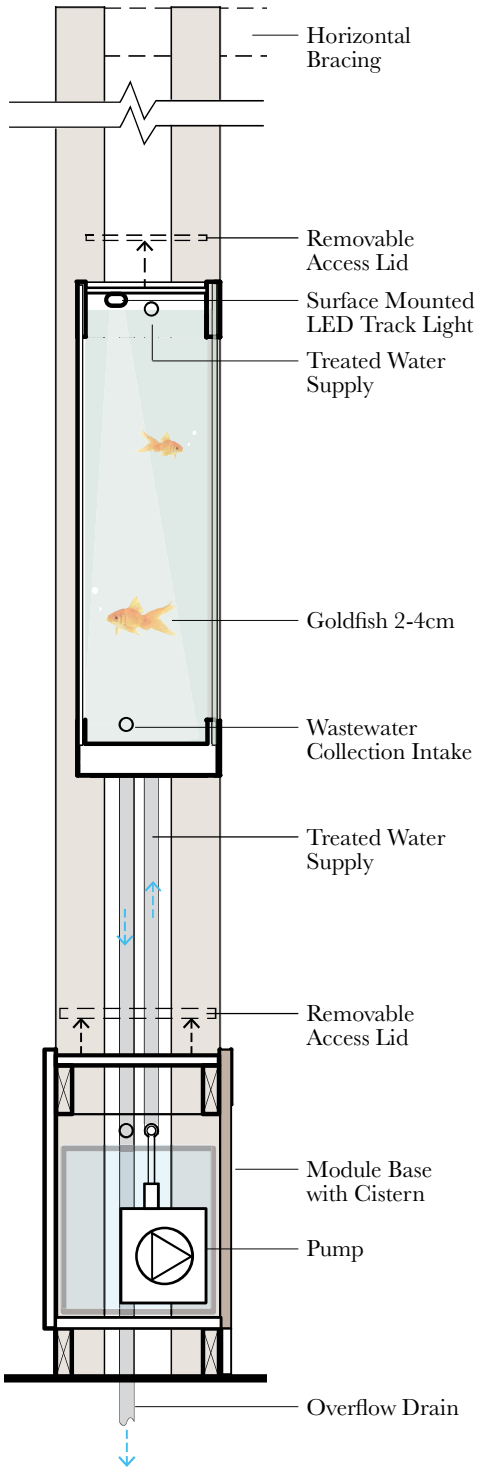


Fig 3.81 Section: Aquarium Module

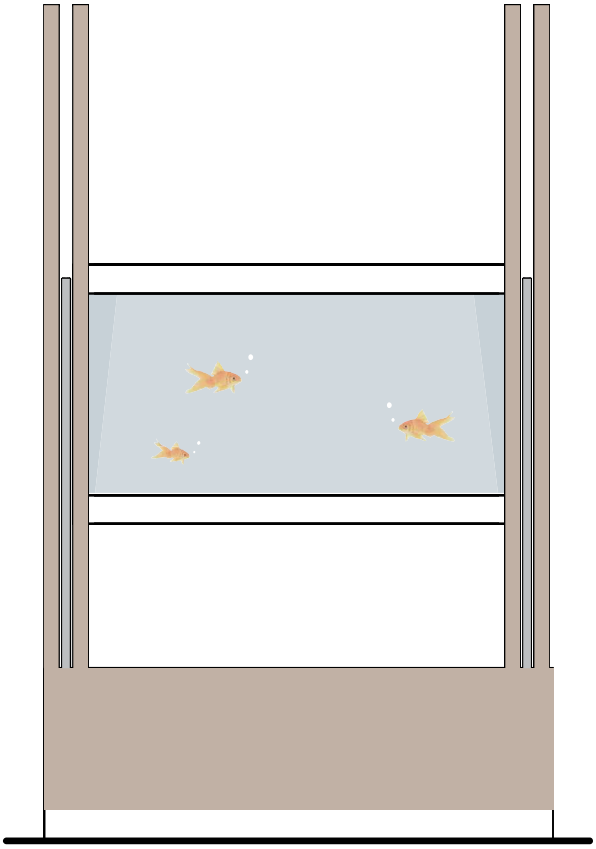


Fig 3.80 Elevation: Aquarium Module

This module is paired with the nursery module to reuse the nutrient rich water from the fish tank as plant food for the plants *(refer to Fig..3.78)*. Aquariums are commonly used in waiting rooms in various healthcare typologies. This one is simplistic, containing hardy goldfish. According to the aquaponic research presenting in Fig.3.50, 1 goldfish provides plant food per 1L of growth media (clay pebbles in this design). The water for the fish tank is supplied from the building's fresh water supply, initially to a cistern in the base of the module, where it is treated and then pumped to the tank on an automated top-up system.

LIVING CALISTHENIC CORRIDOR

TRELLIS MODULE

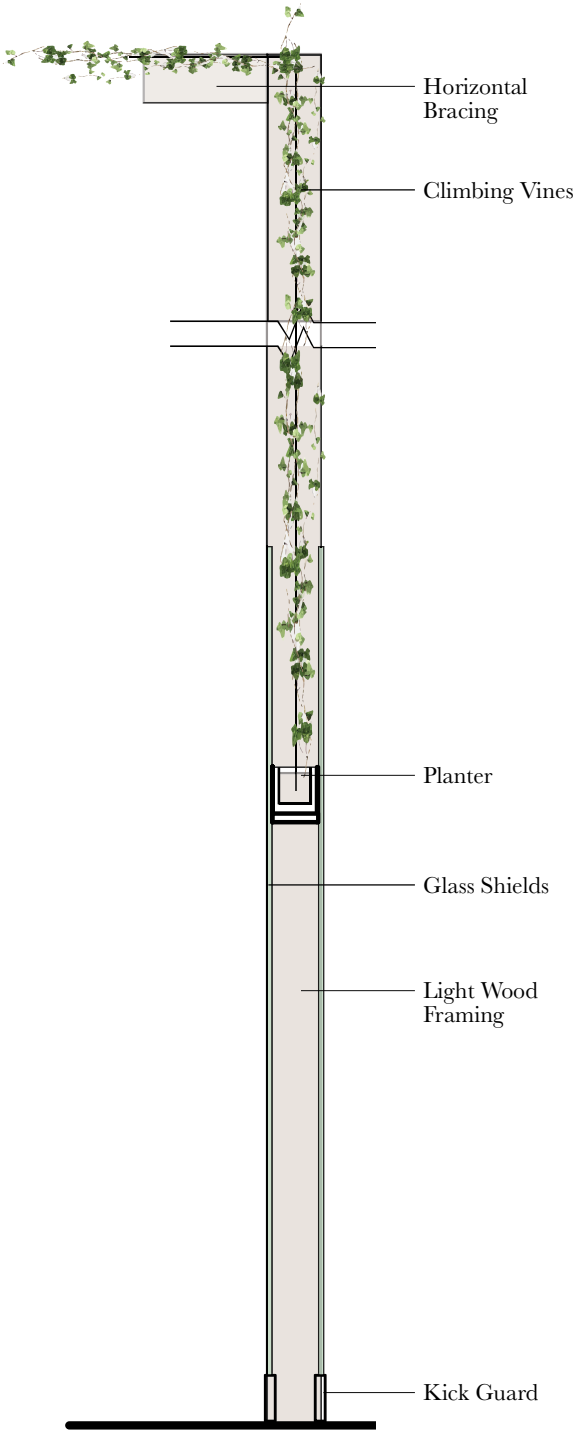


Fig. 3.82 Section: Trellis Module

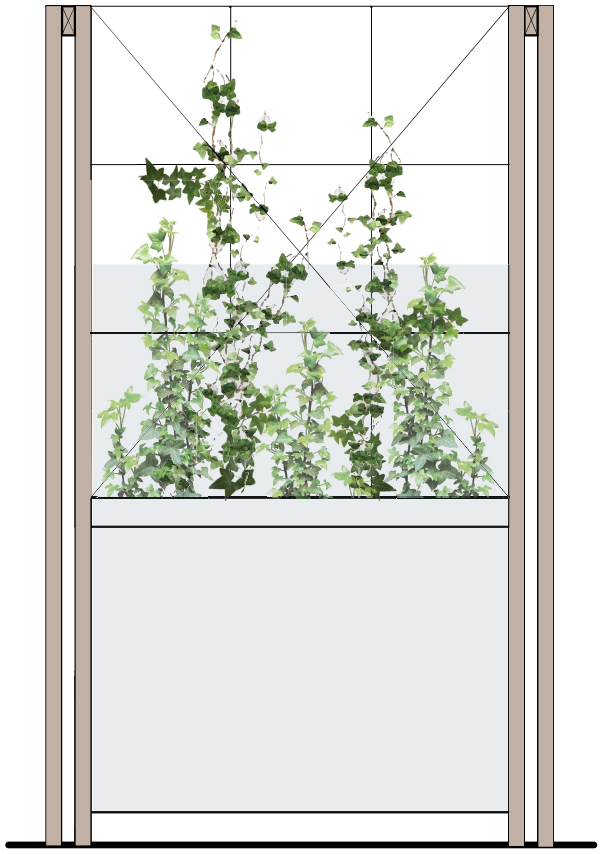
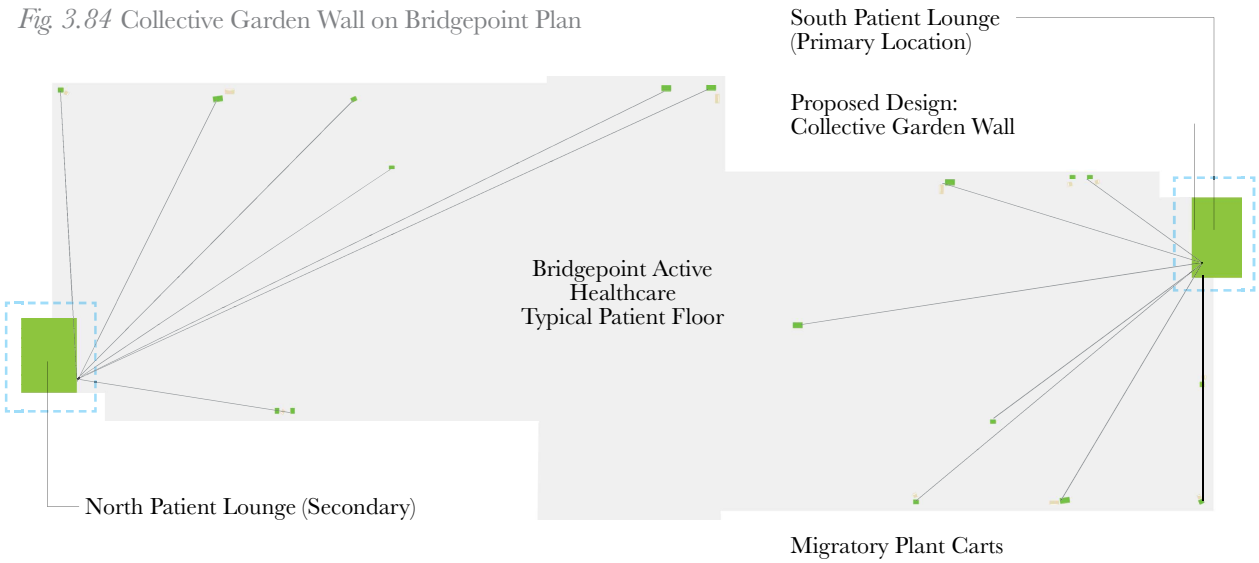


Fig. 3.83 Elevation: Trellis Module

This module is independent in function and freestanding, but uses the opposing modules as bracing for structural support. This simple living system of climbing ivy contains a shallow raised bed of soil in a tray. This module requires manual watering every one to two weeks, as this plant is fairly drought-resistant. This system is affordable , easy to maintain and protected by a sectioned, sliding glass screen, that slides down for maintenance.

Fig. 3.84 Collective Garden Wall on Bridgepoint Plan



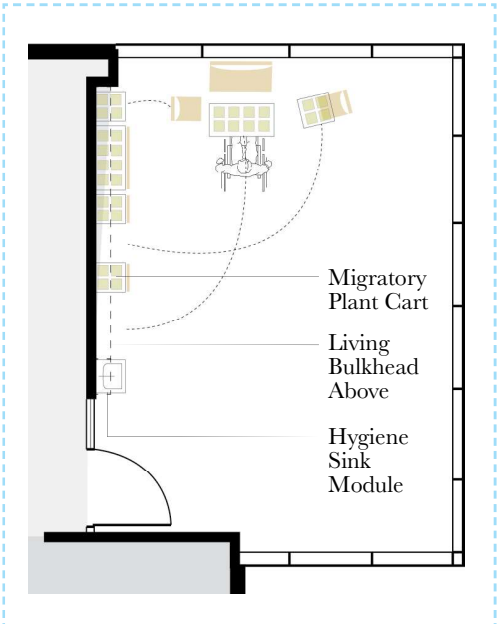


Fig. 3.85 Collective Garden Wall Enlarged Plan

This design intervention is the most versatile and custom fabricated, which will make it the most expensive of the three designs. This design is integral to the year-round horticultural therapy program that it can facilitate. Maintenance is required occasionally to tend the permanent plant modules and the patients plants when docked or inserted on the Misfit Plants Rails. The Migratory Plant Carts offering a gardening surface, seating and plant storage. This design transforms the use of the patient lounges to become interactive, therapeutic, captive, social hubs.

DESIGN INTERVENTION 3

COLLECTIVE GARDEN WALL

Fig. 3.86 Proposed design intervention: Collective Garden Wall & Migratory Plant Dock

– Migratory –

Integrated System – The Collective Garden Wall in Lounges

This design intervention is proposed for patient floor lounges; to animate these spaces year-round. The system comprises of the collective garden wall, which also acts as a docking station for the patients' migratory plant carts. The plants for the carts are matured plants from the gym nursery modules in the *Living Calisthenic Corridor* system. The garden wall also contains a *Living Bulkhead* for permanent, out-of-reach plants to grow in vertical living panels. The carts are custom design, they are multi-functional as a plant tray with custom plant containers, a mobile cart, a gardening table and have integrated unfixed seating. These carts are height adjustable and come in single or double width for wheelchair accessibility. The garden wall docking system allows patients to bring their plants in for tending by the sessional gardener.

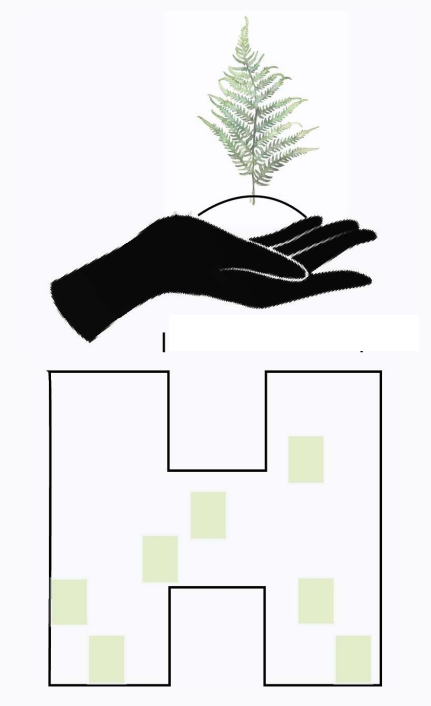


Fig. 3.88 Interactivity & Immersion: Full Contact & Migratory

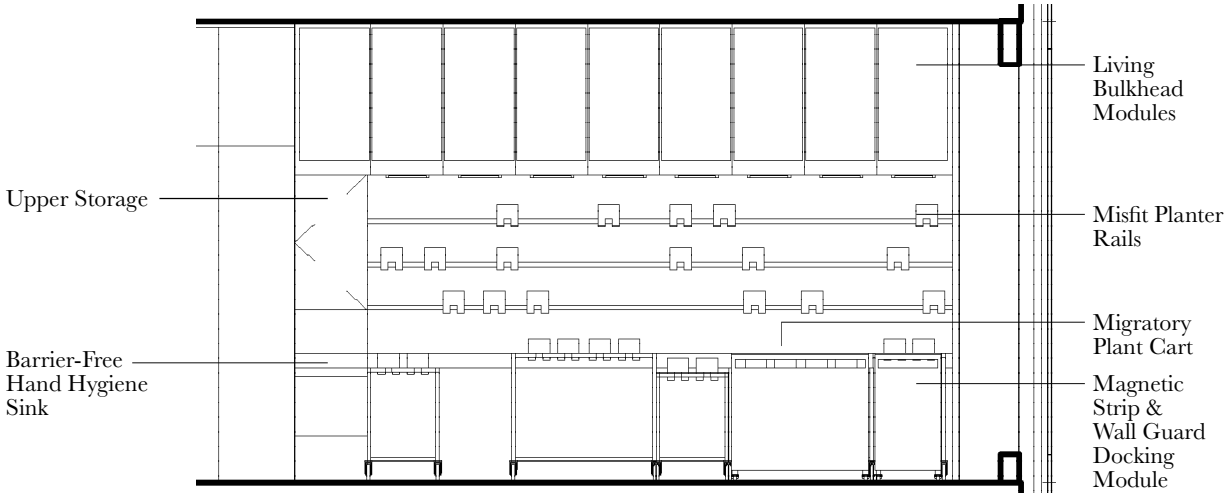


Fig. 3.87 Collective Garden Wall Elevation

DESIGN INTERVENTION

COLLECTIVE GARDEN WALL COMPONENTS

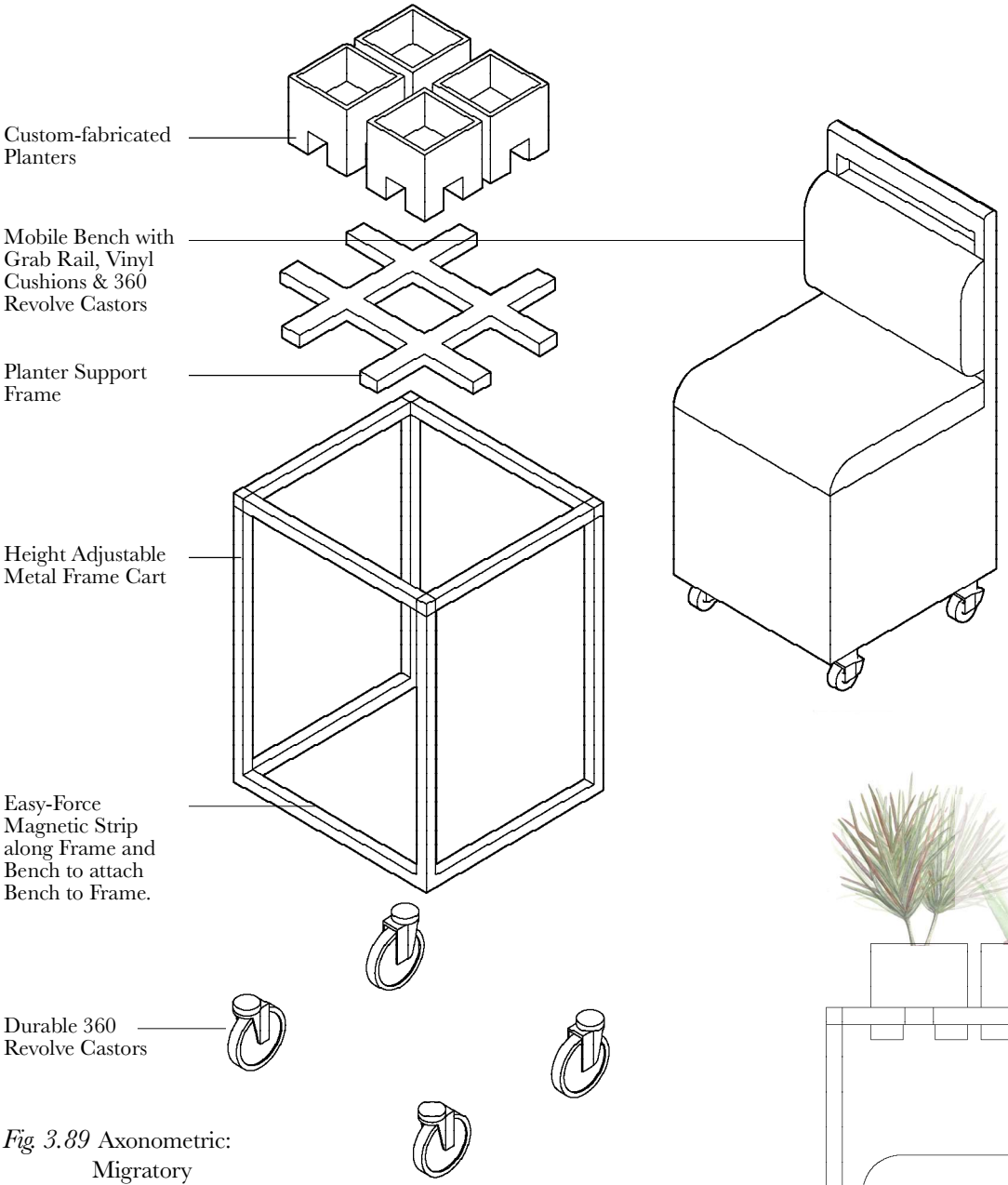


Fig. 3.89 Axonometric: Migratory Plant Cart

The Migratory Plant Carts are custom fabricated carts similar to existing hospital carts. These carts have removable benches of wax-coated wood and vinyl fabric. The planters are custom and are beneficial to reducing over watering by patients. Carts are intended for personal use by patients, and therefore transference of contact-bacteria should be minimal.

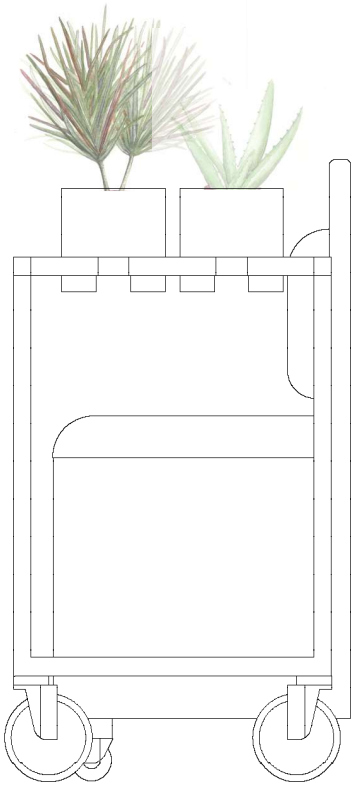


Fig. 3.90 Elevation: Migratory Plant Cart

Fig. 3.91 Migratory Plant Cart in Bridgepoint patient room.

CONCLUSION

This thesis addresses the issue of why typical health care spaces in Canada, continue to be designed in a manner that lacks the therapeutic qualities necessary, for healing the mind, body and soul. After defining the problem, studies and interviews were conducted to look at healthcare architecture through a critical lens. This lens revealed issues of affordability, accessibility, maintenance, efficiency and meeting the Canadian Standards Association's standards for safety and hygiene. Through research into elements essential to designing a comfortable healing environment, contact with natural landscapes and social connections are proven as significant factors for design response. Such research included the placebo effect of therapeutic design, which proves that these design qualities in a healthcare environments can improve patient recovery results. This Evidence-Based Research has supported the implementation of artificial biophilic design interventions within hospitals and healing gardens outside of hospitals.

Through researching living systems technology, there are many precedents of vertical living walls being used indoors in atriums in health care centres, but no purpose-built living systems are found beyond the atrium and closer to patient quarters. …This design intervention provides therapy and comfort, which will reduce medication expenses, reduce stays and increase turn-over for new patients. According to Bridgepoint Active Healthcare's POE, boredom is a critical issue in long-term care, and can cause a magnitude of issues disrupting hospital operations. Horticultural therapy at various levels of interactivity and locations in a hospital can produce happier patients and therefore help the hospital run more efficiently, with less violent incidents towards other patients and staff.

Through interviews with infection control and healthcare architects this thesis grounded the design interventions to existing long-term care and rehabilitation hospitals. The proposal became more convincing when applied to the hospital typology of long-term care, due to requiring less critical infection control standards. Bridgepoint Active Healthcare, was selected as the model for complex continuing care and rehabilitation hospitals, as it presented extensive research on the qualitative perceptions of the design in the POE report. This design exploration could have been abstractly applied to a generic hospital design, but using a new purpose-built hospital for this typology

with a thorough report on its perceptions by patients and staff, added another level of realism to the proposal. The designs appear modest in architectural form, this is because the goal is to have this proposal as realistic as possible, by means of affordability, maintenance and operation feasibility, since public healthcare architecture must sustain practicality.

The three design interventions range in interactivity due to IPAC consultation stressing the importance of limiting physical contact from many patients to natural elements that cannot be fully sterilized. Therefore, the most restrictive design is located in the most public area, the exterior terrace accessed from the cafeteria. As an exterior design, the Living Screen could suit more critical hospital typologies, like acute care. In unison with the range of interactivity, the designs range from public to private in location and usage. All of the designs require plant species that are highly resilient and drought resistant, to reduce water and care demands. All species cannot be toxic or be highly allergenic. The modularity of all the design interventions allows for existing hospitals to add on modules to meet the dimensions of various spaces and budgets, or to phase sections of the design with phases of hospital renovations.

The Living Screen is designed to be attached to an existing exterior platform. A great benefit of this design, for Bridgepoint specifically, is that the garden is accessible by viewing from the interior and balcony level to everyone, barrier-free. A maintenance walkway allows for non-intrusive tending to plants by contract gardeners and systems technicians. The biggest drawback to this design is the structural requirements will be substantial to support such a large cantilevering planter with integral cisterns. With a narrower planter and a few modules, this system seems feasible enough for small balconies or ground-level patios. This system has the highest capital cost of the three designs, for durable, weather-resistant materials and construction. It requires occasional care and maintenance, at the end of fall and at beginning of spring. The rainwater collection system adds some complexity and maintenance services to the design, but is an important sustainable objective. The benefit to this system is that is can buffer unwanted city noise pollution, also absorbing air pollution and reducing smells, and it provides a captivating vantage point, as the natural garden transitions with all-season plantings, that are selected

to attract birds and butterflies.

The Living Corridor is intended to be installed along a span of an exterior wall, to support the frame of the modules and to access natural sunlight for the plants. However, if there is a more suitable location away from the exterior, than it can rely on grow lights, which will increase power demand. The simplicity of the framed system allows it to be customized. The benefits of this design are that they add colour and life to physiotherapy gyms, to reflect and support the active growth and transformation in patients. The system will evolve over time to captivate patients interest as the plants and fish grow and are replaced. The patients have a sense of attachment to the plants as they personally plant them from seeds and watch them grow during long-term physio sessions. This design intervention varies in price per number of modules. The amount of care required for the fish is minimal and acceptable as aquariums are common to many waiting rooms in other hospitals. The drawback to this design is that it requires water supply, but having continuous, automated supply, reduces maintenance. This design is the least expensive, as the system is constructed of light wood framing, requires less maintenance and reuses supplied water and nutrients through the quasi-hydroponic system.

The Collective Garden Wall contains a collections of various modules: the hygiene sink and storage module, the top Living Bulkhead modules, the middle misfit planter rails and lastly, the bottom array of docking modules. This wall requires water supply internally for the sink and to supply the Living Bulkhead's hydroponic system. Embedded and external plant spectrum LED lights require electricity. The systems requires little external maintenance as the patients tend their own pots with monitored guidance and assistance. Additionally the docking wall allows patients to leave their carts to be tended to professionally. The capital cost for installing this system is higher than the corridor because of the custom-fabricated components, but the long-term operating and replacement costs would be minimal. The benefits to this design are the modularity, the dynamic nature of it, the plants improve indoor air quality and provide healthy stimulation to patients, visitors and staff.

The goal of this thesis is to provoke the acceptance of living systems as a significant design component to long-term care hospitals,

to promote faster and enhanced recoveries. Though, the design interventions presented in this thesis are proposed as systems applied to existing hospitals, this strategy would ideally be proposed at the early phases of schematic design development. They should be included in the hospital's functional program, to ensure funding is secured for these systems and programs. This is done today for therapeutic design interventions such as, public art installations and interactive exterior gardens. An example of both these therapeutic design strategies being planned for from the initiation of a new hospital design, is presented in this thesis and was discussed with the architect, Terry Montgomery, for Holland Bloorview Kids Rehab. Hospital.

It was evident through research, that horticultural therapy has been a longstanding, successful program, provided to patients in many long-term rehabilitation, palliative and hospice care centres. However, all of the examples found, were for permanent exterior "healing gardens" or temporary interior potting sessions. Therefore, this thesis is not arguing the need for horticultural therapy in long-term care, but the need for innovation for living systems facilitating horticultural therapy, within permanent features in interior architectural assemblies in cold climate regions.

I began this thesis with an initial failed design approach, that involved merely attaching a greenhouse at the ground level to an existing hospital. I then found through research that a greenhouse is unnecessary today, with the advancements in living systems technologies. Also, this approach was very unconvincing, in that a greenhouse is a huge capital and long-term operations investment and would be cumbersome for patients with mobility issues. Horticultural therapy can be a permanent architectural feature within long-term care spaces, with merely some plant spectrum LEDs or even better, natural daylighting from large spans of glazing, hydroponic irrigation systems and most importantly, tending by patients suffering from boredom. The maximum success of the design interventions presented in this thesis, is achieved if they are all applied to a hospital, offering diversity in location and interactivity. Patients should not have to shuffle or wheel themselves to a greenhouse, exterior rooftop or ground level garden or even a public atrium, to enjoy horticultural therapy, but to have horticultural therapy brought to and integrated into the spaces closer to them.

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APPENDIX

UNIVERSITY OF WATERLOO

May 8, 2018

Dear [Participant's Name],

This letter is an invitation to consider participating in the study I am conducting as part of my Thesis for a Master's degree in the Department of Architecture at the University of Waterloo under the supervision of Professor Terri Boake. I would like to provide you with more information about my thesis and what your involvement would entail if you decide to take part.

Study Title: ***The Nature of Healing: Living Architecture for Long Term Care & Rehabilitation Hospitals***

Summary of Thesis Research:

The design priorities for hospital architecture since the industrial revolution have generated machine-like "antiseptic architecture". This architecture has estranged nature from medicine, as the modern man dominated nature in attempt to control illness and disease. In opposition, Evidence-Based Design research by designers and environmental psychologists has consistently proven that contact with nature greatly improves patient outcomes in hospitals. This has influenced the recent design strategies such as biophilic design, which promotes bringing the outdoors inside indirectly or artificially. For example: the design of windows with views of nature in all patient rooms and the installation of artwork that displays themes or scenes of nature. The issue with these strategies, is that they only tend to visual sensory and thus are not accessible to all patients. The goal of biophilic design strategies are to reduce stress and improve wellbeing in these overly sterile environments. The environmental stressors in hospital interiors such as chemical smells, irritable noises and sterile aesthetics have been proven to cause patients stress. Psychological stress is proven to hinder the immune system and intensifies patients sense of symptoms like pain. This increases risk of addiction to pain medications fueling the opioid epidemic in Canada. Coincidentally, these environmental stressors that cause this harm occur due to the policy and procedures that generate the sterile environments meant to protect patient immune systems. Patients experience strain and isolation – staring at white walls, hearing alarming sounds, smelling stinging chemicals and in the winter have nowhere to wonder to for a change of scenery. These conditions affect the patient's capacity to recover. The design of health care architecture must seek homeostasis between meeting medical requirements, clinical standards and the physical, mental and spiritual needs of the living human beings within.

Intent of Thesis:

The purpose of this study is to explore how architectural design strategies can mitigate the environmental stressors endured in health care interiors in Canada today. The study seeks

professional response to why nature is not directly brought into hospitals today, even with the advancements of green technology and the societal adaption to holistic medicine. This study questions if the disadvantages really do outweigh the benefits. To initiate a dialogue about re-imagining health care architecture with nature as an essential and integral component to hospital interiors; to provide stress relief, multisensory stimulation, a place to go to rehabilitate, exercise or play, an acoustic buffer, biofiltration to remove smells and to humidify overly dry interiors. What if integrating living therapeutic systems into health care interiors could support a year-round accessible, diverse environment of growth and health?

This study is collecting professional experience and response to the subject of blurring the threshold between nature and hospital interiors. Professionals such as architects, living systems designers, landscape designers, botanists, horticulturalists and health care representatives are invited to respond to the current condition of health care interiors and the restrictions in place, as well as dream about the future potential of health care design possibilities. I believe that because you are actively involved in [health care/horticulture/living systems] you are best suited to speak to the various issues outlined in the attached document of interview questions.

Participation Guidelines:

Participation in this study is voluntary. It will involve an interview of approximately 30-60 minutes in length to take place in a mutually agreed upon location or by phone or email. You may decline to answer any of the interview questions if you so wish. Further, you may decide to withdraw from this study at any time (before the thesis is published: by January 2019) without any negative consequences by advising the researcher. With your permission, the interview will be audio recorded to facilitate collection of information, and later transcribed for analysis. Shortly after the interview has been completed, I will email you a copy of the transcript to give you an opportunity to review, confirm the accuracy of our conversation and to add or clarify any points that you wish. When information is transmitted over the Internet privacy cannot be guaranteed. There is always a risk your responses may be intercepted by a third party (e.g., government agencies, hackers). University of Waterloo researchers will not collect or use Internet protocol (IP) addresses or other information which could link your participation to your computer or electronic device without first informing you. At your preference, you identity and association to this research will be confidential. If so, your name will not appear in any thesis or report resulting from this study, however, with your permission anonymous quotations may be used with the professional title of your choosing. Hard copies of forms will be kept locked in my graduate office, scanned and then shredded immediately. Recordings will be transcribed to my password-protected computer, accessible only by myself. All digital data and transcribed documents will be retained for at least one year and then deleted. If you choose to be identified as a participant in this study, there is risk of the professional community challenging your opinions on the subject matter.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE #23092). If you have questions for the Committee contact the Office of Research Ethics, at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca.

Interview Questions

Representative of Infection Prevention and Control:

The Role of IPAC in Hospital Design:

1. Do you have experience working with protocols that restrict the design of interior spaces in health care?
2. What are the processes that determine if a new building material or architectural system on the market is suitable for health care interiors?
3. What are the most significant changes you have witnessed since you started working in health care? How did these changes occur and what challenges were faced in making these changes?
4. Can you help me outline the system of bodies that council and decide on changes made in hospital standards in Ontario?

Professional Opinion Questions on Thesis Design Proposal:

5. If the living plant systems I am proposing are soilless and have an operable glass screen shield to prevent any splatter on the leaves, would you consider this system as a material surface as cleanable as toys that children play with?
6. Visitors already bring potted plants into patient rooms, what restrictions are in place on those plants?

IPAC today and IPAC of the future:

7. The restrictive measures of IPAC address the immediate health risks of patients in health care, but when overly prioritized in design, research has proven that these overly sterile spaces cause harm to patients' mental wellness (due to stress) which hinders their immune system and long-term ability to recover, do you believe that our current public health system is short-sighted and could evolve to address both short-term and long-term health?
8. Do you think the design of most hospitals today in Ontario need to improve the balance of sterility and comfort in design of interiors?