THE ENHANCEMENT OF LEARNING THROUGH THE DESIGN PROCESS: RENOVATING THE FORT RIVER ELEMENTARY SCHOOL IN AMHERST, MA

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THE ENHANCEMENT OF LEARNING THROUGH THE DESIGN PROCESS: RENOVATING THE FORT RIVER ELEMENTARY SCHOOL IN AMHERST, MA

A Thesis Presented

by

REYHANEH BASSAMTABAR

Submitted to the Graduate School of the University of Massachusetts Amherst in partial fulfilment of the requirements for the degree of

MASTER OF ARCHITECTURE

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Department of Architecture
ENHANCEMENT OF LEARNING THROUGH THE DESIGN PROCESS FOR SCHOOLS: RENOVATING THE FORT RIVER ELEMENTARY SCHOOL IN AMHERST, MA

A Thesis Presented
by
REYHANEH BASSAMTABAR

Approved as to style and content by:

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Ray K Mann, Chair

_______________________________________
Naomi Darling, Member

_______________________________________
Professor Stephen Schreiber,
Chair, Department of Architecture
DEDICATION

To my family and Mr. Mohammad Babaee
For their advice, their patience, and their faith.
   Specially to Mr. Babaee,
   I could not imagine it without him.
ACKNOWLEDGEMENTS

I would like to acknowledge my academic advisors for their role in the development and success of this project. First, I would like to thank Ray Mann, the Chair of this research project, whose extensive experience and knowledge of architecture from Asia has been an invaluable resource, offering both richness of design and courageousness of spirit. Ray was very patient and supportive in the most challenging year of my life, she reminded me of my love for flow, movement, and their impacts on our wellbeing. I want to also thank my faculty advisors from the Architecture and Design Department at UMass: Naomi Darling, the Member of this research project, whose attention to detail propelled this project forward; and Caryn Brause, who led me to be a professional person.

I want to pay tribute to Mr. Mohammad Babaee, who sculpted my understanding of what the healthy life is and how to explore it. He supported my education by encouraging me to observe my surrounding scientifically even when we are looking at the background and history of art and architecture, to learn about our spirit. I wish to express my appreciation to my friends and family who have been a continuous source of patience, strength and inspiration throughout the past two and half years of this graduate program. A special thank you to Kuhn Riddle Architects, a talented and creative group of designers, a place where learning a tiny task was the biggest relief because it was elevated from the ocean of shared experiences.
ABSTRACT
THE ENHANCEMENT OF LEARNING THROUGH THE DESIGN PROCESS:
RENOVATING THE FORT RIVER ELEMENTARY SCHOOL IN AMHERST, MA

MAY 2018

REYHANEH BASSAMTABAR,
M.ARCH, UNIVERSITY OF MASSACHUSETTS AMHERST

Directed by: Professor Ray K Mann

The purpose of my thesis is to discover a logical way to connect the ideas of Rudolf Steiner, developer of the Waldorf Education Method, and current theories of educational and psychology with the architectural design of an educational facility while maintaining Massachusetts Department of Education standards. With this purpose in mind, I studied a school, built in 1973 in Amherst: the Fort River Elementary School. The current school structure is in architectural conflict with many of the ideas extolled by the Waldorf Method. Among the questions I wish to address in my thesis are: “What is the role of architecture in enhancing the quality of education?”, “What are the design elements which inspire learning?” “Can a Waldorf Method based design be compliant with Massachusetts Standards?”
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CHAPTER 1

Thesis Intent: Adaptive Re-Use

Introduction: Fort River Elementary School

Figure 1: Fort River Elementary School, Amherst, MA

Source: Massachusetts Historical Commission (MHC)

The Amherst School District includes three elementary schools: Crocker Farm, Fort River, and Wildwood. Fort River and Wildwood Schools offer grades Kindergarten through six while Crocker Farm provides classes in Pre-K through six.

“The Town of Amherst submitted their Statement of Interest (SOI) for the Wildwood Elementary School on March 19, 2013. To summarize the deficiencies here, the District has identified the existing open classroom arrangements, a diverse student population with a need for differentiation and intervention, a general lack of appropriate ELL (English Language Learners) spaces and inherent problems in building circulation with the existing location of student toilets and the necessity to pass through active learning classrooms in
order to reach the student toilet facilities. These deficiencies have been identified as direct problems that the District wishes to correct so that they can provide the best possible educational experience for all of their students. The existing Wildwood and Fort River Elementary Schools were built only a few years apart and are nearly identical in design and layout.”

The School Committee voted on January 19, 2016, to approve the grade reconfiguration (one of the committee’s options to solve the issue) to include a co-located grade 2-6 school to accommodate a total of 750 students. This grade reconfiguration would include an enrollment for a 750 student 2-6 school, which would implicate

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1 “2016-02-11-Wildwood-ES-FINAL-PSR.Pdf.” wildwood.projects.nv5.com
redistricting to a district-wide system, maintaining the existing Crocker Farm Elementary School as a Pre-K – 1 and creating a new single 2-6 building, to replace the existing Wildwood and Fort River Elementary Schools. The District will be revisioning Crocker Farm School given its change from being a PreK-6 school to a PreK-1 early childhood center.

Both buildings now show similar deficiencies, both from a design viewpoint and an infrastructure viewpoint. Both schools were built with open-plan classrooms at a time when such design was the prevailing model. Since that time it has been shown that such an environment is not conducive to learning for all students. The relatively high percentage of students needing differentiation and intervention is not well served by the existing environment.

![Amherst Elementary Schools Enrollment Trend](http://wildwood.projects.nv5.com)

*Figure 3: Amherst Elementary Schools Enrollment*

*Source: http://wildwood.projects.nv5.com*
All data on following figures is from the 2014 TELL Survey that was completed by teachers in all districts in the Commonwealth, which is indicating the teachers and staff point of views of Crocker Farm, Wildwood, and Fort River schools.

Figure 4: The Physical environment of classrooms support teaching and learning”
Source: http://wildwood.projects.nv5.com

Figure 5: Teachers and staff work in a school that is environmentally healthy.
Source: http://wildwood.projects.nv5.com
The Fort River Elementary School - as they introduced themselves- is a place to develop the whole child - physical, intellectual, social, emotional and creative - in an environment in which all students are nurtured and challenged according to their individual strengths and needs. The core mission of the Amherst Public Schools is to “provide all students with a high-quality education that enables them to be contributing members of a multiethnic, multicultural, pluralistic society.”

The Fort River Elementary School is a one-story building covering approximately 82,000 square feet. The overall layout of the building is organized around a central connecting corridor with two separate looped corridors – one to the north and one to the south. The Main Entry is located on the west side of the building and leads directly into the main connecting corridor. The Main Administrative Offices are located about halfway down the main connecting corridor on the right (western side). The Cafeteria and associated Kitchen spaces are located on this (southern) side of the building along with the primary mechanical spaces and designated delivery areas. The western corridor loop connects the classroom “quads”, the Library, the Gymnasium and various small-scale teaching spaces as well as teacher planning spaces. The original building was designed as an “open classroom” model that was reconfigured with temporary partitions and furniture soon after completion in an attempt to correct some inherent acoustical issues and general organizational missteps. Fort River was built in 1973, with no major renovations since. The partitions between the classrooms were installed in the mid-1980s, this will be examined in depth later. The square footage of Fort River is approximately 67,500. As a result of this reconfiguration, the bathrooms can now only be

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2 Christensen, Dusty, “Composition of Committee to Study Fort River School Underway.”
accessed by passing through several active classrooms causing frequent distractions and daily disruptions. This has caused problems for many years and is one of several driving factors that pushed the Town to pursue this building project with the MSBA.

The district submitted Statements of Interest to the Massachusetts School Building Authority for renovations to Fort River and Wildwood schools. MSBA notified the district in December that Wildwood’s Statement of Interest has been invited to move forward into the MSBA’s Eligibility period, which is the next step in the process.

Figure 6: Existing Plan - Fort River Elementary School

Source: Author
CHAPTER 2

Ideas of School Environments

Historical Development of American School Architecture

The idea of a community school is not a new concept, after all the formation of an educational institution was first and foremost constructed as a place for constituents to come together to exchange ideas. The development and planning of American school facilities have traditionally mirrored that of the educational pedagogy of its time, that in turn has been shaped by many societal forces such as social, economic, and political objectives. One simple example of this would be the societal changes during the Industrial Revolution, when the need to educate immigrants in urban centers increased drastically, causing schools to occupy multistory factory buildings, and educators to fashion their curriculum around large class sizes. These changes haven’t happened overnight - some reforms have happened gradually, taking hundreds of years - while more recent changes to curriculum and learning styles have happened rapidly; most likely caused by the advancement of processing speed and increased dependency on technology. Over the past four centuries there have been three distinct periods of transformation which have influenced educational practices; they are the Colonial period (1650-1849), the Industrial Revolution (1850-1949), and the Information Age (1950-present). This section will briefly examine the current Information Age to better understand where we are and where we are heading with educational practices. The current situation, categorized as the Information Age, has seen the most dramatic wave

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of experimentation in educational research of curriculum and school design; a far cry from the previous factory model of education. This new age brings with it an exploration of open school plans, middle school concepts, and the small learning community approach. In the early 1950s there was a dramatic increase in enrollment and high demand of school construction prompting architects to create a standardized plan for school buildings. Most of these schools were built with the lowest price, creating poorly insulated structures and downscale systems compared to the standards of today\(^4\).

In the 1960s, the United States’ educational community began to fundamentally question the effectiveness of the traditional format of learning and opted to adopt the British “informal education”, a method of open education. These large open spaces for schools were designed to be flexible, that could change between team teaching to small group and individual learning. It was argued, that this learning technique provided educators with the opportunity of teaching students with diverse achievement levels and allowed students the freedom for self-directed study\(^5\). Unfortunately, these schools failed right from the start dose mostly in part to the noise and visual distractions the open plans caused. These factors weren’t the only things which contributed to its’ demise: there were also inadequacies in the training process for teachers, causing them to revert back to the traditional methods of teaching. While the open plan was busy failing, there was another alteration to the educational structure brewing; the introduction of the “middle school”. It was argued that the transition between the self-contained classroom style and the unregimented high school style was too drastic for students to take; they needed a style

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\(^4\) Brubaker, Planning and Designing Schools. Director of Special Sales, McGraw-Hill. 1998.
that would allow them to comfortably adapt to the high school style of learning. With this new model children would be able to receive the supportive structure similar to the elementary school, while incorporating the subject-oriented curriculum of the high school.

The design of the middle school was based on the concept of smaller learning clusters within the building preferably called houses. These houses were intended to create a sense of community between the families of students in them, while the other common areas such as the library, gymnasium, administration, and art and music department were designated for use by the whole student body. The success of this style was even applied in some high schools. By the 90’s most educators were fully supportive of the “house plan” initiative and that newly constructed and existing school facilities should be transformed into schools-within-schools. Research has shown that smaller schools and the concept of seven schools-within-schools increased participation rates in school activities, extracurricular activities, social connectedness, and even academic achievement rates have increased; compared with larger schools. When planning these schools, architects look for ways of creating a variety of diverse learning styles that support personal learning, collaborative learning, team teaching, and self-directed learning. The flexibility of each space is very important as well as personalization which can give a student a sense of ownership and responsibility for his or her surroundings. In this new design instructors should be more flexible and shouldn’t be constricted to the confines of the office block of the traditional learning style, but, instead should have an informal lounge format and have student meeting areas adjacent to the lounge. Looking

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at the bigger picture we have journeyed a long way from the one room school houses and even the more recent traditional lecture class format. Schools of the 21th century are going to have to adapt to ever-changing curricula and learning styles, the immense infiltration of technological support, and becoming more economically viable to support a variety of programs and activities. For future schools, some of the styles mentioned in the previous paragraphs can still be beneficial as long as they are applied with a mix of styles offering schools flexibility when designing curriculum. Economically, if we are going to invest millions of dollars in new school facilities, they are no longer going to be able to address only some of the issues while ignoring others. Community schools will have just as many incentives for tax payers without children as it will for taxpayers with children. These schools will have more accessibility for the larger community; offering students the chance to use the community as a learning tool and a support system, as well as providing community members more programs and facilities geared towards their needs.

With this background including discussions of how schools evolved to meet changes, now I evaluate where we are now, and how education has changed through the lessons it learned.

**The Waldorf Education**

I am interested in the Waldorf Education Method, because among the leading educational methods its philosophy of child development and pedagogy impressed me the most. What is its history? What is the Waldorf’s teaching philosophy? Why do I find it of particular interest to me as an architect? What design features have traditionally been
used in Waldorf Schools? Where have these design features succeeded and where have they failed?

The Waldorf concept emerged after First World War in 1919 in Stuttgart, Germany. It was the combined idea of Emil Molt and Rudolf Steiner. Emil Molt owned the Waldorf-Astoria Cigarette Company and was interested in building a school for his employees’ children. Rudolf Steiner (1861-1925) was an Austrian philosopher, social reformer, and architect. Molt in company with Rudolf Steiner intended to establish a system that would not only challenge the new generation, but would cultivate their artistic and social abilities as well. In addition, this educational system would in theory nurture the capacities that would allow children to adapt to a rapidly changing world.

Rudolf Steiner’s Educational System

Steiner’s main work Intuitive Thinking as a Spiritual Path; A Philosophy of Freedom was published in 1894 and is well-known as “Anthroposophy” or “the wisdom of human being”. Steiner defined it as “a path of knowledge to guide the Spiritual in the human being to the Spiritual in the universe”. His works’ subjects include philosophy, the evolution of consciousness, the sciences, the arts, and education. Based on its philosophical and spiritual foundations, the Waldorf School grew quickly and internationally-recognized. One of the salient features that form the Waldorf’s approach to the education that it is based on the developmental approach addressing the changing needs of the growing child. The other salient feature is the idea of transforming education into an art that

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8 Emil Molt was a German businessman, social reformer, and anthroposophist. He was the director of the Waldorf-Astoria-Zigarettenfabrik, and with the company of Rudolf Steiner co-founded the first Waldorf School. (1876-1936)
educates the whole child - the spirit, soul, and body of the child. Here, the question is, how does this transformation into an art apply to a system including teachers? Steiner answers this question by giving some examples about painters who work with light, color, and form and musicians who work with melody, harmony, and rhythm so teachers work with the curriculum and their pedagogical methods, and with the children. I believe that with architecture, a building can transform into a piece of art that can have strong impacts on educational process. This aspect of working through art, plays a vital role especially in the elementary school in which their methods derive directly from art.\(^9\)

“The education of the young child is based on imitation and example. […] Young children live in a world of deeds; to them, play is work and work is play.”

**Child Development**

In Steiner’s point of view, the human being is composed of four “bodies” which are categorized in both physical and nonphysical aspects of the human being. Of our four “bodies”, only the physical body can be perceived by our senses. There are three higher “bodies” in us, the “etheric body”, the “astral body”, and the “I” that are not physical. We can perceive their presence and experience them only through their effects on our bodies and our souls.\(^10\) Steiner’s method reflected his demand to educate the children in the light of spiritual science.

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The human being develops through the four bodies which mature at different times. The physical, etheric, and astral bodies are “soul functions”. They are the foundations of our existence, which they develop provide the basis of intellectual and psychological processes or “soul functions”. As a brief description, the etheric body serves as a foundation for our thinking, the astral body is responsible for our life of feeling, and the “I” allows us to experience and express ourselves. Our four bodies will born after each seven years, etheric born at the age of seven, the astral body born at the age fourteen, and the I born at around the age of twenty-one.

I believe that for educators is required to be familiar with each of bodies and their impacts on children’s growth. Should I be talking about what I believe? As an architect being aware of our client (children) is vital and that knowledge is the right path to start the designing process. I deeply agree that after birth, it is our job to provide an environment to let the child continue his/her growth in a healthy and harmonious physical, emotional, and spiritual manner. Architects who design for this early ages must be very clear about what works on each body from the outside. For instance the growth of the etheric body is the development of inclinations of the conscience, character, and memory. Therefore maybe we need to avoid being very simple in our design, a little amount of complexity in our design ideas is required to challenge their mind and memory. To develop the child’s memory, we can harness rhythm, and repetition, for instant to stimulate their imagination.

“The etheric body is a body working through time, and etheric processes are always

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rhythmical”\textsuperscript{12}. The theory is that young children respond strongly to rhythmical phenomena and also that rhythm can help them to understanding their lives. Rhythmical activities also create a feeling of well-being and a sense of security in the child.

To understand the nature of the young child, Steiner stated that children do not differentiate between their body, soul, and spirit. It is interesting that children in this early ages recreate their entire environment within themselves. Therefore the surrounding of children affect them deeply, the role of an architect gets more important, the architect must be aware of all impacts of each shape, form, and color that he/she creates in a school. Young children perceive and respond to their environment, also they reflect that perception in their surroundings as well.

A final important point is that Waldorf schools educate their pupils significantly through arts. Because art engages our feelings, stimulate our imaginations, and foster enthusiasm and joy, they allow the children’s souls to grow in healthy, harmonious ways. An artistic space could optimize a Waldorf School’s goals. Waldorf education cares a lot about the architecture of its schools because creating a relationship between human beings and the spirit is the job of art. In the space where teachers and pupils are realizing the art of education, the role of architecture is to create a framework in which teaching becomes possible as an artistic process in a way that Steiner described.

Based on this theory, all school buildings are capable of establishing the education as fluent and naive as an artistic process, because the human physical system always

\begin{footnote}
\end{footnote}
responds, consciously or unconsciously, to the built environment. There are many ways to become aware of this interaction, such as ask ourselves how we really feel in a building: assured, depressed, abandoned, ignored and pushed aside as a person, unlucky, devastated, or at home, inspired and heaved beyond ourselves.

**Waldorf’s special Architecture?**

Buildings which were built in the past as Waldorf schools, they probably would revealed the architectural development of Waldorf schools, but they have been replaced by new ones. It is of course a fact that the new construction of Waldorf schools should not copy the past, but I agree with Roberto Trostli\(^\text{13}\) that the values of the past can be transformed and comprehended in a new way in the present. All architects are aware of this fact that the demand of a living architecture is much greater now than in the early twentieth century. The scope of Rudolf Steiner’s opinion that indeed beneficial architecture can have a healing effect in the moral nature of the human being is becoming increasingly vivid in view of the technologization of the relationship between the I and the world.

One of the most important features in the Waldorf school community is creating a common awareness of all processes. Eurhythmmy utilizes the “forces at work” in the etheric sphere. “Eurhythmmy is an expressive movement art originated by Rudolf Steiner in conjunction with Marie von Sivers in the early 20th century. Primarily a performance art,

\(^{13}\) Roberto Trostli the editor and introducer of Rudolf Steiner’s book: “Rhythms of learning”
it is also used in education, especially in Waldorf schools, and – as part of anthroposophical medicine – for claimed therapeutic purposes.” 14

For instance where in Waldorf school architecture we are able to see the attempt to interpret the terms of the etheric body in the shape of a space? If we wanted to give examples, one could cite the upper school building of the Waldorf School in Moss (2013) in Norway or the straw bale and cob-built Waldorf kindergarten in Leipzig (2011).

Figure 7: Waldorf School Moss Norway / Architects: Winfried Reindl, Imme Denker, Joachim Zimmer.
Source: www.waldorftoday.com

“A completely new dimension of thinking about architecture is opened up which goes beyond the usual discussion about what is “organic”, “living” or “anthroposophical” in architecture, in other word, creating a connection with a mystery impulse means placing

oneself individually into the continuity of a spiritual stream in awareness of one’s responsibility towards the spiritual world as a school.”

The concept of metamorphosis, which had emerged in the architecture created by Steiner, connoted that a specific form in a building always relates in an inner relationship to the overall form of the building. In other words, the selection of shapes in all systems is not by chance, if we select them and design them in the best relationship with their function, then we create a healthy system. Metamorphosis prevents arbitrariness in architecture – for example as the shape of the hand, the foot or the head are not the actual human being but each of these forms only makes sense in a specific place in the context of the human organism to define the human spirit which has an adequate habitation in our physical sphere. The introduction of the concept of Metamorphosis to architecture created the possibility of bringing the laws of what is built on a physical plane in turn – in a contemporary way – into harmony with spiritual laws.

A school building serves as an intermediate space between the home and the society. The school must express the soul and spiritual life of a specific school community. Since the age of the people for whom it is built comprises a span of almost two septennia, it requires forms which are appropriate to indicate the life rhythms occurring between starting in kindergarten and leaving school. In its best buildings, Waldorf school architecture develops spatial qualities which overcome the arbitrariness in the language of forms of contemporary architecture, devotes their suitable place to right-angles and squares and allows for an experience of what is living through, for example, double curved

surfaces. The Swedish color designer Fritz Fuchs (and others) lasur\textsuperscript{16} (azure, or glaze artist, it possesses immense experience in artistic color design for various functional rooms. in which the whole child is hired for his training.\textsuperscript{17}

\textbf{Figure 8:} Widarschule Bochum-Wattenscheid / Architect: Klaus Rennert

Source: www.waldorftoday.com

\footnotesize
\textsuperscript{16} At one time the French used “lazure.” The new American word, then, is most closely related to the French. The word azure, already in the English language, comes directly from the French and refers to the blue appearing in a clear sky, the word has Persian origin of “lazur”\textsuperscript{16}

\textsuperscript{17} http://www.waldorftoday.com/2014/09/human-beings-as-the-measure-of-things-on-the-architecture-of-waldorf-schools/
The Montessori System

Figure 9: Montessori Elementary School / Marlon Blackwell Architects
Source: www.archdaily.com

Movement Enhances Learning

“If you wish to give the means to the child for his development you must give them in such a way that the child can, and must move. ...In all her books, lectures, conversations, Montessori incessantly returns to this great theme of the importance of movement.”

—E.M. Standing Maria Montessori, Her Life and Work

As I started to study Montessori education I realized that movement could be a key for learners, as we all need to move to get through life, we must know that how children learn is intimately connected to their movements. it is interesting when you see a child while learning, she/he moves in her/his seat and has many movements, the scientist proved that this is a part of the learning process in children. When movement is involved, the brain is stimulated differently than it is when one is passively watching and listening.
Physiologically the brain part which is related to the movement is prefrontal. The prefrontal is a portion of cortex that is employed for learning. Activating of this part of the brain caused the most activation in learning regions as well.

The brain depends on all types of movement to develop. For instant, how the pathways in the brain control the movement of my fingers as I sketch something. When I learned to draw, it took conscious effort to move my hand. But, practice makes perfect. It takes practice to learn to hold a pencil, then to draw.

Joy is not measurable on an IQ or SAT test. Intelligence and creativity develop as children explore the world, figuring out on their own how things work, and with designing how to move them architecturally, an architect can enhance this learning process.

**The Montessori Education**

Maria Montessori, the founder of Montessori Method (1907), observed that movement enhances learning. She was an Italian scientist, medical doctor, and educator. In her book, The Discovery of the Child, she wrote: "One of the most important practical aspects of our method has been to make the training of the muscles enter into the very life of the children so that it is intimately connected with their daily activities."

The Built Environment and thoughtful Circulations allow children to move freely around the classroom and the school spaces. Moveable furniture can let children to arrange their seat in the way they want at a specific moment. Children choose an activity - they walk to its place in the classroom, pick it up, and carry it to a table or mat. Much work is done on small rugs on the floor. A student from a Montessori school said it best: "I like school because you can walk around the classroom and not sit in desks all day."

20
You make your own snack.... We can choose our own work." Children must feel they are free, then they won’t feel anxious or threatened, that have bad influence on their learning.

Dr. Montessori based her method of education on the premise that learning is linked to movement. Children handle Cylinder Blocks or the Pink Tower, learning subtle differences in weight and size. Children discover themselves and the larger world by moving about. Dr. Montessori definitely believed that there is no substitute for movement.
The Physiology of Learning

There are physiological changes that are associated with the learning process and that underlie memory storage. Most current researchers look for such changes within the central nervous system, for it is this network of neurons that is largely responsible for processing information and producing behavior. Four categories of physiological theories of learning are discussed: neuronal-synaptic models, RNA-protein models, glial models, and non-connectionistic theories. Learning depends on experience and may lead to long-term changes in behavior potential.18

The major assumption of neuronal-synaptic models is that learning involves a change in the neurons which makes it easier for some neurons to influence the neural transmission of the neurons with which they have connections or synapses. Such models are popular because neurons are the units of the central nervous system which apparently underlie behavior and because the billions of neurons in the human brain are interwoven in a vastly complex web which seems intricate enough to account for the complexity of human learning and behavior.19

RNA molecules are involved in the production of proteins, some of which affect neural transmission. Changes in RNA molecules and proteins have been shown to be correlated with learning. Thus proponents of RNA-protein models of learning suggest that memories are stored in specific molecules of RNA or proteins or both. One set of controversial experiments offered in support of RNA models is the memory transfer experiments. These involve training one set of animals on a task, extracting their RNA

and injecting it into a second set of animals, and demonstrating that some memory was transferred with the RNA. Currently there are many complications with this type of research, and theories of the RNA-protein models and exactly how they work are still in dispute.  

Glial cells are cells that support the activity and functioning of the neurons, and in this capacity they can affect the firing activity of neurons. A glial theory of learning, then, would postulate that memories are stored in glial cells and are expressed in terms of the glial cells’ influence on neurons. Essentially no one advocates a glial model of learning, although the glial cells have been incorporated into other physiological models. Ultimately a physiological explanation of learning will probably involve some combination of neurons, glia, RNA, and proteins.

Non-connectionistic theories of learning postulate that learning is not based on specific connections between specific neurons, but rather depends on coherent patterns of electrical activity among groups of neurons. Thus memory is recorded in terms of an electrical pattern. One advantage to non-connectionistic theories is that they allow for the possibility of specific neurons being destroyed without necessarily impairing memory, so long as other neurons can still produce the required patterned activity.

Considerable research has been directed toward identifying exactly where memory traces are stored. Some animal research has involved selectively destroying parts of the brain in an attempt to obliterate memory traces. Such attempts have not been successful in localizing memory traces, suggesting to some researchers that specific

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memories may be stored in several different places. Electrical stimulation of some areas of the human brain has caused the subjects to recall specific memories, perhaps because the stimulation somehow activated a memory trace. There is also evidence suggesting that information stored in one hemisphere of the brain may be transferred via nerve fibers to the other hemisphere, where the information is then also stored. Severing these nerve fibers produces a split brain where the two hemispheres learn things independently to some degree.\(^{21}\)

\(^{21}\) http://uwf.edu/wmikulas/Webpage/concept/chaptertwo.htm
The Psychology of learning:

The prefrontal cortex (thinking brain) is the last part of the brain to develop; it develops during adolescence and it is the part of the brain that is in charge of judgment, and decision-making which are the skills that get developed at that particular time in life.

How information is processed? According to Dr. Kathy Theuer\textsuperscript{22}, Information enters our brain through our senses and goes directly to the thalamus which is the sensory relay station. From there the brain takes that information and decides if that information is perceived as being threatening or not. If it is perceived as threatening, it’s processed quickly and it’s perceived as not threatening it’s processed in a much slower fashion. Quick processing involves information going from the thalamus to the amygdala, which is the center of emotion, to the cerebellum which is the center of movement for a flight or fight flight response, this is useful if we are trying to save ourselves and survive, but not so good for school. We want to slow processing, where information comes into our thalamus then it goes to our hippocampus which is the center of memory and then off to the cortex where we can think about that information.

\textsuperscript{22} Associate Dean & Director of Accreditation at BRANDMAN University
For schools we need the slow process of information so we must consider how to minimize threatening conditions, which some of them are psychological and some of them are physical. We need to create an environment that has fewer threats that might inhibit learning.

**Types of Threats**

Physical threats, intellectual threats where kids feel like they are not academically competent, Emotional threats where people are harassing or teasing others, cultural and social threats where a child feels like he/she is not doing well, or is weak.
Biophilic Design for schools:

As Winston Churchill once said, “We shape our buildings and therefore, they shape us.”

Why should Biophilic Design be considered as part of the solution? How does it make a profit for a learning space? Biophilia is humankind’s innate biological connection with nature. Due to the considerable amount of time people generally spend indoors, there is a need to connect humans to nature even when they are in built environments. This connection nurtures health and well-being, which can enhance the productivity of a person, one reason could be considered as increasing the levels of creativity.

People spend approximately 90% of their time indoors and much of that time is spent in schools. Therefore, it is very important to consider this fact when designing classroom environments. The convenient design will have a strong positive influence on students. Recent studies have shown that integrating nature within schools can make them more comfortable for students, enhancing attentiveness and productivity. A 2005 study conducted by the California Department of Education found that students who participated in nature programs performed 27% better in science testing than students in traditional classrooms. The University of Illinois Human-Environment Research Laboratory indicates that when children with Attention Deficit Disorder (ADD) are connected with nature from as young as five years old, their ADD symptoms are significantly reduced. Also, there are many tests that reported 20 – 26% higher test scores in classrooms with ample natural light by the Carnegie Mellon School of Architecture. In the most recent studies of the importance of daylight in schools, the Heschong Mahone
Group, Inc. found significant evidence that access to outdoor views through windows in classrooms improved student performance by 5 – 10%.

We can name the additional benefits of biophilic design in the classroom:

- Enhanced creativity
- Improved cognitive function and productivity
- Enriched clarity of thought
- Reduced boredom, stress and aggression
CHAPTER 3

Precedent Studies

Waldorf Schools

I studied two Waldorf schools, to see how the architects interpreted Waldorf philosophy in their designs. Critique of conventional approaches to architecture

The transparency of walls (often glass), the relationship of the building to the built environment and, the view that architecture should build with users in mind are the global criteria for describing a contemporary architecture. But if we put these criteria to the test by examining the concrete effects of such buildings on the human, we will understand that people are complex systems that are sensitive to their environment. Human’s perception works according to the interpretations of patterns in his surroundings.

One particularly example is the Phaeno Science Centre near the railway station In Wolfsburg by the architect Zaha Hadid.

Figure 12: Phaeno Science Center, architect Zaha Hadid
Source: http://www.mosingenieros.com/2012/12/las-7-futuras-maravillas-del-mundo.html
“After the building was opened, an additional space had to be built in which visitors could recover their inner equilibrium after they had become physically sick because of the many sloping walls and slanting floors. According to the British newspaper The Guardian, the structure is nevertheless considered one of the twelve most important modern buildings. This background, illustrates the dire situation of current architecture, but also its desire to penetrate into wholly new spatial qualities, Waldorf schools are justifiably want to harness this common architectural impulse in their school buildings. By reflecting on the potential of their architecture, which can be developed a fresh out of Rudolf Steiner’s anthroposophy case, they are setting standards not just in education but also in school architecture.”

Figure 13: Kindergarten Leipzig, by Markurt Architekturkontor, Leipzig - Architekturbüro Denker & Zimmer, Berlin

Source: www.waldorftoday.com

The Hartsbrook School / Fitch Architecture and Community Design – Amherst

Their design does not include curved lines and shapes, just in the blackboards and some furniture we were able to see the traces of anthroposophical art. A lot of activities related to the natural life, farming, planting, keeping domestic animals in the barns.

“The heart of the Waldorf method is the conviction that education is an art – it must speak to the child’s experience. To educate the whole child, his heart and will must be reached as well as his mind.” —Rudolf Steiner
Indian Community School of Milwaukee Franklin, Wisconsin

2009 Design Excellence Award from the AIA Committee on Architecture for Education

Architects: Chris T Cornelius in Collaborating design with Antoine Predock Architect

“This project was completed in collaboration with design architect, Antoine Predock, FAIA. Predock was selected through an invited competition and Chris Cornelius was selected to be a part of the design team as an American Indian designer that would help ensure the accurate cultural translation in the architecture.”

“The client purchased a 142-acre site just south of Milwaukee in Franklin for a new K-8 school. This 150,000 square-foot school differs from most schools in a number of ways. A center of community for the American Indian population in Milwaukee. The school’s mission is to teach cultural values as part of educating young people. The large public spaces in the building are intended for community use, including dining for 800, a theater for 400 and a gym.” _Chris T Cornelius

“The methodology they employed to communicate the cultural values of the people who will use this school, was to create of a series of graphic laminae. Each of these laminates graphically communicate the cultural values that are shared by the 11 nations in Wisconsin. Laminae connote an inherent strength through the act of lamination. By creating a syntax of their own, each of the laminae may be read in the singular, but one can read them in conjunction with other laminae. Through this synchronic syntax, one can read the Native ethos of all things together and the role of reciprocity.”

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24 “Indian Community School.” www.studioindigenous.com
25 According to his lecture at the Design Building of University of Massachusetts spring 2017: the laminate is the product of bonding together and assembling the ideas and concepts of cultural elements.
The clients desired a cultural expression that was integral to the architecture and not applied in a decorative manner. Every effort was made to be selective of the areas that would manifest cultural relevance and Chris T Cornelius created a cultural program of spaces that identified material qualities, programmatic usage and the opportunity for integrating culture. “The areas of cultural relevance and meaning are designed by studio: indigenous and represent my exact design role in collaboration with the design architect.”

----Chris T Cornelius

“As you will see in the following pages, the direct design authorship of Cornelius’s firm - studio: indigenous - is in areas such as; classroom naming, identification of laminate topics, creation of explanatory graphics, the design of an entire space called “the Place of Nations”, the design of furniture, etc.” 26

Figure 16: Indian Community School of Milwaukee Community

Sources: www.studioindigenous.com

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26 From Chris T Cornelius’s lecture at Design Building, Amherst, MA. 2017.
Sources: www.studioindigenous.com
This is an interesting interpretation of cultural values for designing a school, children will continue learning when they are walking in the school. Changing the spaces’ name will drive their attention.

Figure 23: Indian Community diagram

Source: www.studioindigenous.com

Figure 24: Cultural program diagram – the second floor; elements designed by studio: indigenous

Source: www.studioindigenous.com
The Farming Kindergarten located in Vietnam which is historically an agricultural country that is facing changes to a manufacturing-based economy. Increased droughts, floods and salinization jeopardize food supplies, with air pollution in the cities. Quick urbanization is denying Vietnamese children to use the green lands and playgrounds, and therefore establishing a relationship with nature make sense.

Farming Kindergarten located next to a big shoe factory. It is designed for 500 children of the factory’s workers, the building is conceived as a continuous green roof, providing food and agriculture experiences to children, as well as an extensive playground which is open to the sky and provides a secure and safe place for young children to play.

The green roof is a triple-ring shape drawn with a single stroke, encircling three courtyards inside as safe playgrounds. Recently, an experimental vegetable garden was realized on its top.
All functions are accommodated under this roof. As the roof lowers to the courtyard it provides access to the upper level and vegetable gardens on top of learning spaces and touches nature.

![Image 1](image1.jpg)

**Figure 29: FK- central_staircase**

**Figure 30: FK - Ground_Floor_Plan**

### Environmental Strategies

The building is established of a continuous narrow strip with operable windows on both sides which maximize the cross ventilation and natural lighting. Also, architectural and mechanical energy-saving methods are comprehensively applied including but not limited to: green roof as insulation, green facades as shading. These devices are designed to be visible and play an important role in the children’s sustainable education.
As a result, the kindergarten is operated without air conditioners in the classrooms despite being located in a harsh tropical climate. According to post-occupancy record issued 10 months after completion, the building saves 25% of energy and 40% of fresh water compared to baseline building performance, reducing its running cost greatly.

**Cost-Efficiency**

The building is designed for low-income factory workers' children, so that was why the construction budget was quite limited. Therefore, the combination of local materials (ex. bricks, tiles) and low-tech construction methods were applied, which also helped minimize the environmental impact as well as promote local industry. All the simple rigid frame built with economical materials, the construction cost per one square meter is only 500 USD including finishes and equipment, which is competitively cheap even within the Vietnamese market.
Figure 32: FK - Environmental Strategies

Figure 33: FK - Continuous Section

All pictures' Sources for this case:
www.archdaily.com
Architectural Senses:

I provide a table in which my understanding of the research material and precedents are helping me to define design trajectory. Similar to human, Architecture has five senses or channels that through them stimulate feelings in us. These five senses are: Movement and paths, space and scale, geometry, light and shadow, and materiality.

**Table 1: Human Qualities & Architecture Senses**

<table>
<thead>
<tr>
<th>Early Childhood Learning</th>
<th>Movement</th>
<th>Space &amp; Scale</th>
<th>Geometry</th>
<th>Light &amp; Shadow</th>
<th>Materiality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sight</td>
<td>Some patterns evoke the sense of movement such as The Golden ratio</td>
<td>Visual and physical contact with space can be used to evoke various feelings.</td>
<td>-Natural forms found in nature</td>
<td>Daylight</td>
<td>Kids’ consciousness is very keen, they travel to the worlds of the objects that are watching.</td>
</tr>
<tr>
<td>Haptic</td>
<td>Haptic materials as a strategy for way finding within a building.</td>
<td>Sharp/angled shapes vs. smooth/soft curves impact on how a kid feel.</td>
<td>Cold space or warm space how certain materials make us feel a specific way</td>
<td>Kids’ consciousness is very keen, they travel to the worlds of the objects that are watching or touching. Learning through touch!</td>
<td></td>
</tr>
<tr>
<td>Hearing</td>
<td>Sound and surfaces influence how users navigate the space. Users tend to navigate a space faster in highly reflected sound spaces as opposed to spaces that absorb sound.</td>
<td>Large spaces which sound echoes evokes feelings of grandeur/inspired.</td>
<td>Transference of sound is impacted by geometry. Hard and soft spaces have different functions.</td>
<td>Direct relationship between materiality and sound transference. Depends on physical quality of materials.</td>
<td></td>
</tr>
</tbody>
</table>
Human Senses & Perception

The visual information gathered from a space directly influences our psychology within a space. The Geometry of objects in a space, Source of Light, Arrangement of Objects within a space, Curved/ Straight Lines have different implications on spatial perception.

This is due to the fact that the human heart syncs with the sounds of its surroundings. A specific frequency can make us deeply relaxed or moderately relaxed. In high frequencies we are invigorated. Thus by controlling the sounds within the environment we can control how a person may feel in a space.

Figure 34: Human Senses and Perception
Source: Author

Sight

Color
- Cool Colors: Calm & Relaxing
- Neutral: Passive Colors
- Warm Colors: Invigorate & Energize
- Bright/Calm: Saturated & Dark - Energize

Pattern & Texture
- Smaller & Static Pat.: Comfort us
- Larger & Dynamic Pat.: Energize us
- Shiny Textures: Energize us
- Matte Textures: Relax us

Form & Line
- Rectilinear Forms: feeling of action & efficiency
- Curved Forms: relaxed feelings while tend to have happy connection
- V-shaped Lines: draw our attention fast as they indicate threat or anger

Visual quality
- Cluttered & Disordered: make us feel tense
- Ordered but moderately Complex: desirable as it peaks our interest
- Too Ordered space: is boring
- Direct Light & Behavior: take risks, Relaxed, Improved problem solving, improves collaboration

Figure 35: Human Senses: Sight
Source: Author
Figure 36: Senses of Architecture
Source: Author

Figure 37: 21st Century Learning Goals
Source: http://www.p21.org

Figure 38: Creativity
Source: Author
Biophilic Design for Schools

Figure 39: GLUMAC SHANGHAI OFFICE

Biometric forms and patterns that established a visual connection with nature. Also, dynamic and defuse light for spaces, provide a smooth vision.

Figure 40: Learning Courtyard at Hazel Wolf K-8, Seattle WA - NAC Architecture
Bringing the nature inside the building, it could be open to air or enclosed space, with operational nana walls that give the opportunity to expand the space as well.

Biometric forms and patterns that established a visual connection with nature. Also, dynamic and defuse light for spaces, with the material connection provide a smooth vision.
The Montessori Schools

Montessori School Design

Site: All Montessorian wished to have the school designed as a village, with a variety of communal spaces, such as libraries, gardens, cafes, and amphitheaters, preferably touch a natural environment.

![Montessori's Site Design](image)

Figure 43: Montessori's Site Design

Building: For the building, a simple, uncluttered aesthetic guides the design, which features natural light and warm materials, bringing nature to the inside of the building, for instance providing natural views by windows or establishing interior courtyards inside the building, and the common use spaces for communal learning and reflection.

![Montessori's Building Design](image)

Figure 44: Montessori's Building Design
**Classroom:** All spaces accommodate free movement, small groups, low-height windows, which mixing up what are physical features vs. what kinds of activities they encourage independent investigation and learning both inside and out.

*Figure 45: Montessori's Classroom Design*

**Amherst Montessori**

*Figure 46: Amherst Montessori School*

There is Need of an easy access to the outside from each learning space, and also the problem with the entrance which is opening to the wall, and staff wished to have a better and welcoming lobby for students and their parents.
Marl School - Hans Scharoun -1971

This school is a city with separate houses and linking streets. Scharoun believed that the design would help the child to understand what it meant to belong to a small group relative to a large one and to move between the two. Turning circulation spaces into meeting places and break hall. An assembly hall or theater as a social center of the school. The purpose behind the separated spaces was to develop in pupils a high degree of territorial identity.
Figure 50: Montessori- Volksschule Darmstadt Hans Scharoun 1951
The easy access to the outside from each learning space with the Break-out spaces as the in-between spaces, are the strong features in the design of this school.

Figure 51: Montessori-Diagram of access way and intermediate spaces
CHAPTER 4

Design Process

Project Site

Fort River Elementary School is located at 70 South East Street in Amherst, MA. Its location is shown as a red target as seen in Figure # (Location Map). Amherst, MA, is located in the Pioneer Valley, roughly 18 miles from Greenfield, 23 miles from Springfield, and 87 miles from Boston. In 2010 the Town of Amherst had a population of 37,819 spread over 27.7 square miles. The white roads represent the main roads in downtown Amherst. The highlighted areas represents the Downtown, University of Massachusetts, and the Wildwood Elementary School. Since Amherst, MA is a college town, the downtown is filled with numerous stores, restaurants, bars, as well as the typical downtown amenities. Due to the size of Amherst there are currently four elementary schools, all ranging from kindergarten through sixth grade. There is also a middle school and a high school. These schools are spaced throughout the town of Amherst.

29 http://www.arps.org/welcome
The entire Fort River School complex is highlighted, showing the relationship of the school in relation to the community, downtown, UMASS, and the Wildwood Elementary School. East Street is the only vehicular access to the site which is going through a looped driveway that provides two separate access points. Either mode of transportation arrives via the same entry and exit pathways. There is also pedestrian access from the northeast corner of the school building leading further northeast out to Main Street. The vehicular pathways are one directional with the buses taking the primary closest route to the building and visitors parking on the exterior ring. There are two primary parking areas on site.

The lot to the west of the school building provides approximately 96 spaces for visitor and staff parking – this lot also accommodates all of the buses in a dedicated lane along the west face of the building. The lot to the south of the school building accommodates approximately 58 spaces for the staff – this lot also accommodates the pickup/drop-off area designated for parents in the morning and the afternoon. The Fort River site is presently zoned RVC (Residential – Village Center). In this zone, educational
facilities are allowed by use and the current school building is an approved entity. The zoning setbacks and limitations are as follows:

![Diagram of FORT RIVER SITE – ZONING](image)

- Minimum Frontage – 120 feet
- Front Yard Setback – 15 feet
- Side Yard Setback – 15 feet
- Rear Yard Setback – 15 feet
- Maximum Building Coverage – 25%
- Maximum Lot Coverage – 40%
- Maximum Floors – 3
- Maximum Height – 35 feet
- Minimum Lot Area – 15,000 square feet

Also, approximately 100 feet to the east of the existing school building, on the Fort River site is a FPC zone. This is designated a Flood Prone Conservation zone and has some additional restrictions and considerations. Building in this zone requires special permitting and carries more restrictive setbacks and limitations, includes:
Figure 54: Diagram of FORT RIVER SITE – FLOOD PLAIN-HYDROLOGY

- Minimum Frontage – 200 feet
- Front Yard Setback – 40 feet
- Side Yard Setback – 20 feet
- Rear Yard Setback – 20 feet
- Maximum Building Coverage – 10%
- Maximum Lot Coverage – 15%
- Maximum Floors – 1
- Maximum Height – 20 feet
- Minimum Lot Area – 80,000 square feet

The Fort River site is relatively flat, however, there are wetlands located on the Fort River School property as well as a substantial area that is zoned FPC (Flood Prone Conservation). The 100 year flood plain extends from the Fort River across the south side of the building, actually touching the southeast corner of the existing parking lot. The FPC, the flood plain restrictions and the wetlands setbacks required in this area will greatly limit the buildable area on the site.
Emergency vehicle access is achieved through the main entry to the site along South East Street. Wetland constraints will likely limit any other potential vehicular access to the site. It is located in a more residential area but still maintains strong connections to Downtown.

Figure 55: Fort River Elementary Aerial

The exterior circulation can be seen in this figure Fort River Elementary Aerial. Safety and security requirements on the existing Fort River site involve good sightlines to the vehicular ingress/egress points and clear areas around the entire perimeter of the building. The low plantings around the building help to minimize the areas of concealment and maximize the safety lighting around the perimeter and at exterior door locations.

Some of the exterior amenities include basketball courts, playgrounds and sports fields. These however mesh into one another creating a sense of a large green lawn.
There are two full-size and 4 half-size paved basketball courts adjacent to the north end of the building (near the Gym). There are two playscapes – one is located at the southeast corner of the building and one is located at the northeast corner of the building. There is also an open playfield to the east of the building that is used for recess and for limited gym classes. There are also several softball fields (one is illuminated) and a small walking track.

The main entryway has clear hierarchy over the rest of the building. There is a large crosswalk and American flag directing people inwards.

The entry is pushed inward creating a built in overhang showing the building’s introverted personality. The entry doors offer some guidance for what visitors should do upon arrival in many different languages that are spoken at Fort River. This is where the clarity stops, once inside there are no clear direction as to where the office is in order to sign in. The office was finally found by walking straight forward.

Figure 56: Hallway- Fort River School
The dark colored doors with small vision panels make the school feel dark and unwelcoming, a stark contrast to the faculty and staff. The office door is highlighted with a red circle to show that it is difficult to find. Not only was the office door difficult to find,
there were doors leading into classrooms directly off of the main hallway potentially creating a security hazard. In the main vestibule there are plenty of student art displays creating a vibe that this school is focused on the children’s different personalities and the diversity of the population. The transitional hallways are still filled with colorful artwork that helps generate a sense of school pride and ownership.

The gymnasium plays an important role in the community. Not only is it the location for physical education, it is the location of numerous youth games and after school activities. Fort River's gymnasium is smaller than a regulation sized court and can be seen in Figure 60: Fort River Elementary Gymnasium. It contains numerous basketball hoops however, they are fixed and the height cannot be adjusted. There is no room for spectators if games are held here. There are doors leading directly outside to the playground and to the outside basketball courts that allow easy integration with the outdoors.

![Figure 60: Fort River Elementary Gymnasium](image)

The library is the heart of many elementary schools both socially and spatially. Fort River's library is located directly in the heart of the classroom area that can be seen in
Figure 61: Fort River Elementary School Library. The library flows into the hallways, some of the bookshelf partitions are seen in the lower row in Figure 28: Fort River Elementary Library.

Figure 61: Fort River Elementary School Library

Figure 62: Fort River Elementary School Library- walls

Figure 63: Small courtyards
Site Analysis

Figure 64: For River School - Site Analysis

Program Analysis

I proposed reorganizing the existing program based on MSBA standard programs for elementary schools. For the K-6 (420+): Increasing the number of classrooms to 18 (3 for each grade). Keeping the kindergarten in the same place as it is now. Creating the break-out spaces in-between the classrooms that are conducive to learning. Dedicating an extra café/rest space near the Gym to provide a smooth and comfortable place which has views to the interior courtyard in addition it is separated with NANA walls that are easy to open and add the space to the interior courtyard for community gatherings. Adding one story above the main courtyard and dedicating it for music & art classes. By dedicating the current library space for the interior courtyard, because of the conditions, no wall around, and structurally it is easy to remove- space.
The open plan classroom has roots in the Montessori Method: “that enable the children to work independently in the same room as others at the same time”, very few classrooms were used to their full potential over a long period of time.

Some teachers were hesitant to expand beyond their territory, thus created their own boundaries using bookshelves and blackboards.

Therefore without these boundaries, it produced anxiety and chaos with the various simultaneous activities and noise levels. This is highly disadvantageous to English as Second Language learners or with children with learning disabilities such as ADD.
### Table 2: Program Analysis

<table>
<thead>
<tr>
<th>ROOM TYPE</th>
<th>EXISTING CONDITIONS</th>
<th>MSBA</th>
<th>MY PROPOSED SPACES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CORE ACADEMIC SPACES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kindergarten - 1st Grade</td>
<td>1,909</td>
<td>3</td>
<td>3,350</td>
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<tr>
<td>Kindergarten - 1st Grade - Grade 1-6</td>
<td>2,920</td>
<td>5</td>
<td>5,630</td>
</tr>
<tr>
<td>Computer Room</td>
<td>585</td>
<td>1</td>
<td>585</td>
</tr>
<tr>
<td><strong>SPECIAL EDUCATION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-Contained SPED</td>
<td>3,758</td>
<td>1</td>
<td>3,758</td>
</tr>
<tr>
<td>Self-Contained SPED</td>
<td>3,758</td>
<td>1</td>
<td>3,758</td>
</tr>
<tr>
<td>Self-Contained SPED</td>
<td>4,312</td>
<td>4</td>
<td>5,503</td>
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<tr>
<td>Resource Room</td>
<td>1,450</td>
<td>6</td>
<td>1,450</td>
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<tr>
<td>ELL Room</td>
<td>300</td>
<td>2</td>
<td>300</td>
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<tr>
<td><strong>ART &amp; MUSIC</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Art Classroom - 25 seats</td>
<td>1,639</td>
<td>2</td>
<td>2,079</td>
</tr>
<tr>
<td>Art Classroom - 40 seats</td>
<td>1,639</td>
<td>1</td>
<td>1,639</td>
</tr>
<tr>
<td>Music Classroom - Large Group - 25-50 seats</td>
<td>1,227</td>
<td>1</td>
<td>1,227</td>
</tr>
<tr>
<td>Music Practice / Ensemble</td>
<td>220</td>
<td>2</td>
<td>440</td>
</tr>
<tr>
<td><strong>HEALTH &amp; PHYSICAL EDUCATION</strong></td>
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<td></td>
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<tr>
<td>Gymnasium</td>
<td>3,637</td>
<td>1</td>
<td>3,637</td>
</tr>
<tr>
<td>Gymnasium</td>
<td>4,600</td>
<td>1</td>
<td>4,600</td>
</tr>
<tr>
<td><strong>Food Service</strong></td>
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<td></td>
<td></td>
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<tr>
<td>Cafeteria / Dining</td>
<td>1,180</td>
<td>4</td>
<td>4,720</td>
</tr>
<tr>
<td><strong>CUSTODIAL &amp; MAINTENANCE</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Custodian's Office</td>
<td>330</td>
<td>1</td>
<td>330</td>
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<tr>
<td>Custodian's Workshop</td>
<td>206</td>
<td>1</td>
<td>206</td>
</tr>
<tr>
<td>Custodian's Storage</td>
<td>118</td>
<td>6</td>
<td>706</td>
</tr>
<tr>
<td>Recycled Hanging Room / Thrift</td>
<td>843</td>
<td>1</td>
<td>843</td>
</tr>
<tr>
<td>Student Storage - Boys</td>
<td>706</td>
<td>5</td>
<td>706</td>
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<tr>
<td>Student Storage- Girls</td>
<td>142</td>
<td>4</td>
<td>568</td>
</tr>
<tr>
<td>Transgender Toilet / Students</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transgender Toilet / Staff</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staff Kitchen</td>
<td>118</td>
<td>1</td>
<td>118</td>
</tr>
<tr>
<td><strong>OTHER</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solar Room</td>
<td>3,377</td>
<td>1,200</td>
<td></td>
</tr>
<tr>
<td>Network / Telecom Room</td>
<td>611</td>
<td>1</td>
<td>611</td>
</tr>
<tr>
<td><strong>TOTAL BUILDING NET FLOOR AREA (NFA)</strong></td>
<td></td>
<td></td>
<td>61,999</td>
</tr>
</tbody>
</table>

62
Architectural Criteria in School Designing

Based on the town’s meetings Fort River Elementary School, is willing to follow the MSBA criteria for reprogramming the school. “The Massachusetts School Building Authority ("MSBA") is a quasi-independent government authority created to reform the process of funding capital improvement projects in the Commonwealth’s public schools. The MSBA strives to work with local communities to create affordable, sustainable, and energy efficient schools across Massachusetts.”

In February and July 2008 an investigation for post-occupancy evaluation was done. The study had many purposes, among which was all attempts to compare the impact of design on the performance of the school in terms of factors such as its flexibility, size, furniture settings, lighting, acoustics, air quality and satisfaction level. The study suggested that three design principles emerged that support application in practice: two of them are as fallowed: the role of naturalness, and appropriate levels of stimulation. These two themes become basic principles to inform the school in design. They were informed by a variety of design parameters, which is in connection of practical options.

- Naturalness – humans have basic requirements derived from our basic needs for light, air and safety.
- Individualization – Each brain is uniquely organized. And all perceive the world in different ways and act accordingly, offering a level of variety, flexibility and one choice could be the best opportunity for success.

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30 http://www.massschoolbuildings.org
• Appropriate level of stimulation – learning involves both focused attention and peripheral perception. While space should not distract from the ability to focus, it can provide sensory stimulation that influences the experience and thus learning. (Taylor 2005).31

Review the Principles to Increase the Architectural Quality of Schools

In addition to those three criteria, I glanced at the other architectural principles as followed:

**Axis:** The direction and position of the learning spaces should be chosen in a way that sunlight and ventilation for spaces, such as classes in all seasons, are performed efficiently, avoid construction of the building in the direction of severe and disturbing winds.

**Repetition:** "Frequent repetition may result in a monotony or a non-hypnotic crash, but on the other hand, it can also inspire a sense of grandeur and inevitability," Charles Jencks says.32

**Symmetry:** The symmetry word is derived from the Greek root of symmetria, whose main meaning is luminous, harmonious and well-formed. In other words, the meaning of the word, as in the present, is not limited to symmetry. In every place of nature that governs equilibrium, there is certainly a work of symmetry. For example, in humans

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and animals, symmetry is limited to external form, while internal organs are non-symmetric.

Asymmetry in humans creates a sense of tension, and humans are inherently tense. An architect can create visual balance without using symmetry, by exploiting balanced communications between inequalities.

**Hierarchy:** By placing several elements together, an order is created in the relations between them. In the architecture, the existence of the same elements is quite rare: because even if they are the same in form and size, they will not be the same in terms of their relationship with other spaces.

**Rhythm:** Frank Lloyd Wright says: "We tend to symmetry and beat, because both are manifestations of life, and camouflage the beat of the beat with elegance, and it is perfect, without fail, but you should never, anywhere, use the symmetry or the beat (rhythm) only because of their own self." 33

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33 Frank Lloyd Wright, Speech in London, 1939, Quoted by "Human Architecture" Berlin, 1969, p. 199
Review the Physical Influences in the design of Schools

**Form:** Simple forms are more balanced than other forms. Regardless of the material, some of the curved shapes are "soft", and some are "hard" to the corner and the broken. Curvature forms and surfaces create momentum, while relaxing. Using the irregular forms makes the child more imaginative and more explicit in his/her memories.

**Light:** both natural light and artificial light in the classroom are desirable. The building must be elongated along an East-West axis. Although fort river school is not in this appealing direction, but, the architect can provide other solutions. Spaces, such as the library and art rooms, where only diffuse daylight is desirable, can be located towards the North while the main learning and teaching activity areas can be to the South.

**Temperature:** maintaining the balance of heat gain and loss at a comfortable level. Thermal comfort in a building is achieved by maintaining temperature, humidity, air movement and human activity conditions within a certain range. By careful orientation of the building, layout and windows we are able to control temperature.

**Sound:** appropriate conditions for listening to wanted sound and not unwanted sound (noise). Comfortable and clear auditory perception, along with freedom from noise not only improves communication but also promotes working and learning efficiency.

**Air quality:** removing humidity, artificial contaminants, odors and bacteria etc.
Renovation or Building New?

Why Renovation instead of building new? This age-old question goes far beyond renovation vs. new construction because it involves multiple issues and community considerations. However, the answer is very straightforward, we as architects must provide the best place for students to learn.

The goal is to provide appropriate and attractive spaces flexible enough to meet the needs of new initiatives, extend the life of the building for more than 30 years, meet all health and safety codes, and comply with federal and local mandates. After all, the building is approximately 50 years old, and it was constructed before energy conservation, and the advent of personal computers.

The answer depends on the cost estimate of building a new school or renovating. It is clearly smarter and more cost-effective to renovate rather than build new. Based on the same experience of Crocker farm school, the renovation totally changed the quality of education there.

The debates about school renovations may be triggered by program changes, failing building systems such as roofs or HVAC, or by health and safety shortages. what is important is to decide if renovating an existing school building will enhance the productivity of the building and positively impact the school community or not. Multiple issues should be considered when renovating an existing school facility. Consideration for funding, traffic, security, life safety, usage of space, technology, and current facility features with value are all important. I strive to compact my understandings about renovation decision making. The following content explains each of these factors;
Renovation Factors to consider are:

1. **Structural Considerations:** Can the condition of the existing building, and its systems, be improved to offer additional years of service?

2. **Role of a Building in the Community:** What are the other functions of the building? Does it serve more than an educational function within the community? We shall know if the building can serve more than one function, we can consider sharing spaces. Schools can save on renovation (and operating) costs by sharing spaces with libraries, theaters, athletic fields, swimming pools, and parks with municipal entities.

3. **Occupant Safety:** What kind of awareness has been gained from site assessments to understand potential threats and risks of the school building? Renovations are an opportunity to provide more secure learning environments.

4. **Educational attributes:** what is the fit between the curriculum and current and proposed settings for the building?

5. **School site:** The existing site already meets the needs of the community, or additional space or extra ground (for instance a scientific lab)?

6. **Planning:** How is this reconstruction appropriate in the macro scheme of the school district? Are there any urban or regional planning issues affecting the decision to rebuild (for example, the development of a new production plant or road)?

7. **Funding:** Who will assist? Will the state cover some of the costs, or will the federal forms be responsible to fund the total renovation cost?
8. **Demographic trend:** Do the enrollments grow or decrease in the school over time?

9. **Educational Facilities Standards:** What the government or the region advises on specific standards for modernization?

10. **Scheduling:** Is it possible to upgrade, when the students are not in school, or during the renovation, there is a fluctuating environment?

11. **Cultural Importance:** Is the Building Historically or Culturally Significant?

As a matter of fact, thinking about the following topics will help the school community to make their decision for renovating or rebuilding:

1. **Financial Benefits:**
   - Renovating Takes Less Time
   - Renovation Costs Less
   - Property Values May Increase with Renovation
   - Renovation Reuses High Quality Materials

2. **Social Benefits**
   - Emotional Ties: Research has found community members become emotionally attached to their schools (Earthman & Lemasters, 2004)
   - History Comes Alive: In addition to learning about architecture and civic responsibilities, existing school buildings also help students

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connect with their own community’s history. (Jimerson, 2006)\textsuperscript{35}. By renovating schools for future generations, we are creating a conversation between the past, present, and future.

- Neighborhood Stabilization: According to Beaumont & Pianca (2002)\textsuperscript{36} when a local school is abandoned, or demolished, a stabilizing anchor is gone, impacting both property values, public and private investment in the community, and the spirit of the local residents.

3. Environmental Benefits

- Less energy: When a building and its supporting infrastructure already exist, less energy is expended. less need for harvesting and creating new materials (Frey et al., 2011)\textsuperscript{37}

- Air quality: to retrofit HVAC systems and eliminate mold and other contaminants and reduce greenhouse gas emissions

- Waste reduction: less construction, less waste sent to the landfill

- Natural light: "Daylighting", as it is now called, is sustainable, energy-efficient, and increases attentiveness, which may improve test scores (Baumgartle, 2013)\textsuperscript{38}

Fort River school building, built in 1973. The light issues such as ventilation and natural light in the current age of environmental awareness, I decided to renovate and


focus the planning process on green design or Biophilic Design that I am going to explain further in this paper.

The building also presented the ideal opportunity to recast current space. For example, the original gym became bigger with windows and a curtain wall on the north side, and the current computer lab became the maker space while, the current library became an interior courtyard to provide natural light and bringing nature inside to have green features in winter as well. The solution to host a library and computer lab is a new space called the media center.

There is one more major reason to renovate. Although, there is enough property available to build a new facility, however, the school had always been a point of pride for the community, I assume that preserving one of the middle schools is worthy for the Amherst community.

**Design Process**

This 68000 sf school, for 480 pupils K - 6 grade, is conceived for renovation. The design’s roof for the mezzanine tilts just like the dipping roof of the old building to have the same language as the old fort River building. It also lets in light from above while allowing the classroom spaces below to be lightened. The scheme creates a fragmented reading of the building which keeps the same scale of the building and makes it more appropriate to the scale of the child. I strive to establish various rhythmical moments and spaces in the school. For example a large window to a beautiful view to bring the seasonal rhythms into the child’s attention. Does this belong under child development or under a chapter of design process?
Figure 66: Diagrams of FortRiver Existing floor plan - Problematic Spaces

**Interior Quad**
- No Natural light and Views for interior quad
- No access to the outside from classrooms
- No access to the restrooms for interior quad
- They have to use the other classes to use bathroom
Problematic Spaces

Hallway
Lack of break off spaces in hallways
Lack of Rhythms
Monotonic spaces with no Bold Spacial Index

Administration/Entrance
General Office is far from the main entrance
No Pleseant & welcoming Lobby

Figure 67: Diagrams of Fort River Hallways - Main Office & Entrance
Figure 68: Diagrams of Fort River Existing SPED Spaces
Figure 69: Diagrams of Fort River Existing Core Spaces - Hard to remove Spaces
This project is seeking to heighten the students’ sense of relationship with the site. Daylight and views to the site knit the interior space to the exterior. The school opens to the south to take in solar gain, while the windows of the additional part on the south and west elevations are used to bring in light entering the building.

Design Process

Figure 70: Sketches of Fort River design process

The palette of natural and regional materials was selected primarily for its durability and sustainability. Interior finishes are free of volatile compounds to create a learning environment with the best possible air quality. Old small courtyards which are now covered spaces are extensions of the interior learning spaces. The entry area hosts quiet activities that calm the child upon arrival, acting as a space of mediation between the
wings of the building. The existing facility have enough square footage to match the district’s middle school standards.

The proposal site plan has a change in parents loop and parking lot. Removing the parking lot from the west side to the south side of the site will provide enough space to create courtyards in front of the west wings of the school, that provides better view for the classrooms.

Figure 71: Diagrams of Proposed Site Plan
That was the major change in the site that needs to change the playground and play field.

Figure 72: Diagrams of New Fort River School
Figure 73: Diagrams of New Fort River School - Ground Flr Plan
Figure 74: Diagrams of New Fort River School - Mezzanine Plan
Figure 75: Diagrams of New Fort River School - Elevations

Figure 76: Diagrams of New Fort River School – Section
Key Elements:

1. **Reorganizing the program:** to provide break-off spaces

2. **Interior main Courtyard:** Addition of the courtyard instead of current library

3. **Small skylights:** Converting the enclosed courtyards to the skylights

4. **Mezzanine:** Addition of the second floor to provide new movement path

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**Figure 77:** Axonometric view of New Fort River School - Key Design Elements
APPENDIX A

PRESENTATION BOARDS
Figure 78: Final Presentation Board 1
Renovation of Fort River Elementary School

Figure 79: Final Presentation Board 2
Renovation of Fort River Elementary School

Design Process

Addition Slyly

Recognizing the program

New Main Entrance & Circulation of Flow

Site Plan Design

Figure 80: Final Presentation Board 3
Figure 81: Final Presentation Board 4
Figure 82: Final Presentation Board 5
Figure 83: Final Presentation Board 6
MEMORANDUM – Not Human Subject Research Determination

Date: December 8, 2017
To: Reyhane Bassamtabar, Architecture

Project Title: The Architectural Observation of Three Elementary Schools in Amherst, MA

IRB Number: 17-212

The Human Research Protection Office (HRPO) has evaluated the above named project and has made
the following determination based on the information provided to our office:

☑ The proposed project does not involve research that obtains information about living individuals.

☑ The proposed project does not involve intervention or interaction with individuals OR does not use
identifiable private information.

☐ The proposed project does not meet the definition of human subject research under federal
regulations (45 CFR 46).

Submission of an IRB application to University of Massachusetts Amherst is not required.

Note: This determination applies only to the activities described in the submission. If there are
changes to the activities described in this submission, please submit a new determination form
to the HRPO.

Please do not hesitate to call us at 413-545-3428 or email humansubjects@ora.umass.edu if you have
any questions.

Iris L. Jenkins, Assistant Director
Human Research Protection Office
REFERENCES


“Biophilic Design for Schools - Google Search.” Accessed September 4, 2017. https://www.google.com/search?q=biophilic+design+for+schoo&safe=active&biw=1920&bih=950&tbm=isch&sa=1&q=Biophilic+design+for+schoo&ou=Biophilic+design+for+schoo&gs_l=psy-ab.3..2292514.2307271.0.2307519.28.28.0.0.0.0.280.3203.10j16j2.28.0....0...1.1.64.psy-ab...0.18.2304...0j0i67k1j0i24k1.eykQzHP8O8#imgrc=OSSQTAW8y9rnM:


