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Spatial Design for Behavioral Education

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Spatial Design for Behavioral Education

A Thesis Presented

by

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ABSTRACT
SPATIAL DESIGN FOR BEHAVIORAL EDUCATION

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The built environment can inadvertently create obstacles for human cognition, emotion, and behavior when ill-designed, neglected, or poorly retrofitted. Deteriorating education facilities exemplify the lack of awareness in regard to the significant relationship between people and their environments. However, simply updating a school does not always accommodate occupant needs, especially for students who are sensitive to external stimuli. Students in behavioral schools who suffer from emotional behavioral disorder (EBD) often display adverse neurological affects from negative life experiences. Common disorders comorbid with EBD, as well as EBD itself, interferes with their ability to control and manage behavior. By identifying common challenges, the proposed behavioral school in Northampton, Massachusetts aims to support the building's program and occupants to achieve specific goals, i.e. academic standards, and behavioral self-management. Environmental-behavior and neuropsychology principles are implemented in overarching themes including biophilic design, behavior defined space, safety, and transitions.

Strategic design elements aim to assist students relearning behavior by clearly defining which behaviors are acceptable in specific spaces within the school and by addressing common cognitions and emotions often associated with the negative behavior. These implementations range from broad environmental-behavioral-neurology principles that manifest themselves in the built environment to address place, personalization, territory, and wayfinding, down to smaller details, including strategically framed exterior views. Unlike traditional day schools, this demographic is tasked with the extremely difficult goal to restructure their consciousness from the inside out, in addition to the baseline academic requirements. As the largest physical teaching tool, the school itself assists the sensitive students and hardworking staff in their transitional journey.

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CHAPTER 1

INTRODUCTION

The built environment affects humans through their experiences and mental processes - whether positive or negative, intentional or incidental. We have seen the success of biophilic design in hospitals and healthcare facilities that help reduce patients' length of stay when they have a window view to nature outside. We have also seen businesses invest in designs that increase employee productivity featuring natural lighting, plants, reduced distractions, etc. These advancements stem from a long history of architectural innovations, theories, and concepts about what is valued when designing a space and the evidence that supports such trials. From the Primitive Hut to the modern buildings today, builders and architects have been able to tackle the necessities from the bottom-up. We can use Maslow's Hierarchy of Needs as a conceptual parallel. Abraham Maslow's psychology theory proposed in his 1943 paper "A Theory of Human Motivation" states that people are motivated to achieve certain needs and that some needs take precedence over others.[1] At the base of the pyramid lies our physiological needs: food, water, rest, warmth to survive. Once this primary level of needs is met, then we can address safety needs including protection from the elements and potential danger. Then come our social needs; as humans, we are wired for connection and contact with other humans and we find fulfillment in a variety of relationships. Remove human connection and we begin to see detrimental effects; these effects are not as immediate as at the bottom tiers, but still have significant impact. Then come our esteem needs; the need to feel useful and accomplished. This is a strong driver for careers; besides financial incentives to serve the lower tiers, humans also thrive on being good at

[1] Saul Mcleod, "Maslow's Hierarchy of Needs," Simply Psychology (Simply Psychology, March 20, 2020), https://www.simplypsychology.org/maslow.html)

something. The counterpart of self-esteem is that we want others to view our achievements as well and associate us with a certain status. At the very top is self-actualization, but we can only strive for self-fulfillment if all the other needs are met.

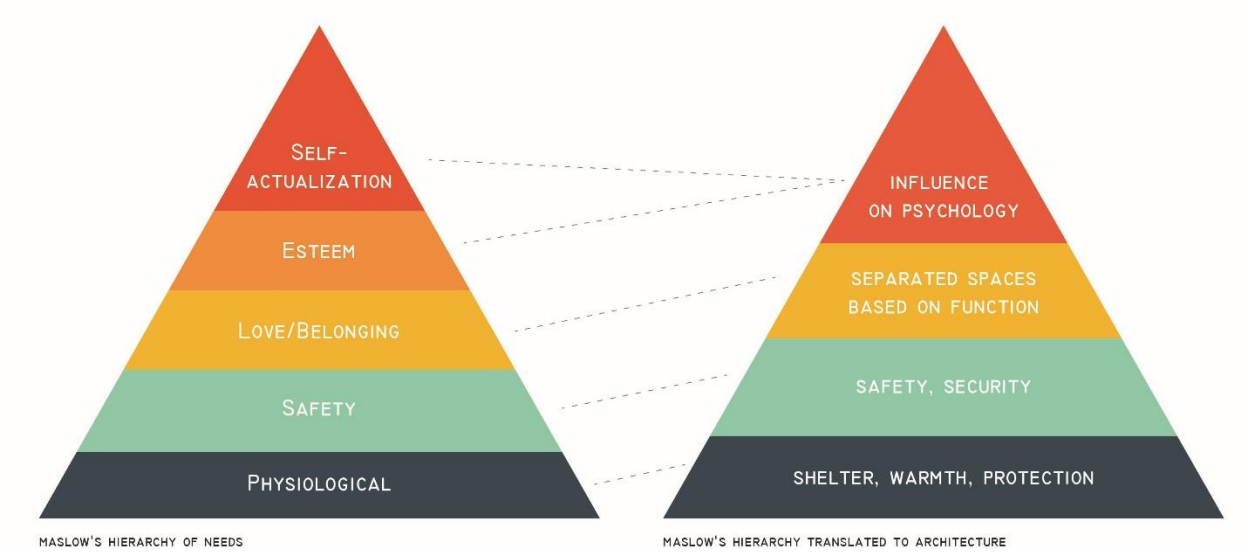

Figure 1: Maslow's Hierarchy of Needs – What Architecture Gives to Us

(Based off Maslow's Hierarchy of Needs)

Roughly translated, Maslow's Hierarchy of Needs for humans can be paralleled by architectural needs, or in other words, what architecture can give to us. The very basics started as protection from rain and sun. Then our built environment evolved to more robust structures that helped protect against the wind and cold, animals or other unwanted humans. Next, basic spaces that served multiple uses became separated to increase functionality. What was once a one-room house that sheltered an entire family evolved to multiple rooms including a kitchen for cooking and eating, a bedroom for sleeping, a bathroom for bathing, and an office for working. At the top lies architecture's influence on an individual's psychology. Places of worship are designed to feel divine and spiritual. The theater addresses acoustics to transmit sound to every corner, and spotlights illuminate the stage to direct focus. However, recent research has ascertained that the

built environment does more than just alter our behavior; it also alters our cognition which is closely tied to behavior and emotions. When a patient is lying in the hospital bed gazing out the window, are his actions any different? Or is it the view of nature that sparks the mind to alter cognition and subconscious thought? Subsequently, these thoughts influence emotions, and amongst the variety of processes going on in the brain, the central nervous system can focus on healing the body prioritizing more basic levels of need. Does a 'better' work environment inhibit distractions and encourage motivation, therefore contributing to a more successful workday and a strengthened sense of accomplishment? If we can identify how to strategically alter our environments based on its effects on cognition, emotion, and behavior, we can produce valuable results that align with the goals of the space.

Welcome to Your World

Sarah Williams Goldhagen, architecture critic, writes Welcome to Your World with the intention of illuminating the reader about the built environment's impact on our feelings, well-being, consciousness, and memories. Goldhagen unveils the extensive impact of some of the seemingly invisible aspects of our environments as evidence that our society needs to reinvent how we build.

The first chapter *The Sorry Places We Live* examines slums as an effective example of some of the 'sorry' built environments in the world. Goldhagen highlights numerous slums across the world and the large number of people who live there, i.e. places like Mumbai and Delhi, India, where slums accounts for 50-60% of the residents, making 1.3 million people per square mile.[2] She describes how children inhabiting a chaotic, densely populated environment

[2] Sarah Goldhagen, *Welcome to Your World: How the Built Environment Shapes Our Lives* (New York, NY: Harper, an imprint of HarperCollinsPublishers, 2017), 4.

display slower overall development both academically in school and behaviorally at home; additionally, these crowded homes are associated with higher rates of child psychiatric and psychological disorders.[3] What is most interesting is that these living conditions not only alter childhood but result in lifelong effects:

> Overcrowding, lack of privacy, and environmental noise diminish a child's capacity to manager her emotions and hinder her ability to deal effectively or even to cope with life's challenges. So not only do slum-dwelling children enjoy fewer opportunities, but they are also less capable of taking advantage of the opportunities available to them…A person's experience of growing up in challenging and impoverished circumstances results in *lifelong* diminished capabilities. (Goldhagen, 6)

Goldhagen transitions to middle/upper-class homes to reveal their own drawbacks, addressing their more subtle yet still harmful aspects. She moves across the globe from India to the suburbs of Plano, Illinois emphasizing the underused yet ample outdoor space and limited spontaneous social interaction.[4] Where the slums lacked in privacy, quietness, and space, the typical middle-class suburb lacks social interaction with neighbors.

Goldhagen then analyzes schools and recalls her own experience preparing to move to New York City, including the search for a private school for her son:

> Most families would be happy to send their children to a certain school in upper Manhattan. This pre-K – 12 school occupies a collection of buildings abutting one another on a leafy side street; its entrance sits in a heavily shadowed, deeply sculpted, Richardson Romanesque masonry pile of earthy tans and reddish browns. But its high school, located in a newer building perhaps forty years old, looked a little less and a little more like a hundred suburban high school degree factories. Its many classrooms, below-grade, were rectangular cinder-block grottoes, with industrial-grade wall-to-wall carpeted floors and ceilings lined with standard-issue white acoustic tiles… Ninth-, tenth-, and eleventh-grade classrooms lined a narrow linoleum-tiled internal corridor, with sound bouncing around and off walls like so many balls on a crowded playground. (Goldhagen, 9)

[3] Goldhagen, *Welcome to Your World,* 4.
[4] Ibid., 7.

This detailed picture of another 'sorry' place is included to emphasize the difference in quality so that the statistics Goldhagen brings in are more tangible:

> Yet research clearly demonstrates that design is central to effective learning environments. One recent study of the learning progress of 751 pupils in classrooms in thirty-four different British schools identified six design parameters – color, choice, complexity, flexibility, light, and connectivity – that significantly affect learning, and demonstrated that on average, built environmental factors impact a student's learning progress by an astonishing 25 percent. The difference in learning between a student in the best-designed classroom and one in the worst-designed classroom was equal to the progress that a typical student makes over an entire academic year. (Goldhagen, 10)

It is hard to sell an idea or convince a board of trustees to spend a significant amount of money on what some may see as subjective. Incorporating statistics informs her positivist approach, the most effective of the three approaches when operating in the business realm. A board of trustees does not lack concern for their students but rather lacks awareness that the physical environment has a great influence on academic success.[5]

Goldhagen then analyzes specific pavilions to demonstrate that incorporating human cognition into design does not always mean it will be successful. She compares Jean Nouvel's 2010 Serpentine Pavilion in London, England with Thomas Heatherwick's 2010 Seed Cathedral; in short, Nouvel's intention for warmth and delight was undermined by his overuse of a harsh red.

Goldhagen revisits the conceptual lack of awareness but this time in the context of university curricula rather than business investments. Not only are boards of trustees largely unaware of these design impacts, but students learning architecture are unaware, too, further preventing the concept from emerging into the mainstream. How can businesses know or request that their architects should include psychological aspects into design if the architects themselves,

[5] Goldhagen, *Welcome to Your World,* 11.

the so-called experts of the field, are unaware? She explains how few design schools offer, much less require, education about how humans experience the built environment whereas other basics including complex geometries, structural systems, construction processes, and parametric design, are all covered. In her own words, "Of the built environment's effects on human cognitive and social development, students learn next to nothing."[6]

After she legitimizes the built environment's role in cognition. She mentions how buildings, cityscapes, and landscapes often remain ignored because they change slowly, if at all, which means they do not demand our conscious attention because, "we are animals: neurologically, wired to ignore all that is static, unchanging, nonthreatening, and seemingly omnipresent."[7] She then breaks down cognition itself to prove its significance related to architecture:

> Cognition is the product of a three-way collaboration of *mind, body, and environment*…the body is not merely some passive receptacle for sensations from the environment, which the mind interprets in a somewhat orderly fashion. Instead, our minds and bodies – actively, constantly, and at many levels - engage in active *and interactive,* conscious *and nonconscious* processing of our internal and external environments. (Goldhagen, 47)

An example of a typically nonconscious processing is an effectively deployed metaphor; "important is big" and "substantial is weighty."[8] However, the built environment plays into our cognition beyond the messages, conscious or subconscious, it sends to us. Deeply rooted in our varying levels of thought, cognitive mechanics encode autobiographical memories.[9] Much of who we are is based on our past and our memories, and our memories are encoded in chunks that include the environment, the smell, the people we were with, the emotions we experienced at the

[6] Goldhagen, *Welcome to Your World,* 34.
[7] Ibid., 39.
[8] Ibid., 77.
[9] Ibid., 88.

moment and so on. The built environment and behavior surrounding us is included is integrated into our self-identity and conceptions of others.

Diving deeper she explains specific examples of how our brains interpret and encode information from our surroundings. We analyze space relative to our bodies, i.e. where elements fall relative to our body in metric space. For example, we typically do not notice the difference between a twelve-foot-high ceiling and a thirteen-and-a-half-foot-high ceiling because in either case, the height substantially exceeds our reach capacity, and therefore we find it difficult to accurately gauge the dimensions.[10] We also use our vision to encode haptic impressions, visual stimuli that provoke us to mentally simulate tactile sensations.[11] The mere sight of an object cues our imagined sensorimotor engagement with it; we imagine its weight, relative size, and how we hold it relative to our bodies. We analyze a setting and then focus on the objects in our visual field we want to touch:

> Human sight excels at rapid gist extraction, our efficient ability to extract essential visual information from our environments so quickly (twenty milliseconds) that the speed is literally within the blink of an eye, and when we do extract a scene's gist, we are rewarded with a little jolt of neurotransmitters that give us a sense of pleasure. (Goldhagen, 151)

These impressions engage us in our environments because we can control what we touch far better than we can control what we see. Surface-based cues elicit more of a whole-body, intersensory, and emotional response; research studies have shown that students participate more in group discussions if their classrooms are filled with cushioned furniture, throw pillows, and rugs.[12]

[10] Goldhagen, *Welcome to Your World,* 96.
[11] Ibid., 95.
[12] Ibid., 158-161.

Goldhagen goes on to introduce canonical neurons, located in the brain's frontal and parietal lobes, that control our motor actions:

> [Canonical neurons] fire when we are doing something such as throwing a clay pot and also fire when we do nothing more than look at an inanimate object, like a lump of clay, and picture ourselves manipulating it. (Goldhagen, 160)

Knowing this, we can being imagine the implications our setting or built environment has on our mental processes. Interestingly, we have another type of neuron in the frontal and parietal lobes that fire similar to the canonical neuron. In addition to motor actions and objects that stimulate the mental process of said motor action, these mirror neurons fire when we observe someone else doing the given action. Not only does the built environment itself effect our mental processes, but the behavior and actions of others within our setting also greatly affects our neurology.

Of these stimuli, haptic impressions and environmental cues, we respond strongly not only to greenery and light but also to natural materials, biomorphic forms, and specific topographical features because we are biologically wired to embrace the natural world. Goldhagen writes, "exposing people even to *representations* of natural landscapes improves people's physical and mental health."[13] Since we are so predetermined to find benefits from being exposed to nature, our childhood experiences with nature play a significant role in our sense of self. Goldhagen explains that people's autobiographical memories are processed in the same part of the brain involved in cognition mapping, therefore autobiographical memories come packaged by place.[14] The more exposure to nature during childhood amplifies a better sense of self.

[13] Goldhagen, *Welcome to Your World,* 147.
[14] Ibid., 142.

Mind in Architecture

Published in 2015, *Mind in Architecture* edited by Sarah Robinson and Juhani Pallasamaa hosts a tailored collection of chapters written by authors, architects, and neurologists. Each chapter, though not directly related to one another, consistently keeps with the theme of neuroscience and how it pertains to the built environment; most chapters note these kinds of approaches are new and still in their infancy.[15]

Harry Francis Mallgrave sets the stage for the book with Chapter 1. Author of more than a dozen books, university professor, and member of the Academy of Neuroscience for Architecture (ANFA) advisory council, he identifies commuter-aided design as the leading method by which buildings are currently envisioned.[16] He offers the idea of neuroscience, another recent technological advancement, as a way to better our designs by giving them more context while focusing less on "novel" aesthetics. He starts with the art-versus-science argument; centuries ago architecture was collectively regarded more as a science and, today it is viewed as more of an art. Mallgrave offers his opinion that this is probably a result of the competitive race for aesthetics and wow-factor. Though he notes the technological advancements of neuroscience as a prominent success of the last half-century, other aspects of brain physiology have also been studied.

The chapter's title, Know Thyself, is a reference to the same quote written in stone on the entrance of the Temple of Apollo at Delphi. It is revealed as a cautionary phrase:

> Warn those who in their vanity seek to understand obscure and far-flung knowledge without first understanding their own human natures. (Mallgrave, 15)

[15] Sarah Robinson and Juhani Pallasmaa, *Mind in Architecture: Neuroscience, Embodiment, and the Future of Design* (Cambridge, Massachusetts: The MIT Press, 2015), 22.
[16] "Harry Francis Mallgrave," Advisory Council, The Academy of Neurscience for Architecture, http://www.anfarch.org/about/advisory-council/harry-francis-mallgrave/

This relates to the chapter's overall theme of rejecting computer-aided design as a primary design vehicle and instead integrating a more sound, neurological approach; focus on ourselves, our bodies, our human nature before we overstep our boundaries by reaching for computer-aided design as a medium to implement these contextually empty designs.

Mallgrave intentionally prefaces his deep dive into biology with a quick recap of Ellen Dissanayake's *Art and Intimacy*, 2000. He finds her conclusion far-reaching but includes Dissanayke's work to give credibility to Colwyn Trevarthen – who she sites, a child psychologist and psycho-biologist at the University of Edinburgh.[17] Neuroimaging studies demonstrate that visual aesthetics, for example beauty found in art, and romantic love share a similar pleasure circuit.[18] Metaphorically, a hedonic is when neurons take the same 'highway.' Mallgrave vocalizes his intention of including Dissanayake and the transition from her work to other later works:

> Today the biological sciences are indeed telling us much about ourselves, much more than we have learned in the past. And while architectural theory over the past half-century has been pursuing the phantom of its coveted autonomy, the biological sciences and their sister disciplines in the humanities have been spawning a bevy of interdisciplinary fields that have been decoding the mysteries of human life with unparalleled success. (Mallgrave, 17)

Mallgrave then criticizes the profession and teaching of architecture saying that they have been steadily moving in a different direction, aiming "successful design" at iconic and novel images in the form of renderings. This is one of the two ways an architect can design:

> A building can arouse our metabolic systems and demand high energy expenditure, or a building can provide a place of relaxation and comforting sociability. Some buildings or environmental events can do both, but my point is the very obvious fact that we can approach a design problem in two general ways. We can design for the "wow" effect, the highly stimulating environment that forces people to come to terms with the intensity and presumed ingenuity of our design, or with greater modesty we can design a place that

[17] Robinson and Pallasmaa, *Mind in Architecture*, 16.
[18] Ibid., 17.

> provides rest and comfort, or perhaps offers the occasion for social rituals or private nourishment. (Mallgrave, 22)

There are appropriate places for both, however, we see that the "wow-factor" in buildings is more common in cities today; urban collections of buildings are designed to be active, aggressive, and abrasive to our senses.[19] Mallgrave concludes by offering the idea of biophilic design as a means to maintain a sensory and physiological balance.

In summary, Mallgrave's position on research advocates for achieving the basics before reaching for far-reaching ideas, and for designs underpinned by the biology of humans rather than the advancements of computer-aided design.

[19] Robinson et al., *Mind in Architecture*, 22.

CHAPTER 2

CASE STUDIES

Hearthstone Alzheimer's Care

Founded in 1992, Hearthstone pioneered the use of evidence-based design in the renovation of a hospital building in Woburn, Massachusetts into an assisted living residence for people suffering from Alzheimer's disease. The residence houses 26 people, "about the size of an extended family unit or small residential community," and includes 24-hour care staff. Hearthstone Alzheimer Care shares its site with New Horizons at Choate that houses 98 apartment residents receiving independent program services and 35 residents receiving assisted living services.[20]

Founder of Hearthstone, John Zeisel, who came to environment-behavior (E-B) from sociology, furthers traditional E-B by integrating neuroscience into the approach creating environmental-behavioral-neurology (E/B/N). The idea is that knowledge of the fundamental principles of human behavior can help designers better understand the relationship between environment and behavior. Zeisel and his team developed hypotheses used to design research methodologies, and once the relationships were identified they could be used for the objectives of a particular design element in order for it to meet its goal. In other words, they linked their research findings to possible design approaches that were then implemented in the Hearthstone Alzheimer Care Residence.

[20] "About," Hearthstone Alzheimer Care, https://www.thehearth.org/about/

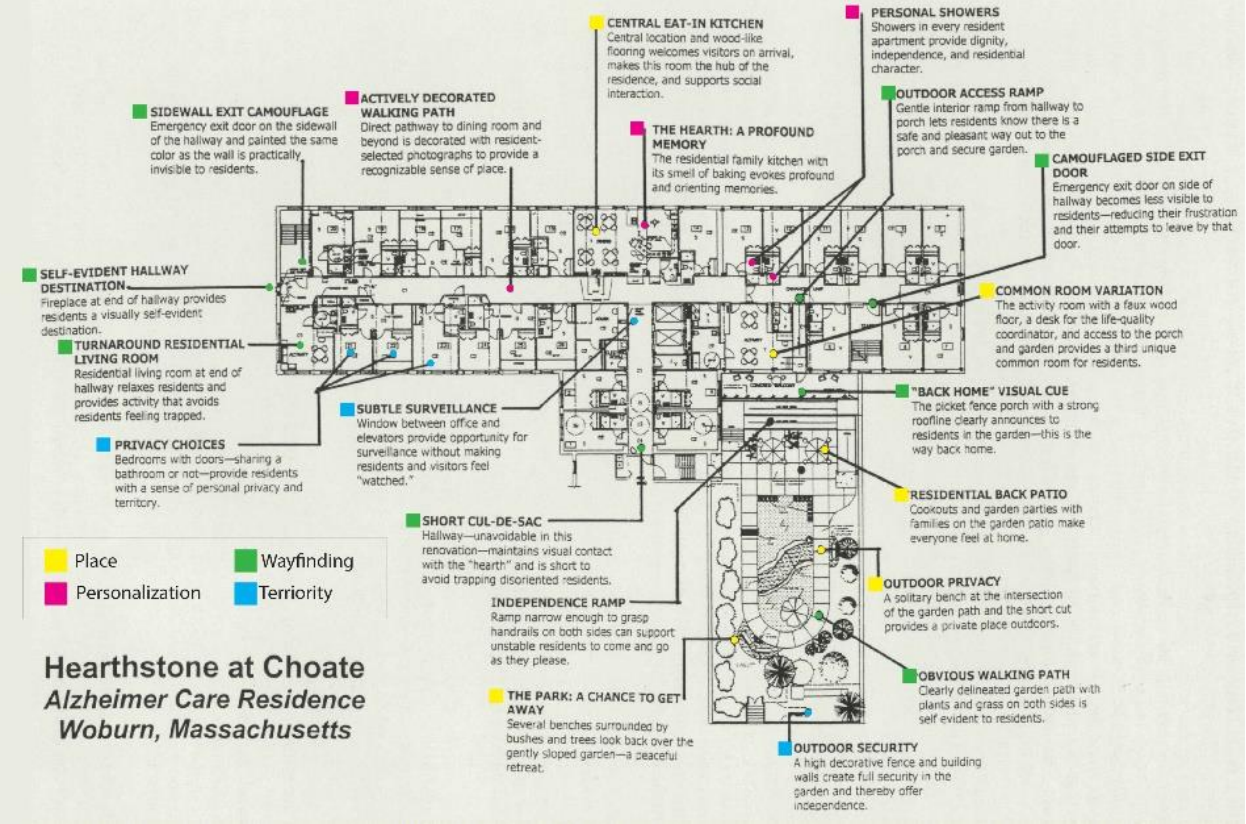

Figure 2: Alzheimer Care Residence – E/B/N Floorplan

(Annotated plan of Hearthstone Alzheimer Residence at Choate, Woburn, MA Zeisel, 2001a).

E-B theory and practice focuses around four core concepts: place, personalization, territory, and wayfinding. Territory, for animals, is geographically based, but for humans, they define boundaries by identifying their surroundings as familiar or unfamiliar. Zeisel integrates these concepts in specific design elements within the residence. Specifically for people with Alzheimer's, aggression is reduced with eight detailed concepts: exit control, wandering paths, individual spaces, common spaces, outdoor freedom, residential character, autonomy support and sensory comprehension. The higher the quality by which all eight environment variables are combined, the more aggression and depression are reduced.

Exits are “camouflaged” from residents’ view to reduce potential agitation, paranoid delusions, and attempted escape. The doors have no windows or views to the outside, they are painted the same color as the walls or other residential doors, and they are located on the side of the hallways rather than at the end. Additionally, the doors have magnetic locks, deactivated by fire alarms, that can be unlocked by coded push pads and are fitted with little or no hardware. Seeing a door or doorknob invites the occupant to use it however intentionally making these exits less visible prevents views and avoids stimulating the idea of leaving.

Common side effects of Alzheimer’s disease include aggression, misidentification syndrome, and paranoid delusions. Hearthstone purposefully increased bedroom privacy and "away spaces" in common areas to reduce verbal and physical agitation among residents. Each resident’s apartment is surrounded by personal furniture and mementos to harness and improve memory, and reduce agitation by helping them to identify territory.

Sometimes, too many common rooms can result in confusion. Facilities with fewer rooms and rooms with identifiable use, for example a dining room, living room, activity room, and staff office, are found to be more understandable and manageable by both staff and residents. Hearthstone limits the number of common spaces and includes a variety of these spaces to reduce physical agitation. When residents leave their own apartments filled with personal items to explore various common spaces, they navigate halls which can cause difficulty with wayfinding. The halls include hangings, photographs, etc. that the residents have selected themselves which provides cues that they are in a familiar place despite little or no recollection of their surrounding environment.

Sensory environments where sights and sounds are controlled, yet understandable by residents, reduce misidentification syndrome of self and others. Common rooms are decorated to simulate a

sense of place by implying different moods, “while residents may not be able to remember the precise attributes of each room, their functioning amygdalae enable them to remember the ‘feel’ of each room.” However, these rooms tend to increase social withdrawal.

A safe, prosthetic environment helps residents keep some of their independence and reduces misidentification syndrome. They are more comfortable, and staff do not feel the need to constantly follow or monitor residents. The outdoor therapeutic healing garden is surrounded by a tall fence to prevent the idea/action of leaving and has a prominent door that signals residents wayfinding so they can easily get back inside. Other elements include a gentle ramp and handrails along the halls to help those who are unsteady on their feet.

The design is planned to augment residents’ memories by tapping the parts of their brains that are still working and relieving the parts that are damaged. This unique achievement in the field potentially impacts how other facilities will be constructed and the regulations and approaches to care for this population.

The Children’s School – Maryann Thompson Architects

Maryann Thompson Architects designed The Children’s School in Stamford, Connecticut as a new and innovative approach to integrate early-childhood education with the environment. Completed in 2007, the 15,000 square foot private elementary school serves 140 children from pre-K to second grade. The Children’s School uses the Montessori Method of Education, a science-based approach that focuses on the child and implements a student-teacher ratio of 11 to 1.

Based off the one-room-schoolhouse, the open environment is designed to encourage students to move freely throughout the learning spaces while maintaining easy observation for the staff. The teacher acts as a guide to the students by manipulating the flexible environment which allows for

a variety of activities and space for both small and large groups. No space within the learning areas has a single, defined use.

Figure 3: Views of The Children's School
(All Chuck Choi Architectural Photography, https://maryannthompson.com/projects/the-childrens-school)

The main entry features large windows that showcase the natural outdoor play area to help relieve separation anxiety. A diagonal view links the open learning areas and maintains the one-room feel. Transitions in the space are defined by changing ceiling heights that parallel the different height roofs instead of traditional walls.

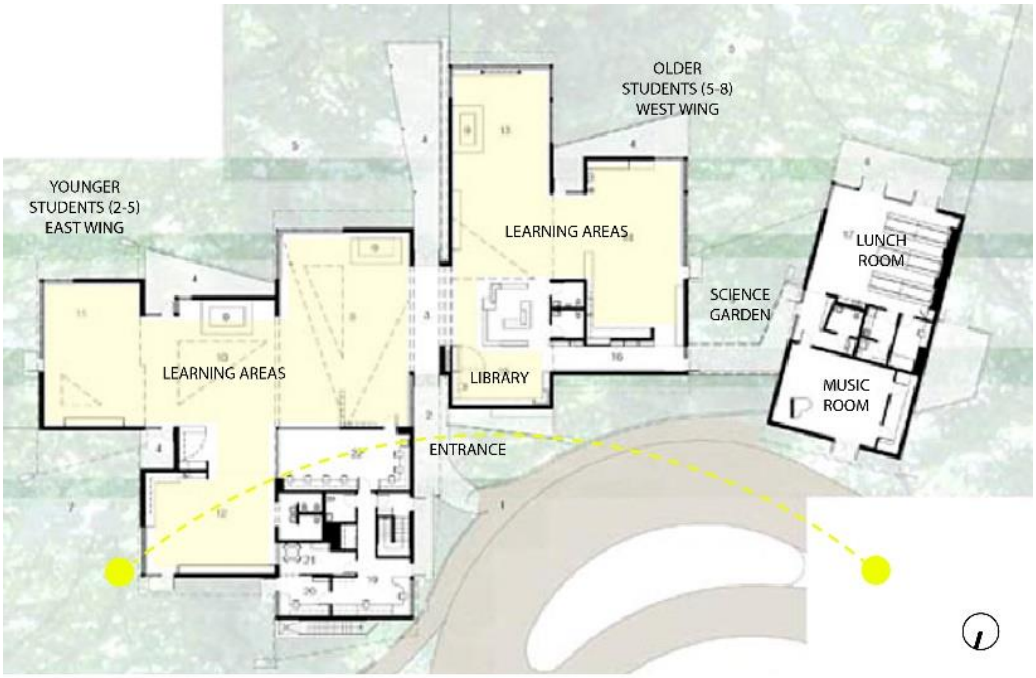

Figure 4: The Children's School - Site Plan Analysis
(Based off designshare.com)

Similar to the unfolding spatial sequences inside, the transition from interior to exterior is blurred by carefully place elements including the vast expanses of glazing in the walls and roof, large roof overhangs, outdoor covered areas, and natural materials. Ample views, as well as physical access, integrate the surrounding, outdoor areas and encourage movement towards and appreciation of nature. Large overhangs provide outdoor covered areas where students can play or have lessons outdoors while the structure simultaneously functions as a shade. External timber cladding on the ceilings underneath the overhangs reinforces the blurred transition from inside to outside (see Figure 5).

Figure 5: The Children's School – Indoor and Outdoor Transitions

(All Chuck Choi Architectural Photography, https://maryannthompson.com/projects/the-childrens-school)

One of the first LEED certified schools, The Children's School incorporate a sustainable approach that aligns with the focus on nature. The age groups are separated into two wings; the younger students occupy the east wing, and the older, full-day students occupy the west to take advantage of the western light. South-facing windows capture views and create the opportunity for thermal heat gain as part of the passive solar design. The clerestories integrated into the skewed roof planes strategically let in natural light from above, as opposed to the side through windows and walls. This mimics how we experience sunlight outside and incorporates the changing cloud cover, rain, and weather to the occupants inside. The clerestories are also

operable to allow for cross-ventilation throughout the building using the stack effect and minimize the need for heating or cooling between seasons. The deep overhangs shield the summer sun but let the winter sun in, and the slanted roofs collect rainwater. All interior finishes are free of VOCs and are recycled or locally sourced.

As part of the child-centered design, elements and materials are introduced to simulate the students' senses. The louvres on the upper glazing cast changing shadows on the carpeted floor where children crawl, sit, and play. Scale is considered vertically, as well; spaces are broken down into varying heights to minimize the apparent scale, keeping with the child's scale. Students are able to experience the building freely, inside and outside, which stimulates self-motivated learning and associating school with exploring and interacting the environment.

The school serves the children of the Stamford Museum's staff to the north. The majority of students are white, 83%, and roughly half are male and the other half female. Single family homes in the area sell from $600k up to $1 million. The median household income for this suburban area is $214,000, well above the national median. Nonetheless, there are many aspects of this school that are more broadly applicable.

CHAPTER 3

NEUROPSYCHOLOGY

Part of the reason why there has been lack of design or research based on the built environment's influence on human psychology comes from the difficulty of measuring subjective and qualitative data. But with advancements in neurology, what was previously speculated, or even unknown, can now be measured with brain imaging tests like magnetic resonance imaging (MRI), magnetic resonance angiography (MRA), positron emission tomography (PET) scans, computed tomography (CT) scans and translated into quantitative statistics.

Three Brains

Humans have three brain classifications: the reptilian (brain stem), mammalian (limbic system), and rational brain (neocortex). The reptilian brain manages survival, sensation, and arousal-regulation. The mammalian controls feelings, motivation, interaction, bonding, and implicit memory. The rational brain controls thinking, language, empathy, planning, and inhibition of impulses.

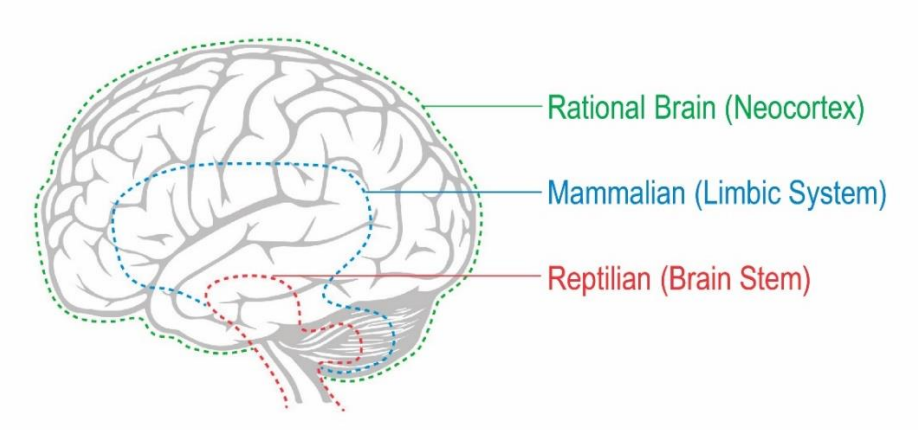

Figure 6: The Three Brains
(Based on How your three brains want three different things, https://optimizeme.nl/en/blog/2017/06/11/how-your-three-brains-want-three-different-things/)

Children exposed to abuse, neglect, etc. show adverse neurological effects on the limbic system. The limbic system contains the amygdala and the hippocampus. The amygdala unfortunately is not very good at discriminating between real dangers and dangers that we are just thinking about; so it responds in the same way to both, and this is tied to the fight-or-flight response.[21] The hippocampus stores and remember information. It tags our memories with information about where and when they occurred. When the amygdala is active, the hippocampus does not work as well and can forget to tag memories with the time and place information which means sometimes, they get stored in the wrong place. When children remember these experiences, it can feel like they are happening again.

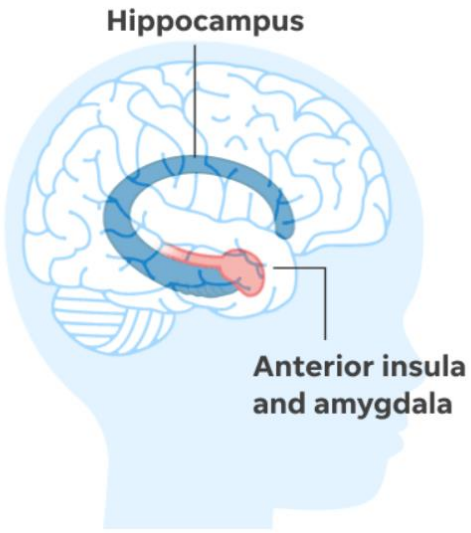

Figure 7: The Amygdala and Hippocampus of the Limbic System
(https://geears.org/news/startling-toll-children-witness-domestic-violence-just-now-understood/)

Stressful experiences disengage the frontal lobes, and over time this can lead to impulsive, short-sighted, and violent behavior as well as increased anxiety, depression, and learning disorders. The fight-or-flight area mobilizes the body; the nature of this system is to bypass the frontal

[21] Functions of the Amygdala and Hippocampus, Oklahoma TF-CBT (Oklahoma TF-CBT), accessed April 23, 2020, http://oklahomatfcbt.org/wp-content/uploads/2012/12/brain-trauma-memories.pdf)

executive functioning and trigger fight-or-flight mode. When this mode is active, the neocortex is disengaged and cannot develop neural pathways or feedback loops.

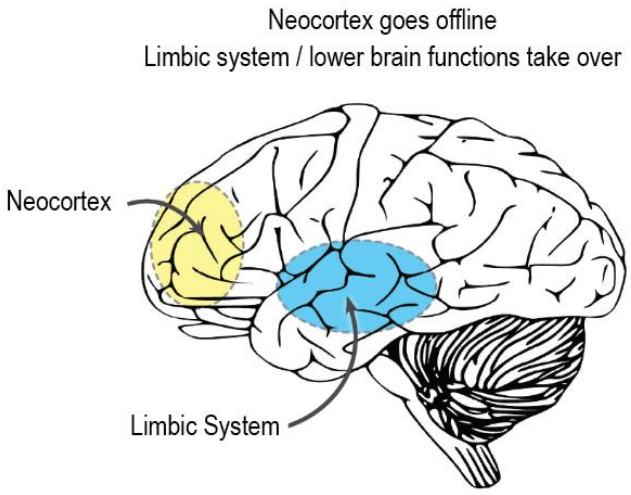

Figure 8: Neocortex Functioning vs. the Limbic System
(Based on Survival Mode: Fight vs. Flight, science.howstuffworks.com)

Neocortex

The human brain has tens of billions of neurons, each one making between 1,000 and 10,000 connections with other neurons. In 1949, Donald Hebb theorized that when two neurons fire together, protein growth takes place and the synaptic bond between them is strengthened.[22] This led to our current understanding of neural plasticity. Figure 9 is an abstract map of the mind and represents the homological scaffolds of brain functional networks. The nodes around the perimeter represent different areas of the brain, and their size is proportional to their strength. The lines that connect them represent synaptic circuits; the width of lines is proportional to their strength; thicker lines denote stronger connections.

[22] Robinson et al., *Mind in Architecture*, 17.

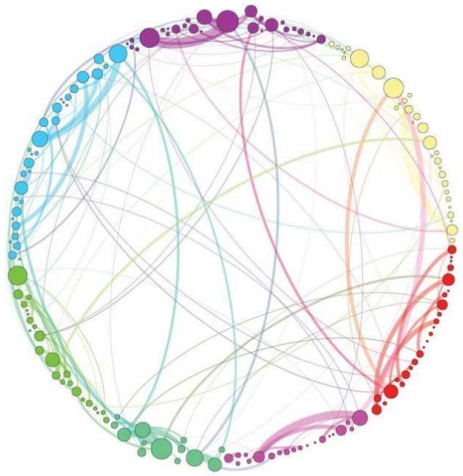

Figure 9: Neural Pathways

(Brain Functional Networks Homological Scaffolds of Brain Functional Networks, The Journal of Royal Society Interface, December 2014 G. Petri, P. Expert, F. Turkheimer, R. Carhart-Harris, D. Nutt, P. J. Hellyer and F. Vaccarino)

We can think of these circuits as sleds carving paths into a snow-covered hill. When a synaptic bond is first formed, it forms its own path from one node to another like the sled carving the first path down the hill. As relatively similar actions and thoughts reoccur, the neurons find it easier to follow the previously developed circuit, similar to the sled following the already carved path, and by doing so, this reinforces the sled's tracks even deeper into that same path, i.e. strengthening the existing synaptic bond. When a circuit is related to a specific type of interrelation of behavior, emotion, and thought, it is called a feedback loop. A feedback loop is defined as a system where outputs are fed back into the system as inputs, increasing or decreasing future effects. Figure 10 depicts a theoretical feedback loop for a child with a behavioral disorder. However, the idea of neural plasticity says that the neocortex (80% of brain mass) can quickly develop feedback loops that reinforce (the sled sliding down an existing track in the snow) or discard past conditions with new ones.[23] We see an exponential growth of neural

[23] Stephen R. Kellert and Judith H. Heerwagen and Martin L. Mador. *Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life* (Hoboken, N.J.: Wiley, 2008), 308.

plasticity in the first few years of early childhood development unlike any other time in a person's life. Then again right before adolescence, children's neural pathways undergo a 'pruning' prior to advancing to the beginning stages of the adult mind. This age group is key in children with behavioral disorders because facilitating healthy feedback loops is especially effective and pivotal during this timeframe. The extensive plasticity of the human brain decreases drastically when a child develops through adolescence.[24]

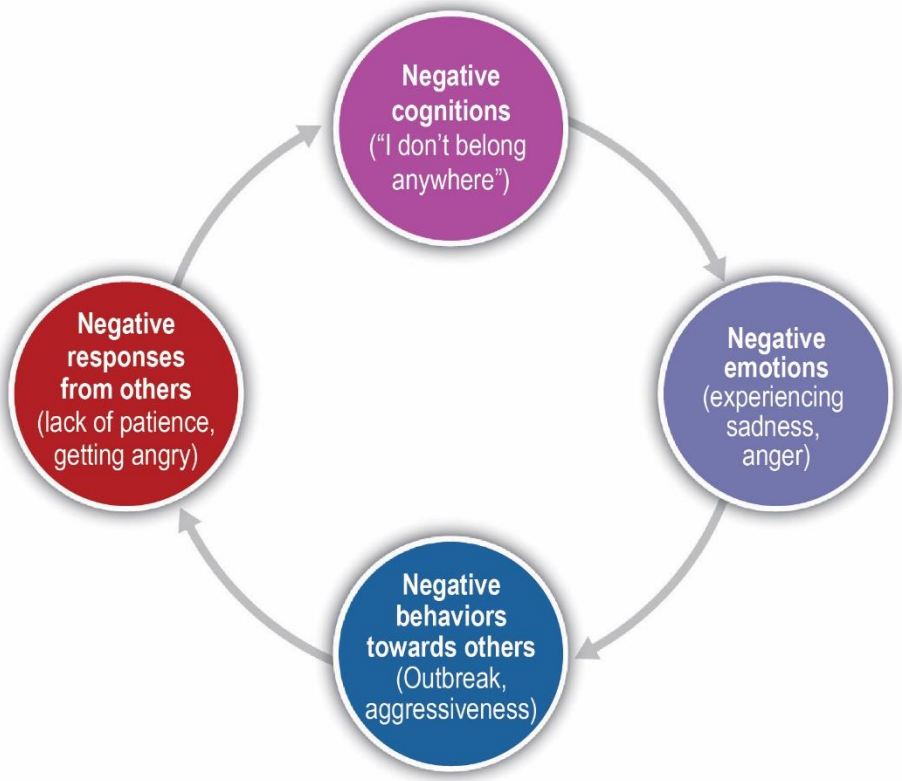

Figure 10: Feedback Loops

[24] Anne Teeter Ellison and Margaret Semrud-Clikeman, Child Neuropsychology: assessment and interventions for neurodevelopmental disorders, (New York, N.Y.: Springer, 2007), 107.

Emotion

Emotion, as we have seen, is a crucial leg in feedback loops, and it relates directly to our built environment in two ways: new models of emotion and emotion's underpinning in the mirror neuron system.[25] Mallgrave remarks the seldom mention of emotion in formal architecture since the picturesque or *architecture parlante* movements of the eighteenth century. But Joeseph LeDoux, famed biologist, offers some relief when he defines emotion as "the process by which the brain determines or computes the value of a stimulus" which helps reframe it as the way we connect with, or experience our built environments.[26] This is in part because emotion is an immediate, biological response and takes place prior to our conscious awareness, i.e. a 'gut reaction'; emotions are embodied within our receptions and are nonconscious not subconscious. An emotion, the electrochemical response generated in the subcortical areas of the basal ganglia and the brainstem, triggers chemical responses (what we call emotional reflection) in the other areas of the brain. These responses are strongly integrated with our peripheral autonomic nervous system, meaning the sympathetic and parasympathetic subsystems. This emotion-based response is the brain's nonconscious way of protecting itself by preparing to encounter negative experiences, for example the trauma, abuse, and neglect. Subsequently, these two subsystems of the nervous system are wired into the insular cortices in each hemisphere of the brain; the sympathetic subsystem wired into the right insula and the parasympathetic subsystem wired to the left insula.[27] Therefore, the insula is now recognized as the area of the brain associated with how we become aware of or reflect on our feelings. This is important for rewiring nonconscious

[25] Robinson et al., *Mind in Architecture*, 18.
[26] Ibid., 19.
[27] Ibid., 21.

emotional responses by developing new circuits and neural pathways to the neocortex. The built environmental can be aligned with these two subsystems by stimulating one or the other.

The second way emotion relates to our built environment is its underpinning in the mirror neuron system. It is helpful to first understand canonical neurons; located in the brain's frontal and parietal lobes, canonical neurons control motor actions. They fire when we are doing something such as playing soccer. They also fire when we do nothing more than look at an inanimate object, such as a soccer ball, and imagine ourselves kicking it. Mirror neurons, also in the frontal and parietal lobes, similarly fire when we execute an action as well as when we mentally simulate the action. Mirror neurons differ from canonical neurons in that they also fire when we observe someone else performing an action, i.e. merely watching someone else play soccer.[28] This major discovery did not happen until the early 1990s when a team of researchers in Parma, Italy, led by Giacomo Rizzolatti, discovered mirror neurons in the brains of macaques. Scientists inserted electrodes into the brains of the monkeys to 'eavesdrop' on the neural circuits as they fired. The monkeys' brain activity was observed as they grasped objects such as peanuts, and subsequently the motor command neurons in the frontal lobe would fire, which have been known for over fifty years. However, what scientists found unusual was that a subset of these neurons became active in monkeys who were not grasping peanuts but simply watching other monkeys perform the action.[29] We now know that humans also have mirror neurons for actions such as grasping objects, similar to the monkeys, but for humans these are called mirror systems. This is important for imitation and emulation; a person would discover how to use an object as a tool or how to build shelter or start a fire. Others around him would observe these actions and could

[28] Goldhagen, *Welcome to Your World*, 160.
[29] Robinson et al., *Mind in Architecture*, 22.

immediately learn to imitate them. These discoveries could then be passed horizontally across generations instead of being vertically passed down from generation to generation in a Darwinian model.

Additionally, humans exhibit mirror systems for more than just motor commands; we see this in emotional responses as well with sensory neurons in the somatosensory cortex. This is important for social empathy. When we see someone else being touched, we empathize with that person. For example, when we witness someone in pain, we map the area of trauma onto our own bodies.[30] Scientists now speculate that some human brain disorders, such as autism, result from a breakdown of a mirror system. However, these mirror systems do not limit themselves to the social world and proprioception of others. Scientists have found evidence of mirror neurons firing when we observe two inanimate objects touching, and this is where the built environment comes in. Neural structures involved in our own body-related experiences apply the same concept to the world around us, but without the social empathy. This brings back theories from Semper and Wölfflin:

> Wolfflin insisted that we animate architectural events simply "*because we ourselves possess a body"* – that is, because the optic nerve stimulates the motor nerves and thereby sympathetically works on our own neural system through our bodily organization. Because we know the force of gravity through our own corporeal experience, we read the weight and balance of a building in gravitational terms. We judge a work of architecture to be beautiful because it in fact mirrors the "*basic conditions of organic life*." [31]

Our brains use what we know from past sensorimotor experiences and apply that in a space. In a matter of twenty milliseconds, visual stimuli provoke us to mentally stimulate an object's tactile sensation, and then the brain rewards the action with a quick neurotransmitter release that gives

[30] Robinson et al., *Mind in Architecture*, 23.
[31] Harry Francis Mallgrave and Robert Vischer and Ikonou Eleftherios, *Empathy, Form, and Space: Problems in German Aesthetics* (Santa Monica, CA: Getty Center for the History of Art and the Humanities, 1994), 160.

us a sense of pleasure. Further, tactile impressions allow us to fully embody a space because we can control what we touch easier than we can control what we see. For example hand-made surfaces, like chiseled stone, elicit our tactile senses to mentally stimulate how it was made.[32] Before we even touch an object we project how it will feel, and while we touch it our brain simulates its construction, bringing us closer to the person who crafted it.

Cognition

We embody our cognitions based on our environments. Fred Gage gave a presentation at the 2003 AIA National Convention on "Neuroscience and Architecture" when the Academy of Neuroscience for Architecture (ANFA) was formed:

> While the brain controls our behavior and genes control the blueprint for the design and structure of the brain, the environment can modulate the function of genes and, ultimately, the structure of our brain. Changes in the environment change the brain, and therefore they change our behavior. In planning the environments in which we live, architectural design changes our brain and our behavior.[33]

Not only does the built environment actively contribute to a person's behavior, but we also see that memories come packaged by place. Memories group together emotions, thoughts, behavior, and the environment of an event, and therefore the environment becomes a memory's setting people take with them for years after. Given this research, we now understand the inherent importance of the built environment and how it effects people.

[32] Goldhagen, *Welcome to Your World*, 151, 123, 160.
[33] Robinson et al., *Mind in Architecture*, 184.

CHAPTER 4

BEHAVIORAL SCHOOLS

One of the most effective places to showcase how the environment can affect behavior is in schools that specialize in teaching students who suffer from behavioral disorders, including emotional behavioral disorder (EBD) and conduct disorder (CD), because these occupants tend to have a lower threshold for stimuli which inhibits their ability to focus on learning. *Architecture and Human Behavior* notes, "architecture is primarily concerned with the setting on occasions for responses," and in this case the setting is the school, and the response is successful learning.[34] Even in the best conditions, teaching proves challenging and stressful; therefore having poor physical working conditions only adds an unnecessary element for teachers to overcome. Aside from intervening with the teachers' potential productivity, the physical environment of the classroom also sends a non-verbal message to the students, mentioned earlier by Goldhagen about how an effectively deployed metaphor in the built environment can function as a prime. Higher quality conditions equate to a stronger sense of importance; students make judgements regarding their purpose, self-value, and the projected values of themselves by others.[35] Based on the premise that architecture is functionally related to behavior, asking building occupants to behave in a manner that not does align with the given built environment invokes an unnecessary challenge.[36] This could be argued for all students at any type of school; why are behavioral disorders unique? Students with emotional behavioral disorder and other conduct disorders have a tendency for bursts of intolerance and lack coping strategies when their

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[34] Steven M. Zifferblatt, *Architecture and Human Behavior: Toward Increased Understanding of a Functional Relationship* (Educational Technology Publications, Inc., 1972), 54.
[35] John Visser, "Aspects of physical provision for pupils with emotional and behavioural difficulties," *Support for Learning*, Vol. 16 Issue 2, (2001), 65.
[36] Zifferblatt, *Architecture and Human Behavior*, 55.

environment is not conducive to expected behavior.[37] Therefore, a specialized environment based on these challenges should be included in the prescription for behavioral schools. However, rudimentarily integrated within the idea that school environments should be customized to aid behavior and learning lies the inhibiting neglect of school buildings throughout the past few decades. The issue of deteriorating school facilities has fallen down the educational agenda and drops lower and lower on the list of priorities that will be granted funding.[38] As mentioned earlier, Goldhagen provides research data that shows a significant increase in academic achievement correlated to the quality of the facility.

Students are sent to a special education school when they continually display extreme behavior that violates social and cultural expectations and are unresponsive to traditional education interventions. This typically includes episodic behavior of acting out in an aggressive manner that inhibits their own learning and the learning of peers. We see both externalized behaviors, i.e. aggression, noncompliance, hyperactivity and impulsivity, and internalized behavior, mental health disorders, social withdrawal, and low self-esteem. The Five Tiers of Provision demonstrates the level of additional support a student may need due to difficulty in academic achievement, behavior, and social adjustment (figure 11). In separate schools designated specifically for special education, we are working with the two most severe tiers.[39]

[37] Visser, "Aspects of physical provision for pupils with emotional and behavioural difficulties," 67.
[38] Helen Clark, *Building Education: The Role of the Physical Environment in Enhancing Teaching and Research. Issues in Practice.* (United Kingdom, ERIC Institute of Education: 2002), 3.
[39] Ted Cole, *How to help children and young people with complex behavioural difficulties: a guide for practitioners working in educational settings* (Philadelphia, PA: Jessica Kingsley Publishers, 2011), 44.

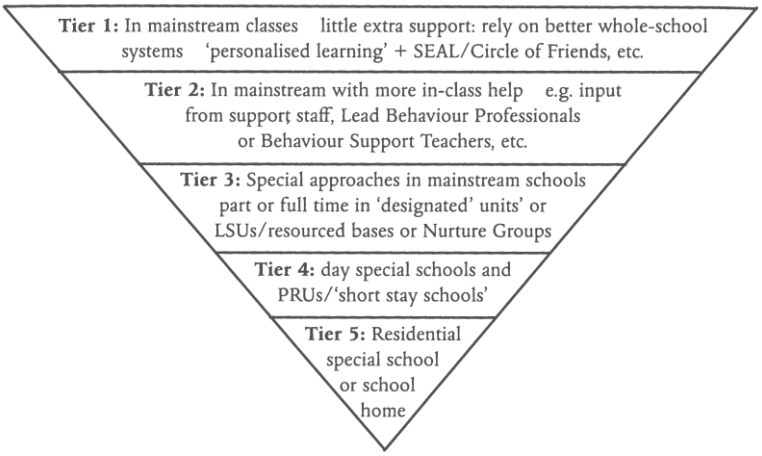

Figure 11: Tiers of Provision

(Ted Cole, How to help children and young people with complex behavioural difficulties: a guide for practitioners working in educational settings, 2011*)*

Peer rejection as a result of aggression is predictive of criminal behavior later in life;[40] the National Center for Special Education Research (NCSER) Longitudinal Transition Study documented that children with emotional behavioral disorder experience higher rates of unemployment, poor work history, and the highest number of social adjustment problems post-high school compared to any disability group.[41] Therefore, these interventions are critical to address behavior and ideally assimilate students back into traditional schools to prevent further challenges in the future.

Common Disorders

Using a bio-psycho-social theoretical model helps explain the development of behavior in children. Many of these students' disorders are likely to come from the following factors: (1) Bio

[40] Ellison and Semrud-Clikeman, Child Neuropsychology, 227.

[41] Ron J. Nelson, "Designing schools to meet the needs of students who exhibit disruptive behavior," *Journal of Emotional & Behavioral Disorders, Vol. 4, Issue 3*148 (1996): 148.

e.g. genetic inheritance and imbalances in the body's biochemistry, (2) Psycho e.g. distorted thought patterns, tending to expect the worst/emotional damage caused by abuse or neglect, and (3) Social e.g. attachment difficulties, parental separation.[42] Therefore, we see common disorders are comorbid with EBD including Attention-Deficit/Hyperactivity Disorder (ADHD), mental health disorders, Post-Traumatic-Stress-Disorder (PTSD), psychosis, and autism. Some disorders and behaviors stem from bio factors like infantile drug addiction, and others originate from psycho/social factors such as physical/emotional/sexual abuse, trauma, physical and/or emotional neglect, and household dysfunction including incarcerated guardian, domestic violence, and substance abuse.

Key elements in this facility include the teachers, the curriculum, and the physical setting. It is critical to note that to meet the needs of students with emotional behavioral disorder, the most important 'tool' in these schools is the positive relationship between teacher and student. Teachers aim to deliver key factors that are crucial in coping with children's disorders: giving respite, helping the children make positive relationships and aiding their re-signification."[43] However, the physical environment can help or hinder this process.[44]

Before a school attempts to update their facilities and built environment, it is important for designers to understand that behavioral schools strive for students to achieve both academic and behavioral goals. To deliver an effective facility, the designer must align the built environment in harmony with the current curriculum and include flexibility for future curriculum.

[42] Cole, *How to help children and young people with complex behavioural difficulties*, 47.
[43] Ibid., 24.
[44] Visser, "Aspects of physical provision for pupils with emotional and behavioural difficulties," 64.

Intervention Strategies

Three common types of intervention strategy include behavioral, psychodynamic, and ecosystemic approaches; often teachers select bits and pieces from more than one model to orchestrate what they find most effective. *Models of Intervention* (Gardner and Gaines) explains:

> The behavioral approach is based upon early theories of learning. Its proponents argue that, as all behavior (good or bad) is learned, it can be unlearned…It is also characterized by an emphasis on behaviors which are measurable (i.e. which can be observed) rather than upon the mental processes (causes) which prompt the behavior in the first place. (143)

This allows the teacher to focus on and identify the student's behavior as a concern and not the child himself. The psychodynamic approach, originated with the ideas of Sigmund Freud, argues that these unwanted behaviors stem from unconscious and subconscious thought. However, teachers are often untrained to dive into these personal spaces, and this model requires medium to long-term intervention. Behavioral schools aim to be a temporary position for students, only a few years at most, which makes the psychodynamic approach less applicable. Third, the ecosystemic model illustrates a child's paradigm of the world around him. The child himself is the microsystem, the child and his teacher and classmates form the mesosystem, the child and his relationship to the school, his parents, and outside agencies is the exosystem, and finally the child in relation to the social and education values of the world in general is the macrosystem.

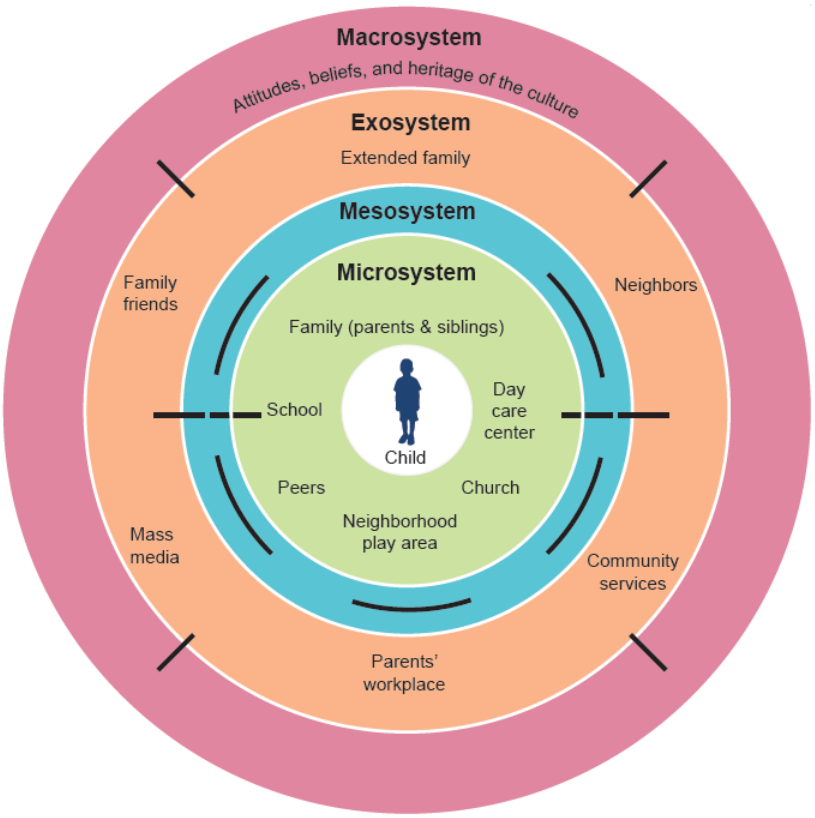

Figure 12: Ecosystemic Psychological Approach
(Based on Bronfenbrenner's Ecological Model of Individual Development)

Problematic behavior occurs when there is a dysfunction between them.[45] If a child forms comfortable and nurturing interpersonal relationships with teachers and peers as well as a positive outlook of the school, a negative home life can still undermine these strides or vice versa. Despite the inability to control all systems within the child's world, this type of intervention helps explain why the child may be struggling. In the field, teachers are fearful of events spiraling out of control and often focus on control and management, which compounds students' underlying problems.[46] Instead, using a whole-picture intervention similar to the

[45] Philip Garner and Charles Gains, "Models of intervention for children with emotional and behavioural difficulties," *Support for Learning*, Vol. 11 Issue 4, (1996), 144.
[46] Cole, *How to help children and young people with complex behavioural difficulties*, 36-38.

ecosystemic model, facilities can shift from merely managing students to focusing on an understand-and-prevent approach.

We can aim to align the teachers' message, reprieve, relationships, and resignification, with the architecture's message to create a responsive design. In order to assist the relearning of behavior, different spaces signify which behaviors are appropriate in that context; for example, physical activity and louder voice levels are accepted in a gymnasium or on the playground but would not be suitable for the classroom.

Using what we know about the relationship between the environment and occupant, we can start to identify design strategies that capitalize on tactile perceptions, memories, sympathetic nervous systems, etc. that could aid students learning to control their behavior.

We can design the school keeping in mind that the students are relearning behavior and relearning how to cope with the stimuli that influences how they behave. Looking at the cognitive behavioral triangle, we see how thoughts, emotions, and behavior are interrelated and influence one another. To address behavior, we must also look at emotion and cognition when designing the built environment.

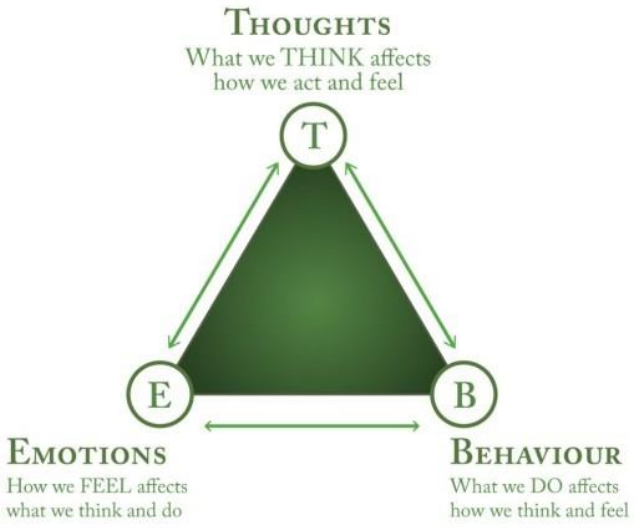

Figure 13: The Cognitive Triangle

(creativemindbody.com)

Upward and Downward Spirals

New research suggests that positive emotions may trigger lasting, durable changes in the structure and function of the brain.[47] Simply put, positive emotions expand people's mindsets in ways that, little-by-little, reshape who they are. Following a positive emotional state, people are more open to new experiences and critical feedback. This self-perpetuating is true for negative emotions as well. Investing a little time into activities that are fun can prove more efficient in the long run. Fifteen-minute sensory breaks in between lessons have shown an increase in focus and performance.[48] It is important to remember a lot of these students live in group homes or foster

[47] Eric L. Garland and Barbara Fredrickson and Ann M. Kring and David P. Johnson and Piper S. Meyer and David L. Penn, "Upward spirals of positive emotions counter downward spirals of negativity: Insights from the broaden-and-build theory and affective neuroscience on the treatment of emotion dysfunctions and deficits in psychopathology," *Clinical Psychology Review*, Vol. 30 Issue 7, (2010), 850.

[48] Justina Mccandless, "Granite's Engaging 'Hub' Helps Special Needs Students Succeed," The Salt Lake Tribune (The Salt Lake Tribune, November 23, 2012), https://archive.sltrib.com/article.php?id=55288943&itype=CMSID#gallery-carousel-446996)

homes or have a difficult home life. They are not always exposed to the fun things, and sometimes all they get is what they get at school.

CHAPTER 5

ENVIRONMENTAL BEHAVIOR

Now that we understand how these children facing such challenges have developed, we can better recognize the inherent importance of the relationship between humans and their environments. As we begin to design the setting to assist occupants managing behavior, we want to focus on minimizing distractions that interfere with learning and focus as well as provide a repertoire of built cues that can be used as instruments for diminishing negative emotions and behavior. Design implementations include capitalizing on tactile perceptions, memories, sympathetic nervous systems, etc. that could aid students learning to control their behavior.

Stressors

Through the conceptual behavior curve, we can analyze the different stages that make up an outburst and design interventions to accommodate different stages when possible. Note that not all stages can be relearned, but occupants can manage self-behavior using one or more of the following to varying degrees. Under traditional conditions, stressors and/or external stimuli including emotions, cognition, or others' behavior, can evoke a change in behavior. Some common stressors include lack or invasion of territory, separation anxiety, unwillingness to learn due to low confidence in academic ability. However, stressors vary per individual, and not every trigger may be possible to identify, eliminate, or minimize.

The stressor portion of the curve focuses on students being too close to one another and lacking personal space which triggers physical aggression. Design implements include separating desks beyond arm's reach, making the school feel comfortable and welcoming to combat separation anxiety, providing personal territory like lockers where they can safely store personal items and have visual access to know others are stealing or defacing their property.

Self-Actualization

The next phase is self-actualization. Pertinent to avoiding an outbreak altogether lies in the ability to identify and acknowledge when an unwanted behavior is about to occur. If students can self-actualize what is happening, they can remove themselves from the situation. Unfortunately, this is not always easy to achieve, and in some cases, certain students will never be able self-actualize and prevent an episode, for example students with psychosis. Design implementations include providing spaces where students can go to remove themselves from the situation and actively calm down to prevent an outburst.

Outburst

These stressors and/or stimuli will eventually cause the outburst: an inappropriate emotional or behavioral response that disables the student, peers, and/or teacher from learning. When this occurs, the teacher or aid relocates the student to an appropriate space where he can work out his emotions and cognitions without interrupting other students' learning. While in this designated space, the goal is to contain the behavior to avoid harm to others or the student himself, lessen the severity, and shorten the length of the outburst. Each classroom includes a sensory room specifically for these moments. In the case that an outburst happens outside the classroom, semi-private nooks located in the corridor can function as a temporary sensory space without requiring the student and aid to return to their classroom.

Treatment

Treatment varies per individual and outburst. Students must learn what works for them and how to treat an outburst so they can later use these strategies as tools or coping mechanisms outside of school. Introducing sustainable treatment and coping mechanisms is vital to ensure that when students leave the behavioral school they do not revert back to old behaviors and undo the work

they have accomplished. This is also known as the greenhouse effect. Biophilia acts as a major strength in this context because it is easily accessible in almost any location and is innately hardwired into our brain structures. Sensory rooms supply ample outdoor views as an opportunity for students to integrate nature as a prime or grounding technique.

We cannot identify all stressors, but we can put in place some flexible responses. The sensory rooms provide enough space for students to safely let out aggression. Students can also opt for soft seating and nature views to help them calm down. In the case that students are particularly sensitive to acoustics or light, the room allows sensory deprivation using black out shades or headphones.

The staff room acts as a designated space for teachers, the occupant often forgotten about. Teachers and staff can control and manage their emotions and behavior more consistently than their students due to experience and matured brain development. However, teaching this demographic is challenging, nonetheless. The staff room offers teachers a place of reprieve after the school day as ended. Instead of finishing paperwork, emails, and other work at their desks, teachers can choose to change their scenery and sit amongst their coworkers to share stories, experiences, and find comfort in others who are facing the same challenges.

Rejoining the Class

Lastly, a student needs to rejoin the lesson after an outburst. They may be emotionally drained and/or uninterested in returning to a difficult subject. A variety of next-step options can ease this transition. Students can relocate to a table or seat at the back of the class before completely rejoining the group; here they can take a sensory break before easing back in.

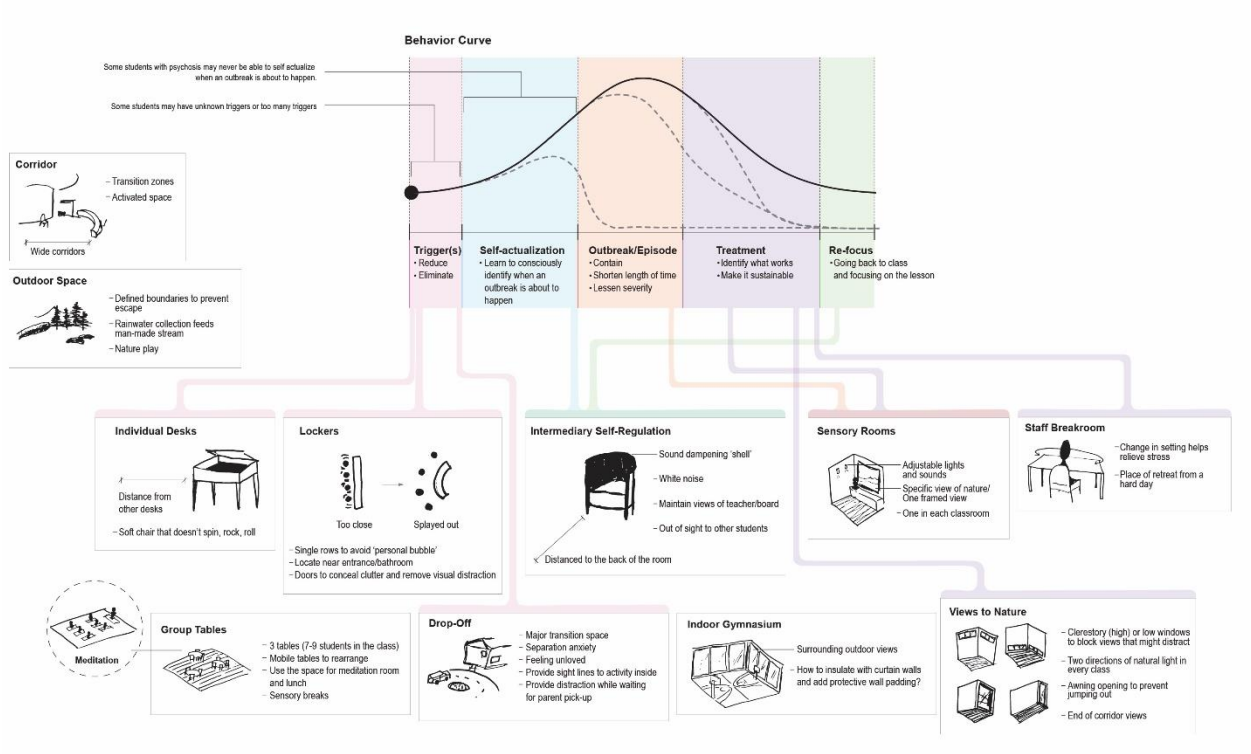

Figure 14: Theoretical Behavior Curve (by author)

CHAPTER 6

LOCATION SELECTION/ANALYSIS

Behavioral schools are often separate from students' group homes or residences. In Figure 15, behavioral day schools in Massachusetts are depicted as red dots, group homes and residences are blue dots, and green dots are organizations that include both the day school and dormitories on the same campus. The eastern half of the state has far more facilities than the west due to Boston and other major towns and cities' large populations.

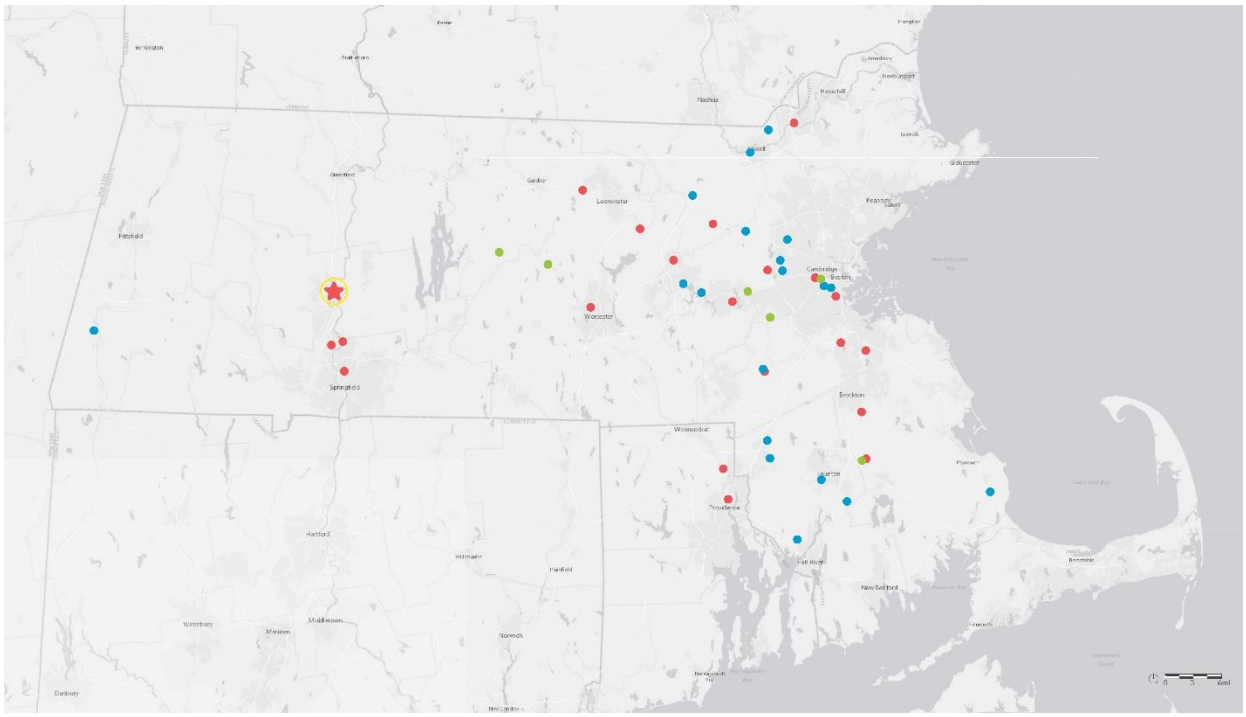

Figure 15: Behavioral Schools in Massachusetts

The circled red star marks the Cutchins Program for Children & Families in Northampton, Massachusetts. This organization includes outpatient care (The Children's Clinic), residential treatment (Three Rivers and Northampton Center for Children and Families), in-home care, and alternative schooling (The New Directions School) to children and adolescents with severe

emotional disturbance. Cutchins Programs specializes in treating trauma in children, sensory processing disorders, co-occurring emotional and autism spectrum disorders.

Initially formed as the Northampton Center for Children and Families (NCCF) in 1975, the program served as an alternative to the Northampton State Hospital.[49] The New Directions school, a Chapter 766 private school licensed by the Department of Elementary and Secondary Education (DESE), formed concurrently to NCCF to serve the educational needs of children residing at NCCF. Many students are in the NCCF residential program and a number are day students. Today, the school serves roughly 30 students from 4th grade through high school.

The school is located on a large parcel 32A-223 in a suburban, residential neighborhood (see figure 16). The eastern side of the parcel is at the bottom of a 20' hill and covered in old growth trees and natural public trails. Due to the grade change, this area is considered a wetland.

[49] "History," Cutchins Programs for Families and Children, https://cutchins.org/about-us/history/

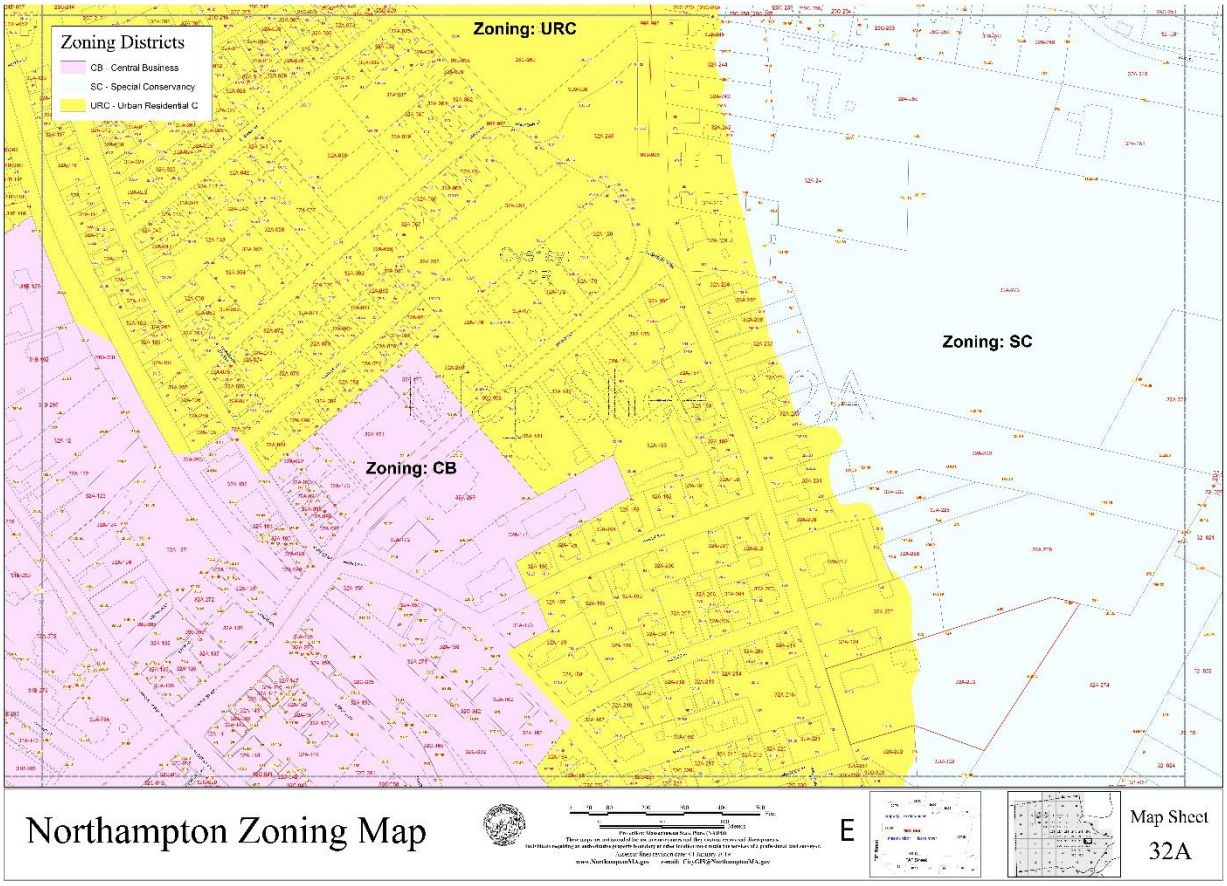

Figure 16: Northampton Zoning Map 32A

(https://northamptonma.gov/)

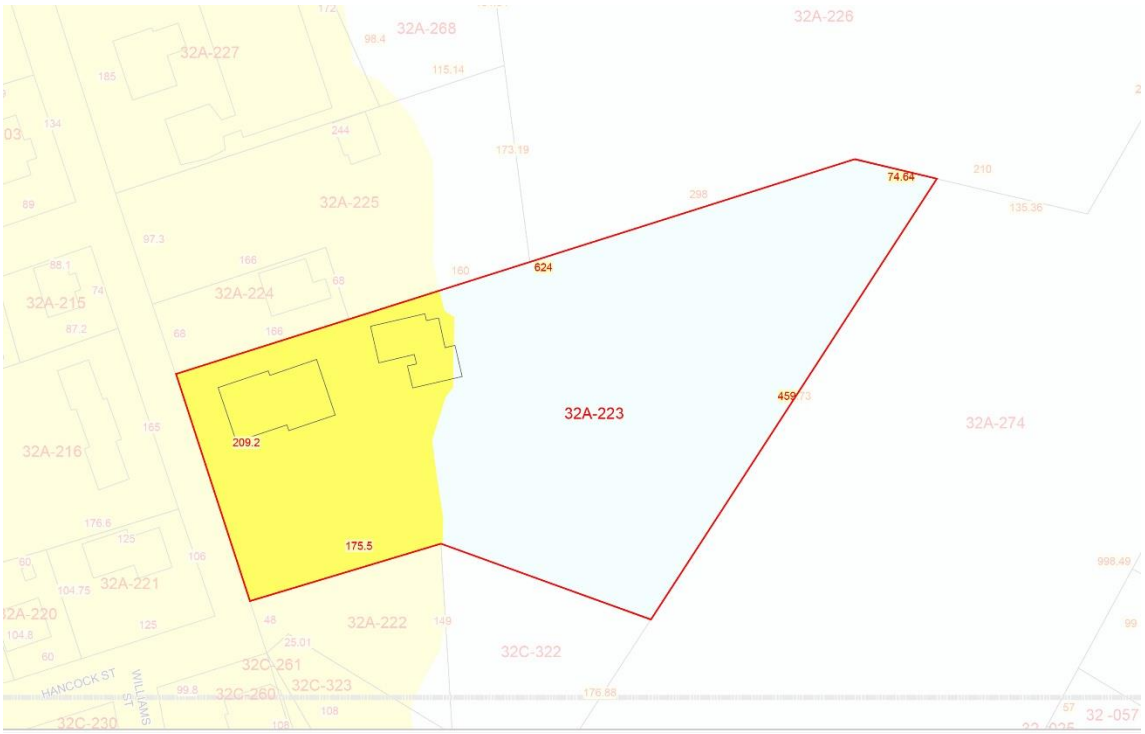

Figure 17: Northampton Zoning Map Parcel 32A-223
(based on https://northamptonma.gov/)

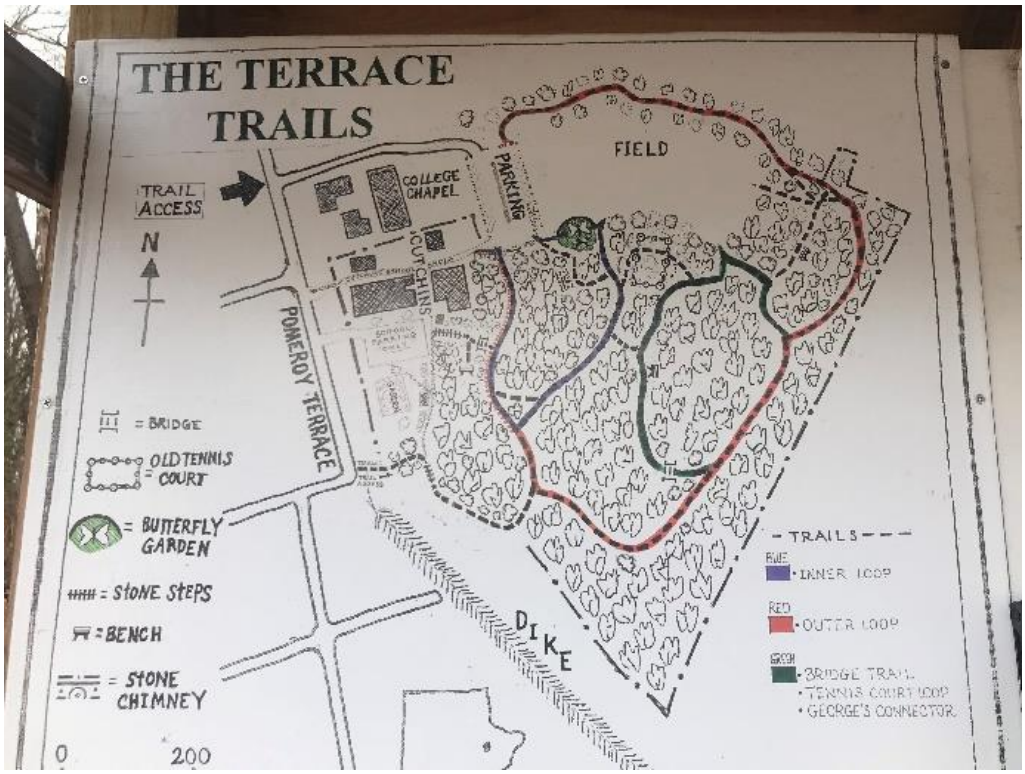

Figure 18: Terrace Trails Behind School, photo by author

CHAPTER 7

DESIGN/PROCESS

The design process was initiated by identifying major space types, key programmatic elements, behavior, emotions, and physiological stimulants and responses. This was followed by mapping out how these elements interact to develop conceptual spaces. The entrance to the school should be easily identifiable to accommodate wayfinding as new students enroll every year. Students may be dropped off by “taxis” from their group homes or by a parent or guardian. Transitioning to a new school can cause separation anxiety and feelings of loneliness.

Once inside, an open and spacious corridor with natural light provides relief as compared to a traditional double-loaded corridor that feels monotonous and institutional. Impromptu conversations and run-ins should be encouraged to occur daily, however conventional narrow halls restrict circulation and add a burdening feel to natural interactions. When we expand the corridor from a circulation path to an activated space, this also opens opportunity for other spaces to connect to the halls and make individual rooms less segregated from the overall facility.

For most of the day numerous activities occur in the classroom. Students therefore develop a sense of territory for their desks, lockers, and belongings. Providing enough physical distance between each individual desk for example, decreases the likelihood of one student encroaching into another’s territory. It also minimizes the ability to invade a student’s perceived personal space which often causes aggression and fighting. The same principle applies at the lockers. Designated safe space allows students a secure spot to store their belongings. Any item can carry a range of value; pencils may be easily lost or stolen, a favorite toy can stimulate distraction, a colorful eraser can be sentimental. Visual access to the lockers ensures security, and students can

worry less about the potential of having an item stolen or defaced by others and can better focus on the lesson. This kind of secure storage may not be available in a student's home life and allows the school to function as a resource.

Light levels, acoustics and furniture also influence focus. The ability to adjust these elements allows for different activities to occur in one room, i.e. breakout groups, meditation, sensory breaks, and therefore allows academic lessons to be flexible to students' needs. Altering the space helps align the built environment's message with the desired behavior.

The sensory room acts as a permanent resource close by. Some schools share sensory rooms or have them located down the hall which further separates the student from the lesson and creates a time-consuming "trip" to a separate destination. Natural light and views to the outside, as opposed to a small room without windows, make the sensory space feel less like a cell or time-out and more like a space to cope with emotions and cognition.

Lastly, an indoor gymnasium provides a year-round space designated to physical exercise and active recreation. Most spaces in the school ask for "inside voices," no running, and controlled behavior. This space accommodates the students' need and desire to let out energy, enjoy a different type of activity, and take a break from more traditional academic lessons. Especially in New England, the weather limits the amount of days kids can play outside. A full-size, indoor gymnasium is not subject to those constraints and can still provide visual access to the outdoors given proper glazing. On a snowy day, students can still play comfortably in the gym while feeling like they are inside a snow globe and experience the seasons as one of nature's cyclical patterns.

Outside, the risk of escape or fleeing increases. Boundaries must be clearly defined without feeling caged. Nature play and exploration is a highly valued part of childhood, and one of key parts of nature and innate to humans is water. Introducing some kind of pool or stream, for example a stream created by rainwater collection, allocates direct and hands-on learning about nature.

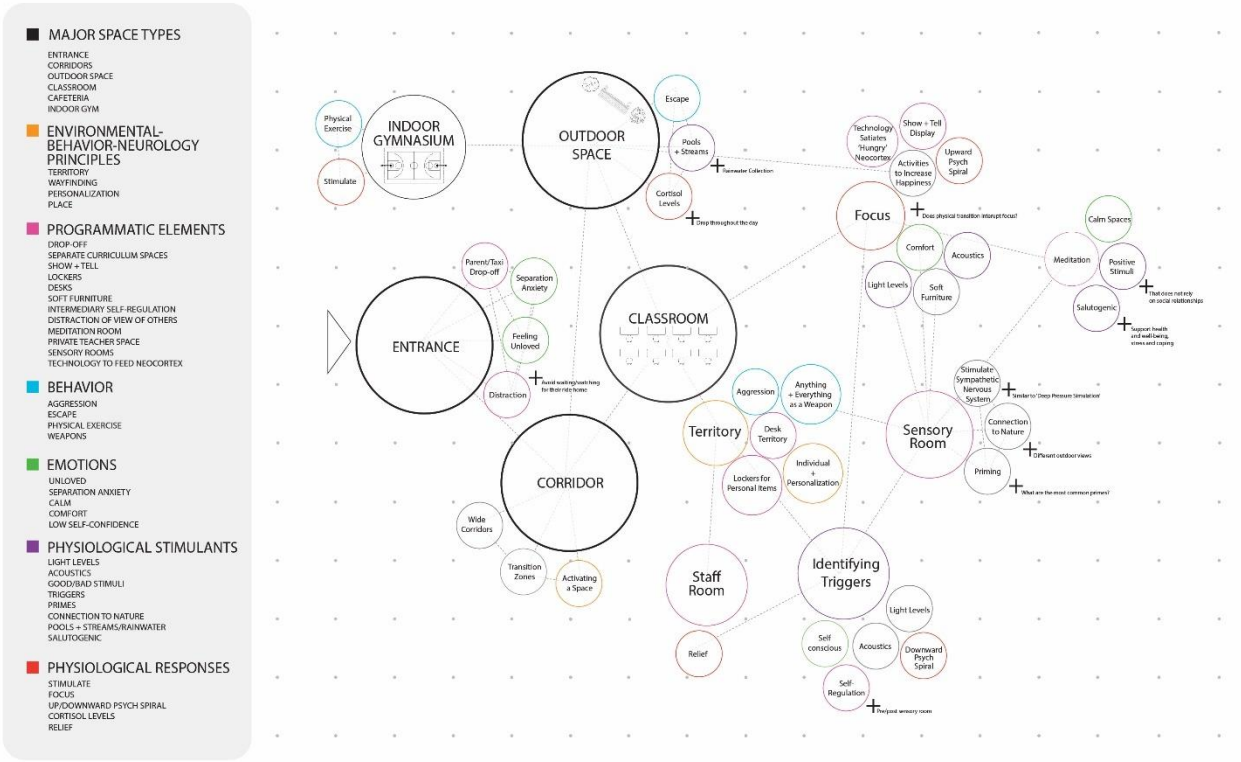

Figure 19: Conceptual Spatial Map

Figure 20: Childhood Experiences with Water, photo by author

Program

Unlike the New Directions School, the new behavioral school proposes students in kindergarten through seventh grade. Junior high and high school levels of behavioral schools use a different approach in order to prepare students who are about to enter young adulthood. Program includes eight classrooms, one for each grade, that will hold between seven to nine students and three staff members, typically a teacher and two teacher's aids. Each classroom includes a bathroom and sensory room. Administrative spaces include offices for the secretary/administrative assistant, the principal, and the occupational therapist as well as two staff rooms, one for the first level and a second for the second level. The computer lab and library sit directly above to take advantage of the northern ambient light for reading. The facility also features a nature laboratory as a designated space for wet activities, exploration, science, and different type of learning less accessible in the classroom setting. The space capitalizes on the wooded site and further reinforces the importance of connection to nature. The nature lab is adjacent to direct outdoor access and a semi covered back deck for outdoor lessons. Lastly, the gymnasium includes a half basketball court.

Concept

The relatively small program gave opportunity to play with the unique site. The idea of a splined circulation path paired with traditionally geometric rooms subtly emphasized the Environmental/Behavioral/Neurology (EBN) theory of wayfinding and expanded the double loaded corridor into a light-filled space. The protruding rooms in both the Day-Care Center for Elderly People by Francisco Gomez Diaz + Baum Lab and the Nursery Fields Forever early childhood education center demonstrate the ample exterior wall surface area and potential for surrounding views and multiple sources of natural light (see figures 21 and 22).

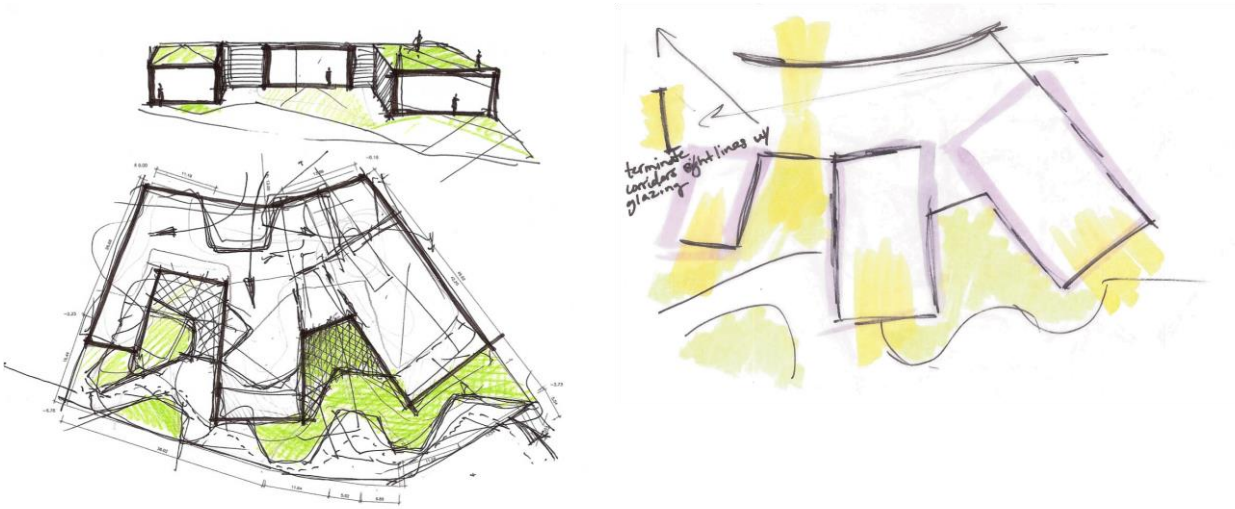

Figure 21: Day-Care Center for Elderly People by Francisco Gomez Diaz + Baum Lab (Day-Care Center for Elderly People by Francisco Gomez Diaz Baum Lab, n.d., Archdaily, n.d., Day-Care Center for Elderly People by Francisco Gomez Diaz Baum Lab)

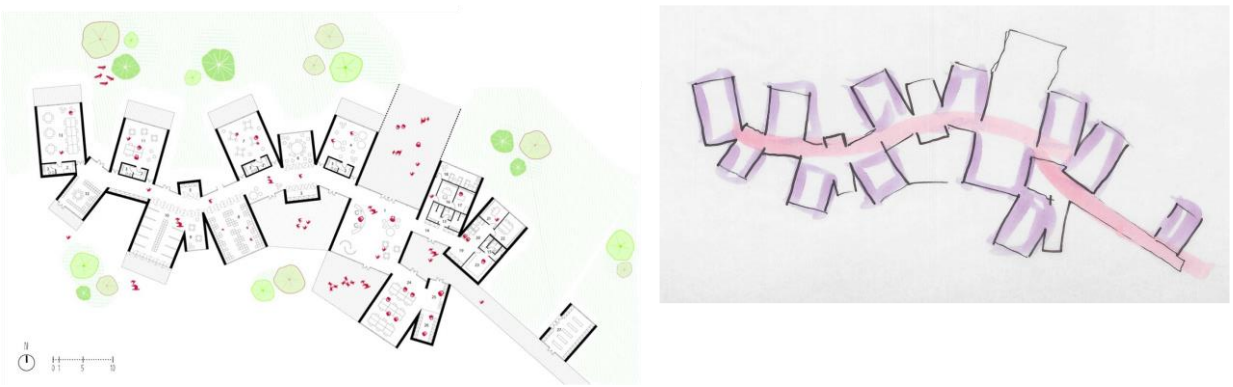

Figure 22: Nursery Fields Forever

(“Nursery Fields Forever” Reconnects Early Childhood Education with Nature, Archdaily, https://www.archdaily.com/781867/nursery-fields-forever-reconnects-early-childhood-education-with-nature/56baa3eee58ece188300005d-nursery-fields-forever-reconnects-early-childhood-education-with-nature-plan)

All classrooms are located on the south for optimal daylighting. This strategic move informed the parking lot placed on the north to avoid direct visual access into to private classrooms. Surveilling the entrance, the administrative offices are also located on the north to monitor who is coming and going. The first-floor staff room is located adjacent to these offices for easy access. The gymnasium is pushed deeper into the site within the trees to encapsulate high clerestory views of the woods and borrow shading on all sides from the tree canopies. Its footprint is slightly skewed at the end of the corridor to further extenuate the splined circulation but also to avoid extending into the wetland area at the bottom of the hill. Additionally, this double height space mitigates the steep grade change and the outdoor classroom deck acts as a lynch pin to keeping the entire facility connected.

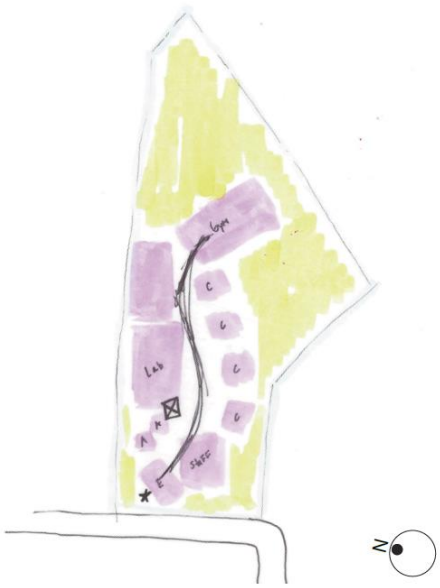

Figure 23: Initial Conceptual Layout

Site Strategy

The parking lot and roughly half of the main building sit on the flattest buildable land of the site. The north of the building dedicates a sloped hardscaping to pedestrian access that meanders down the hill amongst a rain garden and tiered retaining walls and finally wraps around the gymnasium under the roof overhang. The south carves out a small, landscaped path of rocks and vegetation that receives rainwater from the classroom roofs and directs the man-made stream down the hill to the wetland area. Old growth trees lining the suburban street privatize the western façade located close to Pomeroy Terrace and the sidewalk. Materials include a phenolic wood panel rain screen that compliments the site, zinc panels that are naturally resistant to mold growth, and a photocatalytic coating on glazing.

Figure 24: Site Plan and Analysis

Overarching Themes

A few overarching themes are present throughout the design of the school; they include, safety, transitions, biophilia, and place + space. It is common in behavioral schools for students to try to escape or run away, to use anything and everything as a weapon, and to act aggressively. Next, we see transitions in academics from a traditional school to special education, transitions from unacceptable to controlled behavior, transitions in nature from inside to outside, and transitions from one space to another. In biophilia, the school emphasizes natural light and views to nature through glazing between classrooms, around the main staircase, and a southern clerestory on the second floor that brings light into the corridor and library. Lastly, the school aims to define place, create a balance of privacy and visual access, and define behavior by space.

Figure 25: First Level Floor Plan

Figure 26: Second Level Floor Plan

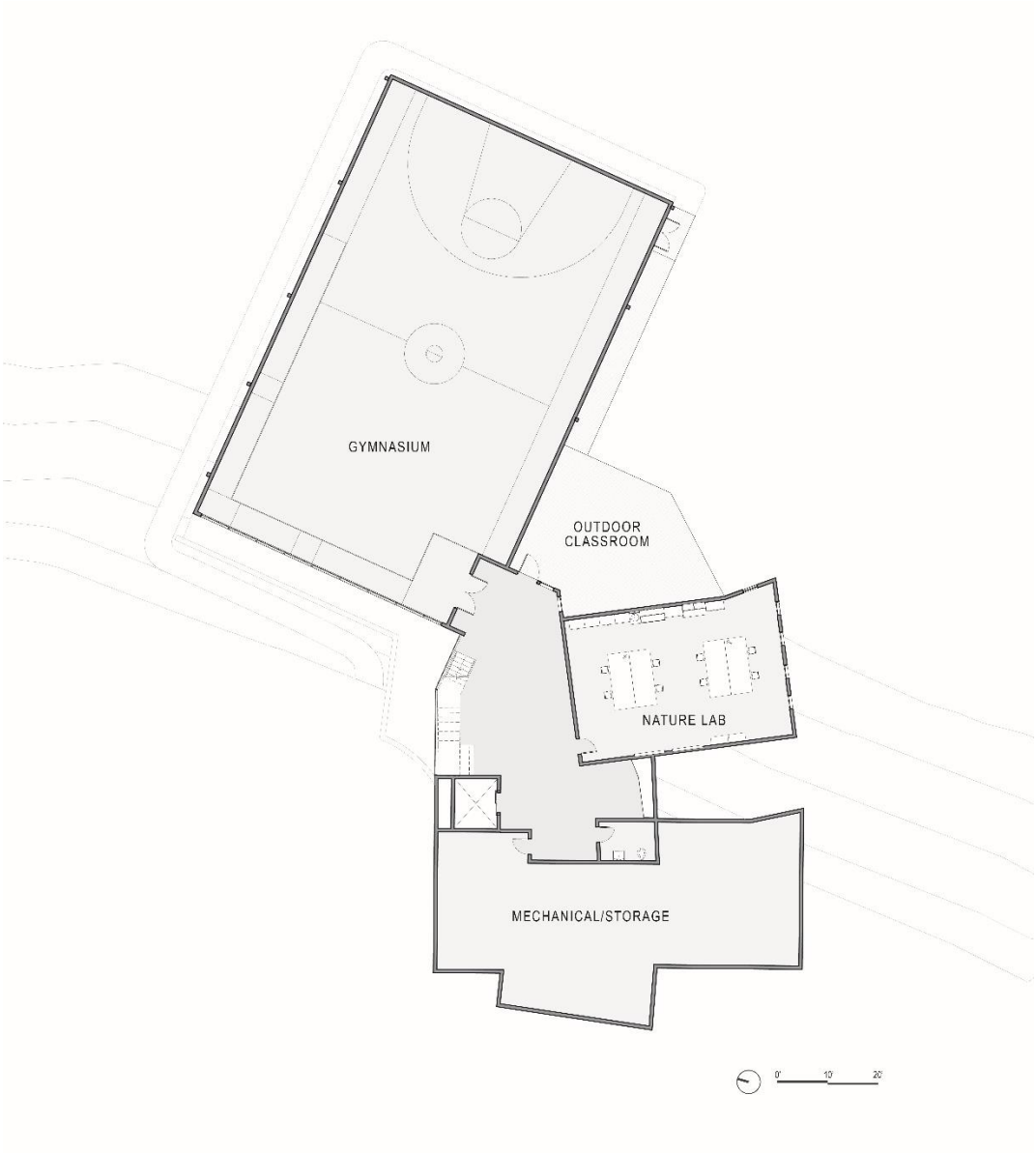

Figure 27: Lower Level Floor Plan

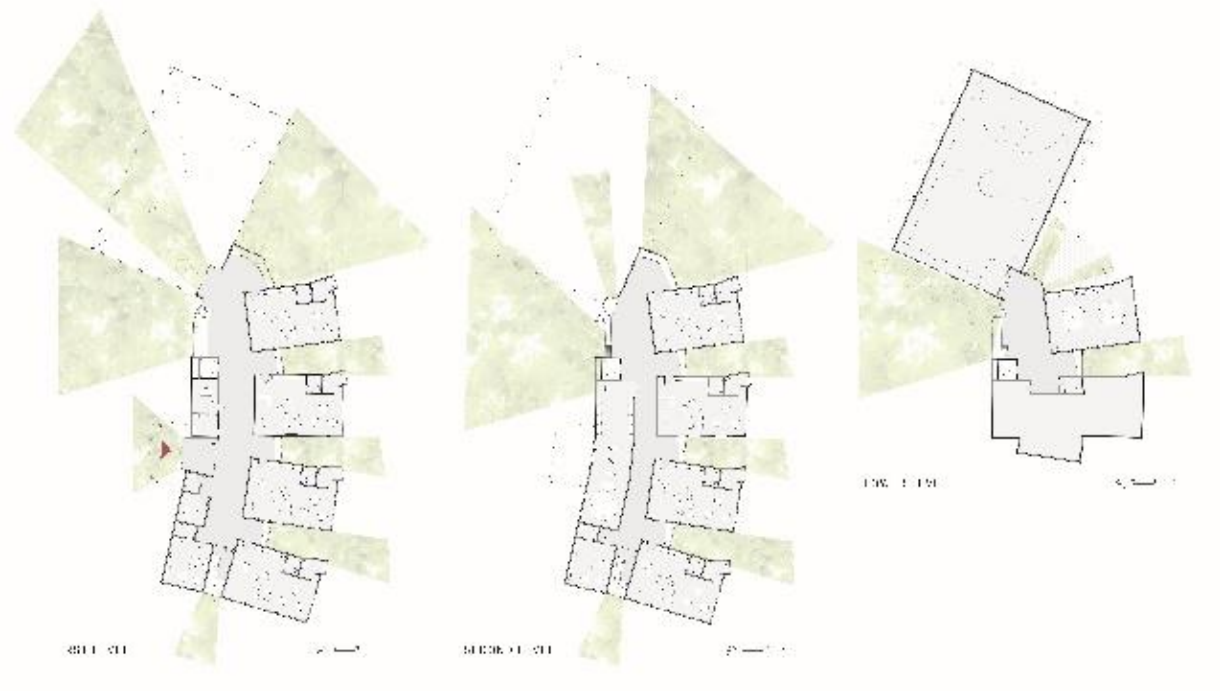

Figure 28: Natural Light and Views in Corridors

Classroom Nooks

Each classroom features a transition nook from the corridor into the classroom and includes a bench seat and a framed exterior view to the south. These pockets of activated space break up the double loaded corridor with program and natural light. They also provide much needed ‘elbow room’ for passing groups of classes and to accommodate unplanned, everyday moments.

Figure 29: Classroom Nook Rendering

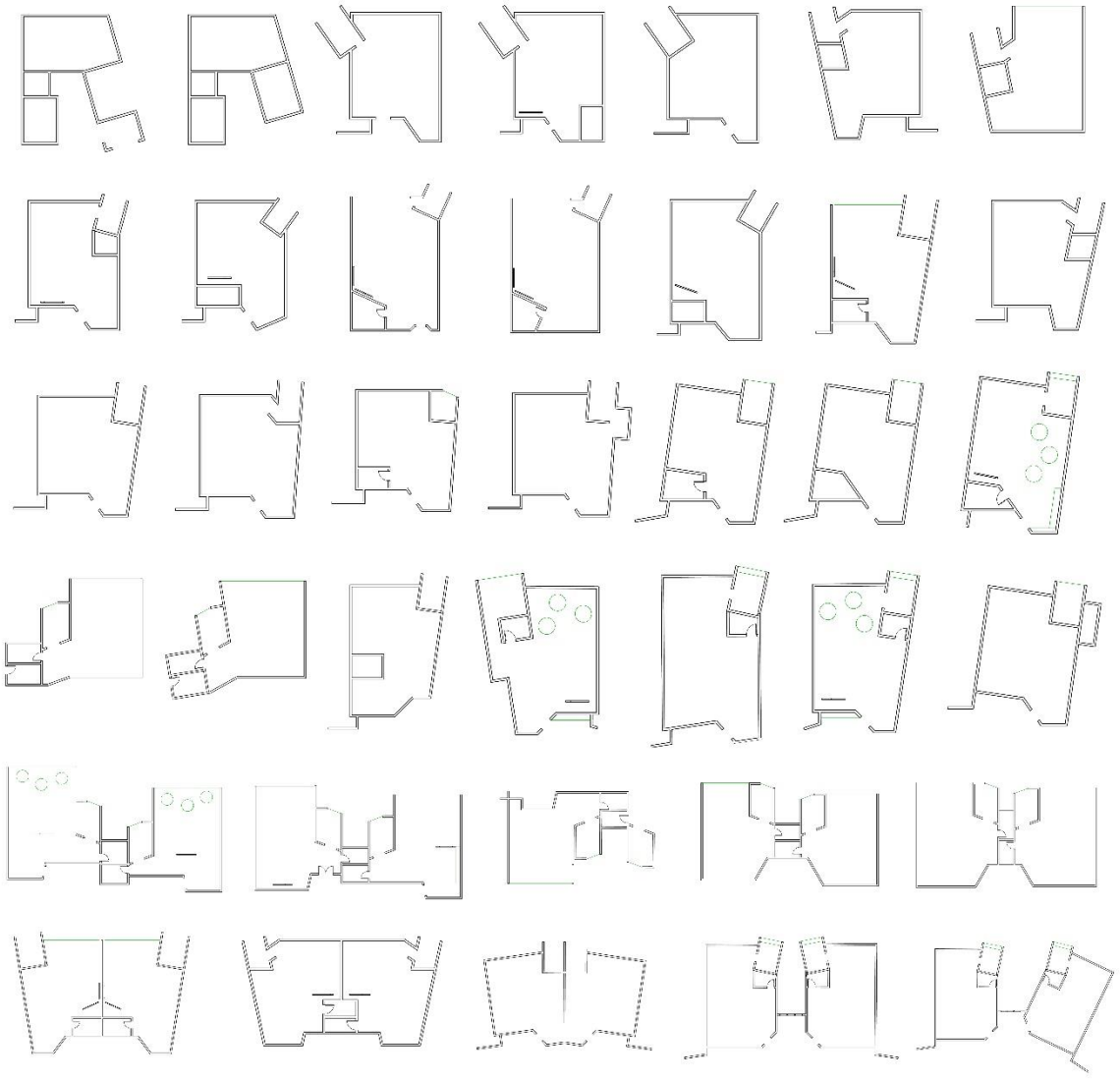

Figure 30: Classroom Iterations

The Classroom

The classroom required numerous design iterations to optimize the nook, the sensory room, and the bathroom locations. Sensory rooms demanded exterior views and therefore were pushed to the back and incorporated into the southern fenestration. Placing the sensory room on the opposite side of the main white board minimizes distraction as students rejoin the lesson. Additionally, the bathroom was grouped spatially with the sensory room to organize internal

circulation and distance itself from the entrance; teachers can monitor students as they travel to the restroom and decrease classroom interruptions.

Once inside, the single entrance opens to a small area dedicated for entry and lockers welcomes occupants. The teacher has her own area for her desk, storage, etc. Individual student desks adjacent serve traditional lecture style teaching, and group tables at the back of the room can be used for a variety of activities, for example the 15-minute sensory breaks mentioned earlier. Teachers capitalize on this by assigning academic tasks right after breaks. Though large glazing incorporates natural light and natural views, solar heat gain from the southern sun can create thermal discomfort. An exterior sunshade protects the interior against the strong summer sun and an internal light shelf extends low winter sun deeper into the classroom. Lastly, high clerestory glazing allows non-distracting views into the corridor to reconnect the separated space with the overall facility.

Figure 31: Classroom Floor Plan

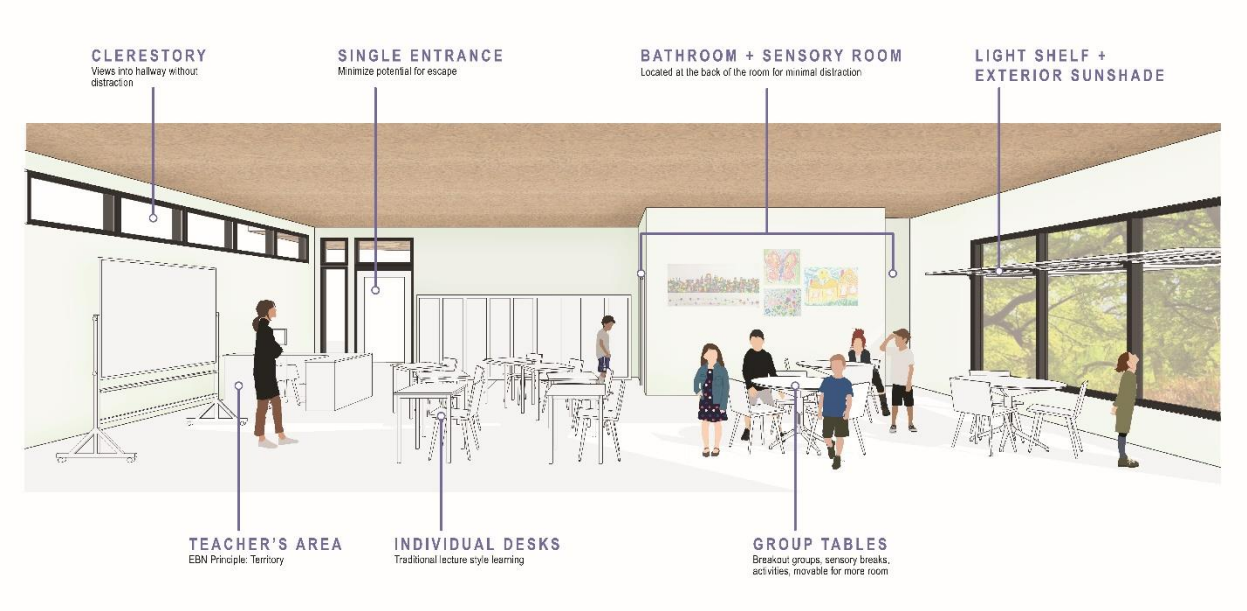

Figure 32: Classroom Rendering

Sensory Room

Sensory rooms are not permitted to have a door because this is considered entrapment. Instead, the wall between the sensory room and the classroom extends to create visual privacy (see figure 33). Within the space, cues suggest behavioral options to cope; the room includes enough space to let out physical aggression, comfy lounge seats, and window seat to gaze outside. Wherever the student chooses to reside, the teacher's aide that accompanies him still has adequate space to sit. The framed view is slightly tilted to offer a change of scenery from the classroom windows and emphasizes the opportunity to integrate nature as a grounding mechanism. However, the optional shade can block strong sunlight or minimize light levels based on preference.

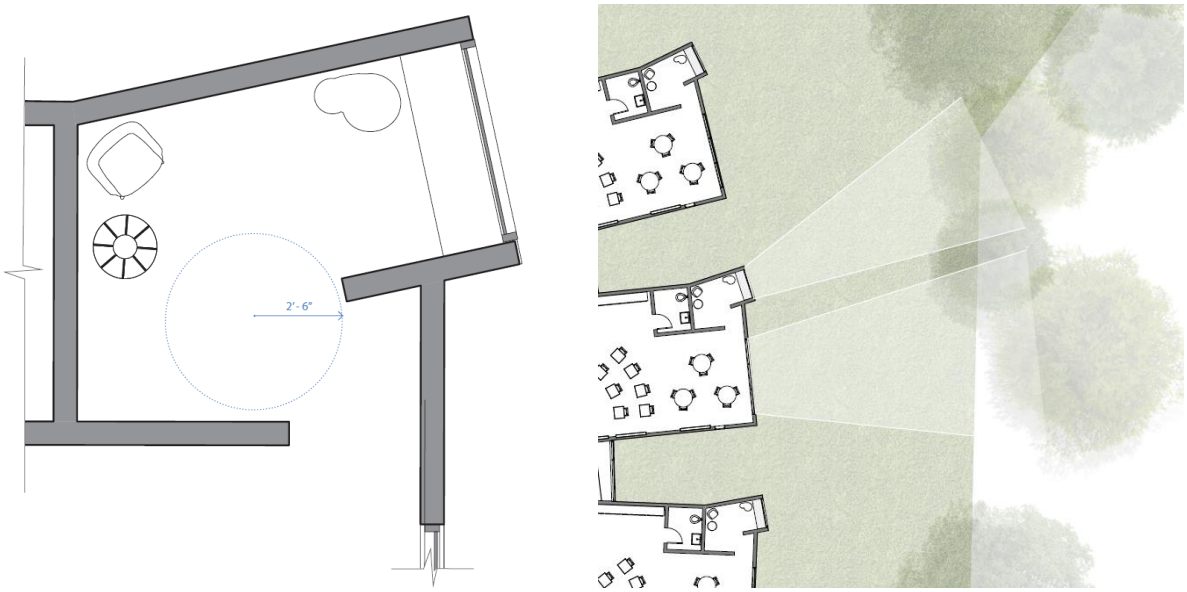

Figure 33: Sensory Room Floorplan and Diagram

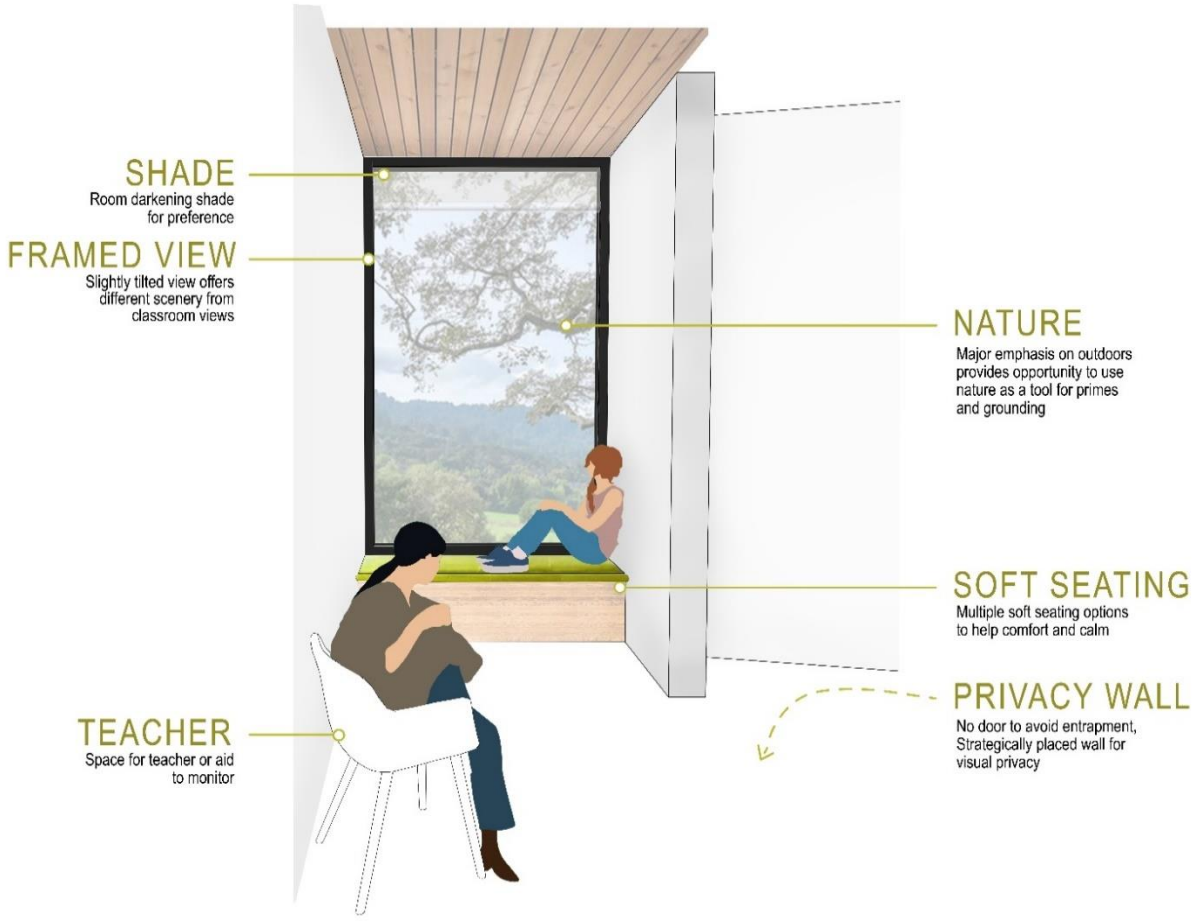

Figure 34: Sensory Room Rendering

The behavior map in figure 35 displays all three levels and the primary designated behavior for each space. Note, categories of behavior are not mutually exclusive and can occur simultaneously in the same room. For example, the corridors depict wayfinding and passive recreation, but their wide design accommodates the unplanned, unpredictable, and spontaneous moments that typically occur but cannot be controlled. Though we can shape spaces to promote specific behaviors, we must also incorporate flexibility to reflect the occupants' human nature.

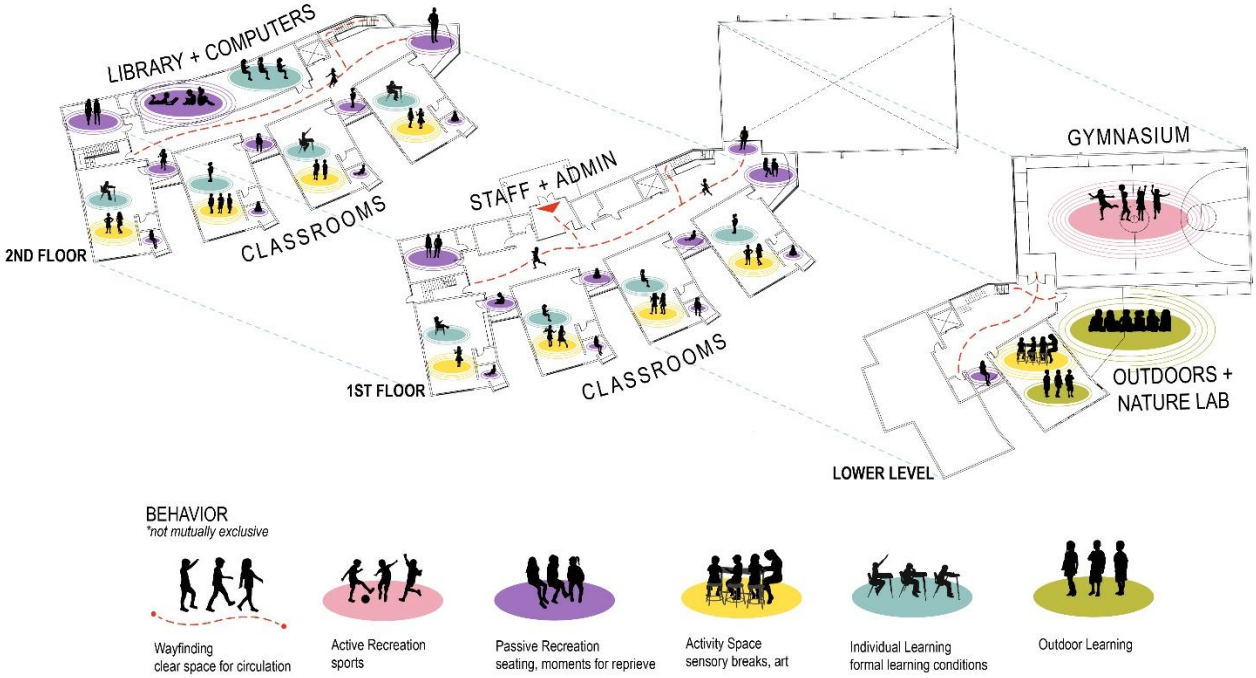

Figure 35: Behavior Map

Figure 36: Elevations

Figure 37: South-West Rendering from Pomeroy Terrace

Figure 38: Front of Building Rendering

Figure 39: East/West Section

Figure 40: North/South Section Perspective

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