Children's Cancer and Transplant Hospital: a Micro Town within a Bubble

CHILDREN'S CANCER AND TRANSPLANT HOSPITAL:

A MICRO TOWN WITHIN A BUBBLE

A Thesis Presented

by

Kimia Samimi

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DEDICATION

In memory of all the little angels who perished as a result of cancer, those who are bravely fighting it, and their loving parents

ACKNOWLEDGMENTS

I would like to express my deep and sincere gratitude to my academic advisors, Kathleen Lugosch and Sigrid Miller Pollin. Their encouragement and constructive guidance have been with me throughout this thesis.

I am heartily thankful to my parents, Niloofar and Mohammad, and my brother, Kayvan, for their unconditional support throughout my degree. I send my deepest love and appreciation to you.

ABSTRACT

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MAY 2012

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As the greatest considerations in health-care design have traditionally been functional — hygiene, efficiency, and flexibility for changing technology— hospitals have evolved to become dehumanizing spaces. In this thesis two specific groups of chronically ill children who have among the longest inpatient stays are studied: cancer and organ transplant patients. Being under immunosuppressive drugs, these children are physically vulnerable thus are kept completely isolated. These long stays and isolation can be very depressing for them.

This thesis undertakes the challenge of designing a fully isolated space that doesn't feel like one or in other words "a micro-town within a bubble". The author intends to achieve this goal through strong visual connections, natural lighting, and creative space planning.

PREFACE

Since the greatest considerations in health-care design have traditionally been functional —hygiene, efficiency, and flexibility for changing technology— hospitals have evolved to become dehumanizing ghettos. Emphasis on shorter inpatient stays coupled with economic constraints has only exacerbated this tendency. There are way too many design regulations in place, covering the major aspects such as sanitation, seismic and fire risks, and handicapped access, down to the finest details like prohibition of slippery floors, that if followed by an unaware designer can lead to the unsavory design of the classic hospital. However, if the design process is started with the human beings and their feelings at its core, one can still manage to mediate all those requirements. This thesis seeks to explore the opportunities of making architecture become part of the healing process and be transformed from a "passive container" to an "evolving healing space" that actually takes part in the healing process.

In this thesis two specific groups of chronically ill children are studied; cancer and organ transplant patients. These two groups of patients are given immunosuppressive drugs as part of their treatment. These chemicals suppress bone marrow function, including its ability to produce immune cells. As a result, transplant recipients and cancer patients are left totally vulnerable to any type of infection or disease. Since at this point exposure to viruses and infection could be fatal for patients, they will be hospitalized in a completely isolated section where there is no direct air exchange or any other kind of direct contact with the outside world. This period of isolated hospitalization could take up

to months which is a very long time for a child to be away from conveniences such as company of friends or fun activities, and not to be able to leave the isolated section.

This thesis undertakes the challenge of designing a fully isolated space that doesn't feel like one; "A micro-town within a bubble". No direct air exchange between inside and outside being allowed, tangible connection with outside or openings could not be employed. Therefore, visual connection, lighting, and creative space planning remain our only tools for achieving a virtual sense of an outdoor space, inside.

Inspired by Grant Hildebrand's ideas in his book "Origins of Architectural Pleasure", this thesis proposes engaging "refuge spaces" that feel safe and homey, and "prospects" to explore. This can create a sense of "in and out" inside an isolated space and fulfill part of children's natural need for adventure.

The author believes architecture to be the art and knowledge of putting various pieces of the project puzzle together in a way to create a product that works best for as many people involved with it as possible. In the case of designing a cancer and transplant wing for a hospital, four group of people are involved: Patients, Parents, Staff and the Community and neighborhood; each having different perspectives of the space and specific demands from it. Another set of pieces of this puzzle are elements that will take this project one step further than the conventional healthcare design. As will be demonstrated throughout this thesis, I have found inspirations from unconventional sources that we do not usually look at while thinking of a hospital; places and settings that have managed to convey a sense of serenity and peace in their own way for many years. These pieces of the puzzle are harder to fit in a hospital design since there are few

precedents incorporating them available to study. However, by thinking outside the box and shifting human to the center in our thinking and decision making process, we can come up with innovative solutions for old problems. Finally, the last set of pieces of this puzzle are all the rules and regulations for healthcare design that set evaluation scales for functionality and safety of the space. The guidelines that are specific to the site location help us respect the community and nature by creating a safe and consistent environment in the neighborhood.

This thesis raises the argument that hospitals tend to be an isolated and stressful zone for both patients and staff. High rates of staff turnover in hospitals verify that matter. In this research, effort has been put into offering solutions for reconnecting hospitals –even the most isolated sections of a hospital- to the community and nature. Presented solutions could be generalized to a broad range of regions and be developed according to specific sites. In the design stage of this project, the focus has been on putting all the three sets of pieces of the design puzzle together and generating a coherent design that responds to most of the depicted concerns.

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LITERATURE REVIEW

Biophilic Architectural Space

It has always been interesting to me to find out whether we can categorize the artistic aspects of architecture by approaching it from a scientific point of view; for instance whether we can gather data from a large number of people who interact with a particular healthcare space, then categorize the data and publish the results as general characteristics of a successful and comforting healthcare space. I have always wondered whether those general rules would be as effective for people with different cultural backgrounds or even for people of different age groups or genders.

Grant Hildebrand in his book "Origins of Architectural Pleasure" classifies architectural characteristics of the settings that people find attractive. According to Hildebrand, settings with such characteristics have always been attractive to people and even though the reasons for liking such spaces have been fading throughout the history, people, being genetically related to their ancestors, still enjoy it. Hence he suggests reproducing those enjoyable spaces by applying these characteristics to make our buildings more satisfying. Hildebrand counts those characteristics as followed: Prospect and refuge, enticement, peril, complex order.

Complex order: Hildebrand believes that while human beings are designed to enjoy complexity and order, order alone is monotony and complexity alone is chaos. To be satisfied by the space, we need to combine these two to have a complex order just like what we do in music. Complexly ordered sound is music which we enjoy and chaotically complex sound is noise which is disturbing to us.

Prospect and refuge: Having rout in our ancestors' need to a place be protected against predators and climate [Refuge] and a place to hunt and find food [Prospect], we still feel comfortable to have a refuge, small and dark and a prospect, expansive and bright in our homes. These two, cannot exist in the same space, they can occur contiguously, however. Frank Lloyd Wright's houses are perfect examples of incorporating these two qualities of space in the design; small subspace with low ceiling and opaque three sides, low, dark, warm and cozy for refuge and larger space, brightly lit with views to outside in three directions for prospect.

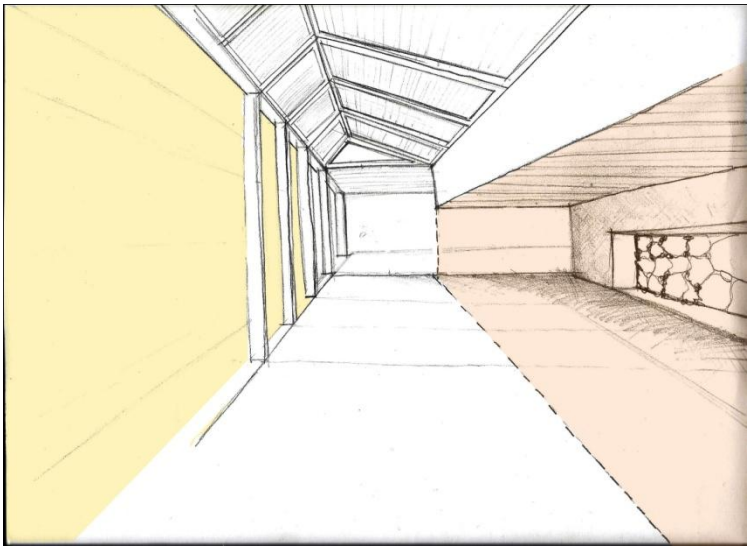

Figure 1-Peospect vs. Refuge (by author)

Enticement: Human beings, having an urge to discover in relative safety, enjoy having spaces to explore. Light plays a major role in forming such space. Lit spaces draw people toward them while dark spaces as passages to get to light, help people conceal; not being seen before seeing probable dangers. The following diagram shows how simply adding or removing an access door and by managing the circulation inside a space, designers can create either a darker refuge for "staying" purposes or a lighter intermediate space for "passing" purposes.

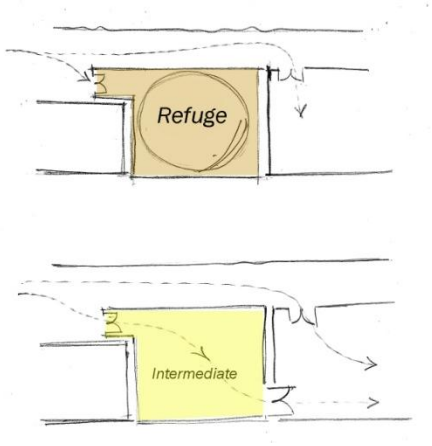

Figure 2. Refuge vs. Intermediate Space (by author)

Peril: Settings that present apparent and dramatic peril, but yet we control the degree of risk thrill us. Elevated passageways across or adjacent to large interior spaces have a similar effect.

Designing Places For People

It is the most natural but yet forgotten fact in architecture that when designing for people, we must study people. In other words, designers should carefully pay attention to the certain needs of the users of the space and it is only possible by "observing" or as C. M. Deasy and Thomas E. Lasswell in their book "Designing places for people" call it "playing the people-watching game".

They believe that while there is so much information available to deal with serious problems of technology, health, safety, and legal constraints, and economics, it is surprising to see that there is so little information available to designers about their principle concern, the human client. This doesn't mean that the human body is not studied enough. The fields of anthropometry is very well developed and excellent reference works are available to architects

but the field that needs to be linked to architecture and to be added to designers' references is the study of the relationship between the environment and behavior. It is specially very important while designing healthcare facilities if we intent to get away from "patient warehouses" and design "interactive healing spaces".

The impotence of the impact of environment on behavior shows even more while designing for children. Children by nature pay a lot more attention to their environment than grownups and as a result of this careful observation, they are impacted by their surroundings even more than adults are. "the nature of our buildings and streets affects our behavior, affects the way we feel about ourselves and, importantly, how we get along with others (1)." The fact that humans are adaptable and get used to any living space that they put into should not become an excuse for careless planning of environment.

There are new connections being drawn between neuroscience and architecture. This can open a lot of possibilities to architects in terms of having a better understanding of what exactly happens in human brain that causes them perceive a particular space as they do. By starting the design from the client's end of the designer-building-client spectrum, the focus will be shifted from the building as a container to people and their needs. "If designers were able to work with a clear understanding of the relationships between behavior and environment, they could create communities where these effects are positive and beneficial. Without such an understanding, the behavioral effects of design are haphazard at best and disastrous at worst. It is like flying without a map or compass (1)"

"As long as we make "assumptions" about human behavior rather than finding out about it, we are likely to make errors. Environmental designers should use the knowledge of human behavior to create places that help people accomplish their purposes with a maximum of satisfaction and minimum of friction and frustration (1)."

The ideal phase to incorporate our knowledge of human's behavior in relation to environment is pre-design stage. This information must help the designers to generate a careful behavioral program, or a supplement to the building program, based on the human behavioral science.

Varieties of Visual Experience

Architects as artists are the creators of the space, but they also need to put themselves in their clients' shoes and examine the space from their point of view. In other words, architects should have a good understanding of humans' ways of perceiving the space and work around it in order to help people feel the sense of space that the architect has in mind. If us, as architects deny this very important aspect of design, the final product of our work might become a "container" that can hold any physical function but doesn't serve as a "interactive" space that communicates with its users on its own.

There are tools in the hands of architects that help them create that interactive space: openings, lighting, surfaces, geometries, colors and textures are among those. Edmund Burke in his book "Varieties of visual experiences" investigates a number of successful interiors and explains why one feels the way they do in those spaces. The following examples are from his book.

Figure 3. Interior, Le Corbusier. Notre_Dame-du_Haut, Ronchamp, France. 1950_55 (From Ref. 2)

Bruke believes that in the design of Nore Dame du Haut, Le Corbusier has reinvented the window like a sculptor. **"**Rectangular openings in a thick concrete wall visually dramatize the process of light entering an interior at many eye levels (2)."

Figure 4. Eero Saarinen. Interior, TWA Terminal, Kennedy International Airport, New York, 1962. (From Ref. 2)

In the interior design of TWA Terminal of Kennedy International Airport in New York, Eero Saarinen has represented the trajectories of flight through the sweeping structural shapes and curved edges. "The interior spatial expression is of a great womb-like cave, with light from a multitude of organic openings penetrating its earthy recesses (2)."

Figure 5. Marcel Breuer. Interior, garden level, Whitney Museum of American Art, New York. 1966, (From Ref. 2)

In the interior design of the garden level of Whitney Museum of American Art in New York, Breuer has moves the viewer's eye through a number of interpenetrating indoor-outdoor spaces at the basement and street levels and creates the illusion of a spacious space in an actually shallow site. "He compensates for lack of acreage with vertical variety and a masterful articulation of surface planes (2)."

Figure 6. I.M. PEI. Interior. Everon Museum of Art, Syracuse, New York. 1965-68, **(From Ref. 2)**

In the interior design of Everon Museum of Art in Syracuse in New York**,** The architect has created a monumental feel in a rather small room. Bruke explains that this has been achieved by attention to fundamentals: honest and uncomplicated enclosure of space, a practical device for washing the walls with light and a modest amount of wall punctuation that allows the art objects to breathe.

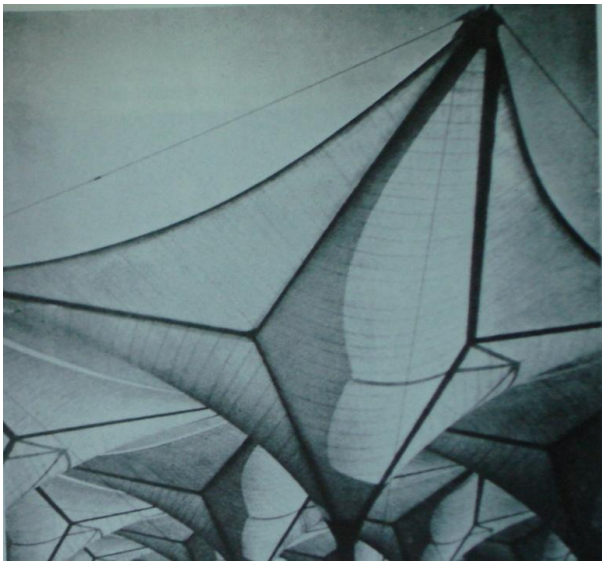

Figure 7. Umbrellas over trade section, Swiss National Exposition, Lausanne, 1964 (From ref. 2)

"Architects persistently seek the tent experience_ for religious or secular purposes_ because of the sense of protection it fosters while we feel bathed in a wonderful overhead light (2)." Although inside, sometimes we can recreate this "tent effect" to let the users of space feel secure and safe especially when we are dealing with children as subjects of design. This idea also ties well with Hildebrand's definition of "prospect & refuge". Inside the tent will be the safe refuge that looks out to outside or even an interior high-traffic hallway in a hospital (prospect).

Figure 8. http://www.centralarchitecture.com/1242/spongebob-squarepants-kids-room-design.html

Healing Places

In order to fully understand what patients go through during their healing process, we need to look at the spaces we design from patient's eyes who has been laying in bed for several days or weeks and does not have much control over their own body. The only means of communication with the outside world for them become what they see, what they hear and what they smell and their only human contacts becomes the short chit-chats with nurses or family visits. In such situation when one loses the ability to move around and explore things for themselves, their working senses become more acute and try to receive as much information as possible and keep their connection with the outside world. A good example of this is a visually impaired person whose hearing becomes more sensitive and acute than other people. for these acute sensors, ready to get signals from the space that encompasses them, careful thought should be put into designing the details.

Can physical space contribute to healing?

"The first study to tackle this question, published in Science magazine in 1984 by Roger Ulrich, director of research at the American Institute of Architects (AIA), showed that when hospital rooms have windows looking out on the natural world, patients heal more rapidly (3)."

In his study, Ulrich analyzed what the patients had already being monitored for- heart rate, EKG, blood pressure, temperature, etc. He used those numbers to measure whether or not the windows had an effect on healing.

He chose forty-six patients whose beds were near windows that overlooked either a grove of trees or a brick wall. "Ulrich had recorded each patient's vital signs and other indicators of health, including dosages and types of pain medication and length of hospital stays. He'd found that patients whose beds were located beside windows with views of a small stand of trees left the

hospital almost a full day sooner than those with views of a brick wall. Not only that, but the patients with nature views required fewer doses of moderate and strong pain medication (3).”

CHAPTER 2

TIMELINE OF HOSPITAL EVOLUTION

The notion that nature was important to healing had been around for thousands of years. "In ancient Greece, temples dedicated to the healer-god Asclepius, known as Asclepieia, functioned as centers of medical advice, prognosis, and healing (4)." These temples were built far from towns, high up on hilltops and were overlooking the sea.

Between ancient times till late eightieth century, the focus gradually shifts from the patients to disease and from healing to diagnosing and treating. Around late eightieth century, architects started implementing ideas that provided a better built environment and hospitals started shifting back from "patient warehouses" to places for healing.

"In Europe the medieval concept of Christian care evolved during the sixteenth and seventeenth centuries into a secular one, but it was in the eighteenth century that the modern hospital began to appear, serving only medical needs and staffed with physicians and surgeons (4)."

"In the nineteenth century, hospitals were built with large windows and even skylights; with large windows facing south and a solarium at the end of each ward (3)."

. "In 1860, Florence Nightingale wrote that darkened rooms were harmful and sunlit rooms healthful; large, airy, bright rooms were the hallmark of what came to be known as a Florence Nightingale (3)."

"In the late nineteenth and early twentieth centuries, the notion that sunlight could heal was very much in vogue. In 1903, Dr. Auguste Rollier opened a sunlight clinic in the Swiss Alps (3)."

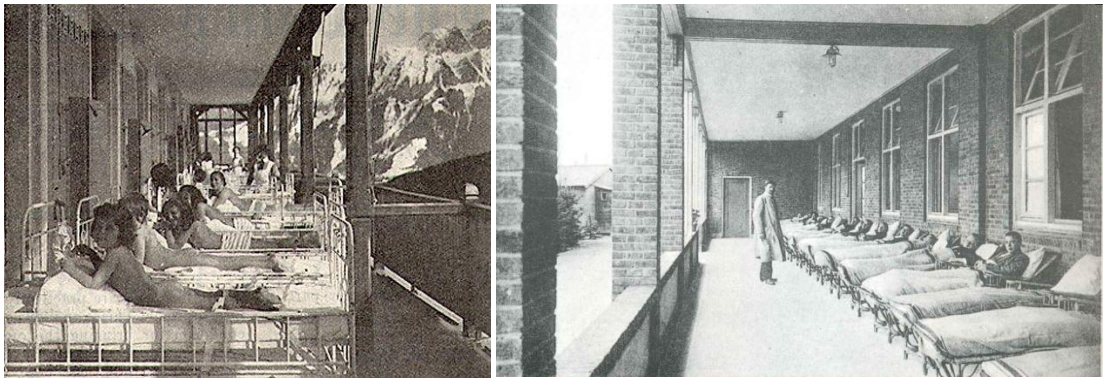

Figure 9. sunlight clinic in the Swiss Alps, http://1.bp.blogspot.com/_-yDGOqcb9Uk/TMD6xKYQPEI/AAAAAAAAAFE/rXfhXy9TQk8/s320/rollier.jpg

Figure 10. sunlight clinic in the Swiss Alps, **http://medaesthetics.files.wordpress.com/2009/07/picture11.png**

"As reliance on and awe of medical technology increased in the mid-twentieth century, the comfort of the patients was somehow pushed aside and their surroundings were often ignored. Hospital planners assumed that patients could adapt to the needs of technology, rather than the other way around. By the late twentieth century, state-of-the-art hospitals were generally designed to accommodate state-of-the-art equipment (3)."

“Modern hospital buildings are designed to minimize the effort of medical personnel and the possibility of contamination while maximizing the efficiency of the whole system. However, the reality is that many hospitals, even those considered 'modern', are the product of continual and often badly managed growth over decades or even centuries, with utilitarian new sections added on as needs and finances dictate. As a result, Dutch architectural historian Cor Wagenaar has called many hospitals:

"... built catastrophes, anonymous institutional complexes run by vast bureaucracies, and totally unfit for the purpose they have been designed for ... They are hardly ever functional, and instead of making patients feel at home, they produce stress and anxiety (4).”

“Some newer hospitals now try to re-establish design that takes the patient's psychological needs into account, such as providing more fresh air, better views and more pleasant colour schemes. These ideas harken back to the late eighteenth century, when the concept of providing fresh air and access to the 'healing powers of nature' were first employed by hospital architects in improving their buildings (4).”

“Evidence-based design often shortened to EBD is a relatively new field of study which emphasizes the importance of using credible data in order to influence the design process. The approach has become popular in Healthcare Architecture in an effort to improve patient and staff well-being, patient healing process, stress reduction and safety (4).”

Neuroscience is the scientific study of the nervous system. Traditionally; neuroscience has been seen as a branch of biology. However, it is currently an interdisciplinary science that collaborates with other fields such as architecture. Studying the relationship of neuroscience and architect is a very new science which basically explains how brain areas are involved with architecture and what is exactly happening in our brains while we perceive a space. John Eberhard, director of research at the American Institute of Architects (AIA), hosted a

collaborative workshop for scientists and architects in Woods Hole, Massachusetts in 2002 to explore the interface between architecture and neuroscience. It was the first workshop of what would become the Academy of Neuroscience for Architecture.

The innovative new Academy of Neuroscience for Architecture (ANFA) was formed in San Diego in the Spring of 2003 by the San Diego Chapter of the AIA. In their mission statement, ANFA has defined their goal to promote and advance knowledge that links neuroscience research to a growing understanding of human responses to the built environment. “The academy's board of directors has identified several topics for study, including "Healing by Design" for Alzheimer's patients. Neuralpathologic changes associated with neurodegenerative disorders are known to cause Alzheimer's. By understanding how such damage to the brain changes perceptions, we may be in a position to know why certain facility designs can calm and aid those afflicted by this disease (5).”

CHAPTER 3

SUSTAINABLE HEALTHCARE ARCHITECTURE

Sustainability in This Design Proposal

"The green building movement is guided by a simple, yet revolutionary idea: that the buildings in which we live our lives can nurture instead of harm, can restore instead of consume, and can inspire instead of constrain (6)."

Although the aspect of "nurturing" sounds natural to be reflected in healthcare buildings more than any other category, throughout the history, healthcare buildings have become the sterile, imposing facilities. However, the recent trend in healthcare design and attention to daylight and connection to nature is bringing the hospitals back to life.

Sustainability by definition, ties with the goal of this thesis- Designing a space that plays role in healing or even heals. Thus it seemed necessary to the author to explore possibilities of thinking and designing more sustainable in the framework of this project.

Janine Benyus (1997) suggests nine principles that define natural systems:

-Nature runs on sunlight.

-Nature uses only the energy it needs.

-Nature fits form to function.

-Nature recycles everything.

-Nature rewards cooperation.

-Nature banks on diversity.

-Nature demands local expertise.

-Nature curbs excesses from within.

-Nature taps the power of limits.

In order to be sustainable in the context of nature, we should follow the footsteps of natural systems. In other words designers should try to avoid interfering with nature's balance. For instance, water can flow in its natural pattern, draining around the building as opposed to being obstructed by building and then redirected to drainage system.

Architect Bob Berkebile and designer Jason McLenan (1999) define the future of architecture as a future of living buildings, operating on the six principles. Living buildings will:

1-Harvest water and energy needs on site.

2-Be adapted specifically to site and climate and evolve as conditions change

3-Operate pollution free and generate no waste that aren't useful for some other process in the building or immediate environment

4-Promote the health and well-being of all the inhabitants, as a healthy ecosystem does

5-Compromise integrated systems that maximize efficiency and comfort

6-Be beautiful and inspire us to dream

Sustainable Materials and Finishes

Rick Fedrizzi in the foreword of the book "Sustainable Healthcare Architecture" says: "It is stunning commentary that in the first decade of the twenty-first century we continue to live in

an era of sick building syndrome_ one consequence of the chemical soup that has resulted from materials and technologies that emit a toxic portion that renders some buildings uninhabitable or puts the people who live, learn, work, and heal in them at risk (2)."

He also believes that although we have been successful in ridding paint of lead and pipes, roofing, siding and floor tile of asbestos, we are still facing with an increasingly chemically complex and risky palette of materials that are sought after because they are inexpensive, look good enough, and meet minimum requirements for performance and safety. We keep using these materials because they are durable and last in place for decades.

Interview with Janet Brown

Contributing Editor at Health Care Design Magazine

Director, Sustainable Operations at Practice Greenhealth

A new position called "Chief of hospital community relations" is getting more and more popular in today's hospitals. Once focused primarily on communications, advertising and outreach, Community relations directors now drive patient experience, access to educational information, music, healthy food and natural views. Waiting time has also been given a lot of attention recently. The time that patients and their families spend waiting in hospitals affects their overall experience to a great extent.

To plan the patients' experience ahead of time, teams or units are forming in today's hospitals. Way-finding unit and communications unit are some of them.

There is great potential for reuse of materials while working on the site of an existing building with purpose of addition or reconstruction. Also grinding and reuse of the dug rocks and boulders on the site and use of cut trees is encouraged to be considered.

Rain gardens are good ways to bring nature into design as well as thinking sustainably. Rain water collection and regional planting are ways of making rain gardens work in the long run.

The water that circulates in the pipes for sterilization of tools and equipments in hospitals is non-contaminated but usually goes to waste. Reuse of this water is encouraged.

Increasing public transportation and connecting the hospital complex with the bike path especially for our site with the lake very close by would be a great opportunity to attract the community to the hospital. In other words we can put interesting activities on hospital campus site and guide people towards it to reduce the isolation feeling among the patients, their parents and the staff. The high rate of staff turnovers in hospitals approves the fact that healthcare facilities have become an isolated environment to work in. Bringing normal activities back to the hospital zone and having people jugging and biking on a path right down the hill where could easily be seen through windows will reduce the feel of remoteness among staff. Thinking about employees' experience is as important as thinking of patients' experience. The staff, after all, are the ones who offer services to patients and providing a healthy work environment for them has an essential impact the quality of services.

Promoting the use of "healthy food" in hospitals through serving it, as well as teaching child patients about healthier diets is another new trend in hospital services. This knowledge would be a great thing for the children to take away from their hospitalization experience.

To eliminate pollutants from the exhaust fan of vehicles on hospital campus, Janet Brown suggests using electric vehicles (Flex vehicles) for on campus use.

Eliminating or reducing the use of materials and finishes that contain cancer causing agents in them is especially important for a cancer care center.

Healthy Alternatives: Interior finishes and materials, furniture and furnishing (7)

The following section is an abbreviation of the webinar "Healthy Alternatives: Interior finishes and materials, furniture and furnishing", presented by Jean Hansen, FIIDA, CID, LEED AP, AAHID, EDAC, Sustainable Interior Design Manager, HDR Architecture, Inc.

The following three communities are affected by our choices for finishes and furniture in healthcare facilities: Building community including patients, families, visitors and staff, local community, and global community.

Sources of chemicals of concern are everywhere in healthcare facilities; in finishes and furniture in lobby and waiting areas, cafeterias, conference rooms, offices, patient rooms, and nurse stations; in drapery and cubicle; and in window shades.

Many of the chemicals recognized as chemicals of concern by national and international organizations are PBTs (Persistent, Bio-accumulative, Toxicant). They are persistent and do not break down rapidly from natural processes and many purist for months and years and they can travel long distances on wind or water from where they are manufactured. They are bio-accumulative because they like to build up in living lean; often in body tissue. They increase their concentration as they move up the food chain becoming the most concentrated in mother's milk. They are toxicant and cause cancer and interfere with natural activities of hormones of human body and can affect the nervous system.

The following is a list of PBTs that are often used in hospitals and the health issues that they can cause in the long run.

1-The most widely used PBTs are in Chlorinated plastics- Polyvinyl chloride, PVC or Vinyl. They are the most widely used plastic in building industry due to their low cost and high

functionality if you don't utilize life cycle analysis (considering long term human health and environmental impacts and the full life cycle of a product). Chlorinated plastics are found in:

-Furniture: Fabrics, table and chair components, connectors, surfaces, wiring and trim pieces

-Finishes: Flooring, wall covering, paint, casework and ceiling

-Window coverings: Draperies, cubical curtains and shades

2-Dioxins is a byproduct of PVCs in manufacturing and disposal. They can be released when PVC burned or landfill fire. Dioxins bioaccumulate in environment as well as human's body and is persistent in the environment for decades.The health effects that are related to Dioxin exposure include cancer, immunological damage and increase in miscarriages.

3-Phthalates are plasticizers used to soften PVC. Environmental health issues related to this PBT include Asthma and respiratory symptoms.

4-Halogenated Flame Retardants are added to many plastic products to meet the standards of flammability in construction and interior materials. They could have significant damage to ecological and human health. Flame retardant could be found in foam, textile, plastics as well as the finishes. In states like California, New York and Massachusetts who have tough fire codes, we can find higher amounts of HFRs in people's body burdens and particularly for women this can cause breast cancer. Looking for furniture, we should consider using materials with reduced or removed flame retardants.

5-Heavy Metals are used as stabilizers in PVC, additives to dyes, colors and pigments, antimicrobials like Silver, and in lighting like Mercury. Healthcare industry has had great success in eliminating Mercury from equipments, thermometer and other devices. Other areas that heavy metals are used in healthcare are armrests in waiting areas, trimmer edges on tabletops or seating,

pacing for wiring, textiles and picture frames. Many of heavy metals can cause cancer, kidney and liver problems and respiratory problems.

6-Volatile Organic Compounds vaporize in normal room temperature and become gases released from materials and finishes into air and affect indoor air quality. Formaldehyde, Toluene, Benzene and Isocyantates are VOCs. They could cause both short term and long term, chronic health effects. The short term affects include dizziness, headaches, eye, nose and throat irritation. Longer term chronic health effects can include damage to our liver, kidney, nervous system and increase cancer risk.

VOCs are typically emitted in high level when the products are first installed and then they taper off to a lower level over time. These types of VOCs are in wet applied products like paints and adhesives. They emit VOCs very intensely for first few days or weeks and they tapper off. But VOC emissions from sub-solid materials such as flooring and furniture may start at a lower level than wet products and they tapper off much more slowly and they contribute to a long term problem.

7-Formaldehyde exists in composite wood products and adhesive products and finish on some textiles. They can cause cancer, liver, kidney and nervous system problems.

8-Semi-Volatile Organic Compounds (SVOCs) are released more slowly than VOCs but also affect indoor air quality. They attach to dust and other particles are likely to be transferred to human by contact or by attaching to dust and being ingested . There is a rising concern about growing potential of SVOCs for causing cancer or other health effects.

9-Perfluorinated Chemicals (PFCs) is found in stain repellents such as Teflon. These chemical are not molecularly bound to products and are released through degradation. They can cause breast, leaver and prostate cancer.

10-Antimicrobials; Health care authorities CDC and EPA found lack of evidence that Antimicrobials can cause harm to human.

11-Bisphenol A (BPA) is found in Epoxy resins (primary compound used to make proxy paint coatings, adhesives and other products) and also found in polycarbonate water bottles, baby bottles and food can liners. Can cause breast and prostate cancer and can interfere in chemotherapy and can interfere in brain development.

How to apply our knowledge to our designs?

At the beginning of your design phase, sit with your clients and determine goals connected to their mission. For example one of the goals that you can set with a client is to have good indoor air quality (IAQ) and to minimize user exposure to harmful chemicals. The action to take regarding this goal could be specified as making careful choices for finishes, components, textile and the casework.

Other examples of such goals can be flexibility, recycled contents, recyclability, packaging and transportation. As your team works on the project, always come back to the goals and tie your concern about chemicals through that visions and goals and work your way towards purchasing safer materials and products.

Healthy Alternatives

Look for companies that align with you visions and goals and produce harmful chemicals free or reduced materials and work with them. Project managers and designers can work with these companies for all of their clients and contribute significantly to reduction of use of harmful materials.

Alternatives to PVC

The following is a list of alternatives for PVCs where they are used the most in hospitals.

-Acrylic and polypropylene edges for chairs and tabletops

-Nylon derivative for electrical wiring for workstations

-Polyurethane and nylon textiles (durable, cleanable and breathable)

-Trevira or Avora polyester, cubicle and curtains (with built-in flame retardants)

-Bio-based textiles

-PVC free resilient flooring, carpet backing, wall coverings, window coverings, wall protection and ceiling tiles

-Alternative wood and metal finishes with reduced VOCs, waste and heavy materials (Powder coating that reduces plastic laminate use, no adhesives and reduces water use and waste and also water based coatings that are low-emitting).

-FCS-certified wood with no added Urea Formaldehyde

-Rapidly renewable materials with no added Formaldehyde such as 10 years bio-based renewable materials, Linoleum for desktops, Poly lactic acid textiles, Bamboo veneers and textiles, Wool textiles, Agri-composite materials.

CHAPTER 4

CANCER AND YOUNG PATIENTS' MOTHERS

"When a child is stricken with cancer, fighting the disease very quickly changes life for the whole family. On top of the often-prolonged medical journey, there are numerous emotional and practical struggles as well. Emotionally, both the child and their family experience everything from fear and worry to bravery and support, and the practical struggles include everything from finances and scheduling to temporary relocation. While the whole family is impacted, mothers often shoulder a large amount of the responsibility. Often perceived as "chief nurturer" as well as coordinator of household schedules and day-to-day tasks, mothers can become physically, emotionally, and psychologically drained when coping with their child's cancer diagnosis and treatment (8)."

It is important for designers to also think of facilities and accommodations for patients' parents and siblings. The relationship between those spaces and patients' rooms should be well-thought of and may vary according to the length of hospitalization, level of sickness and other case-by-case criteria.

CHAPTER 5
PRECEDENT STUDIES

Bloorview Children's Hospital, Toronto, Canada

Figure 11. Bloorview Hospital, Canada, Exterior, http://www.metropolismag.com/story/20080220/health-and-happiness

Architect Terry Montgomery, of Toronto firm Montgomery Sisam: "Most hospitals have a big atrium, and that gives the wrong impression. I think when you enter a place like a hospital; you want to have a feeling you're not going to get immersed in it (9)."

In order to minimize the common institutional feel of the hospital, the architecture team decided to break a few conventions of healthcare design. For instance, the public spaces like the lobby are covered with maple hardwood instead of the common floor covering in hospitals- linoleum.

Figure 12. Bloorview Hospital, Canada, Interior, http://www.metropolismag.com/story/20080220/health-and-happiness

The architectural team managed to convince Bloorview to build up a six story building on a midtown ravine as opposed to low-rise but vast floors. This way, they have achieved many good views of the ravine.

Figure 13. Bloorview Hospital, Canada, Balcony, http://www.metropolismag.com/story/20080220/health-and-happiness

Long, narrow hallways in typical hospitals are among the least desirable places to be. They are usually dark and almost never encourage people to want to stay in them. Montgomery, the architect of Bloorview hospital, has seen hallways differently in his design. They are wide and bright and serve as places to hang out and not just pass through. The architect would like to call them “streets”. Children can do all sorts of activities including biking in the hallways.

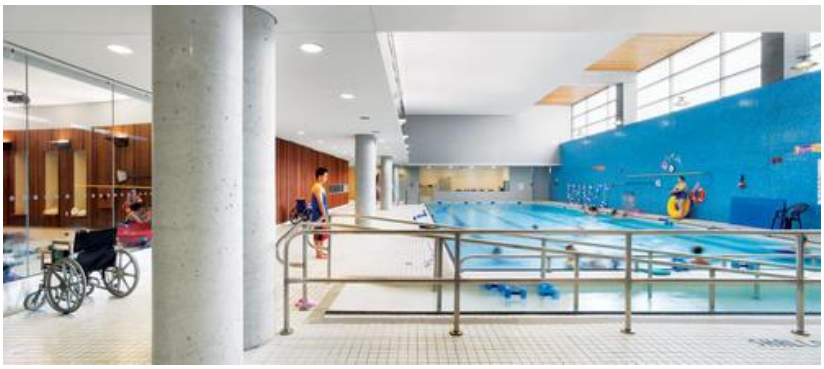

Figure 14. Bloorview Hospital, Canada, Pool, http://www.metropolismag.com/story/20080220/health-and-happiness

"islands of interest" - pieces of art, interactive exhibits, a saltwater aquarium and views of the skyline and ravine made possible by floor-to-ceiling windows. Part of the journeying is that children come upon these focal points with something special to see or touch or do. They also act as directional landmarks.

One of the very interesting features in this hospital is the tilted opening in the ceiling over two of the balconies. It is comparable to Tadao Ando's design for Naoshima Art Museum. Capturing time and nature is the essence of Ando's work which is also meant for the design of this hospital. This is to let the inpatients with long stays feel like they are living in a humanized space which is thoughtfully designed for them.

Figure 15. Bloorview Hospital, Canada, Balcony, http://www.metropolismag.com/story/20080220/health-and-happiness

Figure 16. Naoshima Art Museum , Photo courtesy Clark Art Institute

Obviously the design team of Bloorview shared the author's concern that whether architecture could be an interactive part of the healing process as opposed to a passive container. They have been successful in responding to this question with their design solution to a great degree.

The following diagram by author classifies the spaces in Bloorview hospital into 3 groups: interior, intermediate and exterior and shows how they are connected together.

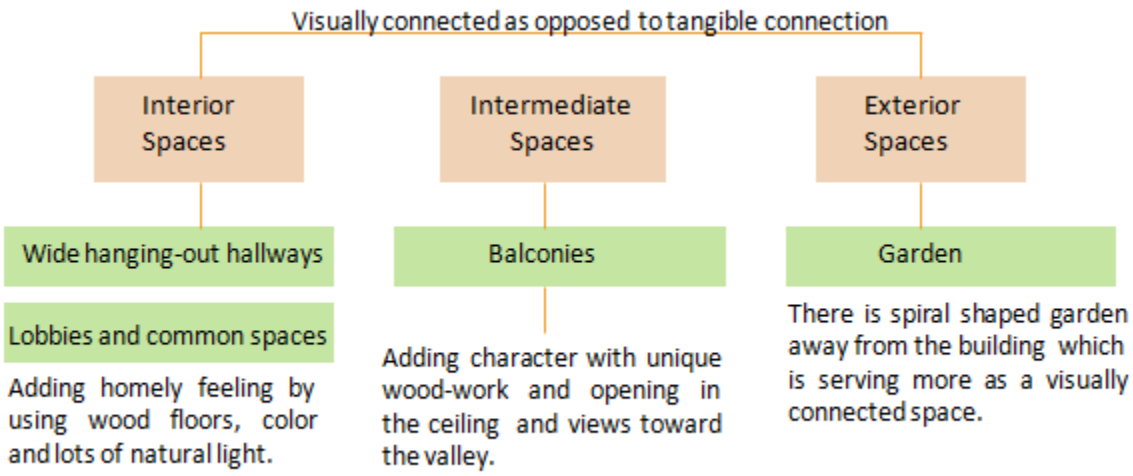

Figure 17. Open, semi-open, enclosed spaces in Bloorview Hospital, (by author)

Rady Children's Hospital, San Diego

Figure 18. Rady Children's Hospital, Exterior, http://www.rchsd.org/

"Rady Children's Hospital serves southern California as the San Diego area's only dedicated hospital for children. The New Acute Care Pavilion addresses the hospital's critical need to expand bed capacity as many of the regions hospitals have diminished or eliminated pediatric programs (10)."

The facility earned an "Innovation in Design" credit for the introduction of sustainable healing gardens which is meant to serve the patients, their families and the staff. "Central to the theme of the Acute Care Pavilion is the "River of Life", manifested through an immense, four-story mineral panel that incorporates a kinetic lighting system and radiates a rainbow of vibrant colors through the front entry curtain wall (10)." The "river" flows to the first lobby and then outside of the building to the yard in the form of mosaic artwork.

There are physiological benefits to watching and listening to running water. Water can create a healing oasis for patients and reduce depression and anxiety. The "river of life" running through the floors and the beach theme that is carried through the patients' rooms with the mosaic work to some degree creates the same soothing effect as being close to water.

Figure 19. Rady Children's Hospital, Exterior, http://www.rchsd.org

Figure 20. Rady Children's Hospital, Interior, http://www.rchsd.org

"We combined all that we know about children and their needs with the growing body of knowledge about the interaction of people and places: the impact of light and color, of texture and tone, of sounds and symbols. We turned to the arts, as well as the sciences, to help our children heal (10)."

In the design of 300 pieces of artwork in Rady Hospital, the architectural team has collaborated with Aesthetic INC. that specializes in designing regional art programs for healthcare organizations. The local artists are selected through a request of proposal process. Involvement of the community in the design process and keeping them involved when the hospital is up and running is among healthcare sustainability mottos. Blair Sadler, the former

president of Rady children's hospital says: "The comments have affirmed that the art creates a sense of place for us, a sense that makes us unique. Young people enjoy the interactive art pieces and the hands-on art experiences. Hospital staff feel special in the work environment and the way finding system as well as our donor recognition system (10)."

Figure 21. Rady Children's Hospital, Artwork, http://www.rchsd.org

"The Rose Pavilion blends innovative design, color, lighting and proportion to give children the best environment for recovery. The unique color and six pitched roofs (that appear to be six houses in a neighborhood) instantly distinguish this building from others (10)."

Figure 22. Rady Children's Hospital, Rose Pavilion, http://www.harryrady.com/rady-childrens-hospital/

“The transition from home to hospital is unsettling. To enter directly into an environment that may be read as remote or disinterested only adds to the stress (1).”**,** C. M. Deasy and Thomas E. Lasswell in their book “Designing places for people” explain that the lobby, unlike the inevitably sterile, technical and frightening parts of a hospital, should be comfortable, the colors should be cheerful, the lights should be bright, and everything in the lobby should be immaculately clean.

That being said, the authors believe that designers should not design the lobby overly “homey” because patients who come to the hospital to solve problems that cannot be taken care of at home need to feel that they are in the hands of an organization that has the knowledge, the experience and the competence to take care of them. “The hospital should create the impression of friendliness and concern but also competence and efficiency (1).”

Boston Children's Hospital

Figure 23. Boston Children's Hospital, Google Maps

I visited the Boston Children's Hospital, Boston, MA in person and was able to observe the experience that patients and parent go through from the moment they approach the hospital to when they get settled in a patient room.

What stood out for me in this visit, was the isolated transplant section. While getting a tour of this section with one of the personnel of the hospital, we had to stand behind two sets of double doors; the first door opened, we entered the vestibule and waited till that door was shut and then the second door opened and we were able to get in the transplant section of the hospital. When I asked about the reason, the hospital staff told me that this section is isolated, meaning that due to the vulnerability of the patients to the germs, there should be no direct air exchange. In fact, even the air in the vestibule gets sucked up by through vents before we enter through the second set of doors.

The layout of most of the hospitals that are located in cities could be simplified to "core and shell" which means the patients rooms are usually located around the perimeter of the plan to

allow as much natural light as possible and the medical and service sections will inevitably be located in the dark core part of the plan.

This layout is the almost inevitable result of building up vertically and in multiple stories as opposed to spreading out on the site. A multiple story, of course, is the most feasible way to go especially in crowded cities with limited and expensive land.

Designers of the Boston Children's Hospital have tried to bring in as much as natural light possible to those dark cores. They have done it through small gardens that reach all the way up to the roof and brings some light in. The parents' and siblings waiting rooms on the other hand remain dark and without windows.

Figure 24. Boston Children's Hospital, Interior Gardens, (by author)

Figure 25. Boston Children's Hospital, Family Waiting Rooms, (by author)

The hallways in the isolated section are ornamented with mosaic work and stain glasses to add some color and interest to the space.

Figure 26. Boston Children's Hospital, Interior Corridor (by author)

After this experience started generating the idea of designing a center exclusive to those vulnerable patients who have to remain in isolated sections. The process of design is elaborated in design section of this thesis.

American Family Children's Hospital

Figure 27. American Family Children's Hospital, WI, Exterior (by author)

Visiting the American Family Children's Hospital in Madison, WI, I realized that the "core and shell" layout, shell being the patients room and core being the medial and services sections, is very common among larger hospitals. Because of that, the family rooms in this hospital remain dark but the designers have brought some natural light into the hallways through glazing that separates the group activity rooms from the hallways.

Figure 28. American Family Children's Hospital, WI, Interior Corridor (by author)

Figure 29. American Family Children's Hospital, WI, Family Waiting Room (by author)

In this hospital, a lot of effort has put into creating spaces that are appealing to children and could be perceived from their height. The main lobby is designed with a "Train station" theme and as soon as one enters the doors, they will face a small theatre with all the details of a real one. This, immediately distracts children from the fact that they have entered a hospital and are about to undergo medical treatments.

Hallways are designed to look like streets. There are street signs instead of regular directory signs and street lights instead of regular lighting. There is even a bar in bright red color for seating in the lobby. Attention to details and creating a distracting space for children is outstanding in this hospital.

Figure 30. American Family Children's Hospital, WI, Main Lobby (by author)

Figure 31. American Family Children's Hospital, WI, Main Lobby (by author)

Figure 32. American Family Children's Hospital, WI, Main Lobby (by author)

Tree of Life in MD Anderson Children's Cancer Hospital

"The Tree of Life stands nearly 8 feet high and is made of a variety of media including strands of multicolored beads, bark made from hand-colored paper and leaves cut from decorated material. Under the tree rests a garden of flowers, butterflies, birds and more, all created by pediatric patients and their siblings at MD Anderson through the Arts in Medicine Program.

Every handmade piece of the tree represents the unique journey of each patient or sibling. For some patients, the Tree of Life was a weekly arts activity that got their minds off treatment and introduced them to other patients. For families, it was an avenue that connected parents with their children for a fun activity, despite the seriousness of their child's disease. (11)"

According to Recardo Campos, of the young patients of MD Anderson hospital, even if you are an outpatient, you can schedule an appointment an come to the hospital to participate in working on the tree of life. He says: "it is very nice feeling to come into the hospital for days that I don't have to get any blood work done or anything and I'm just here to draw. And hang out. It is a really cool feeling! You definitely need that when you are in treatment; have things to feel normal. For me it is a escape in a way. I get to come here and sit down and just focus on task at hand and not have to think about I'm having chemotherapy in a week or that my surgery is in 27 days. It has been a very cool goal to have."

This is one example of ways to help children make a bond with the hospital and its community. Their picture in mind of a hospital can be transformed from a scary zone to “their hospital” where they go to hang out with their friends and fulfill their need for adventure as well as getting their treatment.

Figure 33. Tree of Life in MD Anderson Children’s Cancer Hospital, (Photo from Ref. 11)

CHAPTER 6

DRAWING INSPIRATION FROM NON-MEDICAL ARCHITECTURE

Traditional Japanese Architecture

The personal experience of a blogger got me thinking whether some of the principles of traditional Japanese architecture, known for its intimate and comfortable spaces, can be used in design of health care architecture. "The first time I visited a traditional Japanese house was at the Edo Tokyo Open Air Museum. What surprised me was that the house had openings on three sides, so it was quite drafty inside. I stayed in the middle of the room, trying to adapt. I walked barefoot on Tatami, which was warm and pleasant. I liked the simplicity and the good taste of the interior and the small spaces, giving a feeling of intimacy (12)."

I categorized the elements of traditional Japanese architecture that I felt are responsible for the calm, intimate feel of those spaces:

1- The filtered, diffused light that passes the paper sliding doors called Oaashi
2- The sudden proximity of enclosed space to small scale green spaces that makes one feel They are almost outside at all times.
3- The soft light brown wallpapers, combined with exposed dark brown wood structure and the comfortable Tatami mats that all together make the space so comfortable
4- The scale of space [defined with Tatamis and partitions] creates a pleasant human size space

Figure 34. Japanses Traditional House, (photo from ref. 12)

5- And finally, I believe the way Japanese low-ceiling houses open up to gardens could be related to Hildebrand's idea of "prospect and refuge space". The house has a safe intimate feel and the garden is a place to explore and the sudden juxtaposition of these two emphasizes on the safety aspect of "in" as opposed to "out". Later in the design section, O have explained how this simple idea has helped me create a "refuge" in patients' rooms.

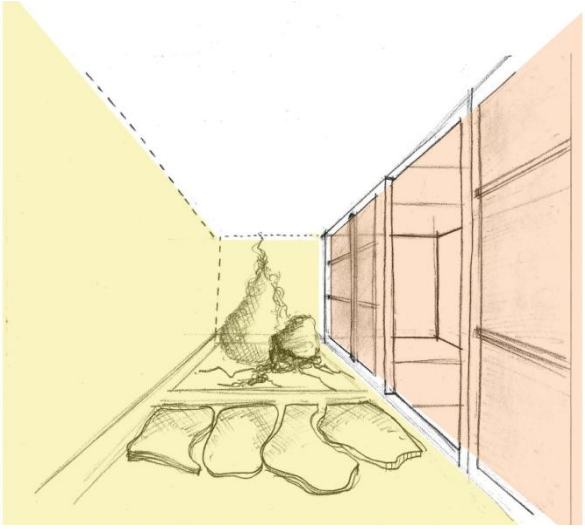

Figure 35. Refuge and Prospect in Japanese Traditional Houses, (by author)

Contemporary Japanese Architecture

Some very unique senses of the space are created by contemporary Japanese architects as Ando. They have amazing tools for their creation that could be learned and applied where it not expected_ Healthcare architecture.

The Zen idea of the microcosm encapsulated in the courtyard garden_"Such things as light and wind only have meaning when they are introduced in a from cut off from the outside world. The isolated fragment of light and air suggests the entire natural world." says Ando. The interaction of sunlight, water and wind are used to reveal the uniqueness of here and now.

Figure 36. Naoshima Art Museum , Photo courtesy Clark Art Institute

In Tadao Ando's "Church of light" natural light, is elevated to the sacred through tectonic isolation.

Figure 37. Church of Light, Tadao Ando, http://en.wikipedia.org/wiki/Tadao_Ando

Traditional Persian Architecture

With a background of living 21 years of my life in Iran and spending 4 years of that in a historical city called Kashan, I had the chance to experience spaces that speak for themselves. They are meant to make the users of the spaces feel a certain way and they actually do. In the dark tall corridors of a historic Bazar with spot lights penetrating from the skylights above, one feels like they should keep moving (directional space) while the colorful pattern of stained glass that reflects on the floor of a mosque creates a soothing space that makes you stay. This is an incredible ability that architecture has but sometimes designers do not use it to its fullest.

Later in design chapter of this thesis, some of these features are used to create interest or in Hildebrand's word "enticement" in some of the patient's rooms.

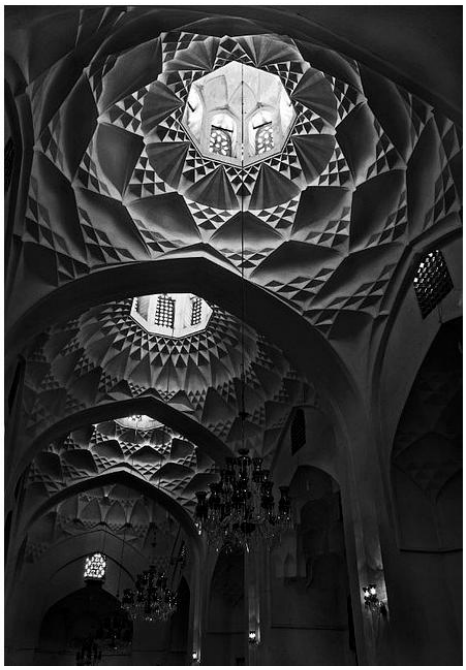

Figure 38. Persian Bazar (Main source unavailable)

Figure 39. Persian Mosque, Play of Light (Main source unavailable)

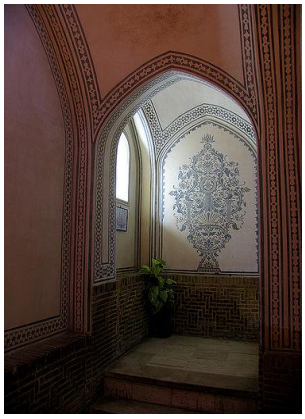

Figure 40. Persian Tradistional House, (by author)

Figure 41. Persian Mosque, Enticement of the play of light and color (Main source unavailable)

CHAPTER 7

RULES AND REGULATIONS

ADA Accessibility Requirements:

Section 6. Medical Care Facilities

6.1 General: Hospitals and rehabilitation facilities that specialize in treating conditions that affect mobility, or units within either that specialize in treating conditions that affect mobility - All patient bedrooms and toilets, and all public use and common use areas are required to be designed and constructed to be accessible.

-Long term care facilities, nursing homes - At least 50 percent of patient bedrooms and toilets, and all public use and common use areas are required to be designed and constructed to be accessible.

6.2 Entrances. At least one accessible entrance that complies with 4.14 shall be protected from the weather by canopy or roof overhang. Such entrances shall incorporate a passenger loading zone that complies with 4.6.6

6.3 Patient Bedrooms. Provide accessible patient bedrooms in compliance with section 4. Accessible patient bedrooms shall comply with the following:

(1) Each bedroom shall have a door that complies with 4.13.EXCEPTION: Entry doors to acute care hospital bedrooms for in- patients shall be exempted from the requirement in **4.13.6** for maneuvering space at the latch side of the door if the door is at least 44 in (1120 mm) wide.

(2) Each bedroom shall have adequate space to provide a maneuvering space that complies with **4.2.3**. In rooms with two beds, it is preferable that this space be located between beds.

(3) Each bedroom shall have adequate space to provide a minimum clear floor space of 36 in (915 mm) along each side of the bed and to provide an accessible route complying with **4.3.3** to each side of each bed.

6.4 Patient Toilet Rooms. Where toilet/bathrooms are provided as a part of a patient bedroom, each patient bedroom that is required to be accessible shall have an accessible toilet/bathroom that complies with **4.22** or **4.23** and shall be on an accessible route.

International Building Code Accessibility Requirements
Chapter 11- Accessibility

Section 1101- General

1101.1 Scope. The provisions of this chapter shall control the design and construction of facilities for accessibility to physically disabled persons.

Section 1103- Scoping Requirements

1103.1 Where required. Sites, buildings, structures, facilities, elements and spaces, temporary or permanent, shall be accessible to persons with physical disabilities.

Section 1104- Accessible Route

1104.1 Site arrival points. Accessible routes within the site shall be provided from public transportation stops; accessible parking; accessible passenger loading zones; and public streets or sidewalks to the accessible building entrance served.

104.2 Within a site. At least one accessible route shall connect accessible buildings, accessible facilities, accessible elements and accessible spaces that are on the same site.

1104.3 Connected spaces. When a building or portion of a building is required to be accessible, an accessible route shall be provided to each portion of the building, to accessible building entrances connecting accessible pedestrian walkways and the public way.

1104.4 Multilevel buildings and facilities. At least one accessible route shall connect each accessible level, including mezzanines, in multilevel buildings and facilities.

1104.5 Location. Accessible routes shall coincide with or be located in the same area as a general circulation path. Where the circulation path is interior, the accessible route shall also *be* interior. Where only one *accessible route* is provided, the *accessible route* shall not pass through kitchens, storage rooms, restrooms, closets or similar spaces.

1104.6 Security barriers. Security barriers including, but not limited to, security bollards and security check points shall not obstruct a required *accessible route* or *accessible means of egress*.

Section 1105- Accessible Entrances

1105.1 Public entrances. In addition to accessible entrances required by Sections 1105.1.1 through 1105.1.6, at least 60 percent of all public entrances shall be accessible.

Section 1106- Parking and Passenger Loading Facilities

1106.3 Hospital outpatient facilities.

At least 10 percent, but not less than one, of care recipient and visitor parking spaces provided to serve hospital outpatient facilities shall be accessible.

1106.4 Rehabilitation facilities and outpatient physical therapy facilities.

At least 20 percent, but not less than one, of the portion of care recipient and visitor parking spaces serving rehabilitation facilities specializing in treating conditions that affect mobility and outpatient physical therapy facilities shall be accessible.

1106.5 Van spaces. For every six or fraction of six accessible parking spaces, at least one shall be a van-accessible parking space.

1106.6 Location. Accessible parking spaces shall be located on the shortest accessible route of travel from adjacent parking to an accessible building entrance. In parking facilities that do not serve a particular building, accessible parking spaces shall be located on the shortest route to an accessible pedestrian entrance to the parking facility. Where buildings have multiple accessible entrances with adjacent parking, accessible parking spaces shall be dispersed and located near the accessible entrances.

106.7 Passenger loading zones. Passenger loading zones shall be accessible.

Guidelines for Pediatric Cancer Centers

By American Academy of Pediatrics (13)

A pediatric cancer center must have the staff and facilities to ensure that the pediatric patient with cancer will receive the best care that is available for his or her diagnosis. The medical staff at such a center is composed of the primary care pediatrician, pediatric medical subspecialists, and pediatric surgical specialists—hematologists/ oncologists, surgeons, urologists, neurologists, neurosurgeons, orthopedic surgeons, radiation oncologists, pathologists, child life specialists, and diagnostic radiologists. These physicians and nurse practitioners, pediatric nurses, social workers, pharmacists, nutritionists, and other allied health professionals serve as a multidisciplinary team committed to the care of the child or adolescent with cancer.

In the United States, the oncologic care of the child or adolescent with cancer should be coordinated by a pediatric hematologist/oncologist who is board certified in the subspecialty of pediatric hematology and oncology by the American Board of Pediatrics. Other subspecialists should be similarly board certified when applicable. Oncologic care should be provided in a pediatric center that has the following personnel, facilities, and capabilities.

Personnel

• Communication with the primary pediatrician, which is essential in the provision of family-centered supportive care

• Board-certified pediatric hematologists/oncologists

• Pediatric oncology nurses who are certified in chemotherapy, knowledgeable about pediatric protocols, and experienced in the management of complications of therapy

• Board-certified radiologists with specific expertise in the diagnostic imaging of infants, children, and adolescents

• Board-certified surgeons with expertise in pediatric general surgery

• Surgical specialists with pediatric expertise (i.e., training and certification, if available) in neurosurgery, urology, orthopedics, ophthalmology, otolaryngology, dentistry, and gynecology

• A board-certified radiation oncologist trained and experienced in the treatment of infants, children, and adolescents

• A board-certified pathologist with special training in the pathology of hematologic malignancies and solid tumors of children and adolescents

• Board-certified pediatric subspecialists available to participate actively in all areas of the care of the child with cancer, including anesthesiology, intensive care, infectious diseases, cardiology, neurology, endocrinology and metabolism, genetics, gastroenterology, child and adolescent psychiatry, nephrology, and pulmonology

• Pediatric physical and mental rehabilitation services including pediatric physiatry

• Pediatric (oncology) social worker(s), pediatric psychologists, child life specialists, and access to family support group services

• Pediatric nutrition experts with the capability of preparing, administering, and monitoring total parenteral nutrition

Facilities

• An immediately accessible and fully staffed, onsite pediatric intensive care unit

• Up-to-date diagnostic imaging facilities to perform radiography, computed tomography, magnetic resonance imaging, ultrasonography, radionuclide imaging, and angiography; positron-emission tomography scanning and other emerging technologies are desirable

• Up-to-date radiation-therapy equipment with facilities for treating pediatric patients

• A hematopathology laboratory capable of performing cell-phenotype analysis using flow cytometry, immunohistochemistry, molecular diagnosis, and cytogenetics and access to blast colony assays and polymerase chain reaction-based methodology

• Access to hemodialysis and/or hemofiltration and apheresis for collection and storage of hematopoietic progenitor cells.

Capabilities

• A clinical chemistry laboratory with the capability to monitor antibiotic and antineoplastic drug levels

• A blood bank capable of providing a full range of products including irradiated, cytomegalovirusnegative, and leucodepleted blood components

• A pharmacy capable of accurate, well-monitored preparation and dispensing of antineoplastic agents and investigational agents

• Capability of providing sufficient isolation of patients from airborne pathogens, which could include high-efficiency particulate air (HEPA) filtration or laminar flow and positive/negative pressure rooms

• Access to stem cell transplant services

• Educational and training programs for health care professionals including the primary care physician

• Coordination of services including home health, pain management, palliative, and end-of-life care

• A regularly scheduled multidisciplinary pediatric tumor board

• An established program designed to provide longterm, multidisciplinary follow-up of successfully treated patients at the original treatment center or by a team of health care professionals who are familiar with the potential adverse effects of treatment for childhood cancer

• Membership or affiliation with the Children's Oncology Group to provide access to state-of-the-art clinical trials; availability of support for coordination to track patients' progress and maintain clinical trials data

• Capability of providing parent, caregiver, and patient education

• Full-time access to translation services to ensure accurate translation and effective communication among all health care professionals and the patient and family

• An ongoing program of assessment of care for continuing quality improvement and safety

• A formal program for cancer education for the family and instruction on self-management

Zoning

Pittsfield, Ma Zoning Ordinance

Section 7.719 Hospitals or Sanatoriums, Requirements:

A. The minimum lot size for any such use shall be five acres.

B. Front and rear yards shall be at least fifty feet in depth.

C. Side yards shall be at least fifty feet in width.

D. The maximum portion of the lot to be covered by all buildings or structures shall be twenty-five percent.

E. Any driveway for ingress or egress for such use shall be located at least forty feet from any adjacent lot line.

F. Sources of potential nuisance factors, including laundry operations, power plants, restaurants or cafeterias, kitchens, ambulance or emergency patient entrances f unloading areas for supplies and food, garbage loading areas, incinerators, and animal laboratories shall be located at least two hundred (200) feet from any adjacent lot line.

G. Off-street parking and loading areas shall comply with design standards and all other applicable provisions of this ordinance.

H. The front yard and all open areas shall be suitably landscaped and maintained with grass, trees, shrubs or walks.

I. Outdoor lighting shall be so shielded as to cast no direct light upon adjacent property or public ways.

J. Within the development, vehicular circulation facilities shall be provided for safe and convenient use in accordance with reasonable site planning standards.

K. The special requirements set forth in this section 7. 719A through E inclusive shall not apply to Hospitals or Sanatoriums in a B-G District (ORO #647, 1989).

L. The maximum height of a Hospital or Sanatorium in a B-G district shall not exceed 4 stories or 50 feet unless the following additional special requirements are found to have been satisfied by the Planning Board in its site plan review, in which case the maximum height may be increased to a height not to exceed 13 stories or 125 feet.

1. A fire suppression system, approved by the local fire department, will be installed in the Building.

2. The traffic impact from such increase on immediately adjacent surrounding streets and intersections can be accommodated in accordance with reasonable traffic engineering standards; and

3. The increase in height is consistent with the master plan, existing surrounding uses and the character of the surrounding neighborhood (ORO #647, 1989)

Interview with Caleb Mitchell;

Conservation Agent of City of Pittsfield, MA

Masters of Science of environmental studies

The Hillcrest campus of Berkshire Medical Center is located on the Onota Lake bank. The conservation committee is very sensitive about all lands around the lake. According to Mr. Mitchell people have owned these parcels for decades, before the conservation regulations have even been conceived. They could build all the way down to the waterfront. Today, they still want to preserve this right and be able to build wherever on their parcel that they wish. The conservation commission seeks to preserve micro organisms that live in the lake and also the habitats in the forest. Extensive developments on the parcels and the rising prices of real estate in

this area has had the adverse effect of disturbing the cycle of life of the fish, micro organisms and other creatures.

The city of Pittsfield has kept the rules flexible. According to Mr. Caleb Mitchell conservation commissions in different towns can take one of the two following approaches: They could either set strict regulations, regardless of case-by-case circumstances and stick to it or to have a proposal-based set of regulations. The first approach means that no matter what the designers and developers are proposing, if it is not in compliance with the pre-set rules, they could be rejected in their first step. An example of these regulations is setback rules. For instance the city of Pittsfield requires a minimum of 35 feet setback and around the Onoto lake this number increases to 100 feet. If the city were to take the non-negotiable approach, incompliant proposals could not have even been presented to the city but it is not the case. Mr. Mitchell believes this flexibility in the regulations can encourage innovative ideas that can help the developers get what they want while avoid causing harm to the nature or even rescue what could otherwise be vanished.

Although the town seeks to allow for innovation and creative ideas the following basic considerations should always be brought into account in order for the city to consider negotiating the proposal. The following topics should be discussed in initial proposals: selective clearing of trees, runoff, erosion, preserving the boulders, minimum Setback of 35 feet (Rare cases are excluded from this).

Mr. Mitchell also explained that big parcels can offer giving up their CR (Construction Right) along the rest of the bank where they are not proposing construction in order to increase the chance of approval of their proposal.

CHAPTER 8

DESIGN

Mission Statement

Figure 42. Layla Grace, Passed away because of cancer, http://www.findagrave.com/cgi-bin/fg.cgi?page=pv&GRid=49457839

As the greatest considerations in health-care design have traditionally been functional — hygiene, efficiency, and flexibility for changing technology— hospitals have evolved to become dehumanizing spaces. In this thesis two specific groups of chronically ill children who have among the longest inpatient stays are studied: cancer and organ transplant patients. Being under immunosuppressive drugs, these children are very vulnerable thus are kept completely isolated. These long stays and isolation can be very depressing for them.

This thesis undertakes the challenge of designing a fully isolated yet interesting space that doesn't feel like one or in other words "a micro-town within a bubble". In order to achieve the "bubble" there should be no direct air exchange between inside and out and in order to create the "micro town" the author uses strong visual connections, natural lighting, and creative space planning as main design tools.

Program

1- Reception and Registration

Information
Patient Reception Desk
Waiting
Patient intake oncology exam room
Cafeteria
Security
Records

2- Emergency

Ambulance drop off
Relative's waiting room
Emergency treatment room
Equipment
Changing room
Washroom
Disposals

3- Imaging and diagnosis:

Angiography suite
CT room
PET/CT room
MRI room
Ultra sound room
Nuclear Medicine room
X-ray room
Laboratories

4- Surgical Unit

Anesthesia
Surgery theatre
Intensive care
Recovery room (Post-anesthesia)
Bathroom
Equipment

5- Treatment

Dialysis
Infusion Area (Public or Private)
Tomo Therapy Room
Radiation Oncology
Varian Linear accelerator Suite
Nuclear Medicine
ICU

6- Inpatient Unit

Inpatient rooms
ICU Rooms
Nursing Unit
Library
Playrooms
Laundry Room

7- In patient Floor Public Spaces

Patient Dining rooms
Group Parents' gathering space

8- Outpatient Unit

Outpatient Rooms (Temporary Stay)

9- Complementary medicine therapies (post-hospital / during):

Acupuncture
Chiropractic care
Genetic program
Image enhancement
Mind-body medicine
Naturopathic Medicine
Nutrition Therapy
Oncology Rehabilitation
Pain Management
Spiritual Support
Survivorship Support

10- Pharmacy

Laboratory
Materials room
Dispensary
Instruments

Dressing materials
Staff room (beds)

11- Research

12- Other

Circulation
Bathrooms
Staff rooms
Services

13- Inn

Outpatient and parents accommodation
Gift Shop
Church
Cafeteria
Hair Salon
Spa
Restaurant
Gym

14- Outdoor Spaces:

Semi-closed parents-patients atrium
Healing Gardens
Parking lots
Access Roads
Drop off areas
Ambulance Shelters
Balconies and canopies
The bridge

TOTAL SQUARE FOOTAGE: 200,328 SF

Site Analysis

The site of this project is located in a sloped land with a total grade change of 90 FT from top to the waterfront in Pittsfield, MA. There is an existing pain management center and a mansion on site. In this thesis it is proposed that the mansion will be transformed to a bed and breakfast for the patients' parents.

While searching for a site for this project, I looked for a major population center in the area where the new hospital would serve a reasonable number of patients in the area and will be easily accessible to further population centers. Choosing a parcel with one side facing the grid of the city and once face facing pure nature also was in mind during my search. The following statistics from the town's website where key to choosing this site in Pittsfield, MA:

- Established: 1761; as a city in 1891
- Population: 40,958 & major population center in Berkshire County with the amenities of a city many times it's size
- A regional center for arts, education and commerce
- The building along streets retain the New England character
- Land Area: 42.32 square miles

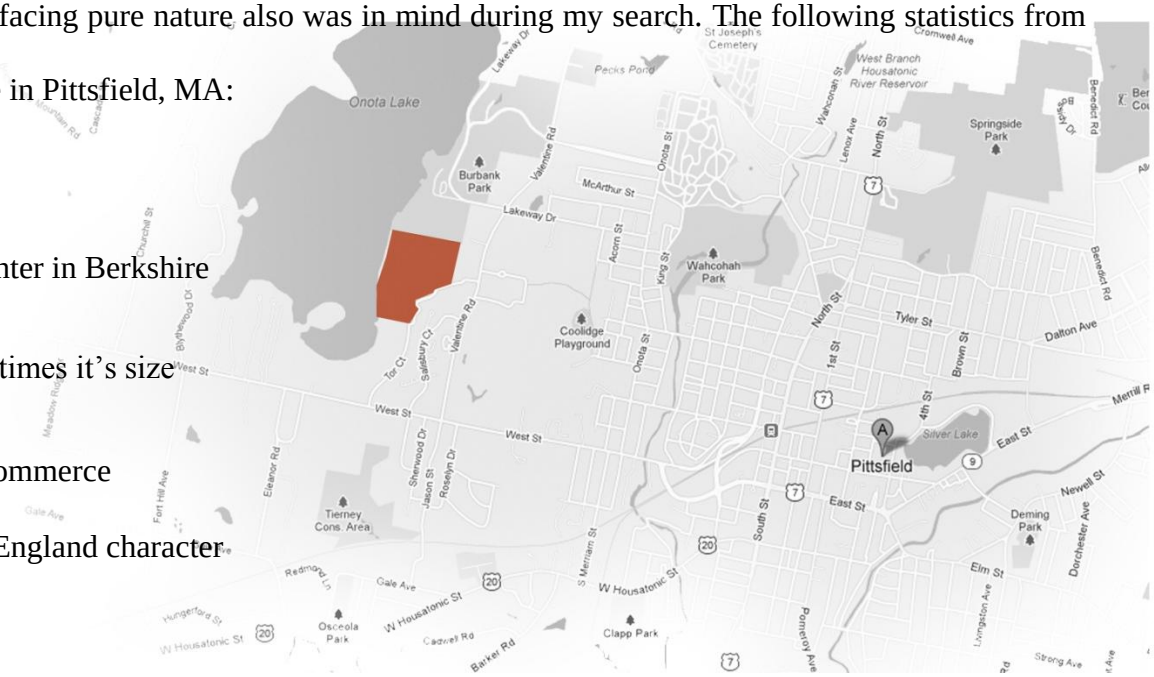

Figure 43. Pittsfield, MA, (by author)

- Number of housing units: 21,366
- County: Berkshire
- Hospitals: Berkshire Medical Center, BMC Hillcrest campus
- Public Transportation: Berkshire Regional Transit Authority Intermodal Transportation Center prepares access to bus, rail and taxi transport systems
- Airports: Pittsfield Municipal Airport
- Schools: 8 elementary, 2 middle and 2 high schools
- 9 Hotels and inns

Figure 44. Site, Pittsfield, MA, (by author)

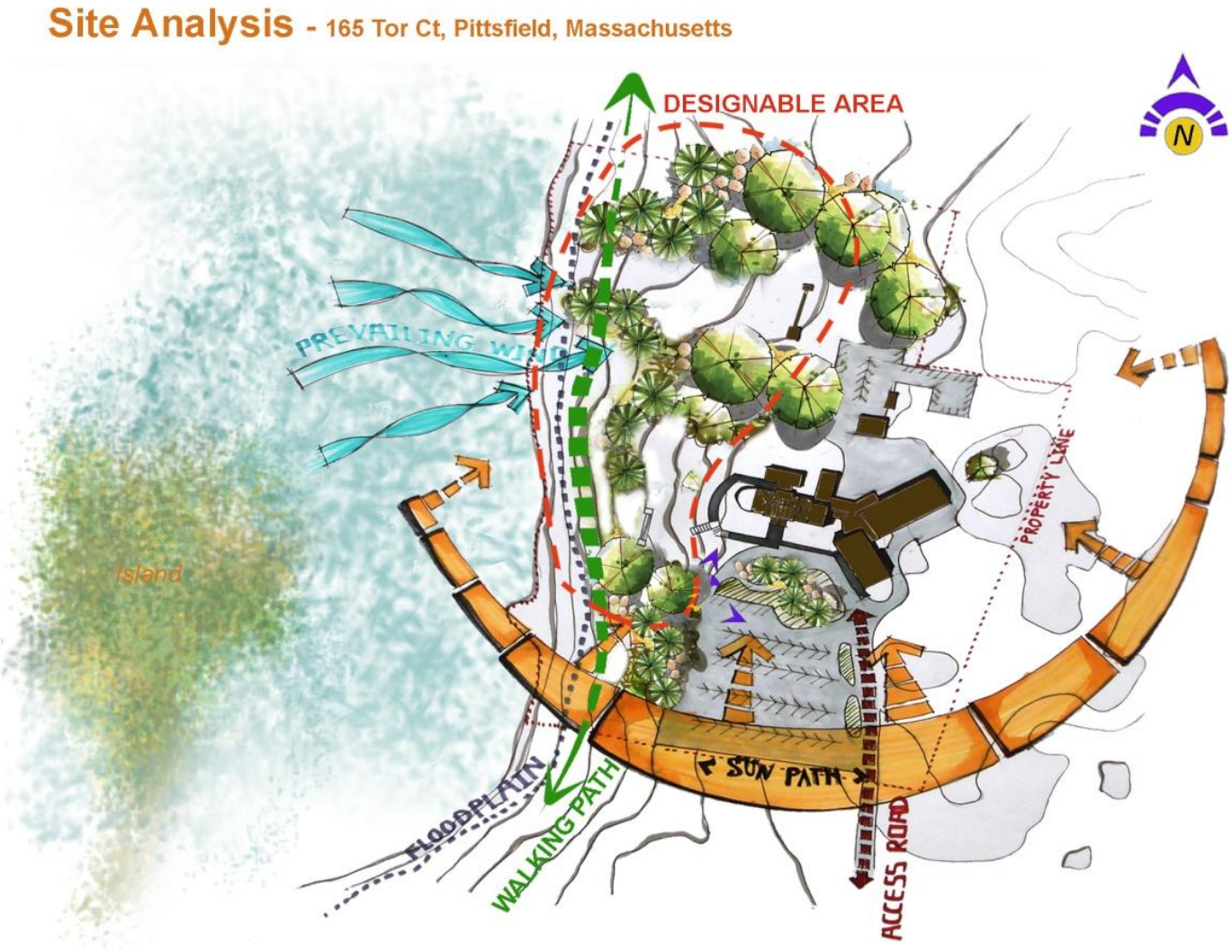

Figure 45. Site Analysis, (by author)

Figure 46. Panoramic view of parking lot and the existing buildings, (by author)

Figure 47. PanoramicView of Site, (by author)

Hillcrest Hospital occupies a very historic site. It has a lot of potential to be turned into an interactive center both for patients, their families, and the local community. There is an old Gazebo sitting on the remaining of the Italian and French formal gardens on the site.

Figure 48. Gazebo on Site, (by author)

There are also some old stairs scattered over the garden. I see all of these as pinpoints that could be used to tie together a contemporary healing garden with a mysterious twist to it.

Figure 49. Remainings of English and French Gardens on Site, (by author)

There are two existing building on the site: An old mansion and an existing pain management center. “The mansion is of the Old English (Robert Adam) period of 1700. Constructed in stucco and stone, the building's most striking feature is the columned front entrance. The mansion was used only in the summer, sometimes only on the weekends. But Tor Court was considered the showplace of the Berkshires (14)”

Figure 50. Existing Buildings on site, Bing Maps

Figure 51. Mansion on Site, (by author)

The existence of a historic building on site could be a really good opportunity to attract the local community to the site. Later in this section, I will explain what uses will be assigned to this building in the new design.

Figure 52. Old Mansion on Site, Interior and Exterior, (by author)

One of the most important features of this site is that it overlooks the beautiful Onota lake. With a 90 feet change of grade from the waterfront to the top of the hill, the new building has the opportunity to capture fascinating views of the lake and the little green island that is located in the middle of the water.

Figure 53. Onota Lake, (by author)

Among other potentials on this site, is the existing walking path. The walking path starts at a parking lot near the site and blends into the site. Currently it is not being actively used but along with other features on the site it has a great potential to invite the local community into the site.

Figure 54. Existing Walking Path, (by author)

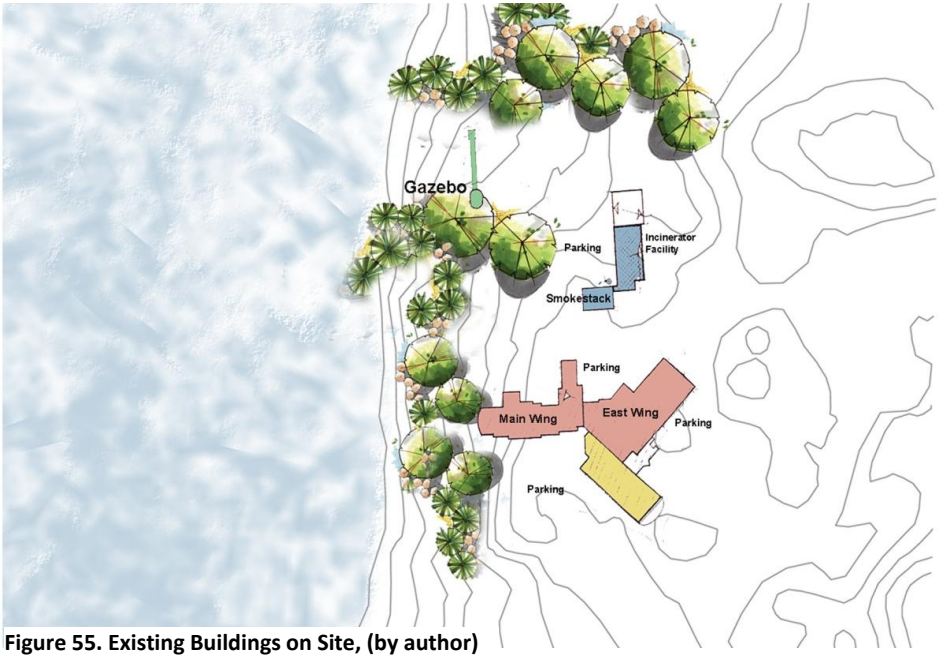

Figure 55. Existing Buildings on Site, (by author)

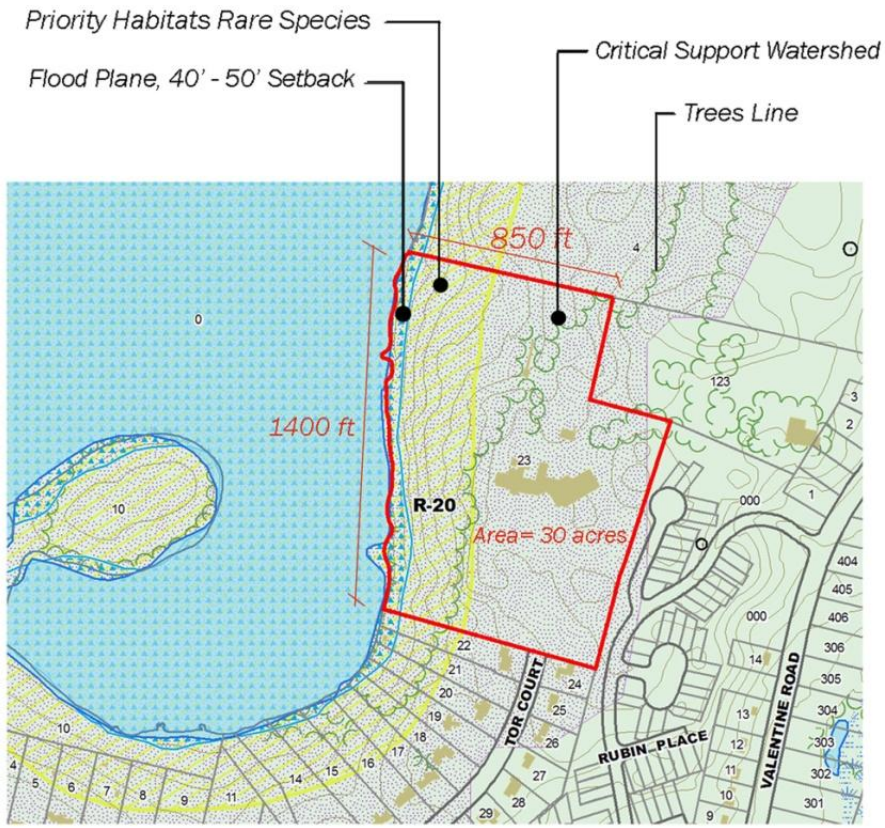

Figure 56.GIS Map of the site (from The city of Pittsfield's website)

Design Process

As explained in precedent studies section, most of today's hospitals in big cities, due to shortage and costs of land, build in multiple stories and end up with a "shell and core" layout of floor plans. Here are the diagrams of Boston Children's Hopital in Boston, MA and American Family Children's Hospital in Madison, WI that I was able to visit in person:

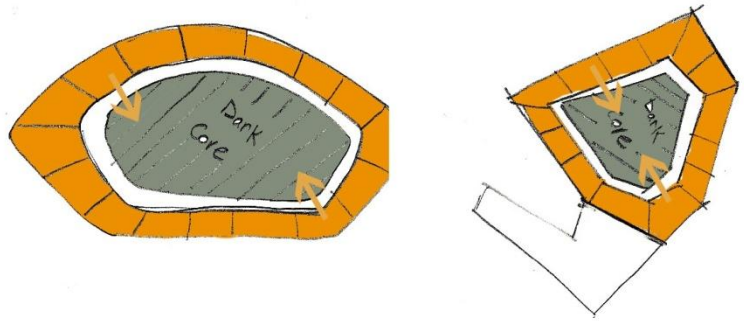

Figure 57. Hospitals' core and shell layout (by author)

Since this thesis seeks to create a soothing and healing retreat for the 2-3 months long hospitalization period of cancer and transplant child patients, the site was picked in a mid-size town where the land is much more affordable yet easily accessible through major traffic routes. This choice of site allowed for designing a spread layout that lets light and views inside.

The following diagrams show my initial explorations of the possible building layouts to maximize the south-west light and capture the beautiful views for as many spaces as possible.

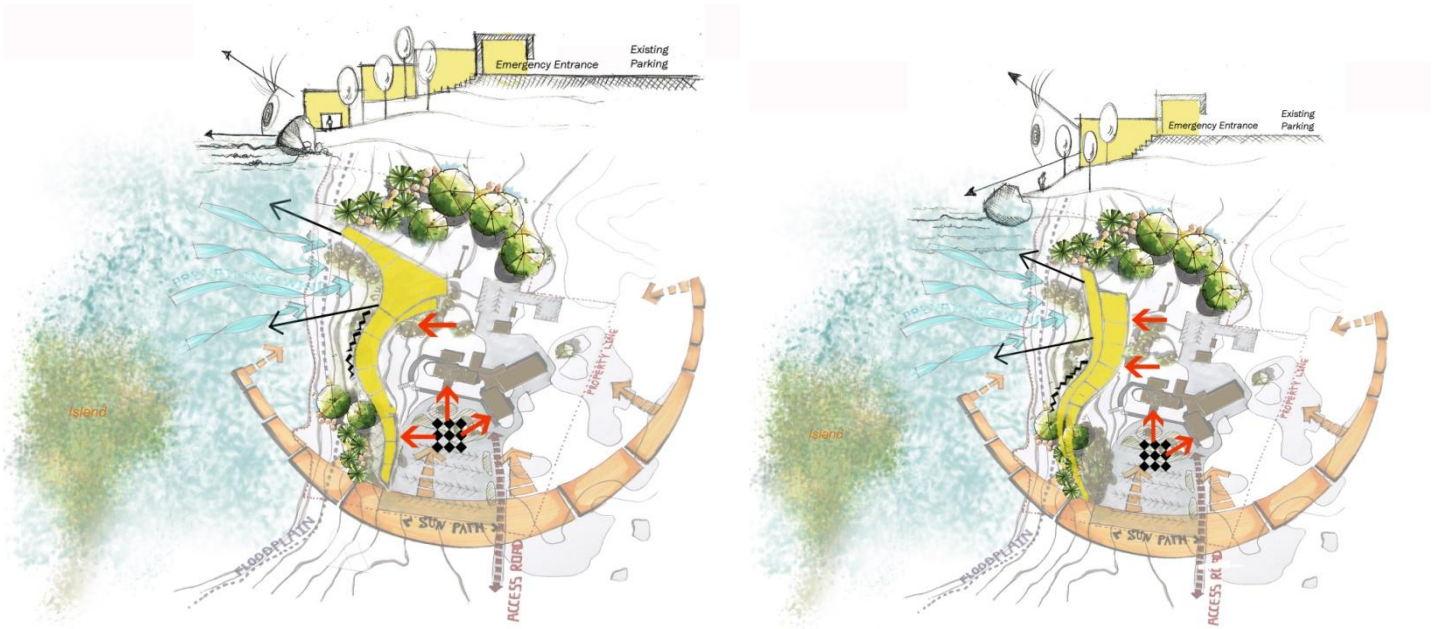

Figure 58. Exploring linear orientations on site (by author)

Simultaneously, I started creaing physical models to explore different possible oriations of the building in relation to topography and existing buildings on site. The idea of lifting part of the building, leading the existing walk path toward the building and letting people pass through the building (while the building itself is isolated) emerged at this point.

My clay model is a general representation of generating several tiers and stacking them on top or next to each other in order to maximize apertures that allow light and the views in.

Figure 59. Clay study model, Exploring different orientations in 3D (by author)

With my floral foam models I explored the orientation of the building and the possibility of reaching out to the water.

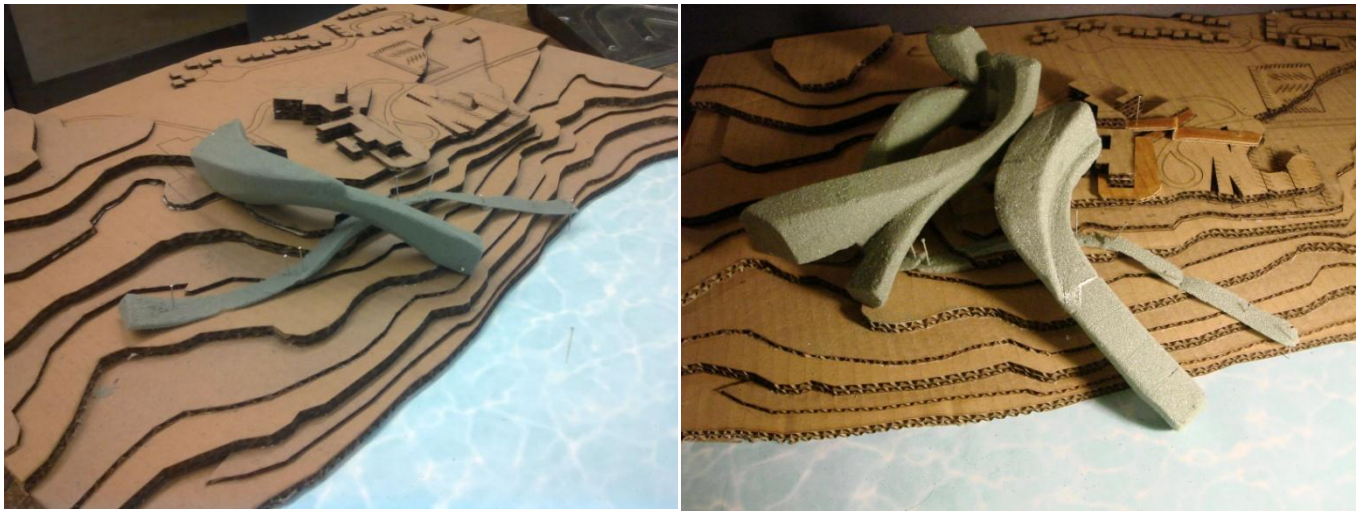

Figure 60. Foam study model (by author)

Images below (starting from left) show the sequence of concept development of this project. The software used for the modeling is Rhinoceros. After working with several physical study models and diagrams, I chose the orientation along North-South axis for the building. This way I achieved maximum views and with stretching part of the form down to the waterfront, I was able to reorient the patient rooms toward south west and avoid the deep west sunlight into the rooms. Later in this section, other strategies are explained that let playful, filtered natural light into patient rooms.

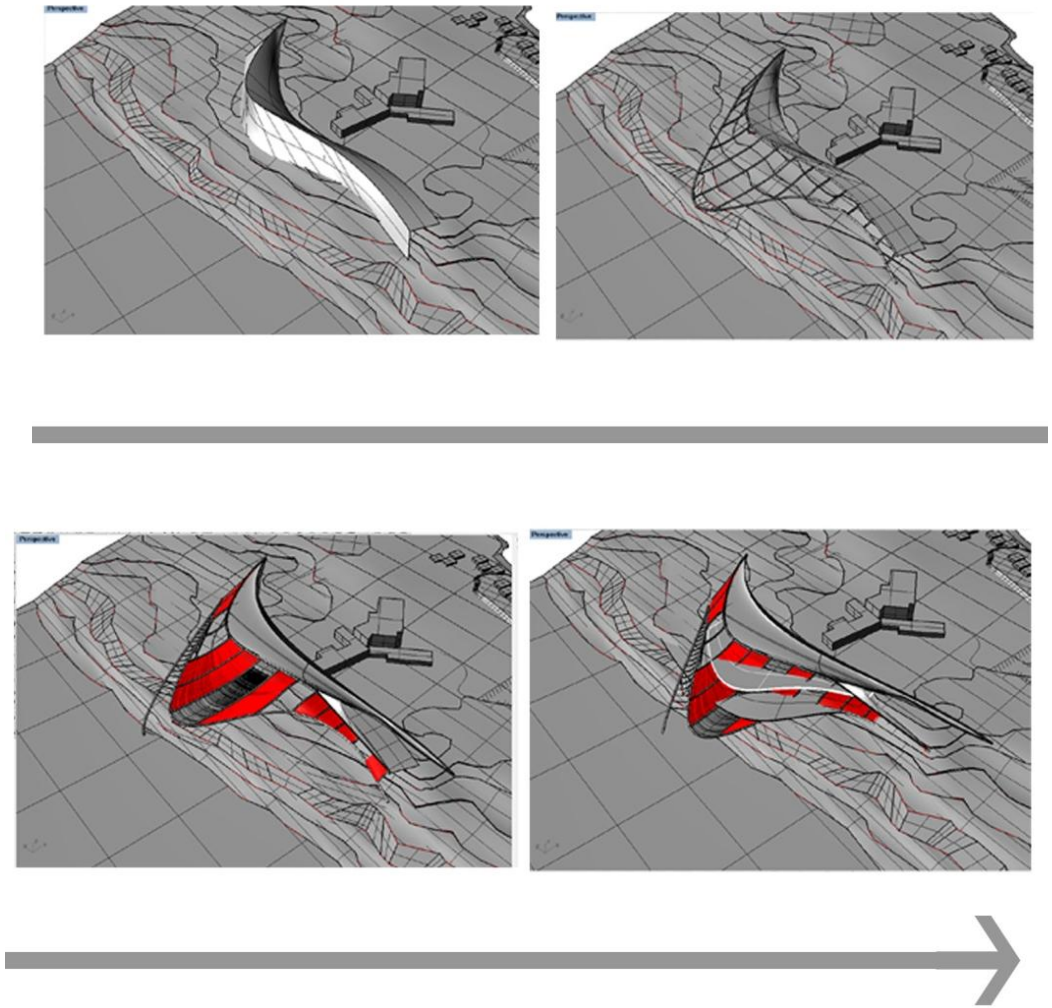

Figure 61. Process of generating the digital model (by author)

The following images are the initial renders of the digital model. The 3D model was exported to Autodesk 3D Studio Max program for rendering.

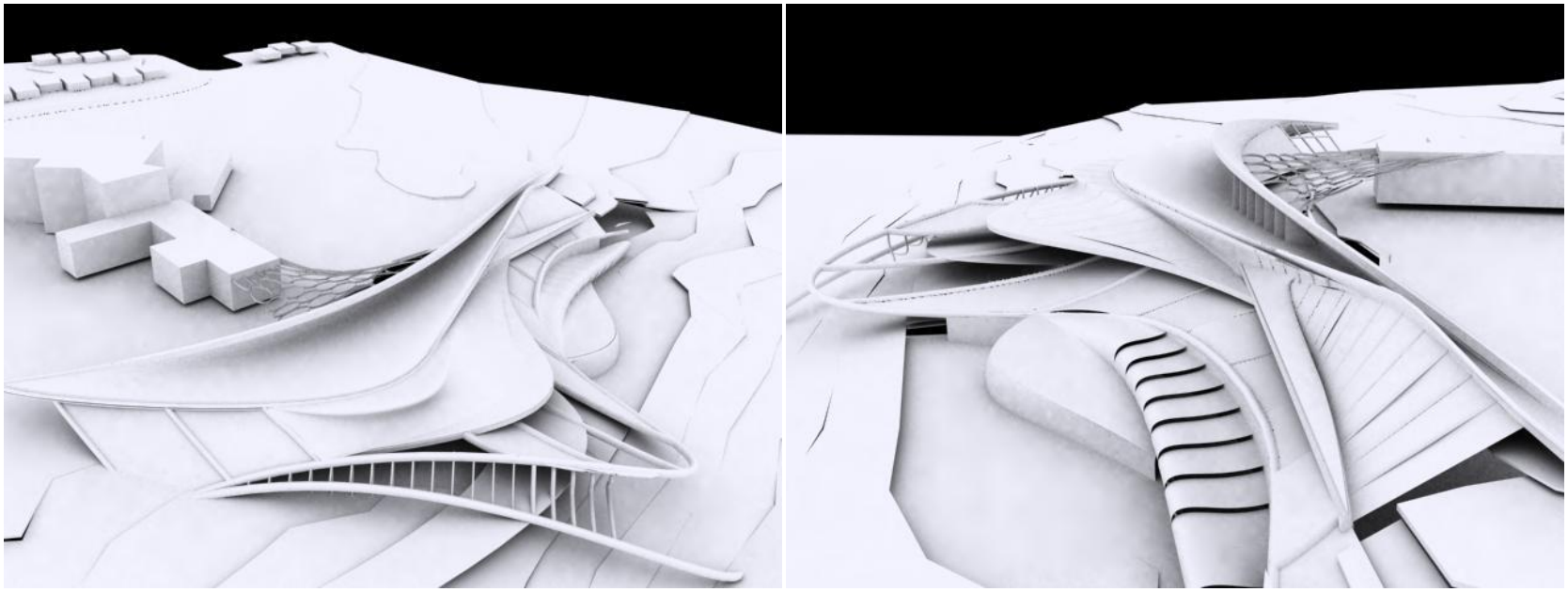

Figure 62. Pre-final digital model (by author)

Site Plan

As shown in the site plan, I modified the existing access roads to the facilities. An access road (on the right) leads patients to a vast circular area. The round shape facilitates the vehicular circulation. The gray area right in front of the mansion is a dedicated parking lot and the green grass area is allocated to possible future expansion of the parking lot. An additional emergency access road detaches from the main road and goes all the way around the old buildings and reaches the emergency section of the new hospital on the left side of the image.

As drivers approach the hospital, the first image they face is the mansion and a net-shaped canopy that connects the mansion to the new building. This first image mattered to me because I wanted to get away from the stressful first impression of a tall, institutional building on children. The unconventional canopy consists of a perforated smooth shape that reaches out from the new building and catches the old building like fishing net. The holes in this dynamic shape are covered with stained fiberglass circles in different colors. They filter the light as it passes through them and create a dynamic, colorful pattern on the floor in front of the main entrance. This cheerful image, being projected on the floor where children can easily see and pass though it, will minimize their stress as they approach the main entrance.

The green line in the bottom of the picture is the existing walking path. This path runs in the space between the site and the waterfront and is currently in need of revitalization. The new hospital creates the potential mutual benefit of revitalizing the existing walk path by providing parking and public activities on site for people and bringing the public to the site and getting them involved in the hospital's public programs. A bridge (shown in color red on the site plan) invites people on the walk path to pass through the lifted-up part of the building and reach the public cafeteria on the terrace of the old mansion or use the dedicated parking lots.

On the left side of the site plan the "healing garden" is shown in color green. This is where the patients, who are in a condition to go outdoors, get to grow their own vegetables or just walk around with their nurses or families. For those children who are not strong enough to walk or be in the complete open space, a semi-open atrium is designed which overlooks the healing garden. This is where patients can sit with their families and watch people walking up the bridge or observe other patients' activities in the healing garden.

Please see the 3D views on pages 83-87 for a better understanding of the explained spaces.

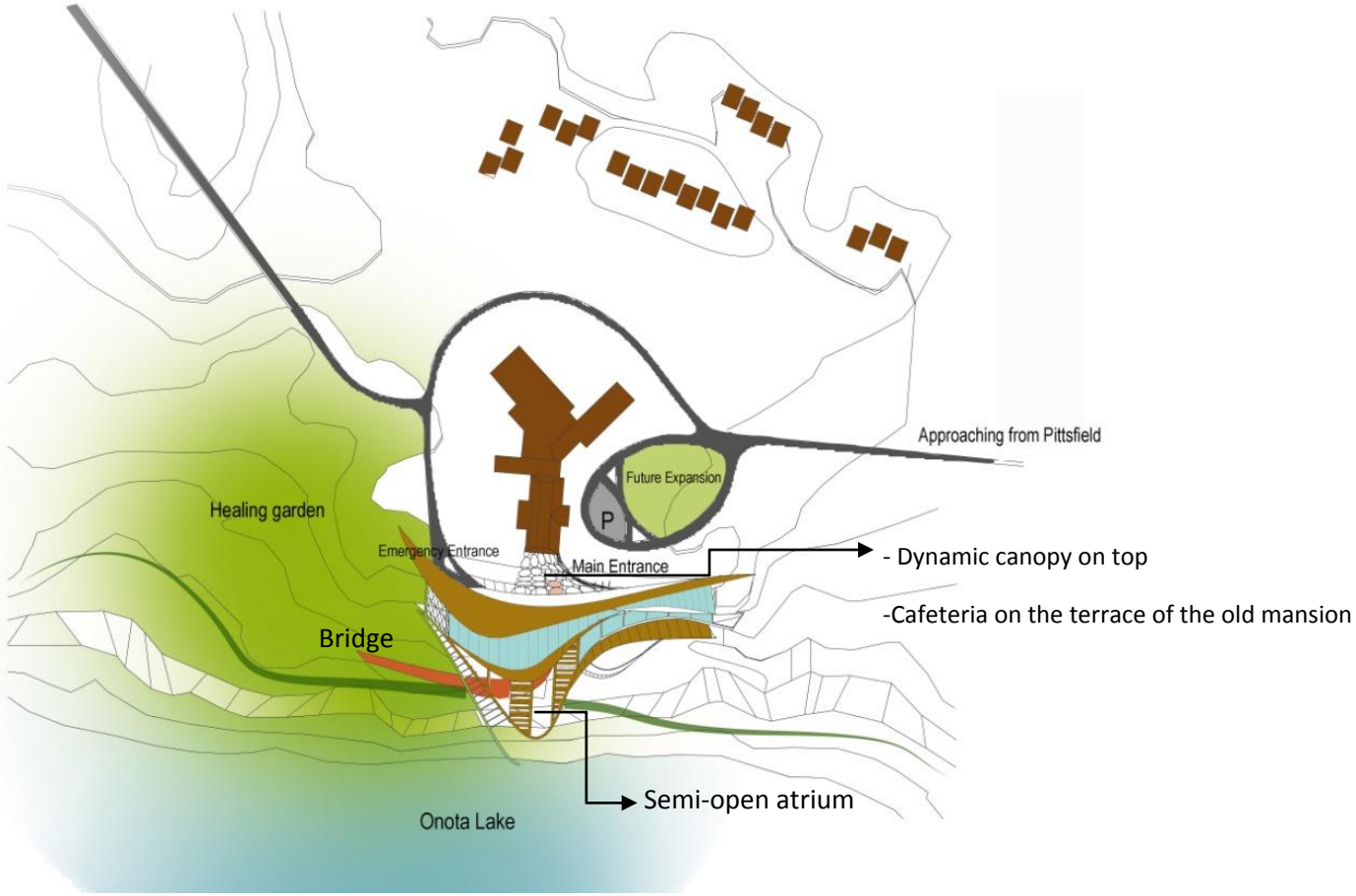

Figure 63. Site plan (by author)

Space Relationships Diagram

The following diagram from the Whole Building Design Guide website (http://www.wbdg.org) shows the relationships of major clinical spaces in a hospital. From the diagram bellow, we can break down the required sections into the following 6 parts: admission, diagnostic and treatment, outpatients, inpatients, pharmacy and emergency. The space are listed in detail in the program in the same section of this thesis.

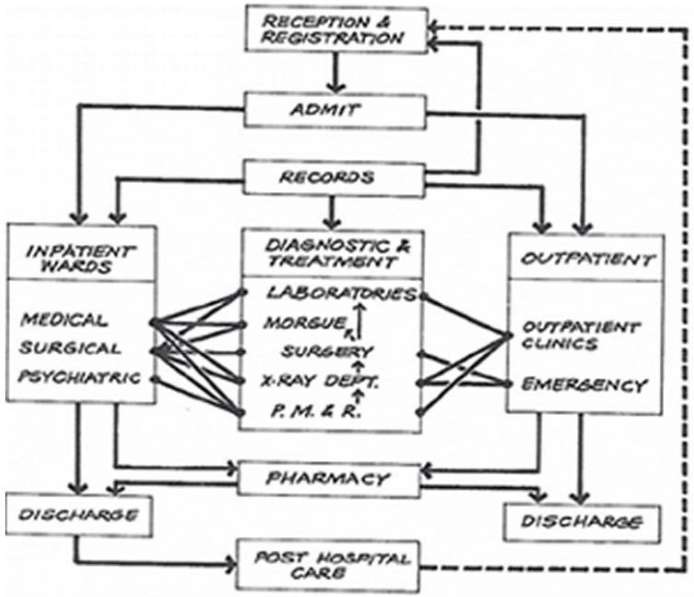

Figure 64. Major clinical relationships- (http://www.wbdg.org/design/hospital.php)

Floor Plans

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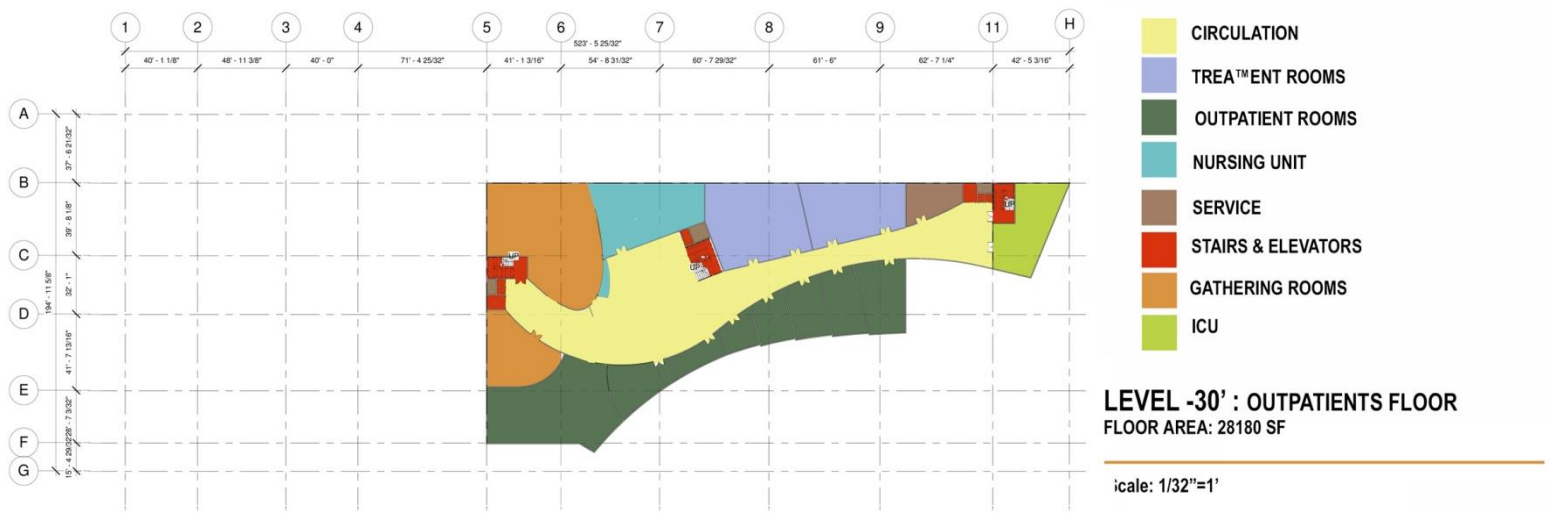
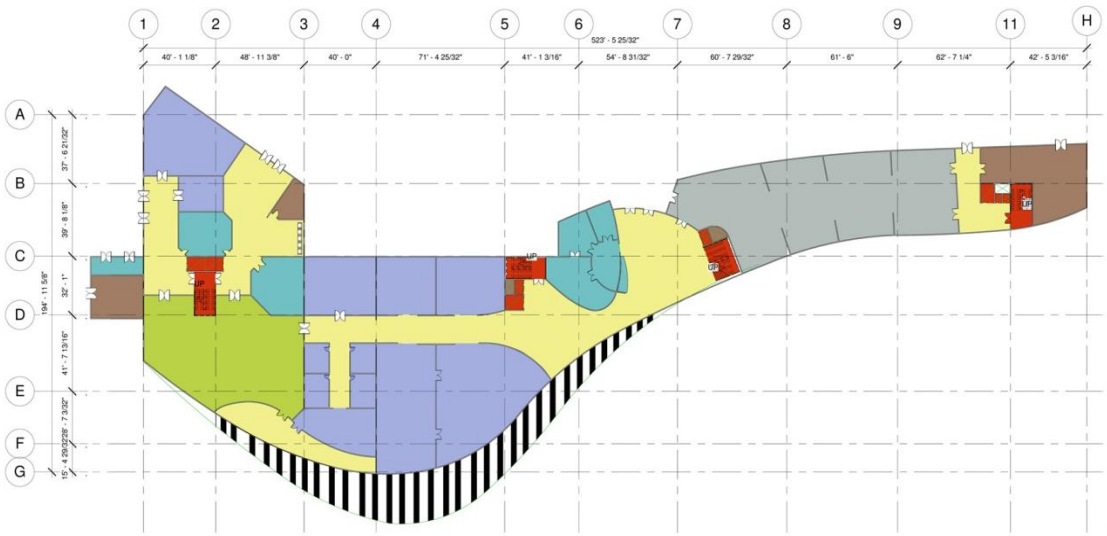


- The plans are 70% of the mentioned scale if printed on 8.5" by 11" sheet.

CIRCULATION
IMAGAING
SURGERY
STAIRS/ELEVATORS

LEVEL +15': IMAGING & SURGERY FLOOR
FLOOR AREA: 27230 SF

Scale: 1/32"=1'

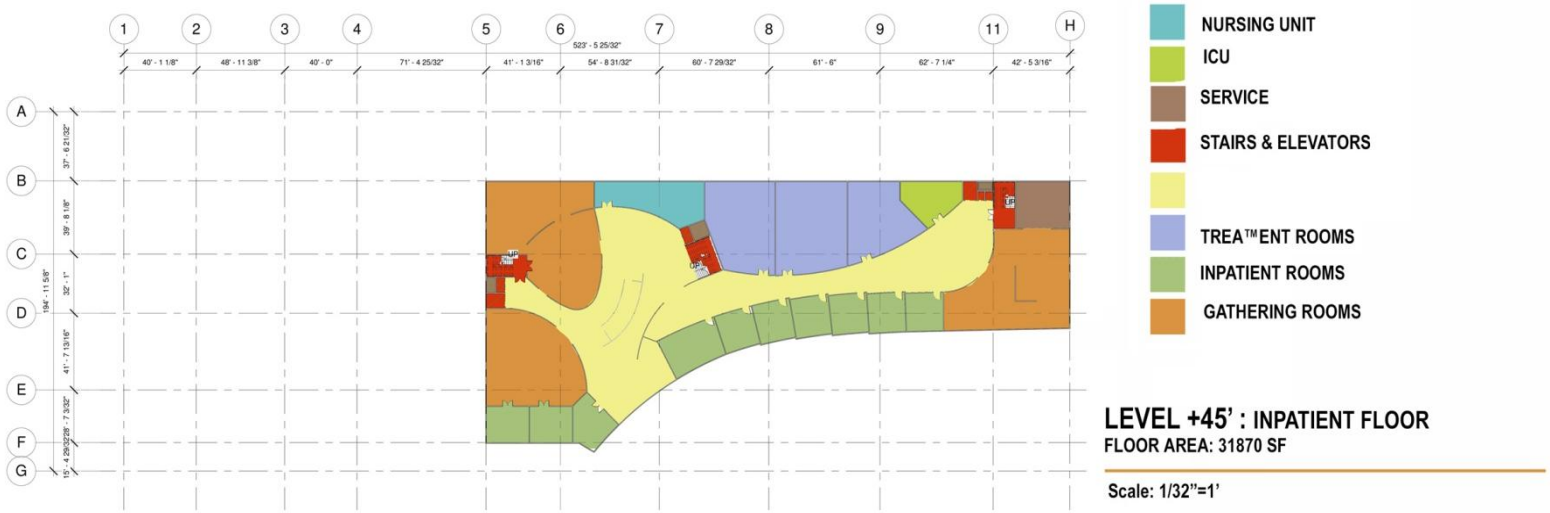


CIRCULATION
ADMISSION/ INFO/ PRELIMINARY CHECK
PHARMACY
DIALYSIS & CHEMOTHERAPY
ACUTE CARE
MECH/ELEC. & SERVICES

LEVEL 0.00 : MAIN ENTRANCE & SURGERY FLOOR
FLOOR AREA: 50730 SF

Scale: 1/32"=1'

- The plans are 70% of the mentioned scale if printed on 8.5 "by 11" sheet.



- The plans are 70% of the mentioned scale if printed on 8.5 “by 11” sheet.

3D Views

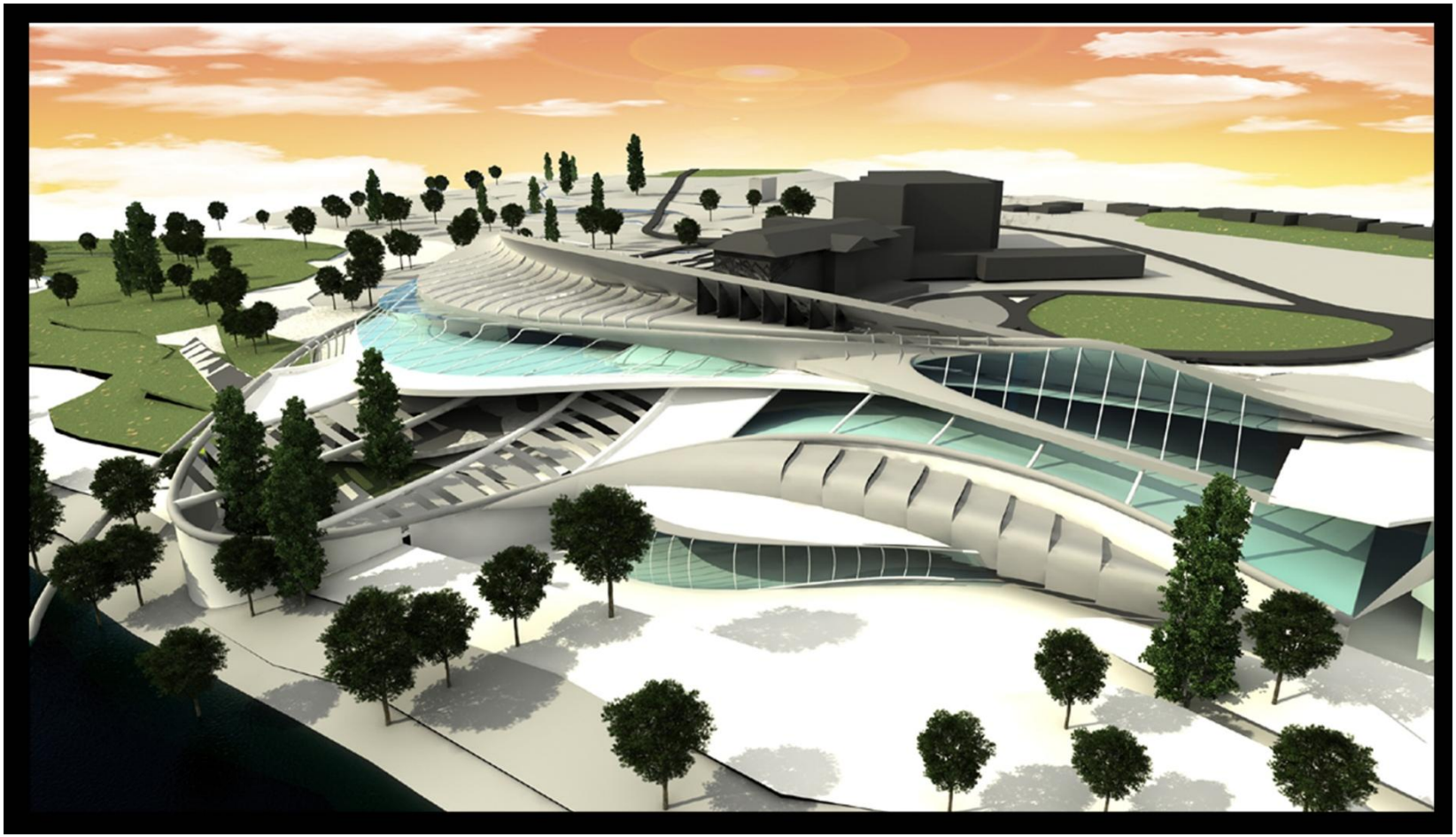


Figure 65. Computer model, bird's eye view(by author)

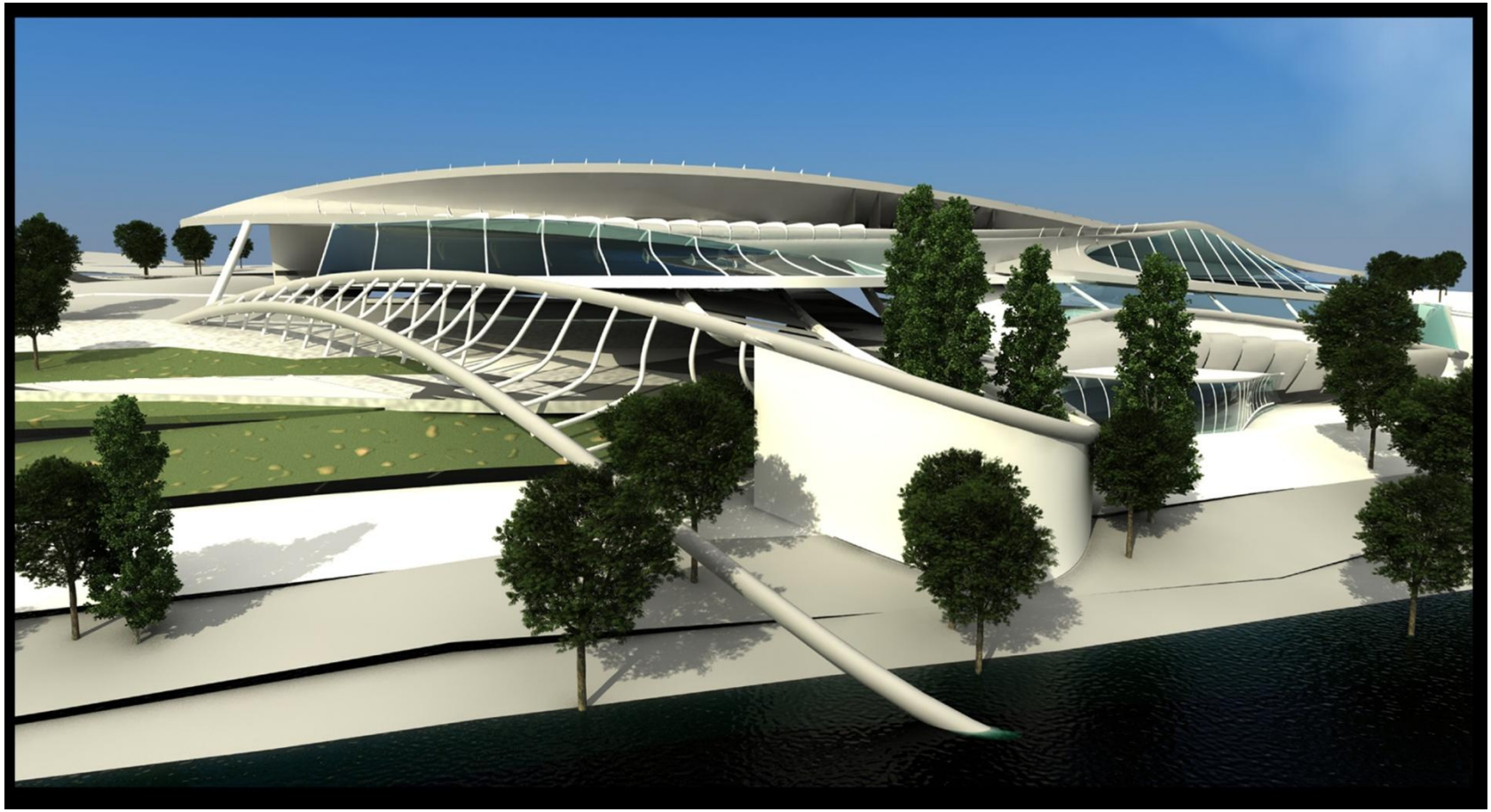


Figure 66. Computer model, bird's eye view (by author)

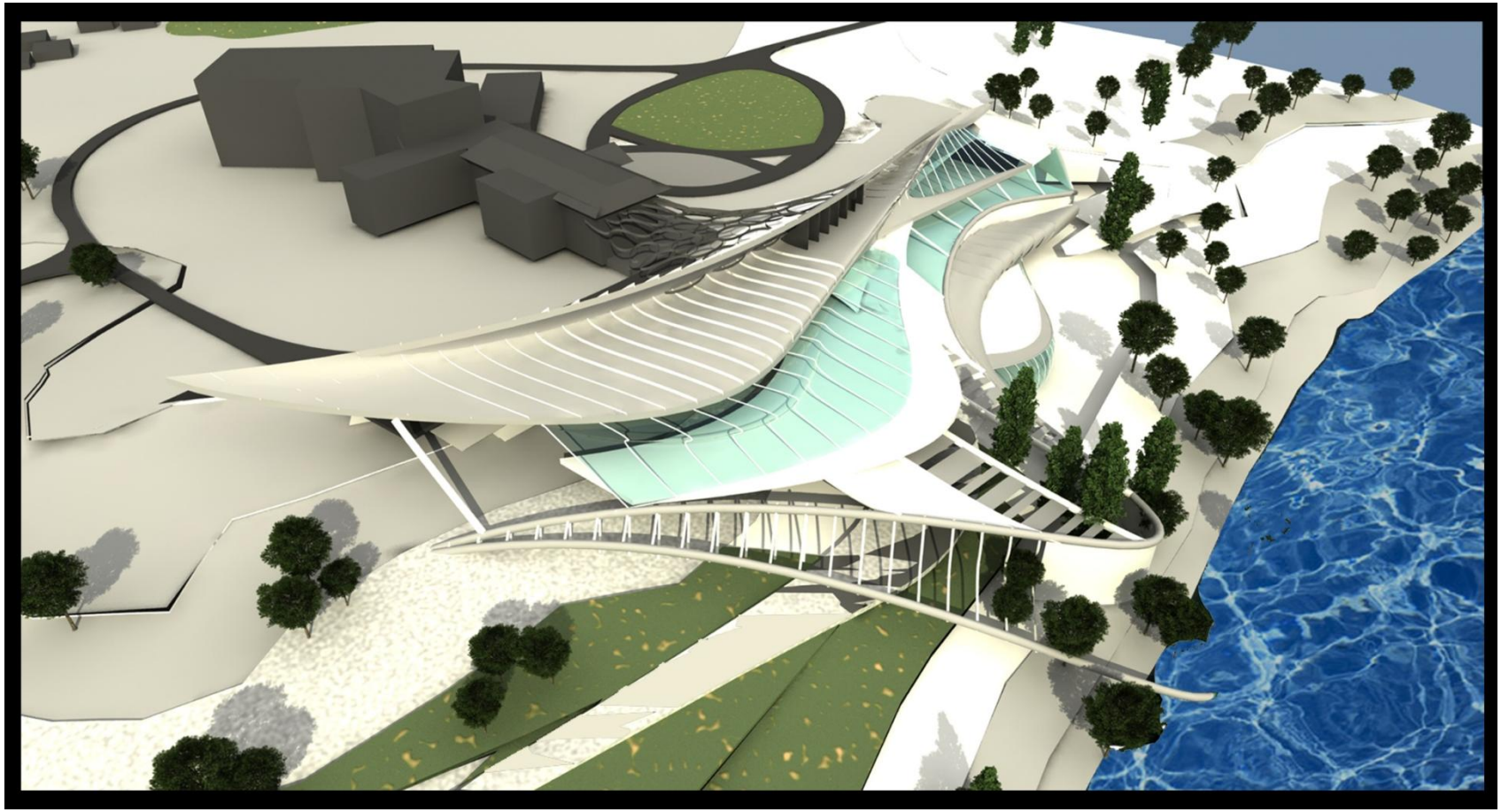


Figure 67. Computer model, bird's eye view (by author)

Sectional Diagram

This is a diagrammatic section that shows the floor plates in relation to the retaining wall, water and existing buildings.

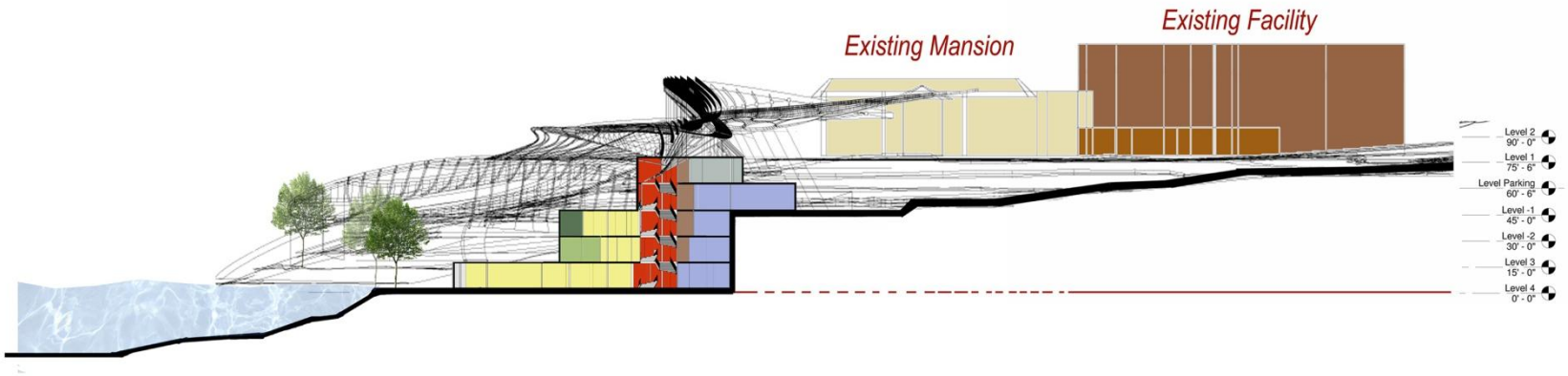


Figure 68. Sectional diagrm, floor plates and retaining wall (by author)

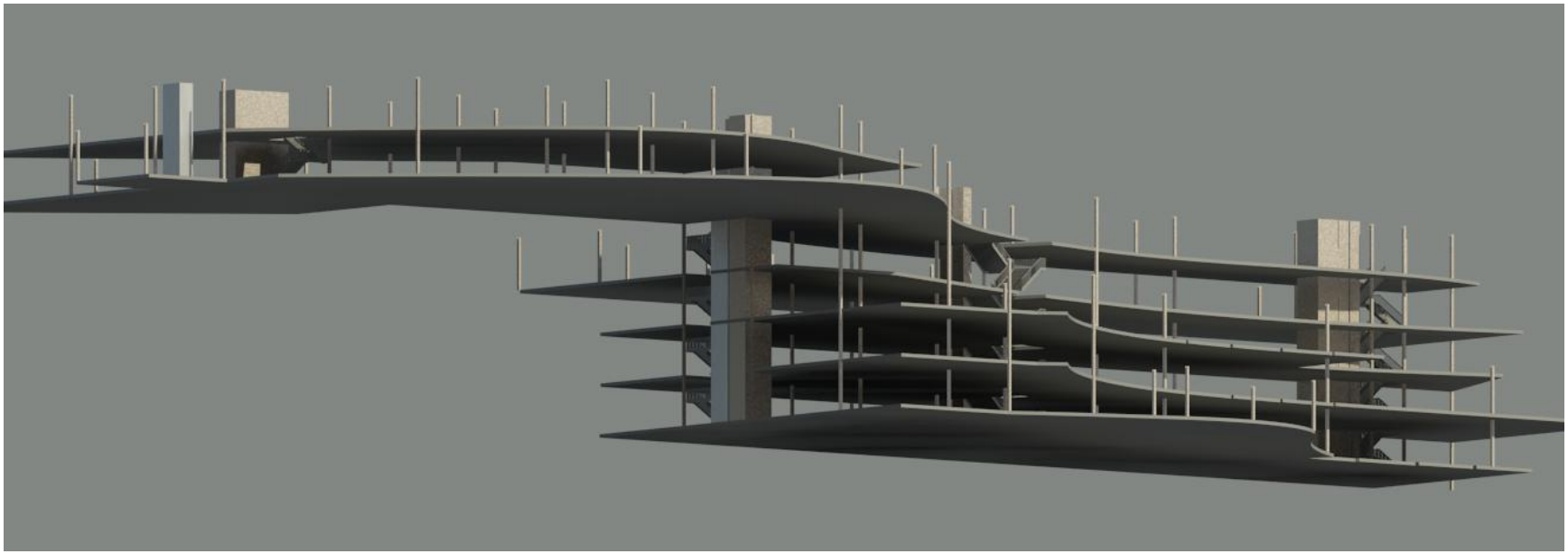


Figure 69. Floor plates, columns, and vertical connections, 3D view (by author)

Patient's Room

In the design of a typical patient's room, I paid special attention to incorporating everything I learned from my literature review and other previous sections and practically use them in creating a homey space for 2-3 months-long stays of child inpatients.

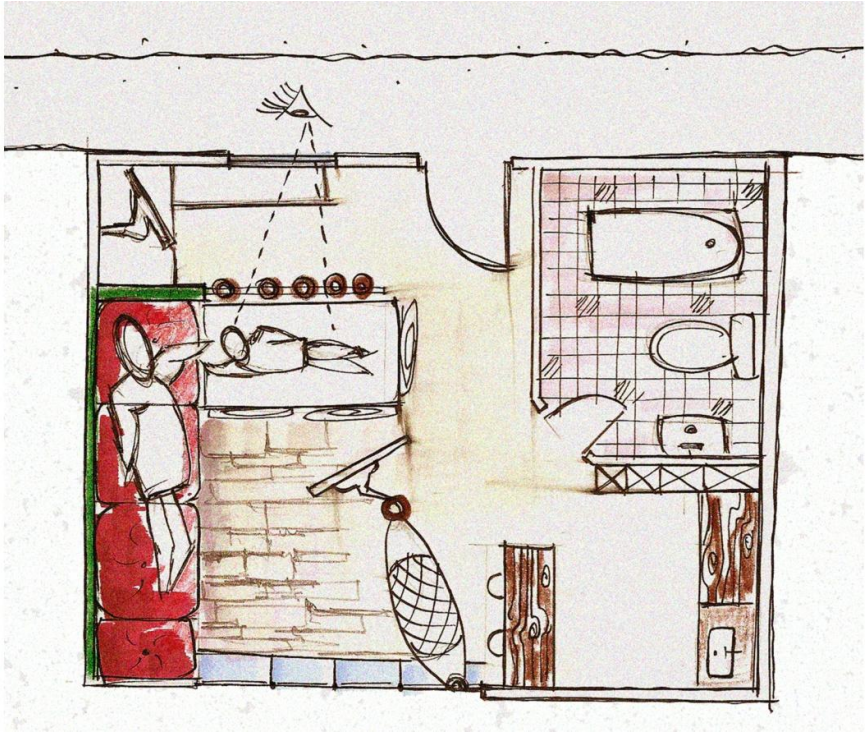


Figure 70. Typical inpatient room, Diagrammatic floor plan (by author)

Starting from the overall layout of the room, I designed a semi-open corridor inside the room. On one side the corridor is glazed and could be viewed by doctors and nurses from the main corridor and on the other side (facing the patient) it is concealed by a sliding perforated wall. This wall, being located right next to patient's head, should bring in warmth to the space. I propose a "bamboo wall" made of sealed real or artificial bamboo. This wall gives the patients some privacy while still let the staff look inside and observe the monitors. The bamboo wall will slide inside a pocket wall in case of emergency and need of access to patient's body from both sides of the bed. Further study on the appropriate material which has the warm tones and natural textures of bamboo but at the same time is approved by healthcare design codes is necessary.

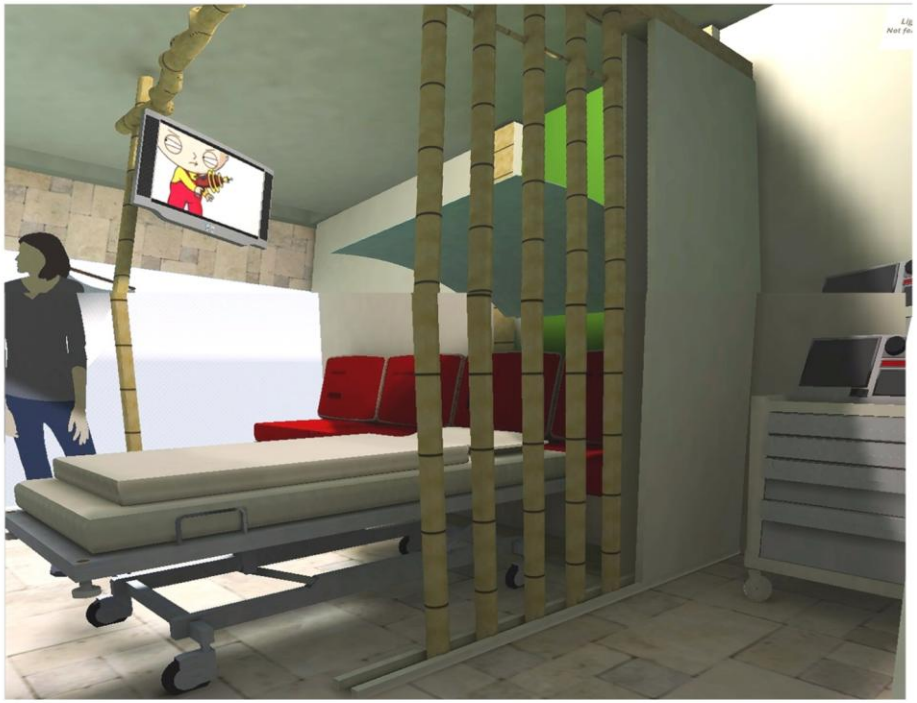


Figure 71. Inpatient room, Bamboo screen and pocket wall (by author)

In almost all hospitals that I have visited, a pull-out coach or a bed to accommodate parents was located across the room from patient's bed and during the daytime, most of the parents ended up laying on the patients bed and holding their child. For the particular subject patients of this thesis, it is reasonable to create a more intimate environment for children and their parents. Some of these

parents know that they do not have much time left with their child and want to spend as much time as they can with them. I reoriented the parents' coach/bed to be located perpendicular (in a L shape) to the patient's bed. This way their heads will be next to each other.

The other feature of this patient room is the canopy above patient's bed. When being sick and having lost the full control over their body, child patients at least need to have control over their surroundings to some degree or they will end up feeling suppressed. The canopy spreads over patient's and parent's head and creates what Hildebrand calls "Refuge" (See literature review section). It opens up to the views of the lake which is the "Prospect" in Hildebrand's word. The elevation and openness of the canopy can be controlled by the child or their parents.

Two other unconventional features in patient's room are designed to make it feel more like home: Kitchenette and hammock. There are sinks and sometimes microwaves in patient's rooms in most of the hospitals but they are usually carelessly located in a corner of the room. Nothing more than "eating together" with family and siblings can create the feel of home far from home. Even looking at the small kitchen island and kitchenware instead of monitors and medical devices can be calming for a child.

A hammock looks over the views of the lake and gives parents and children a place to swing_ not the kind of experience that they can have in all hospitals. The more the opportunities for small activities in the room and the more the things to look at, the less depressed and bored the patients will be.

To take even more advantage of the spectacular views of the lake and the foliage, the windows are extended to the floor (L shaped profile). Taking advantage of seamless views through frameless corners was initiated by Frank Lloyd Wright in the Falling water house.

In the design of the skylight I was inspired by traditional Persian houses. The stained glass in those houses filters the natural light and generates a moving artwork on the floor. The colorful pattern on the floor, which moves as the hours pass, will be of visual interest to child patients, laying on their beds.

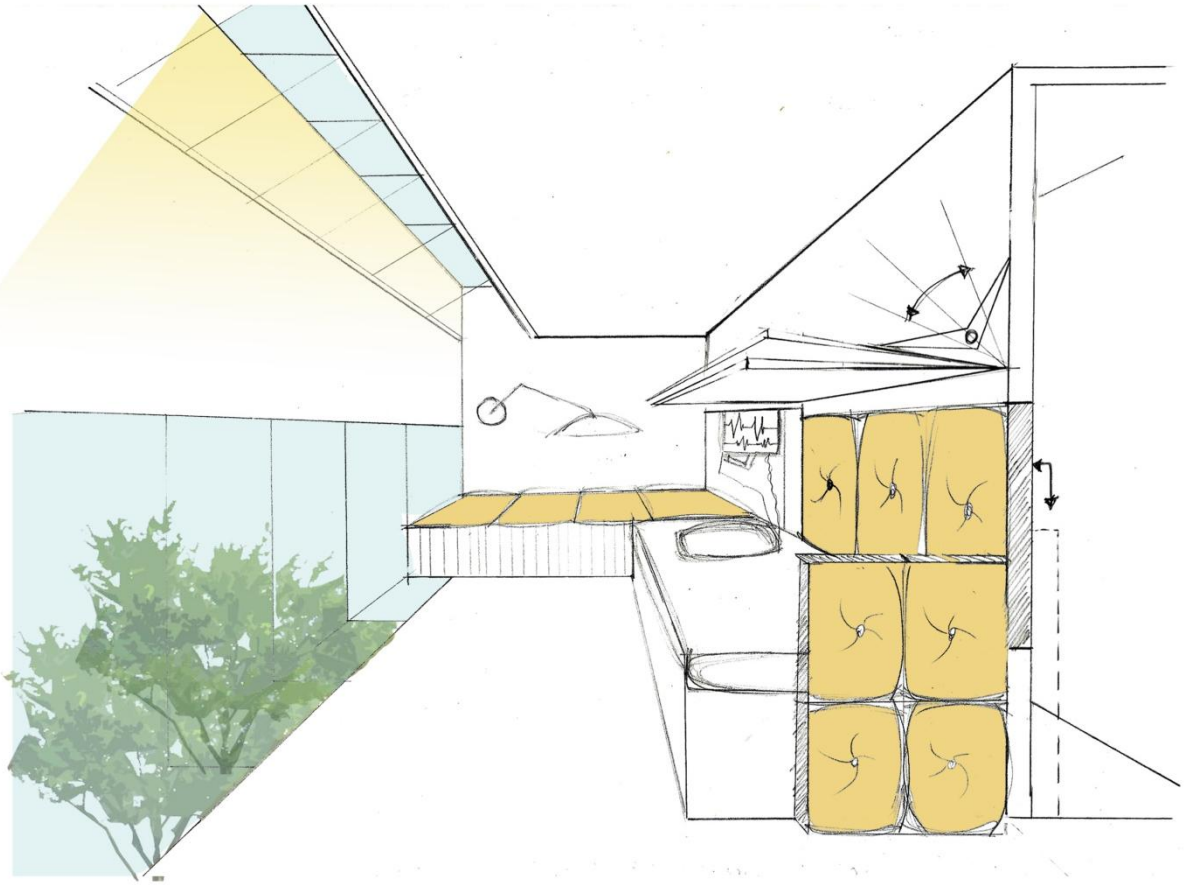


Figure 72- Typical inpatient room layout – Initial sketch (by author)

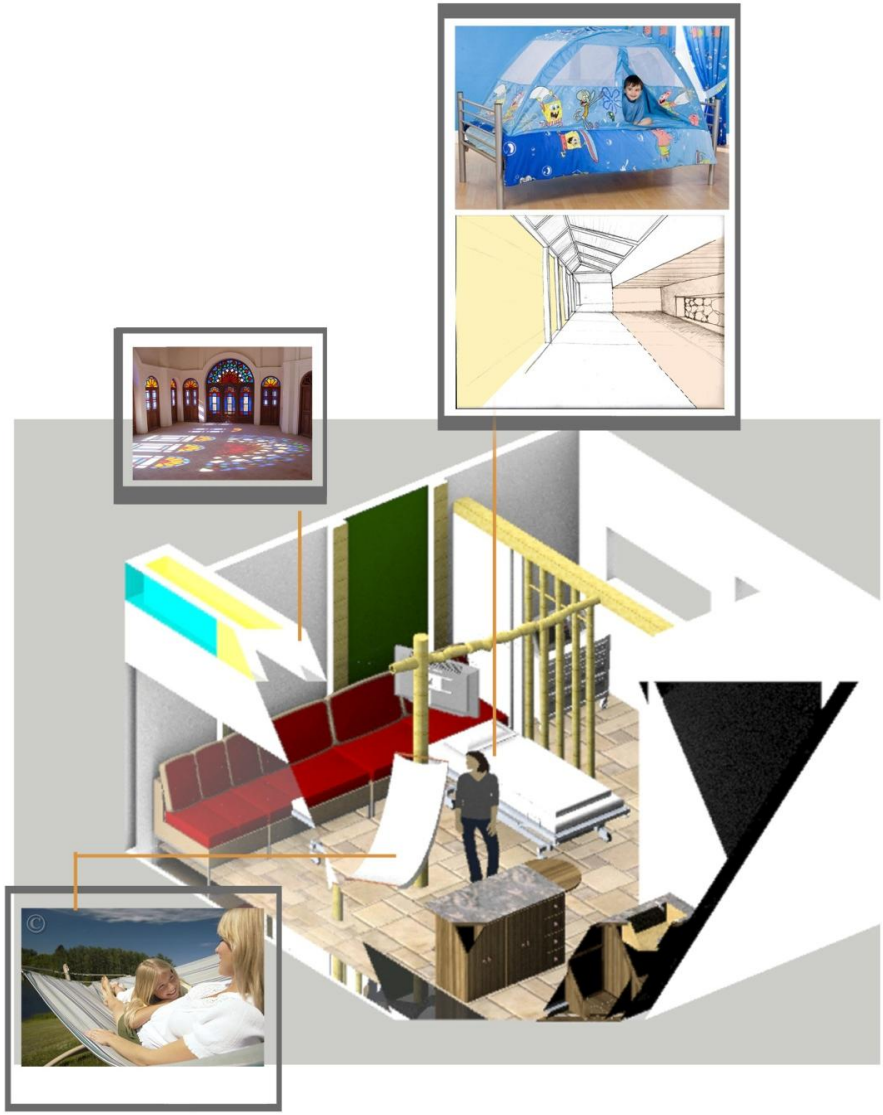


Figure 73. Typical inpatient room layout (by author)

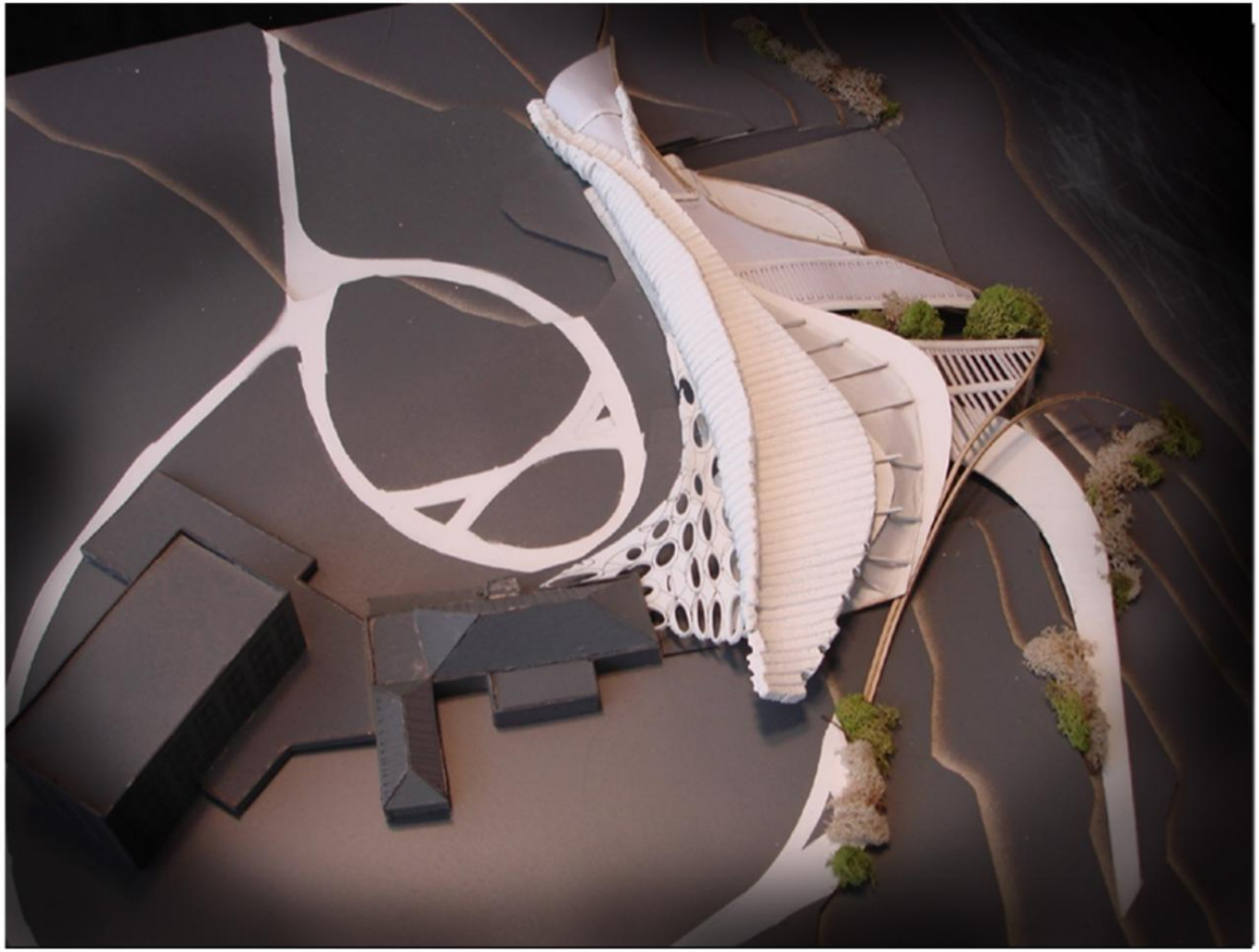


Figure 74. Physical model (by author)

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