ENCOURAGING HEALING IN HOSPITALS

AN INTEGRATIVE APPLICATION OF EVIDENCE-BASED DESIGN

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ABSTRACT

At the crossroads of an industry crisis and a culture revolution, healthcare facilities today are largely antiquated, technologically inadequate and altogether unable to support the required medical and healing activities. Regardless of politics, aging demographics and increasing health insurance subscribers will double the demand on the healthcare industry in the coming years. As focus shifts towards patient-centric care, concentrating on safety and quality of experience, the notion of the hospital's built environment shifts from specialized care towards a more holistic approach.

We must now treat patients, not simply disease.

ACKNOWLEDGEMENTS

This degree & document would not have been possible without the support of my parents, Hemantha & Lisa Surath:

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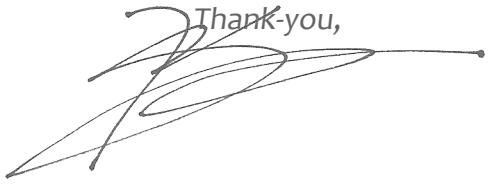
for your guidance during this complex process,

and to our thesis focus group:
for providing perceptive and often hilarious insights along the way,

Thank-you,



Samantha R. Surath

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I

INTRODUCTION

Recent research has accumulated over the decades, supporting an undeniable truth: physical environment and stimuli play a crucial role in the healing and recovery process. Nowhere is this relationship more apparent than in hospital and healthcare facilities. When viewed in this manner, healthcare facilities must serve medical demands while providing a supportive atmosphere that helps users understand and adapt. As such, healthcare facilities must assume a new role as vital parts of communities, with resources for everyone. Despite the programmatic potential that can serve patients and communities, these facilities remain stark and rigid structures; they often resemble jails or prisons. Healthcare design has been partial to efficiency of staff and space in the past, causing existing structures to often seem at odds with their proposed services. For example, numerous studies demonstrate that exposure to natural light and visual access to greenery have extensive benefits on the physiological and psychological state. These are resources that are rarely available in existing facilities, and sometimes dismissed as important considerations when designing.

Due to the inherent size and scale of these facilities, many studies have examined this cause-and-effect relationship through its more detrimental aspects; while quickly becoming obsolete with regards to technology, current buildings are also being criticized for their stark and rigid environmental qualities. Medical professionals and administrators are seeing correlations between better building design and better patient experiences. As we further understand how key aspects of the physical environment affect patient recovery, a new approach to healthcare design is gaining traction. Evidence-based design (EBD) encourages architects, planners, and administrators alike to look outside of their traditional disciplines for design influences. As a variety of publications, from nursing guidelines to medical journals, document healthcare users' responses and criticisms of existing facilities, healthcare design must no longer be based on pure architectural theory.

New healthcare precedents, spurred by innovations in both theory and technology, have changed the relationship between man, the built environment, and nature. Projects such as the Groot Klimmendaal rehabilitation center in the Netherlands modernize the traditional programmatic approach to healthcare facilities. NORD Architect's Nye Vardheim questions the nature of a hospital opposed to that of a home. Further architectural precedents, often with completely different programs, continue to renegotiate how man relates to healthcare and architecture. Additionally,

new programmatic components and arrangements can provide an alternative to traditional hospital structure, creating more accessible functions for patients & communities alike. Components such as teaching kitchens, libraries, public gathering space create a foundation of social support that helps change the dynamics of the hospital environment. Communities with hospitals have the potential to connect with the surrounding natural and urban fabric. With the incorporation of new ideas and information, healthcare facilities can better address today's healthcare issues with modern solutions.

The course of this thesis reviews the body of evidence supporting EBD, and identifies three main architectural objectives that embody many of the necessary changes. Translating experimented interventions into architectural concepts provides alternatives to current healthcare facility standards and programmatic organization that better support the recovery process. These concepts are demonstrated through the design of a new long-term acute care (LTAC) facility expansion of St. Joseph's Hospital in Chicago, IL. The focus for the proposed expansion will focus on the patient experience, and concentrate most on the design and configuration of the patient floors.

The following document provides a brief examination of current healthcare facilities and practices, often best criticized by intra-industry studies. Selected studies offer an overview of relevant medical research, particularly regarding the effects of nature and light on the healing process. Consideration of the explored material identifies the methods which influence the proposed design. An urban site, fitting an appropriate set of criteria, provides the context for a new facility. Finally, the process of design and the final concept are presented through two-dimensional materials, and evaluated.

II

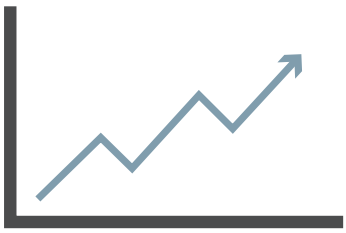
SURVEY OF FIELD

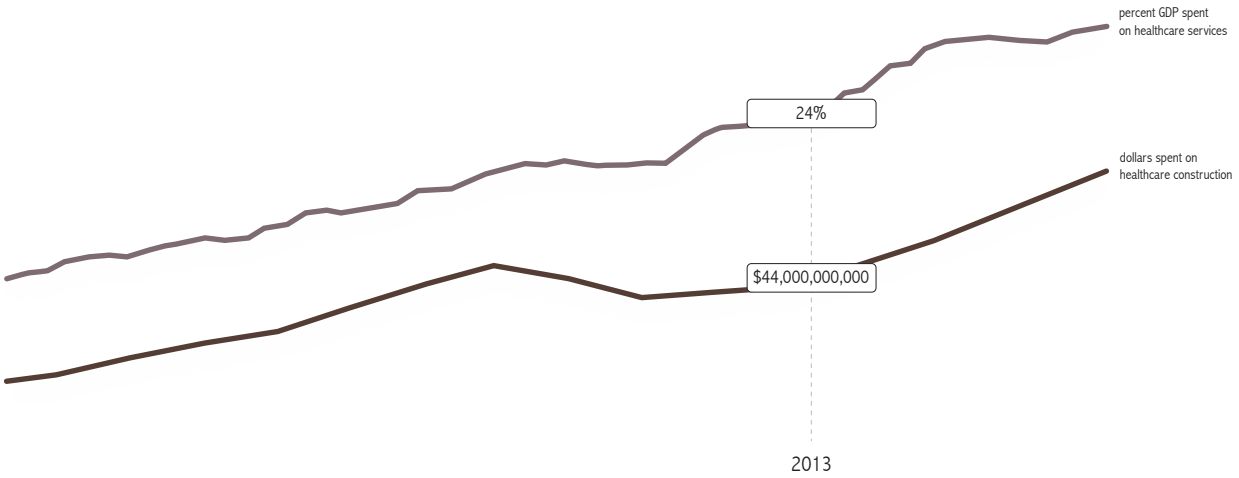
1.0 THE BASIS FOR CHANGE IN HEALTHCARE

In the coming years, demands on healthcare facilities is expected to increase significantly, reflecting the maturity of the Baby-Boomer generation, in addition to overall global population growth and increased life expectancies. Existing facilities today are already criticized for outdated technology, as many advances in the recent years have greatly changed the way medicine is practiced. Building new facilities or undertaking extensive renovations is likely to be the largest financial decision faced by hospital boards today, with implications that will affect healthcare services and access for generations to come. With recent economic and financial hardships, every dollar spent on building in the healthcare industry becomes that much more valuable. As a growing body of evidence links the physical environment with safety and quality outcomes for hospitals, administrators are required to consider the application of evidence-based design as an important aspect of investment, or risk suffering consequences in a very competitive and transparent environment.

1.1 A Changing Industry

A unique set of factors has led to the healthcare industry's current building boom. The Baby Boomer Generation is now reaching an average age of 63 years old, and in general requiring more medical attention as a whole. This is creating an increased demand for occupancy, particularly in long-term acute care facilities, and providing major stimulus for hospital expansion. Additionally, according to a census of hospital administrations across the country, most existing facilities built in the 1960's and 1970's are deemed completely inadequate for the types of procedures and surgeries performed today, barring extensive and often expensive renovations (Smith, 2007).





The Institute of Medicine notes a quality and safety revolution that is sweeping the country, greatly changing the public expectations of many industries, including healthcare. Consumers, employers, and payers are demanding that hospitals reduce system-based errors that harm and even kill thousands of patients

In addition to these increasing demands on the overall industry, hospital leaders face a host of daunting and often competing business demands, among them: unpredictable reimbursement, work-force shortages, skyrocketing costs, mounting consumer and employer expectations. The Institute of Medicine notes a quality and safety revolution that is sweeping the country, greatly changing the public expectations of many industries, including healthcare. Consumers, employers, and payers are demanding that hospitals reduce system-based errors that harm and even kill thousands of patients annually (Salder, 2006). This has greatly increased inter-hospital competition, with reviews of hospital reputation and quality of care heavily influencing funding, hiring, and the ability to retain the most qualified staff.

As it stands, a major hospital building boom is already underway. According to an analysis by RSMeans Business Solutions, in the United States in 2007, $41 billion was spent on hospital construction, and $40.7 billion was spent in 2008. In 2007, the U.S. Census Bureau concluded that healthcare construction growth had increased by 15% in the last two years (Hoppszallem, 2007). This already strong healthcare construction sector is expected to surpass a total of $70 billion in 2013 (FMI, 2008).

Despite the increased spending in healthcare construction, economic conditions have put restrictions on healthcare construction. The average cost of building a 'standard' community hospital has risen from $180/sq. foot to over $350/sq. foot in just 5 years. This continuing increase means that costs to build or renovate can easily double during the time a project moves from drawing board to completion. Hospital boards and administrators are hard-pressed to

make sound investment choices when it comes to hospital facility design, carefully considering the projected growth and demands the healthcare industry will undergo in the following decades.

As this opportunity for building better hospitals presents itself, administrators are recognizing the physical environment's role in eliminating avoidable conditions that adversely affect the patient experience, as well as revenue enhancement and cost avoidance, making good design an important long-term investment. However, despite the insurmountable medical evidence that design of the physical environment can improve quality and safety, many hospitals are still hesitant to implement these innovations because of perceived economic barriers.

1.2 Connecting Improvements to the Physical Environment

Evidence-based design is the process of basing decisions about the built environment on credible research to achieve the best possible outcomes (Center for Health Design, 2008). The actual physical environment in which people work and patients receive care is one of the key elements that can be changed to reduce avoidable conditions that negatively affect revenue and patient experience. With research quantifying and measuring the impact of the physical environment on patients, a dollar amount can suddenly be equated to good design of the physical environment. Not only does effective design enhance a hospital's performance from a medical standpoint, it can also provide measurable impact on costs and budget from an administrative view.

1.3 Balancing Costs and Savings

Key in the business considerations of healthcare construction is the balance of one-time construction costs against operational savings and revenue enhancements. A review of published research and actual experience in facilities employing evidence based design concluded that actual savings resulted from reduced infections, lowered patient transfer rates, fewer patient falls, lower pain medication costs, and lessened employee turnover rates. Additionally, market share and philanthropy reputations were markedly improved, resulting in better reputations of the studied hospitals. With effective management, the increased costs of evidence-based design was identified as a sound long-term investment based on operational benefits over several years (Berry, Parker, Coile, Hamilton, O'Neil & Sadler, 2004). With theirs and others' research, a compelling business case for better hospital designs had been made.

In order to respond to the administrative demand for measurable success and its impact on safety, quality and cost from a business perspective, the Center for Health design has provided priority design recommendations based on the strength of evidence available. Some can be implemented in any facility at any time without significant modification and with relatively low cost. Others are expected to be employed only during construction or major renovations. While valuable tools for administrative leaders in the healthcare industry, these recommendations represent a superficial

response to evidence-based design, leaving larger interventions and approaches unidentified. It is here that the designer becomes crucial- intelligent enough to understand the literature behind these recommendations, and adapt that knowledge into more integral design solutions, in addition to the interventions listed here.

Continuing to incorporate information from the administrative side of hospital design and construction, the Center for Health Design suggests five questions for consideration during a major building project:

1. **Urgency**: Is the expansion/replacement actually needed now to fulfill the hospital's mission? What is the cost strategically of not proceeding?
2. **Appropriateness**: Is the proposed plan the most reasonable and prudent in light of other alternatives?
3. **Cost**: Is the cost/square foot appropriate in light of other projects being built in the region?
4. **Financial Impact**: Has the financial impact of additional volume, depreciation expense and revenue assumptions been reasonably analyzed and projected?
5. **Sources of Funds**: Is the anticipated combination of additional operating income, reserves, borrowing, and philanthropy reasonable and enough to support the project?

And with the incorporation of evidence-based design, a sixth question has been suggested:

6. **Design**: How will the proposed project incorporate all relevant and proven evidence-based design innovations to optimize patient safety, quality, and satisfaction, as well as work-force safety, satisfaction, productivity, and energy efficiency?

In order to address this last question effectively, organizations should have a process for critically evaluating proposed evidence-based design features to determine which will have the greatest impact. A return-on-investment (ROI) framework is offered by the Center for Health Design which describes the business-case issues that need to be considered when evaluating specific evidence-based design innovations.

As we complete our understanding of the driving forces behind this new approach to healthcare, the crucial role of evidence-based design becomes more apparent. Hospital leaders and boards face a new reality: they must employ all reasonable quality-improvement techniques available, which will almost always harness a bundle of tactics, that when implemented in an integrated way, produce the best results. Leaders must understand the clear connection between constructing well-designed healing environments and improved healthcare safety and quality for patients, families and staff, as well as the compelling business case for doing so.

While building a new hospital or undertaking a major renovation may be the largest financial decision a board will ever make, making that decision in today's construction boom provides another unique opportunity. Administrators and designers have a chance to transform the culture and processes of the overall organization of healthcare to maximize its investment. Hospital leaders have an opportunity and an obligation to provide patients in their care with an optimal healing environment, and designers have a unique tool, evidence-based design, with which to design that environment.

2.0 WHAT IS EVIDENCE-BASED DESIGN?

"An evidence-based designer makes decisions—with an informed client—based on the best available information from credible research and evaluations of projects. Critical thinking is required to draw rational inferences about design from information that seldom fits a unique situation precisely."

-Hamilton

Perhaps this is not the most glorious description of a designer's task, but implied above lies a key aspect in process—the consideration and incorporation of information generated in fields other than design. Evidence-based design (EBD) is particularly applicable to healthcare design, reflecting the evidence-based approach that makes up today's medical practice. It appeals to physicians, who already practice based on medical research. It provides patients and families with consistently higher quality experiences in healthcare facilities. It appeals to administrators by reducing costs and improving effectiveness. It helps direct and justify costly design decisions. And it benefits the patient, encouraging effective, lower-cost health care.

Within the healthcare industry, EBD represents a growing trend in facility design. As growing evidence supports the direct relationship between the physical environment and patient health, it remains to be seen how designer can assimilate this new information into successful facility designs that serve the patient, medical staff, and others best.

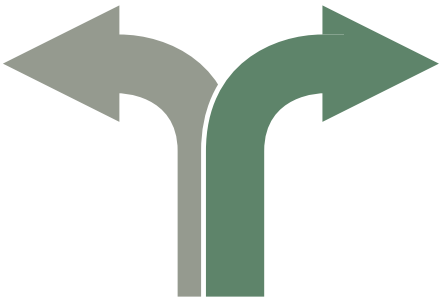
Championed by the Center for Health Design, organizations across the globe are looking for better solutions than those established by current healthcare standards. With the industry's current building boom showing no signs of slowing, collaborative movements such as the Pebble Project encourage healthcare organizations, architects, designers and industry partners to work together to identify built environment solutions that measurably improve patient and worker safety, clinical outcomes, environmental performance and operating efficiency.

With serious issues at stake, many consider this approach an emerging foundation on which to base design decisions. As such, this approach to design should be viewed as a consolidation of information and collective knowledge, rather than an attempt to develop rules and limits. Most agree that "cookbook" architecture suggests dull, repetitious buildings that will likely do little to improve current healthcare practices, let alone prove adaptable to the ever-growing understanding of the physical environment's effect on human health. Research-informed design should mimic the continuous search for truth as seen in the scientific world: as new information is generated, further hypotheses are suggested, tested, and proven true or false. Ultimately, each failure or success contributes to a greater understanding of functionality, whether regarding cellular biology or theoretical physics.

Here, evidence-based design touches into the sciences. Borrowing from environmental psychology, it becomes apparent that these design hypotheses must be tested in the real world- as a problem-oriented field, it must respond to ongoing issues occurring in real life, not in a laboratory. Successful 'experiments' with evidence-based design must respond to actual society.

SAFETY & ACCESSIBILITY

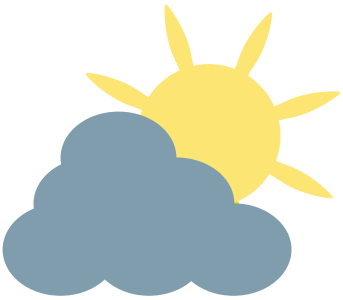
PAIN MANAGEMENT



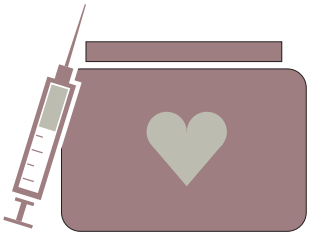
WAYFINDING

ENVIRONMENTAL PSYCHOLOGY

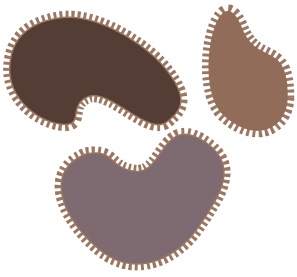
NATURE & GREENERY



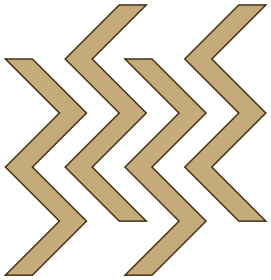
DAYLIGHT



EQUIPMENT & SUPPLIES



INFECTION CONTROL



STRESS & ANXIETY MANAGEMENT

3.0 THE EVIDENCE BEHIND EBD

In order to begin the process of evidence-based design, an understanding of relevant information must be developed. Healthcare encompasses a wide array of services, and the scope of information that must be considered when designing medical facilities can prove daunting. For this thesis, the focus of consideration will be on improving patient outcomes through environmental measures. This more narrowed category provides a definitive user—the patient—and touches on the needs of parallel users such as staff and administration. However, it is often recognized that by best serving the patient, parallel users also benefit.

The following review of relevant literature is divided into general sub-categories used by the Center for Health Design. It begins by identifying patient issues that have been linked to the physical environment, and then explores relevant research to develop a platform for successful evidence-based design.

3.1 Reducing Patient Pain

Pain is a nearly inescapable and serious problem in healthcare treatment. Mounting scientific evidence has shown that exposing patients to nature can substantially alleviate or reduce the level of pain felt by the patient (Malenbaum, Keefe, Williams, Ulrich, & Somers, 2008; Ulrich, Zimring, Quan, & Joseph, 2006; Ulrich, 2008). Additional research suggests a correlation between higher levels of daylight and reduced pain levels. The internationally growing recognition of the environment-pain relationship emphasizes the importance of incorporating nature, light, and other environmental factors into healthcare facility design in order to enhance pain management (Malenbaum, Keefe, Williams, Ulrich, & Somers, 2008).

Design measures for incorporating environmental factors to reduce patient pain remains very general for the most part, calling for basic measures such as large windows in patient rooms, and displaying visual art with representational nature subject matter in settings where pain is experienced. Randomized studies also demonstrate the effectiveness of technology to simulate nature where access to actual nature is not possible (Ulrich 2008). Including auditory distraction has also proved effective for relieving more severe pain. Modern pain theories suggest that patient rooms or treatment spaces with environmental stressors such as noise may exacerbate pain (Malenbaum et al. 2008). The overall implication remains that building orientation and site planning in healthcare projects should carefully consider patient access to nature views, sounds and daylight, and avoid plans that reduce such exposure.

i. Providing Nature Distractions to Reduce Experienced Pain | Exposure to nature may decrease pain by eliciting positive emotions, reducing stress, and distracting patients from focusing on their pain (Malenbaum et al., 2008;

Ulrich et al., 2006; Ulrich, 2008). A study of matched recovering surgical patients found that those with a bedside view of nature had better postoperative recovery than those with a view of a brick wall. This was demonstrated by a reduced need for pain medications, in addition to shorter post-surgery stays, better emotional well-being, and fewer complications (Ulrich, 1984). When tasked with viewing color pictures mounted within their line of sight, patients assigned a view of trees and water needed fewer doses of pain medication, as opposed to those assigned views of abstract art or no images (Ulrich, Lunden, & Eltinge, 1993).

According to distraction theory, pain requires considerable conscious attention. Therefore, as a patient becomes distracted or diverted by pleasant stimuli such as nature views or daylight, less attention is paid to their pain, and the experienced pain will diminish. This theory predicts that the more engrossing the distraction, or stronger the stimuli, the greater the pain reduction (McCaul & Malott, 1984). The implication then remains that distractions may be more diverting, and hence effective, if they involve aural as well as visual stimulation, or induce a heightened sense of immersion (Ulrich, 2008). A clinical trial on the effects of distraction during a colonoscopy found that while visual distraction reduced experienced pain, it did not affect the levels of self-administered sedation during the procedure. However, when combined with classical music, both experienced pain and self-administered sedation were notably reduced (Lee et al., 2004). Numerous additional studies combining visual and aural distraction demonstrated reduced pain against non-distracted control groups. Patient reports and nurse observations suggest that the combination of visual and auditory distraction improves patient comfort and tolerance for procedures (Kozarek et al., 1997).

ii. Using Daylight Exposure to Reduce Patient Pain | There is a presumed difference in the pain reduction mechanism for daylight than for nature: daylight exposure directly increases serotonin levels, a neurotransmitter known to inhibit pain pathways. A study of the effect of daylight on patients undergoing spinal surgeries indicated that those exposed to more sunlight reported less stress and pain, and required 22% less analgesic medications, resulting in a 21% reduction in medication costs (Walch et al, 2005).

3.2 Improving Patients' Sleep Quantity & Quality

It is generally recognized that hospitalized patients have an increased need for sleep because of their illnesses. However, in reality, they often suffer from diminished circadian rhythms and overall poor sleep quality while hospitalized (Southwell & Wistow, 1995), leading to increased stress and anxiety (Novaes, Aronovich, Ferraz, & Knobel, 1997; Topf & Thompson, 2001), impaired immune function, ventilator compromise, disrupted thermoregulation, and delirium (Wallace, Robins, Alvord, & Walker, 1999). These effects are likely detrimental to the healing process and lead to increased morbidity and mortality (Krachman, Dalonzo, & Criner, 1995).

Over 70 articles have been written regarding sleep in healthcare settings, including descriptive, correlational, and intervention studies. It has been widely acknowledged that sleep disruption and deprivation are common problems in healthcare settings, particularly for high-acuity patients who are more sensitive to environmental conditions. Environmental factors, such as noise and light, may result in electroencephalographic arousals and awakenings, keeping patients from deeper and more restorative sleep stages (BaHammam, 2006).

Certain environmental approaches have been shown to improve patient sleep. Notably, the use of single-patient rooms reduces noise generated from roommates, visitors, and healthcare staff (Southwell & Wistow, 1995; Yinnon, Ilan, Tadmor, Altarescu, & Hershko, 1992), and improve patient sleep quality (Gabor et al., 2003). Additionally, the use of high-performance sound-absorbing materials to reduce reverberation time, sound propagation, and noise intensity have been shown to improve patient sleep quality (Berg, 2001; Hagerman et al., 2005; Philbin & Gray, 2002).

Pharmacological assistance alone cannot achieve the desired quantity and quality of sleep in ICU's (Brown & Scott, 1998), particularly without detrimental side effects. Environmental interventions have been developed to reduce environmental noise and structure patient-staff interactions around ideal circadian cycles. Additionally, maintaining a normal light-dark cycle of a day has shown favorable results. Environmental interventions have generally proven more effective than organizational interventions (Gast & Baker, 1989; Moore et al., 1998; Waler, Francioli, Meyer, Lacon, & Romand, 2000).

Systems such as noiseless paging systems have been proposed as possible noise reduction strategies, in addition to emphasizing patient exposure to natural daylight to help retain normal circadian rhythms (BaHamman, 2006; Wakamura & Tokura, 2001).

i. Improving the Acoustic Environment for Patient Sleep | Installing high-performance sound-absorbing materials for environmental surfaces can reduce reverberation time, sound propagation, and noise intensity levels (Berg, 2001; Hagerman et al., 2005; Philbin & Gray, 2002). In one study, when sound-absorbing tiles were in place, patient rooms showed a 5-6 dB drop in sound levels and a reverberation time reduction from 0.8 to 0.4 seconds, indicating more ideal acoustical conditions. Patients reported fewer awakenings caused by noise (Hagerman et al., 2005). Other researched demonstrated that by only reducing reverberation times, sleep quality is improved (Berg, 2001).

Providing single-bed rooms as opposed to multi-occupant rooms has also been successful in reducing noise levels and improving sleep quality. The presence of other patients cause the majority of noises, from visitors, staff, or patient noises such as coughing, crying out, and bed movements (Southwell & Wistow, 1995; Yinnon et al., 1992).

The average noise level in multi-bed rooms can be 51 dB higher than that in a single room, with respectively higher peak levels (65 dB vs. 54 dB). Total sleep time in single bed rooms is greater than in open ICU settings, although the number of awakenings was similar (Gabor et al., 2003).

ii. Improving Lighting Conditions for Patient Sleep | Avoiding light pollution can be a successful intervention for improving sleep quantity and quality. Findings suggest that patients experienced deeper sleep when exposed to artificial daylight during normal daylight hours (Wakamura & Tokura, 2001). Some evidence suggests that when light is necessary during normal nighttime hours, having a lower-level ambient light is less disruptive than having a darker average with brighter peak exposures. More research is needed to determine the best compromise between required lighting for safety and staff function and patient sleep quality and quantity.

3.3 Reducing Patient Stress

Research has confirmed that hospitalized patients experience stress, and a large portion suffers from acute stress. Some of that is considered unavoidable accompaniments of illness and medical treatment, but growing evidence suggests that much results from the shortcomings in healthcare organization and culture. Additionally, poorly designed physical environments have the potential to create patient and familial stress (Ulrich, 1991; Ulrich et al., 2006).

The stress experienced by a patient is a negative outcome itself, while also directly affecting many other outcomes. Detrimental psychological, physiological, neuroendocrine, and behavioral changes have been associated with stress response (Gatchel, Baum, & Krantz, 1989; Ulrich, 1991). In addition to increasing natural levels of steroid, cortisol and other stress hormones that tax the major organs, research has demonstrated that stress physiological responses can suppress immune system functions (Kiecolt-Glaser, et al., 1987). Stress-related immune impairment decreases resistance to infection and worsens recovery outcomes (Cohen, Tyrrell, & Smith, 1991; Kiecolt et al., 1995).

i. Reducing Stress by Controlling Noise | The World Health Organizataion (WHO) provides guideline values for continuous background noise in hospital patient rooms: 35 dBA during the day & 30 dBA at night, with nighttime peaks not to exceed 40 dBA (Berglund, Lindvall, & Schwela, 1999). However, surveys of existing facilities show that actual background and peak noise levels fall in far higher ranges, with 35 studies identifying an overall increase, rather than decrease, in hospital noise levels since the 1960s (Busch-Vishniac, et al., 2005). On average, background noise levels range from 45 dB to 68 dB, with peaks frequently exceeding 85 dB (Aaron et al., 1996; Allaouchiche, Duflo, Debon, Bergeret, & Chassard, 2002; Balough, Kittinger, Benzer, & Hackl, 1993; Blomkvist, Eriksen, Theorell, Ulrich, & Rasmanis, 2005; Cureton-Lane & Fontaine, 1997; Falk & Woods, 1973; Guimaraes et al., 1996; Hilton, 1976; Homberg & Coon, 1999; Kent, Tan, Clarke, & Bardell, 2002; McLaughlin, McLaughlin, Elliott, & Campalani, 1996;

Robertson, Cooper-Peel, & Vos, 1998). It is worth noting that the decibel scale for quantifying loudness or sound pressure intensity is logarithmic, each 10 dBA increase represents a sound pressure level that is 10x higher.

Medical equipment and staff voices generally produce noise at 70-75 dB levels at the patient's head (Blomkvist et al., 2005) which, when combined with noises from alarms and certain specialized equipment can easily exceed 90 dB. Many hospitals have observed peak levels in the range of 100-110 dB, representing a significant risk for noise-induced hearing loss (Hodge & Thompson, 1990; Lowe, 2003; Nott & West, 2003).

A review of industry research identifies at least three major reasons why hospitals are excessively noise, and therefore, stressful. First, the sources of noise are unnecessarily numerous and loud. Acknowledged examples include, but are not limited to, staff voices, paging systems, alarms, bedrails, telephones, and pneumatic tubes. Second, many existing environmental surfaces are hard and sound-reflecting by nature. This creates poor acoustic conditions (long reverberation times) that enable noise to echo, linger, and propagate over large areas and into patient rooms (Blomkvist et al., 2005; Ulrich, 2003). Third, multi-occupant rooms create environments where much noise originates from other patients, which often cannot be prevented but can be mitigated through the use of single-bed rooms (Baker, 1984; Southwell & Wistow, 1995; Yinnon et al., 1992).

Another section of this thesis identifies noise as detrimental to sleep quantity and quality. In addition to this, noise elevates psychological and physiological stress in patients, as indicated by elevated feelings of anxiety and annoyance (Bently, Murphy, & Dudley, 1977; Haslam, 1970; Hilton, 1976; Synder-Halpern, 1985) and physiological changes such as elevated heart rate and blood pressure (Baker, 1992; Morrison, Haas, Shaffner, Garrett, & Fackler, 2003). One study found that when sound-absorbing tiles were installed, patients evidenced lower physiological stress, slept better, reported better care from nurses, and had lower incidences of re-hospitalization (Hagerman et al., 2005).
As evidenced in earlier sections, there are effective environmental approaches to quiet healthcare settings, which can not only improve patient's sleep quantity and quality, but reduce physiological and psychological effects of stress. The most prominent of solutions appears to be the single-bed room. Literature indicates that noise levels are consistently lower in single-occupant settings. A survey of 2.1 million patients from 1,462 facilities in 2003 showed patient satisfaction with noise levels on average 11.2% higher than those in multi-occupant rooms, regardless of age, gender, facility type and size (Press Ganey, 2003). Considering the number of potential variables, and the difficulty hospitals generally have increasing satisfaction scores by 2-3 percentage points, this is an extremely large difference.

Another prominent solution is to eliminate noise sources, which often accompanies technology upgrades and simple acoustic insulation strategies (Berg, 2001). Combined with high-performance sound-absorbing materials, noise levels,

reverberation and echoing can be effectively reduced (Blomkvist et al., 2005; Philbin & Bray, 2002).

ii. Providing Nature Distractions for Reducing Patient Stress | General biophilia theory holds that humans have a partially genetic tendency to respond positively to nature (Wilson, 1984). Additional theoretical arguments propose that a capability for rapid recovery from stress following challenging episodes was vital for survival, and why evolution favored the selection of individuals with this predisposition towards a restorative response to nature (Ulrich et al., 1993; Ulrich, 2008). The implication remains that modern humans, have a capacity to derive stress-reducing responses from certain nature settings and content, but have no such disposition toward most built or artificat-dominated environment and materials, such as concrete, glass, and metal (Ulrich, 1993; 1999, 2008). "These theoretical arguments have a practical design implication, which is that designing healthcare buildings with nature features may harness therapeutic influences that are carryovers from evolution, resulting in more restorative and healing patient care settings" (Ulrich, 2008).

Scores of scientific studies have generated strong evidence that real or simulated views of nature can produce restoration from stress in both medical and non-medical settings. The strength of these findings lies not only in self-reported measurements, but diminished observed physiological markers of stress, such as positive emotional, psychological and physiological changes. Self-reported feelings such as pleasantness and calmness are consistently increased as anxiety, anger, and other negative emotions are diminished (Hartig, Book, Garvill, Olsson & Gärling, 1995; Ulrich, 1979; Ulrich, 1991; Van den Berg, Koole, & Van der Wulp, 2003). Some have postulated that by providing pleasant distractions, nature scenes may block worrisome, stressful thought patterns (Ulrich, 1981). Responses to nature distractions are fairly immediate, with physiological restoration manifested within 3 minutes at most, and within seconds in certain systems (Fredrickson & Levenson, 1998; Hartig, Evans, Jamner, Davis & Gärling, 2003; Joye, 2007; Laumann, Gärling, & Stormark, 2003; Parsons & Hartig, 2000; Parsons, Tassinary, Ulrich, Hebl, & Grossman-Alexander, 1998; Ulrich, 1981; Ulrich, Simons, & Miles, 2003). Some studies suggest that looking at built environments not only fails to simulate a positive physiological restoration, but in fact may worsen stress (Ulrich, 1979, 1991; Van den Berg et al., 2003).

Individualized studies have shown the restorative effects of nature exposure on stress, from extended exposure during procedures to timed exposure prior to or immediately following surgeries. In addition, one study found that while patients exposed to artwork depicting nature had less anxiety and stress, and required fewer doses of strong pain drugs than a control group with no artwork, patients exposed to abstract art had even worse outcomes than the control (Ulrich et al., 1993).

iii. Providing Garden Access for Reducing Patient Stress | A few studies suggest that gardens can provide the desired restorative effects for patients, families, and staff (Marcus & Barnes, 1999; Sherman, Varni, Ulrich, & Malcarne, 2005; Ulrich, 1999; Whitehouse et al., 2001). They can not only provide restorative nature exposure, but foster social support, access to restorative escape, and control with respect to potentially stressful environments (Ulrich, 1999, 2008). In addition to lowered reported stress and physiological markers during actual use (Sherman et al., 2005), garden users reported improved emotional well-being during the duration of their stay (Whitehouse et al., 2001).

Limited evidence suggests that gardens alleviate stress most effectively for adult users when they contain green or verdant foliage, flowers, water, grassy spaces with trees or large shrubs, a modicum of spatial openness and compatible pleasant nature sounds (Marcus & Barnes, 1995, 1999; Ulrich, 1999, 2008). Similar observations have been made in assisted living facilities, indicating a preference for outdoor spaces with greenery, flowers, birds, and water features (Rodiek, 2005).

iv. Providing Art Exposure for Reducing Patient Stress | Few studies have measured patient pain and stress response to artwork, generally measuring patient preferences instead. However, limited findings suggest a pattern coinciding with those regarding nature exposure. Results show a consistent preference for representational nature art, with many showing adverse reactions to abstract art (Carpman & Grant, 1993; Ulrich, 1991; Ulrich & Gilpin, 2003). The majority also displayed a preference for any representational nature art over best-selling pieces or masterpieces by Chagall and Van Gogh. The most positively rated painting depicted a gentle waterfall with vegetation (Nanda et al., 2007). Pediatric studies show similar findings, suggesting that irrespective of age or gender, the majority preferred nature art over abstract or cartoon-like images.

Limited evidence suggests that artwork with subjective content or style can increase stress or worsen other outcomes (Ulrich, 1991, 1999; Ulrich & Gilpin, 2003). A study of psychiatric patients suggested strongly negative reactions to artwork that was ambiguous, surreal, or could have multiple interpretations. Further findings from the study of sculpture installations suggest detrimental effects of abstract or ambiguous works, with 22% of patients reporting an overall negative emotional response (Hefferman, Morstatt, Saltzman, & Strunc, 1995).

3.4 Reducing Patient Depression

Depression in healthcare patients is a serious, widespread, and costly problem. A large body of evidence stresses exposure to bright artificial light and daylight as effective means to reduce and improve mood, even for patients hospitalized for severe depression. Artificial light is commonly used in structured or formal protocols for treating

depression, with some studies suggesting that patients suffering from depression can have more favorable outcomes, and shorter stays, if they are assigned to sunnier rooms. The evidence suggesting that patients' depression is diminished by daylight exposure underscores the importance of building orientation and site planning of healthcare complexes (Ulrich et al., 2006).

i. Providing Light Exposure to Counteract Depression | The mechanisms by which light exposure alleviates depression are not fully understood. Light falling on the retina influences the activity of the pineal gland, and by this pathway suppresses or delays the production of melatonin. The lowered levels of this hormone reduce depression and its symptoms, increasing daytime alertness and fostering better sleep quality (Martiny, 2004). An analysis of 20 randomized studies published by the American Journal of Psychiatry concluded that light treatment for nonseasonal and seasonal depression is "efficacious, with effect sizes equivalent to those in most antidepressant pharmacotherapy trials" (Golden et al., 2005). Light exposure as treatment for depression is also faster acting that antidepressant drugs, generally producing significant results in less than 2 weeks of treatment, while pharmaceutical therapy generally requires at least 4-6 weeks.

Other studies focused on daylight as opposed to artificial light. While most studies of artificial light exposure as a treatment for depression produced broadly parallel results to those using natural light, some found that patients assigned to sunny rooms had stays on average 2.6 days shorter than those assigned to shaded rooms (Beauchemin & Hays, 1996). These effects were observed not only in patients hospitalized for severe depression, but patients in other categories at risk of developing depression during hospitalization, such as those with cardiovascular diseases and cancer. Additionally, one study showed reduced mortality rates in sunny rooms than in north-facing shaded rooms (Beauchemin & Hays, 1998).

3.5 Reducing Patient's Length of Stay

Limited literature directly links the physical environments of hospitals with a patient's length of stay. However, the few studies conducted consistently identify a positive impact from both, despite being conducted among specific types of patients

i. Sunlight and Length of Stay | As mentioned in the sections detailing patient depression, exposure to sunlight has a documented effect on patients' length of stay. One study showed bipolar patients to have a 3.67 shorter mean hospital stay when placed in brighter, east-facing rooms, as opposed to west-facing rooms (Benedetti et al., 2001). Similarly, patients with depression staying in sunny rooms stayed on average 2.6 fewer days than those in sunless rooms (Beauchemin & Hays, 1996). Additionally, exposure to sunlight has been linked to reduced mortality rates

in sunny rooms, with the greatest difference shown in female patients (Beauchemin & Hays, 1998). A retrospective nationwide study of Veterans Health Administration hospitals documented a link between climate variables and length of stay for psychiatric patients: those located in warmer and drier climates had shorter lengths of stay (Federman, Drebing, Boisvert, & Penk, 2000).

ii. Views of Nature and Length of Stay | As mentioned in previous sections, exposure to nature has a documented beneficial impact on patient outcomes including the reduction of stress, pain, and length of stay (Diette et al,. 2003; Tse et al., 2002; Ulrich, 1984, 1991). One study reported on the direct relationship between exposure to nature views and length of stay, where patients recovering from abdominal surgery had shorter lengths of stay when assigned a view of nature, as opposed to a view of a brick wall. Additional studies are needed to examine the direct relationship between environmental factors and patient's length of stay.

3.6 Reducing Spatial Disorientation

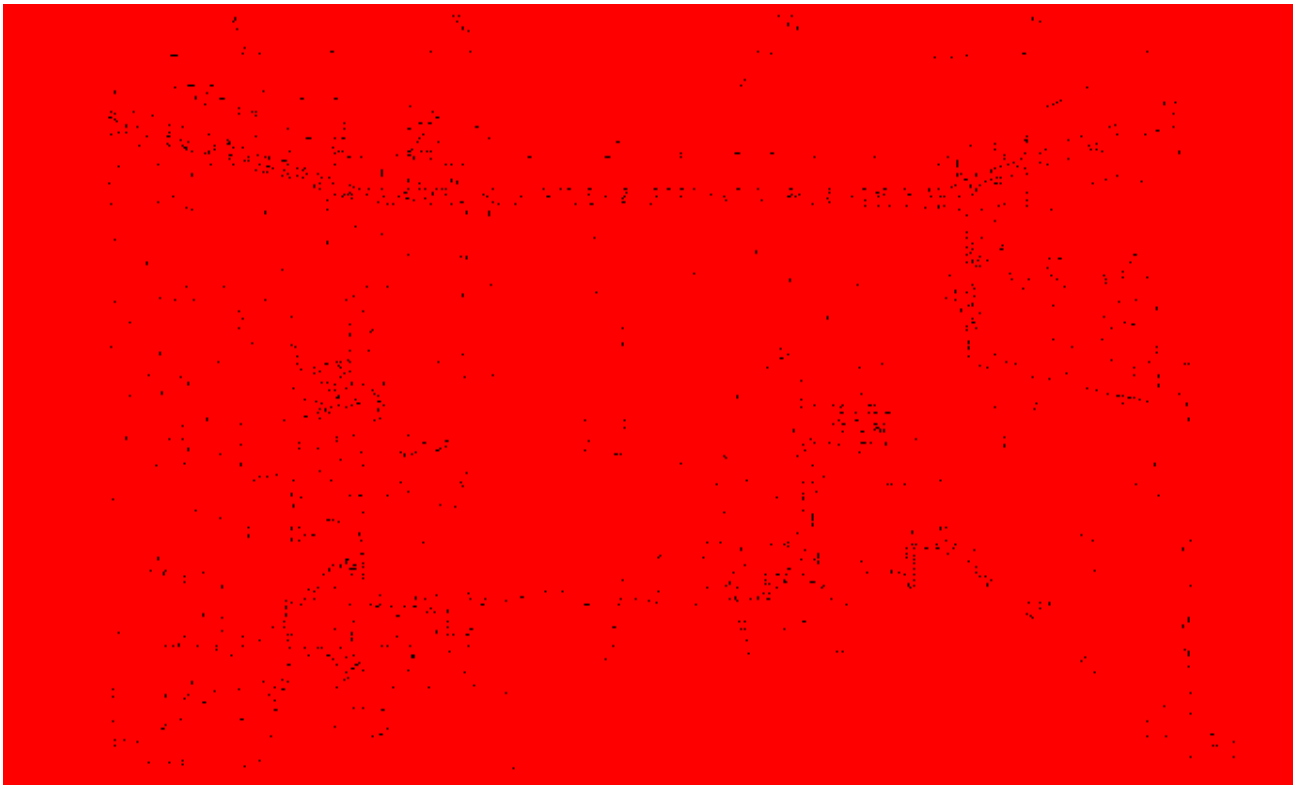
Wayfinding in hospitals is a costly and stressful problem that has a particular impact on patients and visitors, who when, unfamiliar with a facility, can become stressed and disoriented. One study calculated the annual cost of the wayfinding system to be more than $220,00 per year, or approximately $448 per bed (Zimring,1990). The majority of these numbers was the hidden cost of direction-giving by non-informational staff, amounting to approximately 4,500 staff hours. Several other studies have documented the high cost of wayfinding solutions in hospitals (Carpman, Grand & Simons, 1990; Christensen, 1979; Foxall & Hackett, 1994).

Numerous studies have explored how people navigate hospitals and similarly complex buildings. People have predictable paths when moving through hospitals. However, spatial syntax analysis has shown that these are not often the most direct or designated paths, but those that are most accessible to all of the other paths in the hospital (Peponis, Zimring, and Choi, 1990). More complex layouts are more difficult to find one's way (Arthur & Passini, 1992; Drinkard, 1984; O'Neill, 1992; O'Neill, 1991a, 1991b; Ortega-Andeane & Urbina-Soria, 1988), and certain characteristics, such as turns other than right, are harder to maintain (Carpman & Grant, 1993).

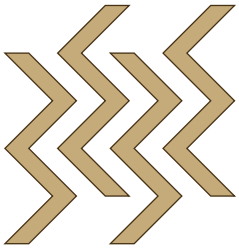
While the evidence about how people find their way continues to grow, little research directly assesses the performance of wayfinding system types, or the impact of wayfinding on other healthcare outcomes. Hospitals should provide integrated systems, including coordinated elements, such as visible and easy-to-understand signs and numbers; clear and consistent verbal directions; consistent and clear paper, mail-out, and electronic information; and a legible physical setting (Carpman & Grant, 1993). A well-integrated wayfinding system includes a majority of components, some of which are directly related to the design of hospital physical environments.

i. External Building Cues | Signs and cues leading to the hospital must be carefully considered, as they are the patient's first point of contact with the hospital. One study used video simulation to assess the relative role of signs and seeing a destination: despite providing signage to direct most traffic to a parking structure, 37% of respondents said they would ignore the signs in favor of a directly visible entrance (Carpman, Grand & Simmons, 1985).

ii. Local Information | Once patients have entered the facility, informational handouts, information desks, you-are-here maps, directories, and signage are critical wayfinding aids (Carpman, Grant & Simmons, 1983; Levine, Marchon, & Hanley, 1984; Nelson-Shulman, 1983-84; Wright, Hull, & Lickorish, 1993). One study showed that patients who had access to an information system (including the previously mentioned aids) were more self-reliant and made fewer demands on staff upon reaching the admitting area. Those without access to an information system rated the hospital less favorably and had elevated heart rates (Nelson-Shulman, 1983-84). When you-are-here maps are not oriented to the direction of travel, people took longer to find their desitination, and their efforts were significantly less accurate (Levine et al., 1984). Another study showed that wall signs were more effective than handheld maps, although a combination of the two was the most successful for wayfinding (Wright et al., 1993).

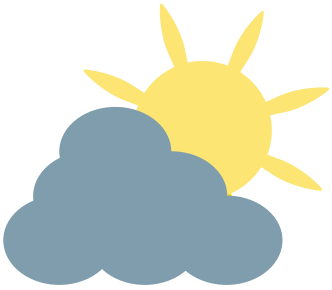


"Method and Apparatus for Biophilically Promoting Patient Relaxation"
Joseph August



REDUCING ENVIRONMENTAL STRESS FACTORS

reduced need for pain medication
reduced reported stress
decreased phsyiological anxiety
improved sleep quantity
improved circadian rhythms
increased patient comfort
increased staff efficiency
improved overall mood

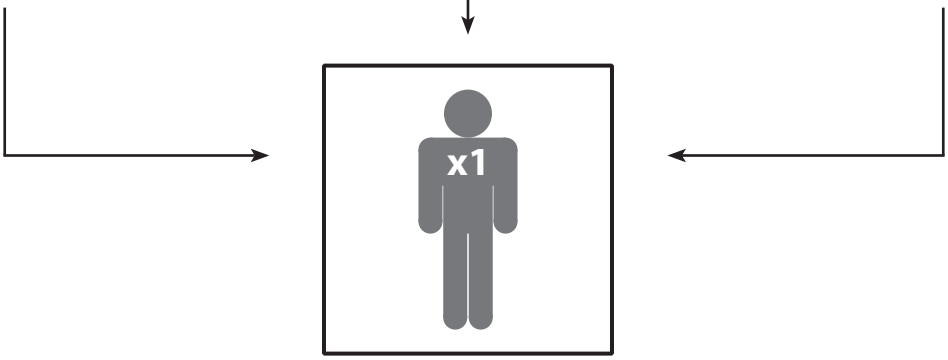


DAYLIGHT / HIGH-INTENSITY LIGHT ACCESS

reduced need for pain medication
reduced experienced pain
reduced reported stress
reduced rate of depression
decreased length of stay
improved circadian rhythms
improved overall mood
reduced lighting demands

VISUAL & PHYSICAL ACCESS TO GREENERY

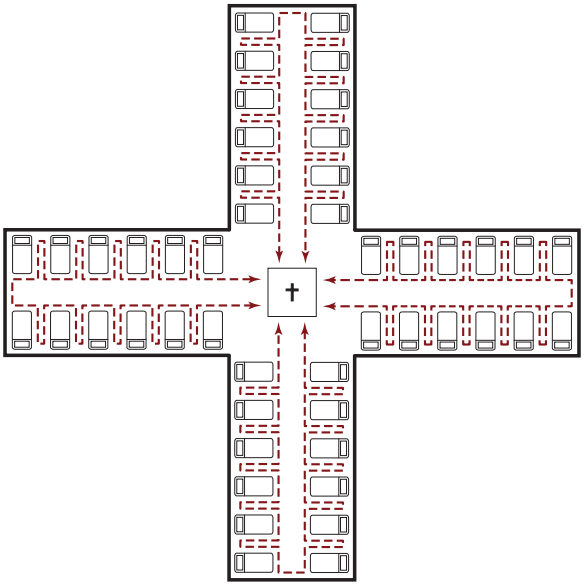
reduced need for pain medication
reduced experienced pain
reduced reported stress
reduced rate of depression
decreased phsyiological anxiety
increased pain tolerance
decreased length of stay
improved overall mood



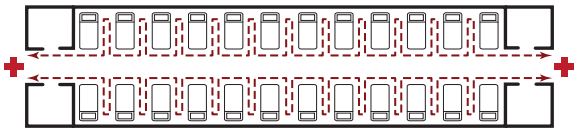
3.7 The Single Patient Room

Additional hospital surveys and business analyses have proposed the exclusive use of single patient rooms as an ideal solution for these resolvable issues in healthcare today. Most effect & cause studies have identified changes within this space that can drastically affect patients' outcomes. While history has long advocated shared or multi-bed wards as the most economical and efficient model, administrators are beginning to agree that single bed rooms are the best economical and medical choice in the long run.

Hospital sick room, 1840



Cross-shaped monastary ward layout, 1400s AD

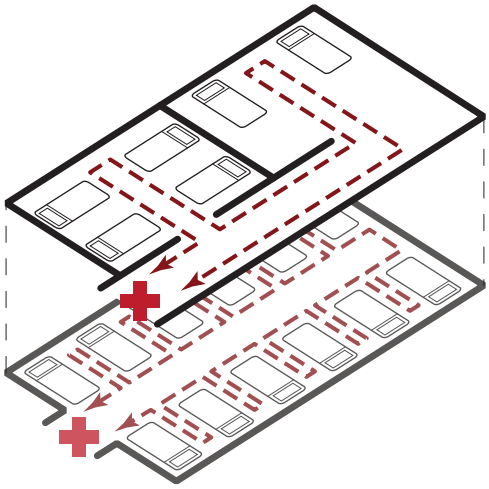


Traditional Nightingale ward with 24 beds

i. A History of the Patient Room | The hospital has undergone various stages of development over the centuries. The history of today's traditional design can be separated into six different periods, through which we can trace the evolution of the patient room (Verderber & Fine, 2000). The first traditional hospital typology emerged alongside religious insitutions during the 1400's, which provided food and care to the poor. Charlemagne was one of the first to spread the idea of these hospitals, proposing that they be constructed alongside any new religious institution. Many were proponents for large, multi-occupancy wards, often housing over 30 patients at a time (Jones, 1995). A cross shaped layout was commonly used, featuring an altar in the center for worship.

Based on her experiences during the Crimean War in Turkey, Florence Nightingale argued that staff efficiency and a highlighted sense of supervision provided a better quality of care, with increased health status and spaciousness outweighing the need for individual privacy (Seymer, 1954). Her guidelines, *Notes on Hospitals*, written in 1859, were some of the earliest to address the maximum allowable width and length of wards, sizes of windows and their relation to patient beds, ambience, heating and ventilation systems, and the use of specific colors and materials (Verderber & Fine, 2000). Up until this time, hospitals had long been associated with substandard care, suitable for those who could not afford better. However, Nightingale's suggested reforms along with advancements in medicine began to remake hospitals as places of healing, rather than dying. This social change of attitude towards hospitals resulted in both the wealthy and poor seeking treatment. As upper income groups began soliciting hospitals, they provided a demand for more private rooms and treatment. By the mid-20th century, larger wards had been replaced by private and semi-private wards (Miller & Swensson, 1995), often called "pay-for" rooms

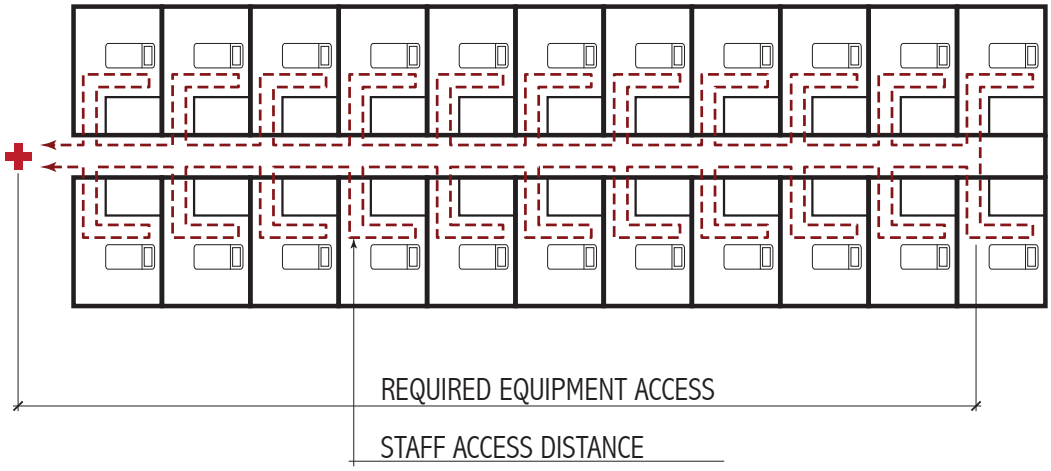
that were only available to the affluent. However, multi-occupant wards were still favored over private rooms because of staff efficiency issues. The desire for privacy was attributed to a changing relationship between public and private in 20th century life, and private rooms were considered a reflection of societal progress rather than based on any medical justification (Thompson & Golden, 1975; Verderber & Fine, 2000).



Combination of large wards & pay-for private rooms

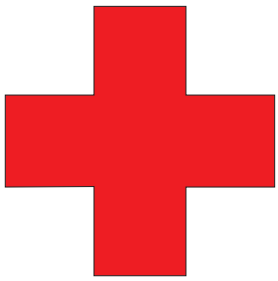
The shift away from multi-bed wards was first seen in the United States following the end of World War II, and considered nearly complete by the early 1970's. Though design trends pushed towards developing all private rooms in hospitals, these inpatient facilities were known to compound patients' sense of alienation, dislocation and fear that accompanies hospitalization and illness (Verderber & Fine, 2000). A compromise followed for facilities that offered variants of medical-surgical units, generally consisting of a mixture of private rooms, double occupancy rooms, and small wards up (up to 6 beds).

While the popularity of single-bed has gained significant traction in the past two decades, proponents of private rooms have been recommending them form the early part of the 20th century. Advocates like A. Bacon, Superintendent of Chicago's Presbyterian Hospital, generally emphasized this approach from an administrative standpoint: private rooms not only provided patients with more privacy and comfort, but more importantly addressed the hospital's goal



of maximum occupancy. Publications supported this claim by stating that almost 100% occupancy can be achieved with single-bed rooms, versus 80% occupancy in double or multi-occupancy rooms (Bobrow & Thomas, 2000).

It has only been in these last two decades that mounting medical evidence supports the use of single-bed rooms. Recent studies on infection control (Kappstein & Daschner, 1991; Muto et al., 2003; Shirani, et al., 1986) support claims of reduced hospital-acquired infection rates. A significant number of studies further demonstrate that nosocomial infection rates are reduced in single versus multi-occupant rooms even when controlling for hand-washing and air quality (Ulrich, 2003).



EFFICIENCY & EFFORT OF STAFF
Minimizing travel distance for staff and equipment can reduce fatigue, clinical error rates, improve staff-patient interaction, and increase efficiency without increasing required personel.

EQUIPMENT & ACCESS
Providing central access to equipment and facilities reduces infection transmission rates, improves patient & staff performance, and saves money by minimizing redundancies.

ISOLATING PATIENTS' STRESS
Using private rooms helps visually and aurally isolate patients from peripheral medical and operational stress, improving patient sleep quality, and reducing anxiety and infection transmission rates.

ii. The Patient's Room Purpose | A large and complicated topic, the design and functionality of the patient's room affects not only patients and their families, but hospital staff and administration. By optimizing the patient's experience, administration benefits through the strategic use of materials and space allocation. Decisions made regarding the patient room affect every person involved in healthcare facilities and management.

The patient's room straddles several different purposes. Primarily this is medical support- while varied from case to case; addressing the patient's needs through equipment and procedures is the basic reason for hospitalization. Activities such as examinations, care procedures, and assisted movement are among those that shape the spatial and programmatic requirements of a patient's room. Additionally, as mounting evidence supports the Importance of social support during recovery, familial needs must be considered alongside purely medical ones. Taking all these different factors into account leads to more satisfied clinicians, patients, and family. This, in turn, satisfies administrative needs by bettering outcomes, reducing complications and readmission rates, providing more medical and financial success for the hospital in the long run.

4.0 LONG-TERM ACUTE CARE AS A PROGRAM

Most persons needing inpatient hospital services are admitted to acute care facilities. However, for those requiring a relatively longer stay, long-term acute care (LTAC) facilities provide comprehensive rehabilitation, respiratory therapy, head trauma treatment, and pain management.

Long term acute care (LTAC) hospitals are specialty-care facilities designed for patients with serious medical conditions that require treatment for an extended period of time, usually over 20 days. LTAC offers more individualized and resourceful care than a skilled nursing facility, nursing home or acute rehabilitation centers. Patients usually arrive at LTAC facilities directly from traditional hospitals, once they no longer require intensive diagnostic procedures or testing.

Long term acute care hospitals have the focused resources to apply very high levels of standard of care to certain medical conditions, typically multiple acute or chronic conditions. These facilities are unique in their ability to care for difficult to treat, chronically critically ill patients who require specialized and aggressive goal-directed care over an extended period of recovery. Issues can include multiple co-morbidities, multi-organ system ailments, and significant loss of independence.

Additionally, these facilities can offer outpatient procedures typically required by cancer, kidney failure, and psychological problems.

III

SCOPE

1.0 DESIGN OBJECTIVES

2.0 PROGRAM SELECTION CRITERIA

3.0 SITE SELECTION CRITERIA

1.0 DESIGN OBJECTIVES

The primary objective of this thesis is the successful design of a new healthcare facility using landform building principles and an evidence-based design approach, which together emphasizes the relationship between the built environment and the patients' healing process.

Evidence-based design (EBD), a necessary and evolving industry approach to healthcare design, incorporates information from additional relevant fields of study. Explored later within this paper, the social, medical, and financial benefits of EBD are well-documented. Considering this, it is nearly impossible to have a discussion of healthcare design without including or employing EBD; it has become an accepted standard within the industry. Despite the wide array of relevant medical studies that have examined the relationship between the healing process and the healthcare environment, most of the findings remain subjective with regard to design choices. The majority of conclusions have been drawn from isolated changes within existing healthcare facilities. This is of particular note, as additional design conclusions can often be extrapolated, and together suggest a potential for exponential improvement of the patients' experience when considered at the beginning of the design process.

The design process that follows concentrates on improving the patients' experience in the built environment, primarly through the patient room floor, providing administrative, financial, and medical benefits for the healthcare industry as a whole.

The design will be limited to areas primary to the patient experience, in order to develop the specifed aspects further within the time allotted.

2.0 PROGRAM SELECTION CRITERIA

Program selection was shaped primarily by technical components of the design objective, but was also influenced by supporting research into existing healthcare facilities. Program components and their arrangements reflect this research more directly.

3.1 Primary Medical Function

Healthcare facilities span a wide range of types, including administrative, laboratory, and residential functions. For the purpose of this thesis, medical and residential components were deemed necessary, so that program spaces still responded to key medical activities, rather than the administrative or business activities that are also essential.

3.2 Non-Emergency Care

Despite the focus on a primarily medical program, emergency care was decidedly excluded from the desired components. Issues with the design, operations and policies regarding emergency care facilities are well documented, and fall well outside the scope and limitations of this thesis. By excluding this program possibility, more attention can be paid to the issues of evidence-based design.

3.3 Supported Focus on Patient Rooms

Supporting literature illustrates the role of the patient's room during the recovery process. User preference and medical research supports the use of single patient rooms for a variety of reasons. By focusing on single patient rooms as a primary component, the best modern approach to the patient's experience can become a focal point for design considerations.

3.4 Potential for Community Development & Integration

To respond to the changing approach to healthcare in society, program functions that can be shared between the local community and medical users are highly desired. By providing community functions side-by-side with acute care functions, the traditional relationship between patients and the community becomes less excluding.

3.5 Non-Specific Demographic Focus

In order to support the desired community aspects of the program, all components should serve a range of demographics. This specifically excludes functions such as geriatric or specialized intensive care, which have been criticized for inherently isolating certain groups. By providing services to a wide range of people, the users have a greater potential for community integration and investment.

3.0 SITE SELECTION CRITERIA

Site selection for this design thesis responded to several key factors. The majority of these factors reflect general conclusions drawn from the survey of field. In considering these factors, an attempt was made to strike a balance between realizing and responding to real-world constraints often associated with urban sites, but also to avoid major restrictions that would hamper the explorative nature of this thesis.

4.1 Adjacency to Existing Healthcare Facilities

The long-term acute care facility typology had its origins in geriatric care; however, with the emergency of diseases requiring continuing care over a patient's lifetime, the program of the facilities began to change. Services such as dialysis, physical therapy, blood transfusions, and chemotherapy have become standardized procedures that are provided to thousands on a daily basis. As such, the provision of emergency medical services is not a priority. However, in terms of administrative and support functions, it seems logical that such a facility would be attached to a new or existing comprehensive facility, allowing shared use of staff and other resources. For this reason, an adjacency to existing facilities was deemed a requirement, as the design of an entire comprehensive healthcare facility falls outside the scope of this project.

4.2 Access to Existing Greenery & Daylight

Considering that much of the relevant evidence regarding improving patient outcomes incorporate natural or environmental interventions, access to existing greenery is considered a key priority. By ensuring possible access from the new facility through site location, design interventions can be implemented above superficial interventions such as artwork. This requires the actual building form to respond to evidence-based design requirements. Additionally, by ensuring visual access to existing greenery, it is more likely that natural daylighting methods will be more successful. A location that receives a more than adequate of daylight year-round was chosen, so that designs would be able to incorporate as much daylight as possible, as opposed to minimally responding in areas that have more geographical issues with daylight access.

4.3 Centrally Located in an Urban Area

As a secondary program objective, community oriented functions will be provided in the public areas of the building. By placing the program within a well-populated urban area, the program can provide services to more people and communities than if it were located within a rural area. Connections to local infrastructure can encourage the community functions of the design. Additionally, as the majority of hospital facilities are located in urban areas, design solutions for increased access and greenery respond to common issues found in modern hospital design.

METHODS

1.0 COMPREHENSIVE ACCESS TO LIGHT

2.0 VISUAL & PHYSICAL ACCESS TO GREENERY

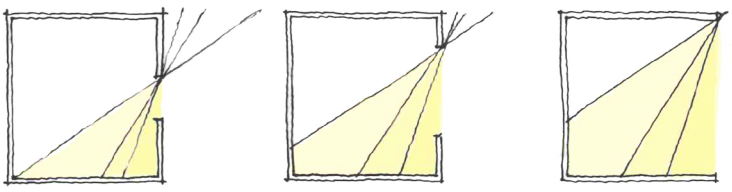
3.0 IMPROVEMENT IN PATIENT PRIVACY & EXPERIENCE

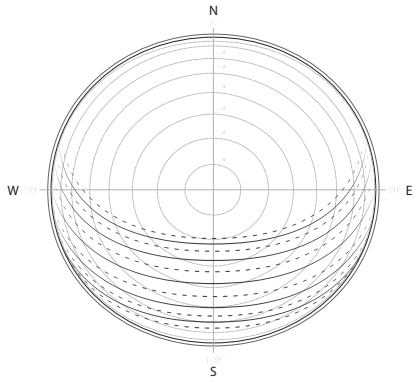
1.0 COMPREHENSIVE ACCESS TO LIGHT

Access to natural light is an ongoing issue in many buildings. Several obstacles already present challenges based on programmatic requirements and spatial organization. Revisiting the traditional hospital ward layout, where the primary concern is staff efficiency, it becomes apparent that a balance between several factors will be necessary to increase the exposure to natural light while maintaining practicality for programmatic function.

Interventions such as high-intensity light fixtures and UVB exposure have proven effective at providing the benefits traditionally associated with exposure to natural light. However, given the scope and size of healthcare facilities, it is more economic and effective to consider building orientation and fenestration carefully from the inception of the project to maximize exposure. Geographical location is not always a controllable variable in any project, but here, by choosing a location that receives a fairly average amount of sun days & duration of exposure, the design components identified have a greater application for other projects.

Movements away from traditional healthcare organization will ideally provide opportunities to draw light further into the building. The goal is to as many aspects of the patient experience to natural light opportunities as desirable. A successful translation of existing isolated light interventions into architectural language will incorporate natural light throughout the building fabric, increasing patient access to natural light, and its accompanying physiological & psychological benefits.





	Chicago	USA
rainfall	35.9 in.	36.5 in.
snowfall	27.5 in.	25 in.
precipitation days	124	100
sun days	189	205
average July high	83˚	86.5˚
average January low	18.4˚	20.5˚
comfort index	47	44
UV index	3.6	4.3
elevation	593 t.	1,443 ft.

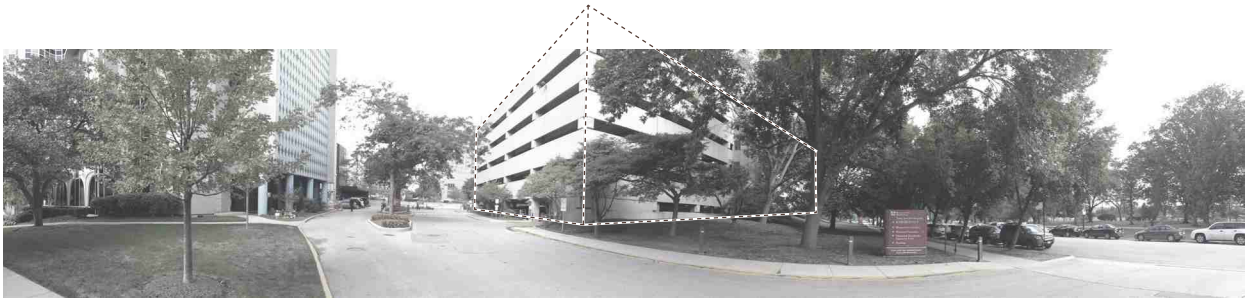
"Access to daylight is important for both staff and patients. For patients, exposure to natural light has been found to reduce patients' pain and the amount of pain medications that they use. Additionally, as a major contributor to normal circadian rhythm, the amount of light that patients are exposed to at different times of day can affect sleep quality.

A considerable body of rigorous evidence indicates that exposure to light—daylight or bright artificial light—is also effective in reducing depression and improving mood. Adequate lighting has been identified as one component affecting patients' overall satisfaction with their hospital stays.

Therefore, site planning and the orientation of healthcare facilities should be carefully considered to ensure sufficient daylight and avoid situations where some buildings block light for others. Larger windows in patient rooms not only provide natural light, but they also have the potential benefit of offering views of nature and should be considered in the design process."

-Healthcare Leadership White Paper #5:
A Review of Literature on Evidence-Based Design

2.0 VISUAL & PHYSICAL ACCESS TO GREENERY



Visual & physical access to greenery— and its incorporation into the built environment— have numerous benefits that can be translated to healthcare facilities.

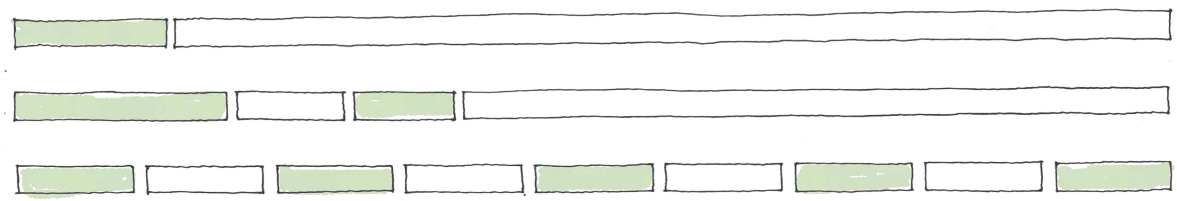
The use of potted plants is a common intervention in existing facilities in order to achieve these benefits. At an architectural level, the inclusion of greenery in the building fabric provides ideal opportunities to not only provide access, but relieve the potential monotony of programmatic arrangement and facilitate opportunities for the inclusion of natural light. In addition to the medical benefits, living plant life can potentially improve indoor air quality, a widespread issue in healthcare facilities.

The selection of a site adjacent to existing established greenery provides the opportunity to incorporate visual access as completely as possible. Additionally, including integrated greenery continues to saturate the patient experience.

"Considerable research has examined the psychological and physiological effects of viewing real and simulated nature. Most available evidence is related to the impact of nature views on patients. There is also limited evidence suggesting that staff experience restorative benefits from views of nature or exposure to gardens.

Nature has been determined to be an effective positive distraction, which can reduce the perception of pain and thereby reduce the use of pain medications. A direct relationship between exposure to nature views and reduced length of stay in a study of patients recovering from abdominal surgery was found in one study. Strong studies have found that exposing patients to nature lessens stress and anxiety.

-Healthcare Leadership White Paper #5:
A Review of Literature on Evidence-Based Design



3.0 IMPROVEMENT IN PATIENT PRIVACY & EXPERIENCE

Traditionally, hospitals consisted of shared rooms, with few private rooms. Given the breadth of research on the subject, the use of only single-patient rooms in new healthcare facilities is an emerging industry standard. The benefits far surpass the initial cost concerns, particularly when hospitals are able to achieve 100% occupancy with single beds, as opposed to approximately 80-85% in multi-bed layouts.

Attached to single-bed rooms comes the idea of same-handedness. Rooms are expected to have an identical layout with relation to the door. This provides staff with an unprecedented level of familiarity with in-room resources, reducing staff errors, and increasing response effectiveness during emergency care situations. Same-handedness provides an opportunity to standardize some components and decrease costs of structure & services.

"The design intervention that positively affects the largest number of outcomes in a hospital setting is the provision of single-bed patient rooms.

Patients in single-bed rooms benefit from increased privacy and the reduction in noise from roommates, visitors, and healthcare staff. These factors improve sleep, facilitate the healing process, increase privacy, provide opportunities for social support, reduce staff stress, and decrease infection rates. Considering all the above-mentioned benefits, it is no surprise that patients are more satisfied with their hospital stays when they are placed in single-bed rooms.

-Healthcare Leadership White Paper #5: A Review of Literature on Evidence-Based Design

HEALTHCARE LEADERSHIP WHITE PAPER #5: A REVIEW OF LITERATURE ON EVIDENCE-BASED DESIGN (2008)
TABLE 1 : SUMMARY OF THE RELATIONSHIPS BETWEEN DESIGN FACTORS & HEALTHCARE OUTCOMES

Design Strategies or Environmental Interventions / Healthcare Outcomes	Single-bed rooms	Access to daylight	Appropriate lighting	Views of nature	Family zone in patient rooms	Carpeting	Noise-reducing finishes	Ceiling lifts	Nursing floor layout	Decentralized supplies	Acuity-adaptable rooms
Reduced hospital-acquired infections	**										
Reduced medical errors	*		***								
Reduced patient falls	***					**					*
Reduced pain		**		**			*				
Improved patient sleep	**	**					*				
Reduced patient stress	***			**	**		*				
Reduced depression		**	**	**							
Reduced length of stay		***									*
Improved patient privacy and confidentiality	**				**						
Improved communication with patients & family members	**				**						
Improved social support	**					*					
Increased patient satisfaction	**	*	*****								
Decreased staff injuries								**			*
Decreased staff stress	****						*				
Increased staff effectiveness	**						*		***		
Increased staff satisfaction	****						*				

* Indicates that a relationship between the specific design factor and healthcare outcome was indicated, directly or indirectly, by empirical studies reviewed in this report.

** Indicates that there is especially strong evidence (converging findings from multiple rigorous studies) indicating that a design intervention improves a healthcare outcome.

V

PRELIMINARY FINDINGS

1.0 SITE OVERVIEW

2.0 USER DEMOGRAPHICS

3.0 SELECTED PROGRAM COMPONENTS

1.0 SITE OVERVIEW

The proposed site is located in Chicago, IL. The Illinois state population is 12,875,255, of which approximately 5,231,351 reside within the Chicago metropolitan area. Covering 945 square miles, it is ranked as the third largest city within the United States. Of the larger metro area, 2,714,856 live within the City of Chicago.

With nearly 11,842 per square mile, Chicago represents a fairly dense urban area. Existing public transportation is comprised of bus, subway, light and heavy rail systems. Multiple interstates pass through the metropolitan area, enabling over 800,000 car commuters to travel daily.

Home to the City Beautiful movement, Chicago maintains a strict urban rhythm, including the numerous art and greenery incentives that provide the interplay between built and natural environments. It remains today the City by the Lake, as connected to its heritage and nature as possible.

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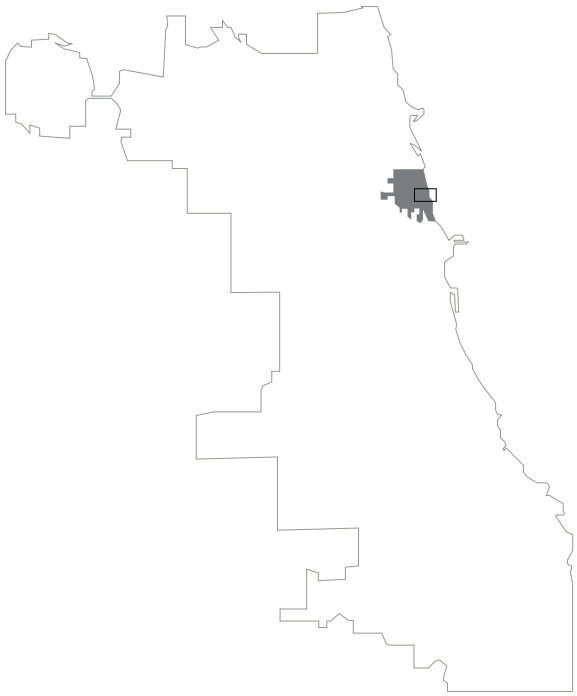
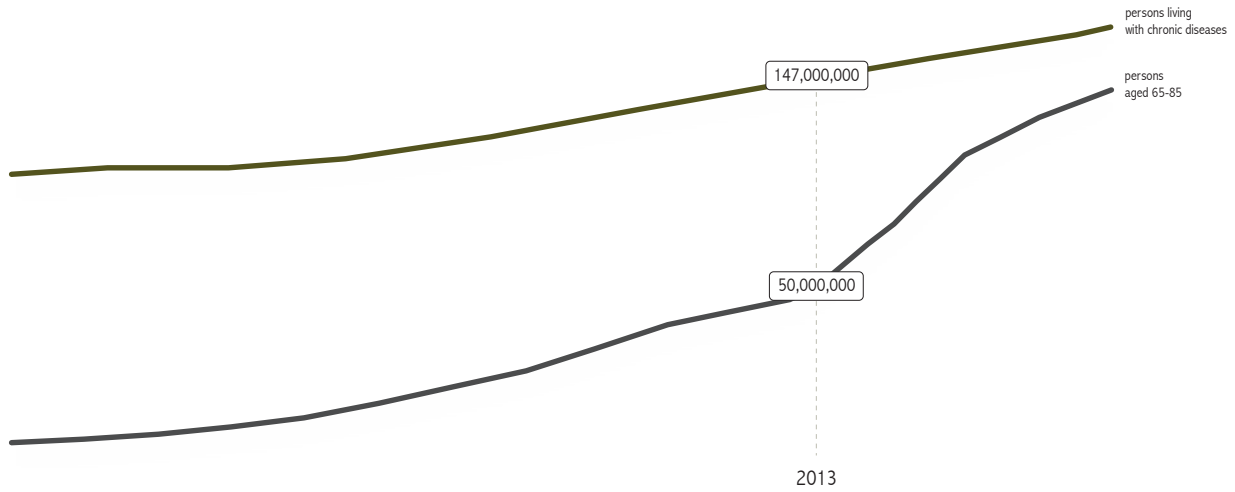


2.0 USER DEMOGRAPHICS



The Institute of Medicine notes a quality and safety revolution that is sweeping the country, greatly changing the public expectations of many industries, including healthcare. Consumers, employers, and payers are

Changing demographics within the American population are expected to drastically increase the number of users of healthcare facilities, in addition to increasing the overall demand for services. Nationally, just over 40,000,000 million persons are aged over 65, expected to increase to over 70,000,000 by 2030. In Chicago metro alone, 12.4% of the population (approximately 650,000 persons) are over 65, expected to increase to well over 25% in the coming years.

In addition to this increase in elderly users, the Patient Protection and Affordable Care Act (PPACA), commonly called the "Affordable Care Act" or "Obamacare" was signed into law in March 2013. Together with the Health Care and Education Reconciliation Act, it represents the single most significant overhaul to the regulations of the US healthcare system since Medicare and Medicaid in 1965.

Intended to increase the quality and affordability of healthcare available to US citizens, it expands public and private insurance coverage, and reduces the cost of healthcare for individuals and for the government. By barring discrimination of sex or pre-existing conditions, an increase of 32,000,000 healthcare subscribers is expected by 2019, raising the percentage of insured non-elderly persons from 83% to 94%.

This represents the single largest increase in demand on healthcare facilities, and directly feeds into the emerging long term acute care (LTAC) specialization.

3.0 SELECTED PROGRAM COMPONENTS

The following section details the necessary program components of the proposed long-term acute care (LTAC) facility. Of note is the inclusion of only single-bed patient rooms. While the literature previously reviewed is overwhelmingly in support of such an arrangement, other sources argue that some situations are still better served by multi-bed rooms. However, these situations generally have a basis in immediate or emergency care; often the benefits of single rooms are not nearly as important as immediate staff access. Intensive care units such as these are still in search of the ideal balance between the benefits of single-bed rooms and the extremely sensitive conditions of the patients they serve. As this thesis' program specifically excludes any type of emergency or immediate care, the following program reflects a move to all single-bed rooms.

The Patient Room: Use denominations are expected to reflect a difference in level of care required by the typical user. Variations in sizing are intended to provide adequate access for medical equipment without crowding patient use; additionally, it can provide for complexity in programmatic layout and help avoid the typical monotonous layout of identical wards. Rooms with shared lavatory access are intended to serve patients requiring a minimal level of care, and may be excluded from the final design based on further research and analysis

Staff Bays: Bays are areas intended for the processing and storage of particular categories of equipment. Access by staff is a priority.

Staff Areas: Staff areas are expected to be well-integrated with patient room clusters, affording staff easy access to patient rooms while providing a safe and well-organized basis for efficiency. If possible, multiple areas should be provided throughout the facility, as opposed to a centrally located hub providing the necessary services.

Administrative Areas: Administrative areas are not expected to be strictly separate from medical staff areas. Some overlap is desired, as opposed to a segregated area solely for administrative function. Any spatial separation between patient and administrative areas should be carefully considered to encourage interaction and a feeling of openness and general access.

Medical Treatment Areas: Medical treatment areas must be carefully designed so that when necessary, access can be restricted to staff only. However, typical measures such as explicit signage and "red tape" should be avoided, instead using layout to separate necessary program functions. Ideally, these spaces will be integrated well enough to avoid the impression of "no trespassing" zones within the interior spaces. These areas may be concentrated away from exterior facades in order to allow other areas to take advantage of natural daylight and views.

DESIGN

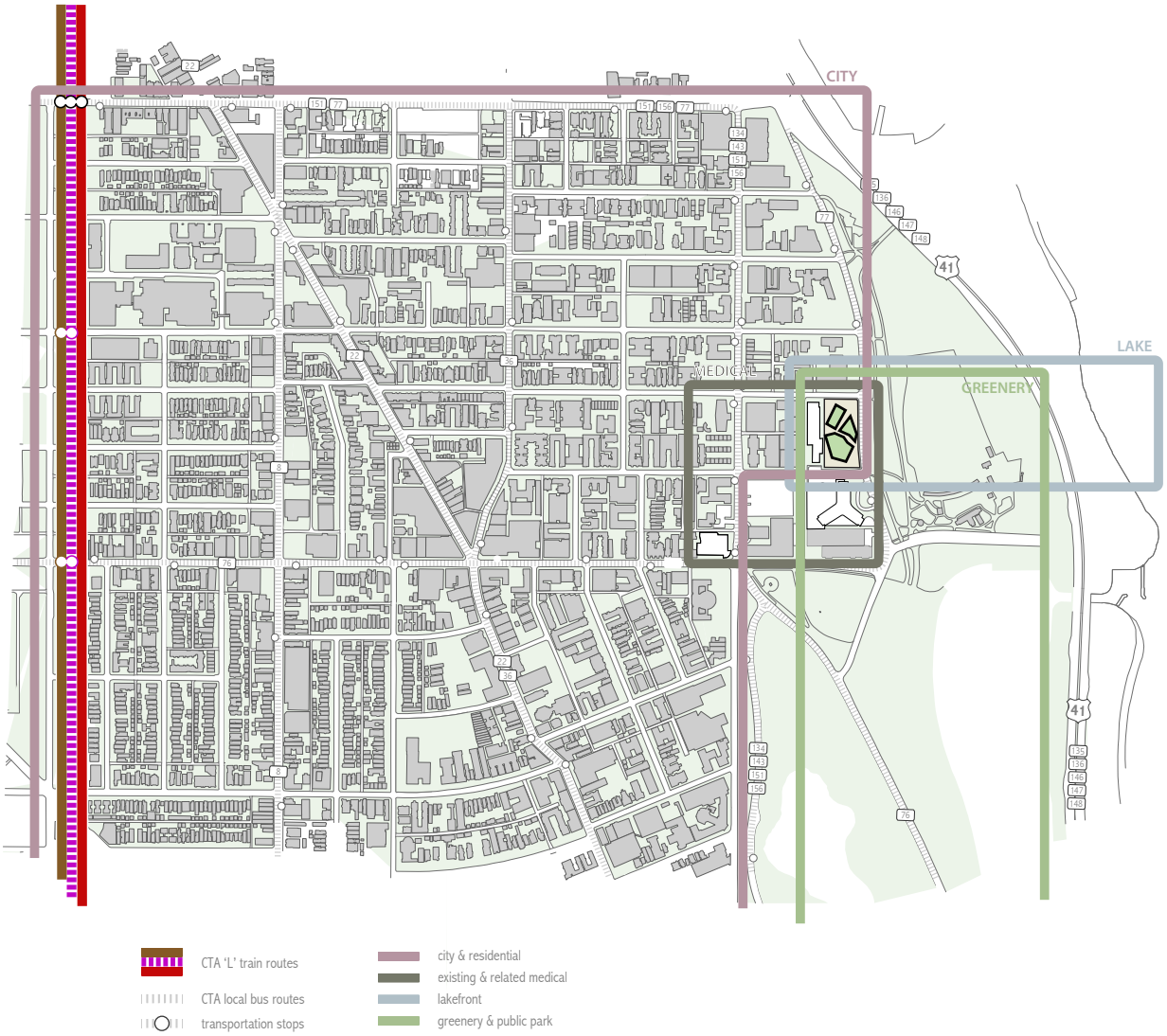
1.0 SITE EXPLORATION

2.0 CIRCULATION & GREENERY STUDIES

3.0 CONCEPTUAL DEVELOPMENT

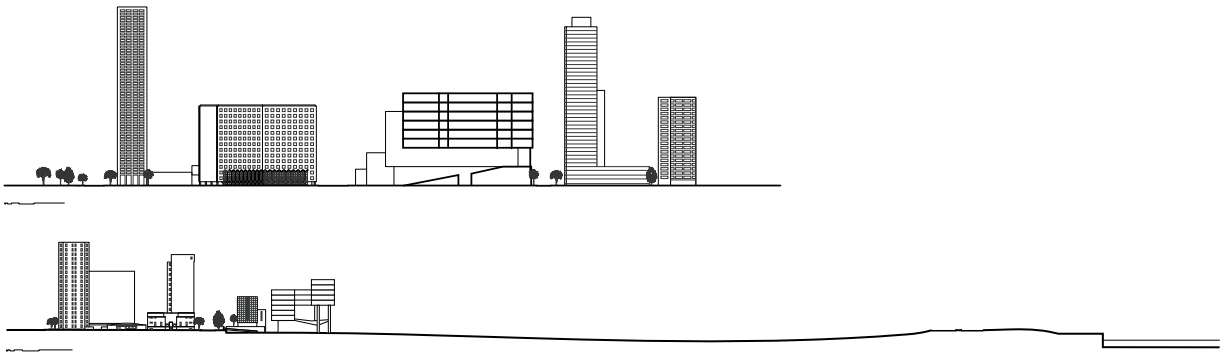
4.0 FINAL DESIGN PROPOSAL

1.0 SITE EXPLORATION



The above map examines the connections between the selected site and the surrounding urban fabric, including information such as local bus routes & stops, light rail access & public greenery areas. Four areas of interaction emerge as the primary concern: greenery, lakefront, medical, and residential connections. Their general areas of interaction are outlined above.

The selected site is located at 2960 N. Lake Shore Drive in Chicago, Illinois. The site is adjacent to and belongs to St. Joseph Hospital of the Presence Health Care group. There is currently a multi-floor parking structure on site, which is slated for demolition in order to expand the existing hospital facilities. The site has street access on the north and east sides, and driveway access to the south. To the west is an existing administrative building for the hospital.



1.1 Greenery & Lakefront Access

N. Lake Shore Drive provides the western boundary for the public lakefront park, providing unobstructed visual access to Lake Michigan, and adjacency to park greenery. A two-lane road with street parking on each side, it is classified as "residential" and has a speed limit of 20 mph. Frequent crosswalks and stop signs allow for a high level of pedestrian permeability from the site to the lakefront park. The lakefront park extends to the south, and expands westward past Diversey Avenue. Southwest of the site is Diversey Harbor, providing access to Lake Michigan for private sail & motor boats. Located directly east within the park is the Diversey Driving Range, which creates more pedestrian use of the directly adjacent park than usual.

Despite the height of some neighboring structures, sun access for the site is largely unobstructed throughout the year, with minimal interference from the administrative building to the west.

1.2 Medical Access

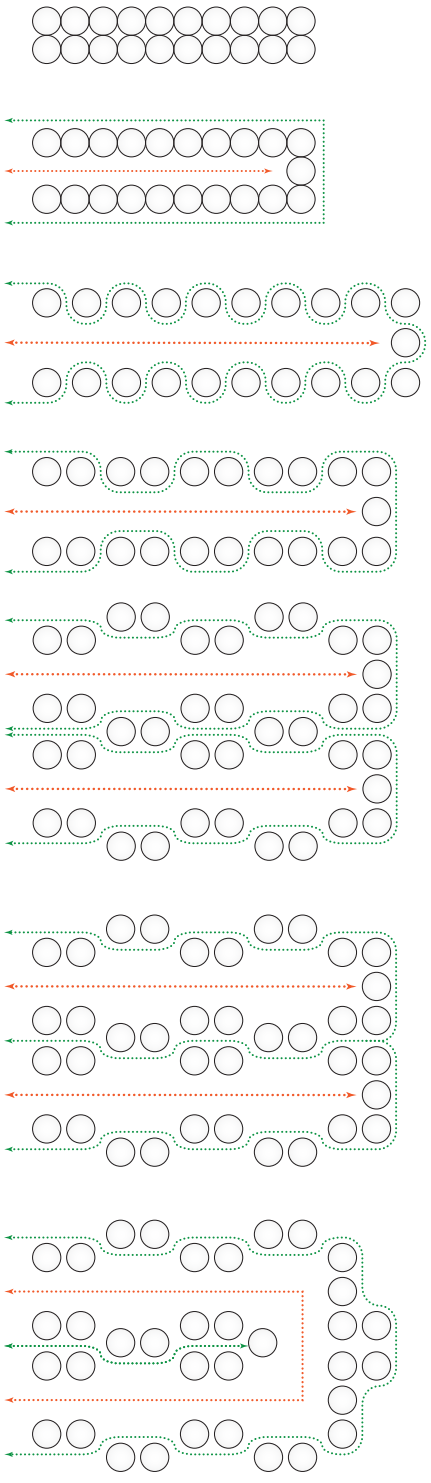
Driveway access to the south is shared with the main hospital facility & emergency room. A pedestrian entrance fronts onto the driveway, one of two main entrances. Pedestrian circulation is provided and marked between the existing structures, N. Lake Shore Drive, and N. Commonwealth Avenue.

Approximately 2 blocks away is the Stone Medical building, containing physician offices for Presence Health Care group. Medical personnel move frequently between these structures. This is reflected in public circulation throughout the area, with crosswalks and sidewalks providing the most direct urban paths.

1.3 Residential Access

The majority of the surrounding urban area is strictly residential, with some commercial areas bordering the busier streets. It is mostly comprised of 3-7 story apartment complexes & 2-story townhouses, interspersed with a few high-rise residential structures.

2.0 CIRCULATION & GREENERY STUDIES



Identifying the general relationship between the circulation, patient rooms and greenery was of primary concern when beginning design. It was necessary to maintain efficiency for staff and users; however a move away from traditional hospital hallways was desired. In order to introduce variation along the path of circulation, exercises in clustering were analyzed for affected changes

Varying movement of individual rooms proved unfruitful. It introduced too high a level of variance, lending an undesired level of complexity and potential confusion. Additionally, it would lead to more complicated services & structures, which due to the size and expanse of the project, were not ideal or economic.

By clustering rooms together, modules were formed that had repeating schemes and relationships to circulation and greenery, but ideally provided enough variation to relieve the monotony of traditional hospital halls. This raised the question of scale within the module: modules consisting of only two rooms had the potential to still create undesired complexity & confusion, whereas modules consisting of 10 or more, lost the practical organization for services & structure purposes.

The use of clustering raised additional questions regarding the necessary access to greenery and light. With regards to staff and user efficiency, double-loaded corridors were unavoidable. Utilizing continuous circulation provided opportunities for more variation, reducing the potentially redundant movement of staff and patients. However, one of the driving design concepts was comprehensive access to greenery and light. The arrangement of clusters had the potential to provide access points along main circulation, but careful planning was required to provide this more public access while maintaining exposure within patient rooms.

3.0 CONCEPTUAL DEVELOPMENT

This proposal began with a traditional ward layout, forming a bar across the site. In following the design concepts, this was widened to accommodate a more spacious circulation path, and larger single-patient rooms. By pulling this volume apart further, additional space is created within the circulation path, finally separating into two bilateral volumes. Diagrammatically mimicking the division of cells, or mitosis, the intent is to create two adjacent volumes with direct relations between. The space between begins to represent a courtyard, providing area for larger plantings and inter-floor visibility and interaction.

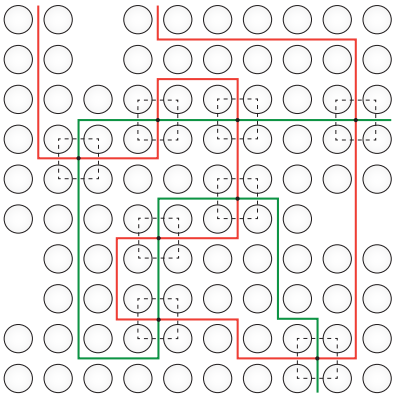
In order to respond best to the site, these two bars can be broken, or kinked, into oblique inward-facing angled volumes. This move provides a largely introspective approach for interior rooms shifts internal focus towards the courtyard. Not a traditionally encircled space, one can perceive the pressure of the exterior environment infiltrating between the two volumes. The north and south ends have gasket-like conditions that penetrate through and relate to the exterior environment, in truth creating a canyon or valley. While circulation across these areas is necessary, differentiation through tectonics and material choices can preserve this intrusion of the exterior. On the exterior, facades are able to take advantage of over 180° views to city and lakefront.

Moving into more literal translations, the vertical circulation cores are placed at the vertices of the two volumes, smoothing out the angular sections. This disparate plane on the exterior facades provides an additional opportunity for a “gasket” condition, allowing the exterior environment to again infiltrate into the volume and interact with the circulation, both vertical and horizontal.

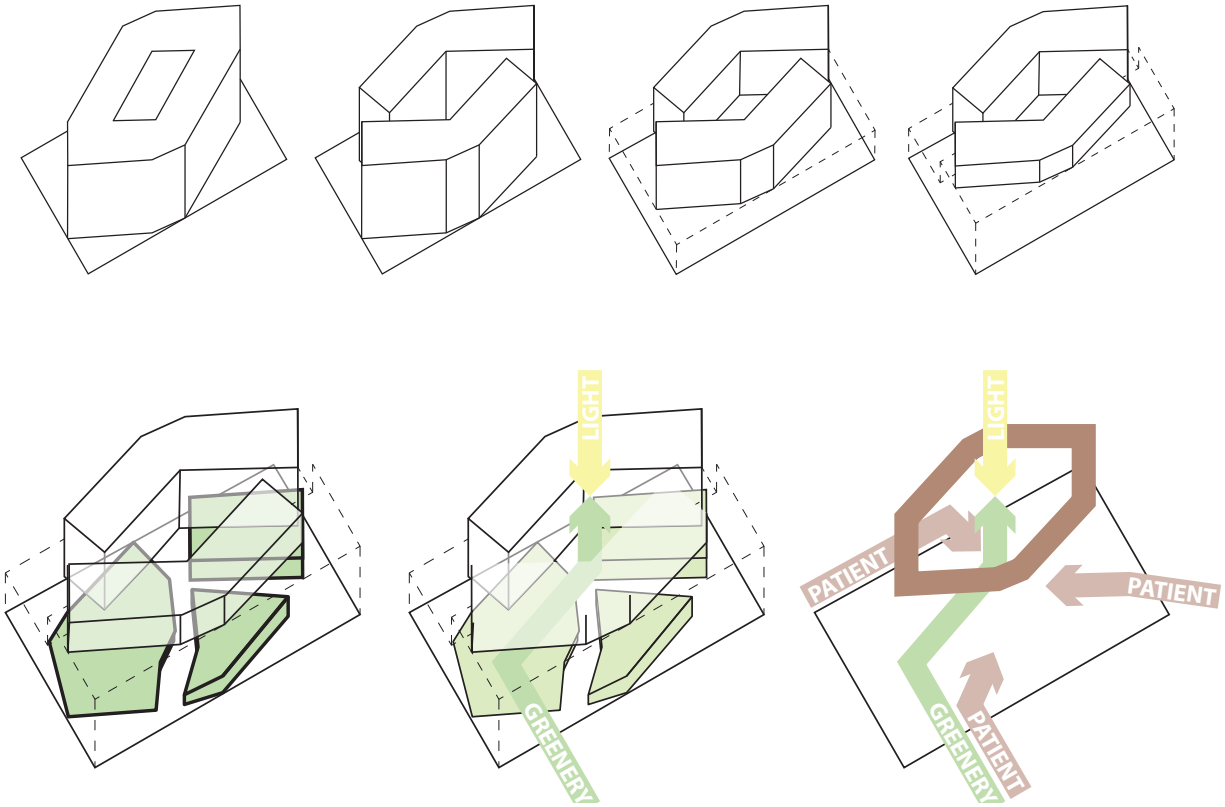
Analysis of the end facades of each bar prompts the volumes to rotate and shift closer, avoiding blocked views from high-rise buildings to the north and south. This shift redistributes the volume of the courtyard, standardizing its width along the length of the volumes. The north and south ends of the courtyard retain the gasket conditions, but become more embedded within the overall building volume, creating more alcove-like conditions.

Continuing a literal translation of the desired form, the circulation path is sketched out, and its instances of interactions with the exterior environment and interior courtyard are identified. Each hall within the two volumes has sightlines to a gasket condition or the exterior, providing a continuous visual connection to the environment and enhancing the individual's understanding of location within the structure.

Further considering leads to breaking each bar into an identical pair of clusters, four in total. Each reads as an individual volume, lending a tectonic separation to the gasket conditions of greenery infiltration.

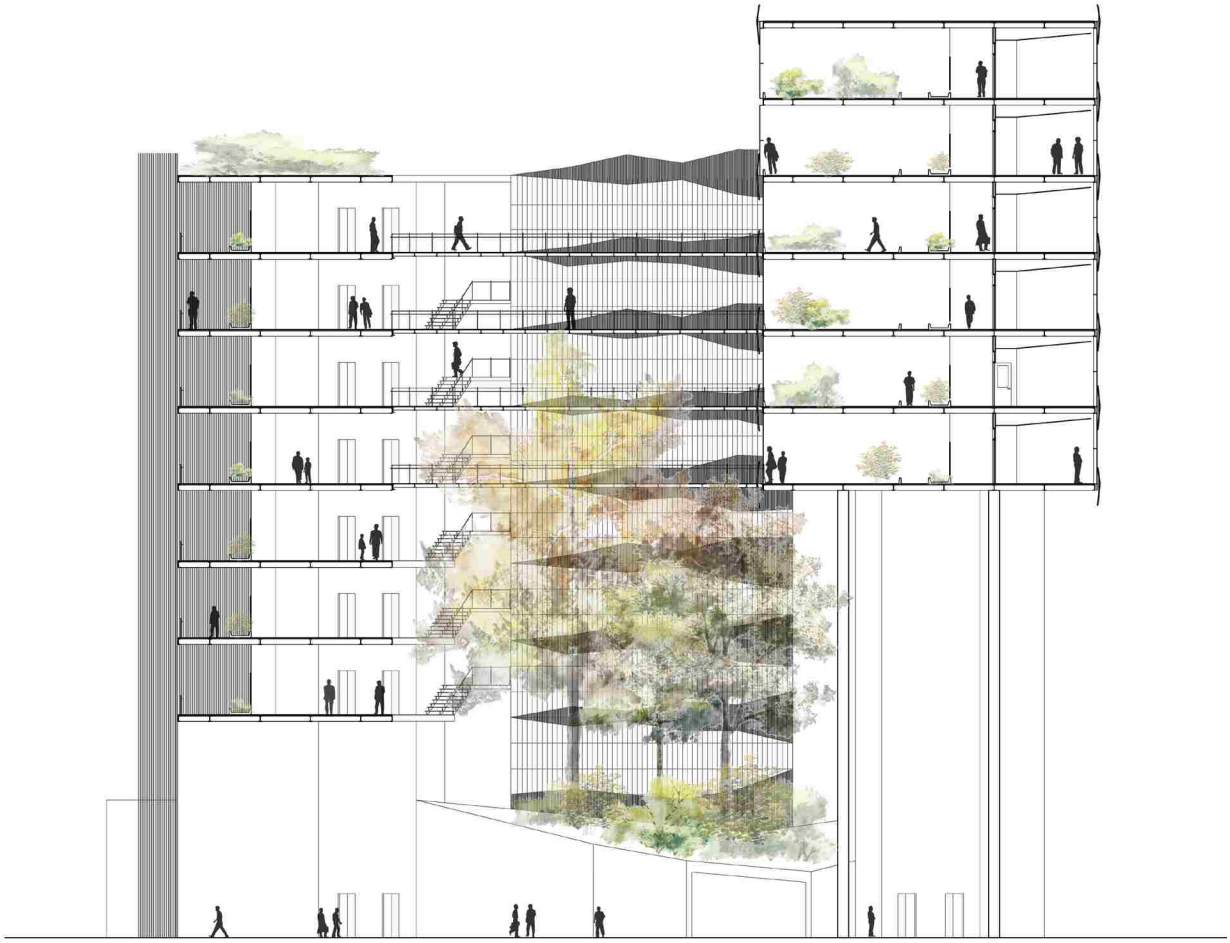


4.0 FINAL DESIGN PROPOSAL



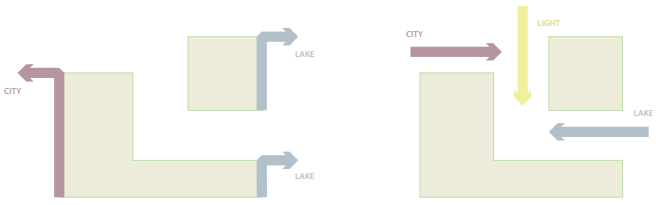
The progression of the building form vertically reflects the desire for comprehensive light and greenery access. Lifting the volume vertically moves the patient rooms above the shadows cast by neighboring buildings, increasing possible sun exposure.

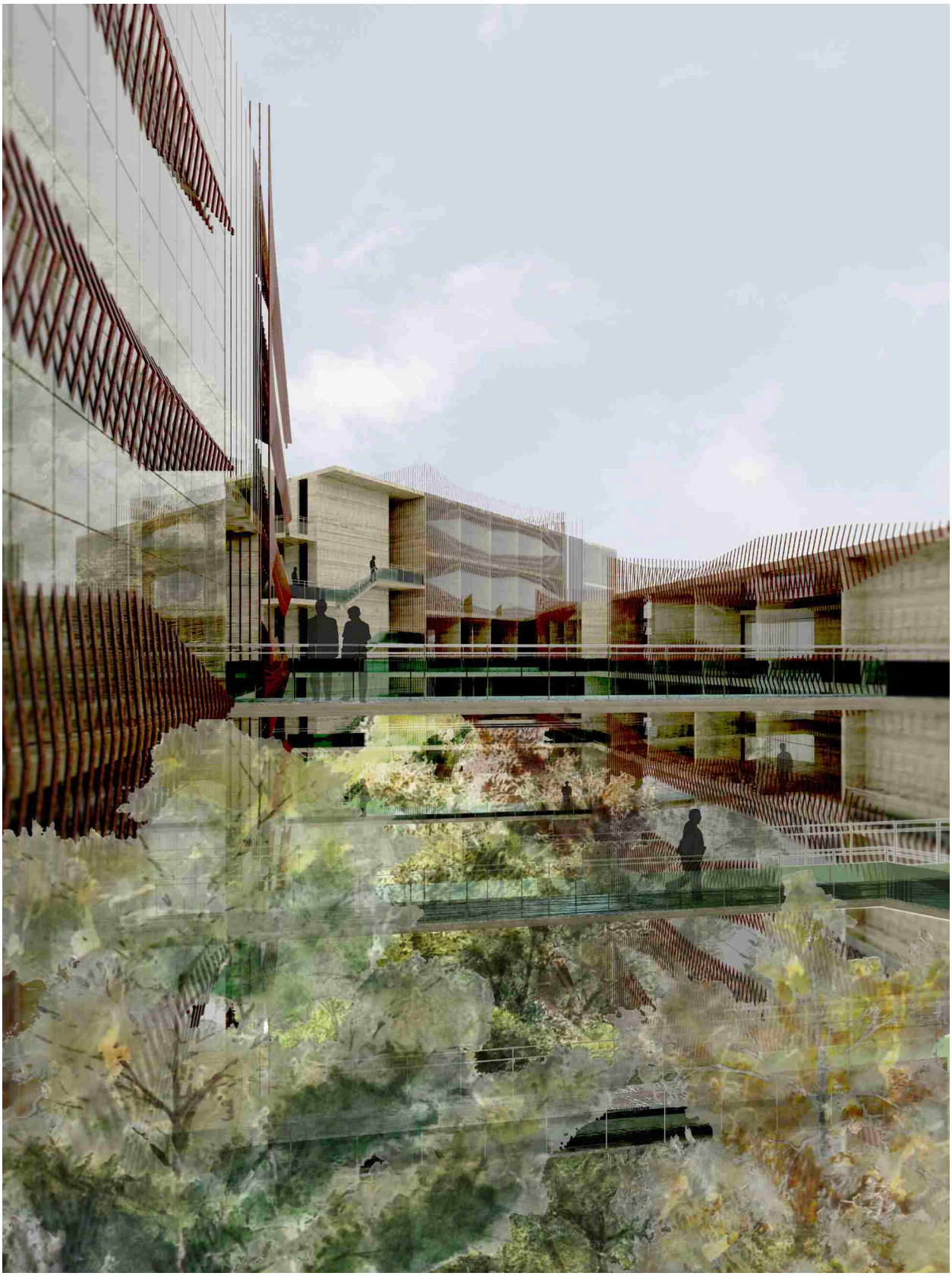
Creating a ramping base for the building provides a planar relationship to the lakefront park that continues into the building's core. While fissures are provided to facilitate ground level circulation and access to program, the broader gestural ramp continues the existing landscape from across the street, allowing the courtyard to be understood as an extension of the park, rather than a disparate green space.

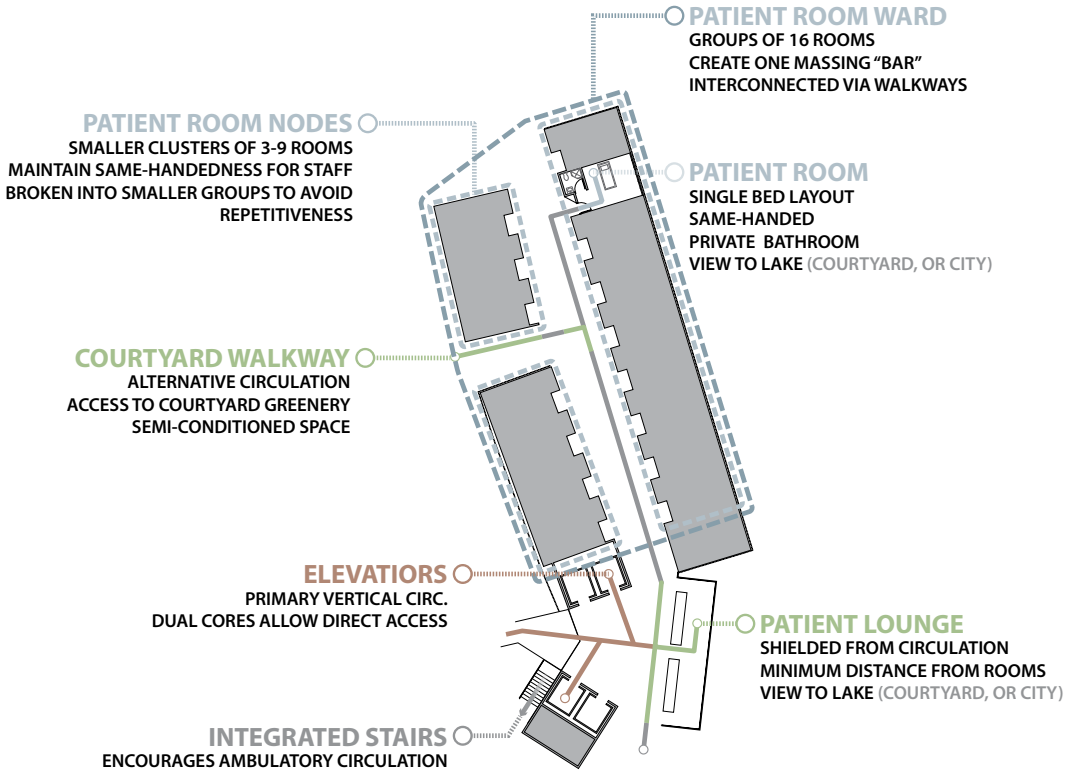


The vertical offset of the two bars provides numerous additional connections. This connects the courtyard horizontally to the lake, partially removing the vertical barrier of the east bar. Rooms on the interior side of the west bar are able to view the lake past the courtyard greenery, and are exposed to early morning light. On the courtyard level, this opens up the user experience, departing from the potentially claustrophobic feeling of a canyon-like space. This also exposes the upper floors of the east bar directly to the west, providing visual and physical access to the green roof of the west bar, but also providing views to the city beyond. Interior rooms on the east bar now experience afternoon light as well.

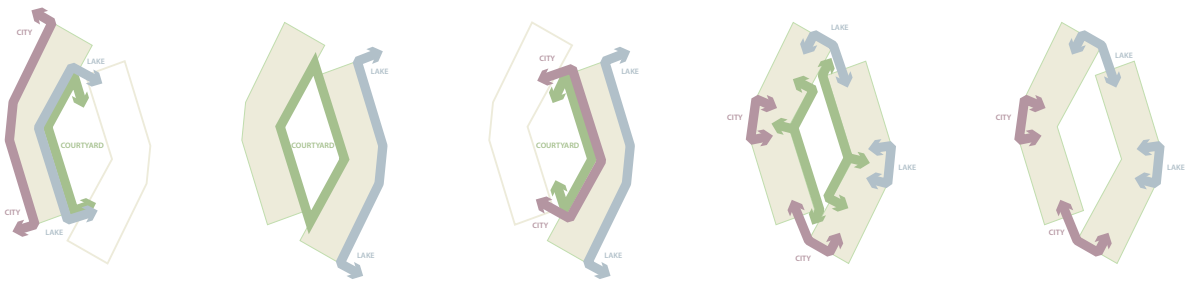
By creating this interplay within the courtyard of sky and lake access, the penetration of the exterior environment becomes a thoroughfare. Despite being enclosed, connection between the two facilitates an exchange of light and greenery, drawing both as completely into the volume as possible.







Circulation with each cluster is as direct as possible, using greenery interventions to avoid monotony, rather than creating complex and possibly confusing paths. Any user has nearly continuous visual access to greenery once exiting the elevators- if one uses the exposed stairs, users have complete exposure during their movement. One within the circulation landing, the patient lounge is separated by additional greenery. As one proceeds down the hallways to a patient's room, instances of double-loaded corridors create a slightly compressive space, spatially transitioning from the more public core into semi-private areas. Courtyard walkways punctuate the interior side of the corridor, providing glimpses into the courtyard and exposure to natural light. When leaving the circulation core, visibility is maintained either to the exposed ends of the volumes or to the larger exposed gaskets between bars. With the courtyard enclosed and considered semi-conditioned space, minimal passageway elements are needed to separate the spaces, creating distinctions between programmatic areas through spatial definitions instead.



CONCLUSIONS

The result from this thesis study was exceptionally insightful into the challenges that face healthcare design today. The primary limitation of the project turned out to be its most crippling; during the 10-week period, clear and concise ideas rose from study, but would benefit from further analysis. The real-world scale of this project would undoubtedly involve numerous people and months of design, thus limiting the scope of consideration at the beginning of the project was a necessary choice.

This concentration on the patient experience and the patient room yielded a successful proposal for the patient room floor, in addition to basic initiatives for the accompanying building organization and form. The proposed design maintains consideration of practical needs while breaking away from the monotonic forms that are traditionally employed. The level of detail reached during the project coincides with the depth of applicable concepts. The next steps would include incorporating specific structure and systems information. This would constitute another iteration of study, however, due to the scripted requirements of healthcare programs.

Some criticism concerns the lack of development of the remaining program spaces, and in particular, consideration of the entry sequence. While the ground level interaction of any building is vital to its success, an argument can be made for its exclusion for the focus this project. In terms of the patient experience, one enters the building, likely from the existing hospital from the south, and proceeds to check in. After that, most patients will spend the majority of their time in their rooms, or on patient floors. If time were not a primary limitation, more development of the ground floors would have followed, particularly to facilitate the fostering of a community within the building and between its program components. The established design language for the patient floor would provide for supporting spatial arrangement and consideration of the patient experience.

Future study would also include design of service areas, exploring the feasibility of this type of project. During the design development, constant effort was given to considering the real-world application of the proposed moves. While depth of detail for HVAC and structure were not included in this study, acknowledgement of its importance in healthcare design was included in consideration of programmatic arrangement and basic dimensions. A study of the effect of incorporated greenery on indoor air quality would be a project of its own: the volume of proposed greenery

has the potential to affect some of the expansive problems facing mechanical systems within hospitals today.

The survey of field would have benefited from additional investigation into precedents and their design process. During the development, many conclusions were drawn from rudimentary studies that are perhaps not traditionally published, but constitute an assumed body of knowledge apparent to those practiced in healthcare design. Outreach to local practices specializing in healthcare could have provided initial insight and provided a foundation for beginning the design process, rather than blindly beginning off pure research.

The strength of the project lies in its avoidance of complexity as a means to relieve monotony. Numerous instances during the design process prompted the use of more complex forms or organization to create variety, but the practical requirements of the program required simplicity. The decision to maintain a linear alignment of patient rooms, but broken down into smaller clusters provided the ideal opportunities to locate services and lounges to gently disrupt the circulation path. By breaking down the components into more human scale pieces, monotony is avoided while maintaining simplicity.

The project is deceptive at its first presentation, with the effect of its interventions revealing themselves after extended study. This level of simplicity is representative of its success—achieving the goal of integrating the design principles at inception, rather than providing the applicable interventions later in the process.

Rather than truly providing any solutions, hopefully this thesis directs the dialogue of healthcare design in a productive direction, highlighting the necessity of an evolution, perhaps more than change, in the current approach to healthcare design.

X

APPENDIX : HEALTHCARE PRECEDENTS & CASE STUDIES

1.0 HEALTH CARE CENTER FOR CANCER PATIENTS

2.0 NYE VARDHEIM

1.0 HEALTH CARE CENTER FOR CANCER PATIENTS

Municipality of Copenhagen Place, Denmark

Designed by NORD Architects

Built 2009-2011

Size: 2500 m2

"You know you're sick when you enter a hospital. Otherwise, you wouldn't go there. The large buildings with their grand reception areas are not places where you can hang out just for fun. But the new Healthcare Center… aims to be just that: a place where you come to get better, get knowledge- and have fun."

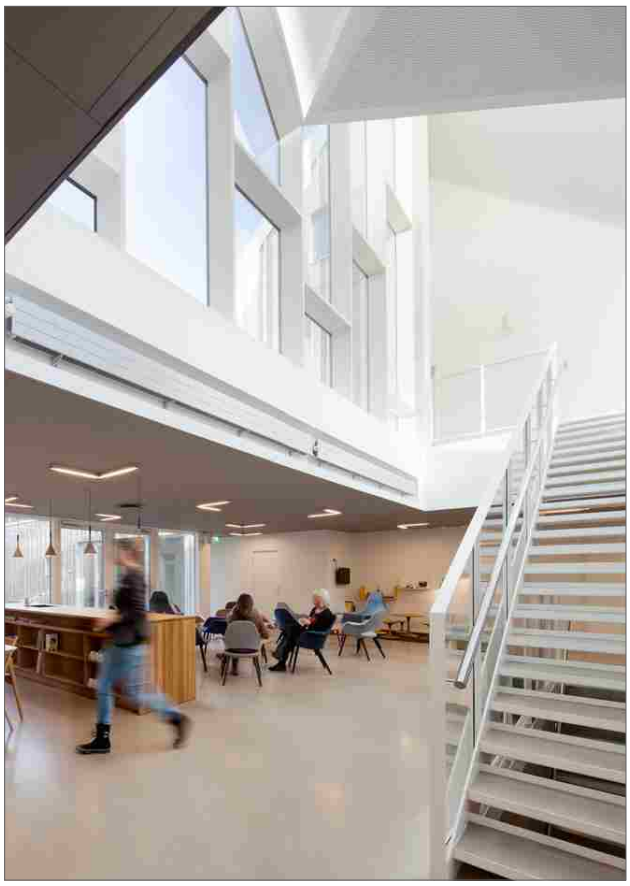
NORD Architects

Commissioned by the municipality of Copenhagen, Denmark, NORD Architects embraced the idea that architecture can have a positive effect on recovery from sickness. Shaped to imitate a cluster of houses, the Health Center for Cancer Patients provides space for a modern healthcare facility without losing the scale of the individual. According to the architects, the main design goal was to produce an iconic building to help create awareness of cancer without stigmatizing the patients.

Visitors enter through a comfy lounge area, staffed by volunteers. From here, patients move through adjacent "houses," which contain spaces for exercise, teaching kitchens, meeting rooms, and other functions. The entire facility wraps around an inner courtyard for contemplation, an unusually quiet haven within the city center. By containing the program functions within smaller modules arranged somewhat linearly, the architects were able to incorporate natural light throughout the

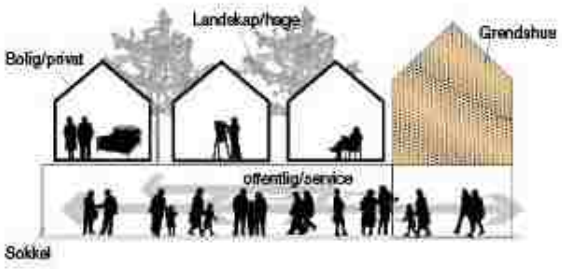
building, and provide nearly 360° interaction with the courtyard through openings and balconies. The raised roof resembles Japanese paper art origami, providing a cohesive feel throughout the facility and a characteristic signature on the exterior façade.

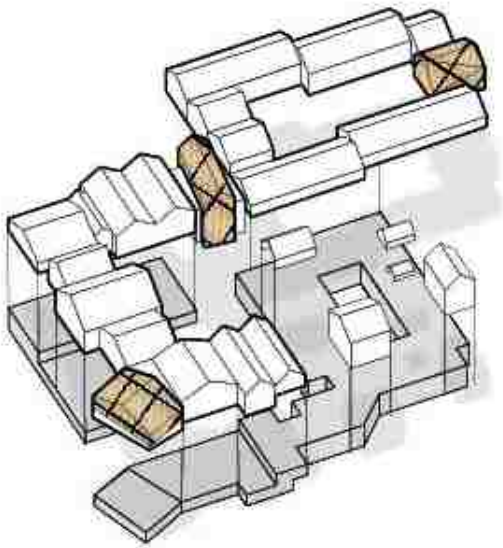
Situated close to the city, patients are treated at the Copenhagen University Hospital (Rigshopitalet), and move here for follow-ups and recovery. Room styling mimics domestic interiors to help patients feel at home.



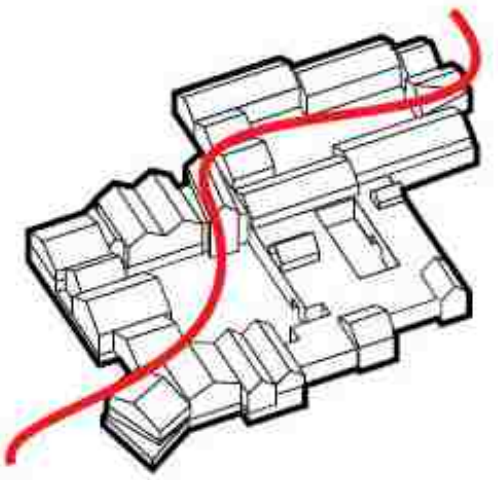
2.0 NYE VARDHEIM HELESCENTER

Municipality of Randaberg, Norway
Designed by NORD Architects + 3RW Architects
2013 Competition Winner
Size: 11,000 -16, 000 m2

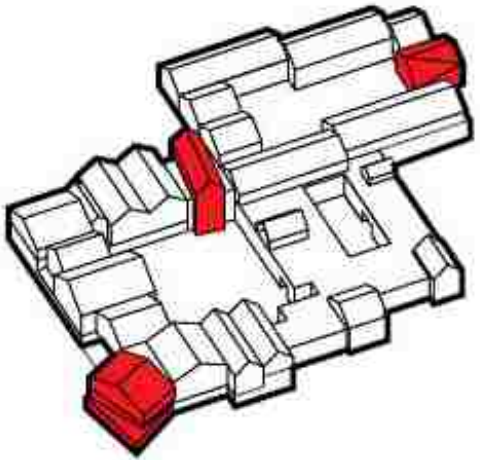


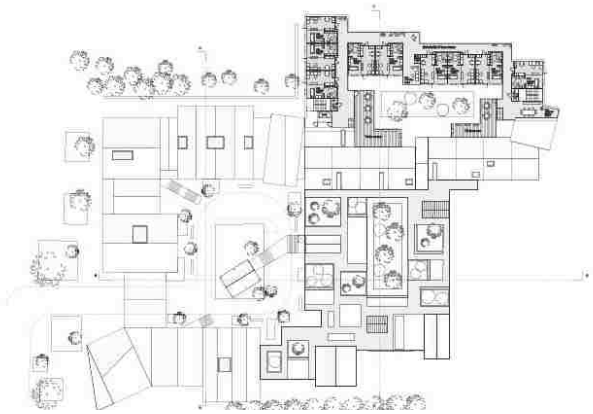


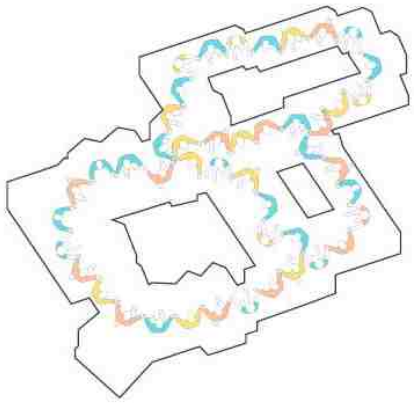
Winning a 2013 competition held by the Municipality of Randaberg, Norway, the Nye Vardheim welfare center re-imagines the traditional approach to Nordic welfare services. Program components range from cafes & shops to nursing homes, consultation offices, and therapy gyms. Their goal was to provide a haven where people are treated, recreate and be nursed.



Covering a total of 11,000 m2, the Nye Vardheim facility offers a variety of treatments under one roof. The traditional type of Norwegian hamlet, called a *grend*, were clusters of houses that shared physical space. These central community area created a sense of unity, common destiny, and connection to the land. NORD Architects + 3RW Architects took these principles and applied them to a modern healthcare facility. Different facilities and institutions each become an individual "home," but together, they create a sense of community between the patients and practitioners.





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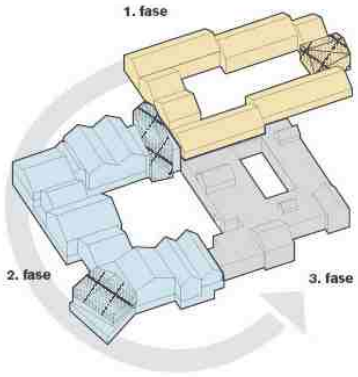
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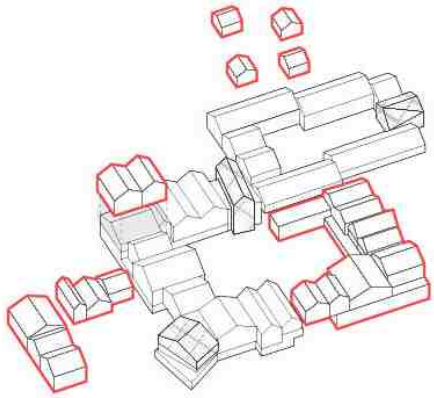

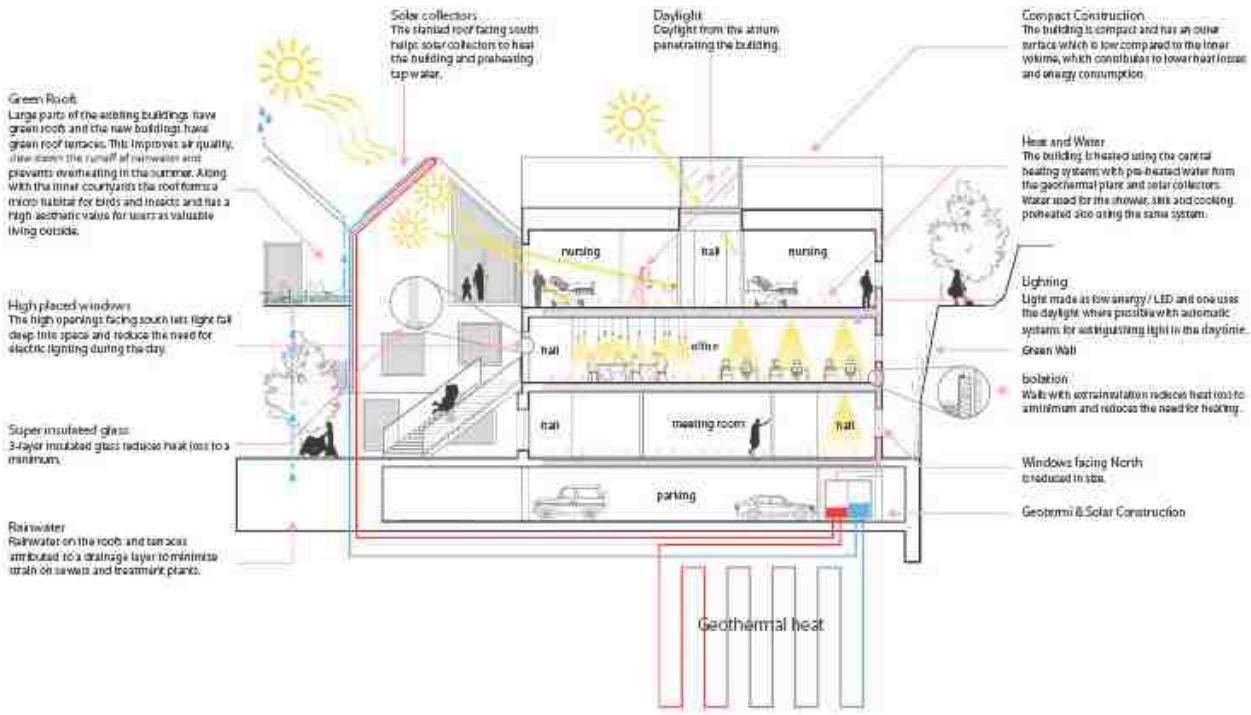
Solar collectors
The slanted roof facing south helps solar collectors to heat the building and preheating tap water.
Daylight
Daylight from the atrium penetrating the building.
Compact Construction
The building is compact and has an outer surface which is low compared to the inner volume, which contributes to lower heat losses and energy consumption.
Green Roofs
Large parts of the existing buildings have green roofs and the new buildings have green roof terraces. This improves air quality, slow down the runoff of rainwater and prevents overheating in the summer. Along with the inner courtyards the roof forms a micro habitat for birds and insects and has a high aesthetic value for users as valuable living outside.
Heat and Water
The building is heated using the central heating systems with pre-heated water from the geothermal plant and solar collectors. Water used for the shower, sink and cooking preheated also using the same system.
High placed windows
The high openings facing south lets light fall deep into space and reduce the need for electric lighting during the day.
Lighting
Light made as low energy / LED and one uses the daylight where possible with automatic systems for adding/dusting light in the daytime.
Green Wall
Super insulated glass
3-layer insulated glass reduces heat loss to a minimum.
Isolation
Walls with extra insulation reduces heat loss to a minimum and reduces the need for heating.
Windows facing North
is reduced in size.
Rainwater
Rainwater on the roofs and terraces attributed to a drainage layer to minimize strain on sewers and treatment plants.
Geothermal & Solar Construction
nursing
hall
nursing
hall
office
hall
meeting room
hall
parking
Geothermal heat

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