DESIGNING FOR THE SENSES

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By
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A DESIGN THESIS
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ABSTRACT

The typology for this project will be a school for the blind. The blind and visually handicapped have the right to be able to navigate effortlessly through the built environment. It is our job as designers to ensure the health, safety, and welfare of everyone who uses our buildings; therefore, in designing we must consider everyone’s needs. A design that considers all the senses through which we gather information will undoubtedly be more holistic and complete than one that only considers sight.

The narrative examines the importance of this project and discusses why we as designers need to focus on the problem. The client for this project will be the state of Minnesota and the primary users will be blind and visually handicapped students as well as teachers, administrators and staff. The major project elements of this approximately 40,000sqft building will include: classrooms, dorms, offices, sensory room, a gymnasium, sensory garden, and a kitchen. This project will be located in Anoka, Minnesota, north of Bunker Lake Blvd and just east of the Rum River. It will emphasize designing for all the senses and research for the project will be done in the areas of: project typology, historical context, site analysis, and programmatic requirements. Lastly, the design process will be documented and preserved in a thesis book.
PROBLEM STATEMENT

How can the built environment be made more accessible and hospitable to the blind?
STATMENT OF INTENT

Typology:
School for the blind

Claim:
The blind and visually handicapped have the right to be able to navigate effortlessly through the built environment.

Premises:
The blind compensate for their lack of sight by relying more heavily on the other senses.

Navigation through and the action of experiencing a place depends on a person’s ability to collect information through his or her senses.

We as designers often focus most of our time and energy on the visual aspects of a design.

Theoretical Premise/Unifying Idea:
This thesis will examine the different ways in which the blind and visually handicapped navigate through and experience the built environment. Understanding of these interactions will be used to develope architecture that enhances the specific characteristics which help the blind and visually handicapped.

Project Justification
It is our job as designers to ensure the health, safety, and welfare of everyone who uses our buildings; therefore, in designing we must consider everyone’s needs. A design that considers all the senses through which we gather information will undoubtedly be more holistic and complete than one that only considers sight.
All people have the right to be able to navigate effortlessly through the built environment. It is our job as designers to ensure the health, safety, and welfare of everyone who uses our buildings; therefore, in designing we must consider everyone’s needs. A design that considers all the senses through which we gather information will undoubtedly be more holistic and complete than one that only considers sight.

It is estimated that over 1.3 million Americans are legally blind and another 21.2 million Americans have some degree of vision impairment even when using corrective lenses. Despite the fact that this is a relatively small section of the population, we as designers are still responsible for the health, safety, and welfare of these people. The Americans with Disabilities Act (ADA) has provided minimum standards for designers to adhere to in order for disabled people to successfully and safely navigate through the built environment, but these are bare minimums and can be greatly improved upon.

The ADA guidelines help the blind navigate though the built environment but they do not help them to experience it. Where most people use signs, maps, and other visual cues to move through the world, the blind use touch, auditory, and even olfactory cues. It is these same senses that can be used to help the blind experience, and not just move through, the world around them.

Throughout history architects and designers have traditionally focused most of their attention on the visual aspects of projects. While this methodology has produced beautiful buildings it rarely created buildings that could be experienced using other senses, which has alienated many visually handicapped people and robbed them of the ability to experience the built environment.
In this project I will explore different methods and techniques that can be used to create a design that appeals to all the senses, thus enabling the blind to better experience the world around them. It comes as no surprise that architecture is mainly a visually based profession, but when every sense is considered it will undoubtedly make for a superior design and a better experience for all the users.
**USER/CLIENT DESCRIPTION**

**The Client/Owner:**
The state of Minnesota will be the owner and client for the project.

**Users:**
Students-The facility will provide services to blind and visually handicapped students ranging in age from newborns to 21. Roughly 80 students will live on campus and attend school full-time nine months out of the year, while others will come for shorter periods of time to attend special classes and seminars.

Teachers-There will be approximately 20 specially trained teachers working during the academic school year. In the summer roughly half the teachers will continue working full-time teaching summer programs and seminars. Teachers will use the facility between the hours of 7:00 a.m. and 4:00 p.m.

Administrators-Administrators will oversee the operation and everyday proceedings of the school. They will be on campus between the hours of 7:00 am-4:00 pm.

Support staff-A number of support staff will be needed to both help the school run as smoothly and efficiently as possible and maintain the buildings and grounds. These positions will include administrative assistants, custodians, groundskeepers, cooks, etc. Working hours for the support staff will vary depending on the specific job.
MAJOR PROJECT ELEMENTS

School:
Classrooms—used to conduct traditional K-12 education classes

Breakout spaces—used for one on one instruction between students and teachers

Gymnasium—for physical education classes

Braille Library—to promote literacy in Braille and provide sources for reports

Cafeteria—for the students living on campus

Offices—for the administration

Outdoor play area—for recreation

Resident housing:
Rooms—for students living on campus

Kitchen—for use by of students

Common area—for group gatherings and socialization
SITE INFORMATION

Region:
Anoka is located in the midwestern United States in the eastern part of Minnesota.

City:
Anoka is located where the Rum River meets the Mississippi River. According to the city of Anoka website, the town gets its name from a combination of two Native American words; A-NO-KA-TAN-HAN which means on both sides of the river and ON-O-KAY which means working waters. While Father Lewis Hennepin first explored the site in 1680 it was not settled until 1844. As stated on citydata.com the town now has a population of 17,289 and encompasses 6.5 square miles.

Site:
The site is located directly north of Bunker Lake Blvd and just east of the Rum River. The topography of the site is relatively flat and gradually slopes down to meet the river. Vegetation on the site consists mostly of natural grasses with a line of trees in the center.

While the site is located in an urban environment, which can be utilized to teach students how to navigate through and survive in a city, it also displays elements of a more natural setting. To the north of the site is a large wooded area with many walking paths and a city park that runs along the river. These areas can provide unique learning opportunities in a natural setting that many blind and visually handicapped people may otherwise never experience.

Directly south of the site, across Bunker Lake Blvd, is Anoka High School. Locating the school close to the city high School will allow students to experience the best of both worlds. They are able to receive their general education from a knowledgeable staff specifically trained to work with the blind and, if they wish, they may take more specialized classes, or participate in sporting events and other extra-curricular activities at the high school.
Bunker Lake Blvd  
Walking path  
Beach on Rum River

Panoramic looking northwest

Panoramic taken by the tree line looking northeast

Site map from mapofus.org
This thesis will study different methods and techniques designers can employ to help the blind navigate through, interact with, and experience built environments. Emphasis will be placed on designing for all the senses to create a space that all people are able to experience and enjoy regardless of their disabilities.
Research will be conducted in the areas of the unifying idea, project typology, historical context, site analysis, and programmatic requirements using the mixed method approach. Qualitative and quantitative data will be collected employing the concurrent transformative strategy. This strategy will be directed by the unifying idea. The design process will be documented utilizing sketches, photography, digital drawings, and physical models. Documentation will be collected on a biweekly basis. The final product will be organized into a thesis book and placed in the architectural library so that future scholars may refer to it.
PREVIOUS STUDIO EXPERIENCE

Second Year Studio:
First Semester 2006-Darryl Booker
   Tea House-Fargo, ND
   Boat house-Minneapolis, MN
   Dwelling for an ecologist CO
Second Semester 2007- Joan Vorderbruggen
   Montessori School-Moorhead, MN
   Dance School-Fargo, ND

Third Year Studio:
First Semester 2007-Steve Martens
   Inuit School-Canada
   Children’s Hospital-Moorhead, MN
Second Semester 2008-Ron Ramsey
   Student Housing-Fargo, ND
   Architecture Library-Chicago, IL

Fourth Year Studio:
First Semester 2008 - Don Faulkner
   Mixed-Use High-rise San Francisco, CA
Second Semester 2009 - Darryl Booker
   Slum redevelopment project-Santo Domingo
   Community Center-Santo Domingo
   School-Africa

Fifth Year Studio:
First Semester 2009-Mark Barnhouse
   Water Resource Experiment Station
SOUND

With the absence of sight sound can become an invaluable resource which the blind can use to gather information about the world around them. According to an article in *Current Science* magazine entitled “Blind People ‘See’ Sound” Franco Lepore, a psychologist at the University of Montreal, conducted an experiment in which he produced a sound and then asked both blind and sighted people to determine the direction of the sound’s origin. Blind people were consistently better at determining the exact origin of sound. Further research suggested that blind people were better able to locate the origin of a given sound because they used portions of their brain, which normally focus on visual cues, to enhance their ability to process auditory stimulation (“Blind People ‘See’ Sound” 2005). In terms of architecture, the ability to pinpoint the direction a sound is coming from can become a useful navigational tool. A simple unique stationary sound could immediately tell visitors what part of the building they are in or act as a destination point within the building. Likewise, but on a larger scale, an overall noise heard throughout the building, such as traffic from a nearby street, could be used to orient people within the building to the larger site beyond.

As Pallasmaa (2005) states in *The Eyes of the Skin* “Space is understood and appreciated through its echo as much as through its visual shape, but the acoustic percept usually remains as an unconscious background experience” (Pallasmaa, 50). An example of this would be experiencing a room, first unfurnished and empty of all things and then experiencing that same room filled with furniture. almost everyone understands that the unfurnished room has an echo which bounces off the hard surfaces and adds to the sense of emptiness that the person sees when they look at the room. Likewise we understand that a fully furnished room will sound softer because the noise is absorbed into
the contents of the room. Pallasmaa stated, “the acoustic percept usually remains as an unconscious background experience” but in the case of many blind people this may become the primary way in which they experience a space (Pallasmaa 49).

John Blackstone of the “Early Show” on CBS did a report on Ben Underwood, a remarkable young blind man who learned to experience the world around him through echo location, the same method that dolphins use. Ben developed cancer in his eyes at the age of two and had to have both of them surgically removed. He has since learned to, in effect, see with his ears. Ben continuously makes small clicking noises with his mouth which bounce off objects around him and return to his ears, helping him to develop a three-dimensional picture of his environment in his mind. Ben’s echo-locating abilities are so advanced that he is able to distinguish many different objects such as cars and trashcans. His unique ability allows him to do everything a sighted person can do. He rollerblades, rides a bike, participates in pillow fights and even plays video games.

While most blind people do not possess the ability to echo locate as Ben does, it is still a legitimate way of experiencing space and can be incorporated into an architectural design through the use of a sound-creating device, such as dripping water, which would provide an echo within a room and help visitors to better understand their environment.

TOUCH

For blind people the sense of touch can be used to gather information about specific objects around them or used as navigational cues. Simply stated it is another way in which blind people adapt and compensate for their lack of sight. As with sound, studies have suggested that blind people have a more acute sense of touch. Daniel
Goldreich, Ph.D. recently conducted a study in which participants, both blind and sighted, touched pieces of plastic with grooves of varying thicknesses cut out of them. A computer controlled device held the piece of plastic to a volunteer’s index finger for exactly one second after, which the volunteer was asked whether or not the piece of plastic had grooves in it. The blind participants were able to constantly recognize smaller groves then the sighted participants. This study proves that, in architecture, even small material or textural changes, such as a different flooring material or wall texture, which most sighted people might not feel, can be easily picked up by a blind person.

The South Dakota School for the Blind and Visually Impaired relies heavily on tactile signs and markers to help students move throughout the building. Each hallway in the building has a different texture assigned to it, and the texture marker for that hallway is located directly across from each doorway. Above the general textural marker is a more specific one which is unique to the room the doorway leads into. This hierarchical system is similar to the address system. When trying to find a specific house one first has to find the street it is on. After the street is found via street signs at the intersections one is able to read specific house numbers to find the house he or she is looking for. Students first find the generic tactile sign and then read the specific marker. Upon finding the room that they want they are taught to put their back to the tactual sign, walk perpendicularly away from it across the hall, and into the room.

Using a cane is also a form of touch. A visually impaired person’s cane acts as an extension of his or her arm. According to the National Federation of the Blind’s website, “Using a long white cane when you walk allows someone who is blind to locate steps, curbs, streets, driveways, doorways, bicycles, elevators, escalators, people, chairs, tables, desks, or any other object or place.” Canes come in all different sizes.
SMELL

Smell is an amazing and often underestimated sense. Human beings require only 80 particles of a substance to detect a specific odor, and we are capable of detecting over 10,000 different smells (Pallasmaa, 2005). According to “Orientation and Mobility Training” (www.tsbvi.edu) smells can be used to let the blind and visually impaired know where they are in a given environment. For example a garage, in general, smells different from a library or a restaurant. When one is in a kitchen he or she may smell the food that is being prepared, but if the meal is over he or she may smell the dishwashing soap. In spaces such as the kitchen, that produce different smells at different times on a consistent basis, the smells can serve not only as locational cues but as hints to the relative time of day. As with the other senses the sense of smell can be used as more than just a navigational tool, it can also be used as a way to experience the environment and architecture. Pallasmaa (2005) captures this idea best when he speaks of walking down a street in an old town:

“What a delight to move from one realm of odour to the next, through the narrow streets of an old town! The scent sphere of a candy store makes one think of innocence and curiosity of childhood; the dense smell of a shoemaker’s workshop makes one imagine horses, saddles, and harness straps and the excitement of riding; the fragrance of a bread shop projects images of health, sustenance and physical strength, whereas the perfume of a pastry shop makes one think of bourgeois felicity.” (Pallasmaa, 54)

Pallasmaa also states that “the nose makes the eyes remember”(54). A specific smell can make people remember things, places, or past events in their lives that they have not thought about in a long time. An odor correctly matched with the typology of a room or space could recall forgotten images in
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the minds of visually impaired people who lose their sight later in life and help them create a mental image of their surroundings.

SIGHT

Color

While it sounds odd that blind people could use sight as a way of experiencing and navigating through space, one must remember that there are different severities of blindness. Total blindness is the inability to distinguish light from dark, but many visually impaired people are not totally blind. This opens up the sense of sight as a possible useful navigational tool.

One of the easiest things to do when considering sight as a navigational tool is to use colors. There are three elements to a color, the first being hue. As stated on www.lighthouse.org, “Hue is the perceptual attribute associated with elementary color names.” When we see a particular color we recognize it by its hue, i.e. green, blue, orange, etc. When making color combinations for the visually impaired it is best to pair darker hues from the bottom half of the color wheel with lighter ones from the top half. It is also a good idea to avoid using lighter colors from the dark half of the color wheel with darker colors from the light half. The more the colors contrast the easier it will be for a visually impaired person to tell them apart (Effective Color Contrast 2009).

The second element of color is, which “lightness corresponds to how much light appears to be reflected from a colored surface in relation to nearby surfaces” (Effective Color Contrast 2009). It is relative and cannot be measured. When trying to increase the contrast between two different colors, lightness becomes the most important quality of color (Effective Color Contrast 2009).

The last element of color is saturation. According to Color Principles, “Saturation refers to the dominance of hue in the color (2000)” Pure hues are
considered to be completely saturated. A gradual desaturation of a hue is accomplished by running the pure hue through a grayscale from white to black. When it reaches black it is said to be completely desaturated (Effective Color Contrast 2009).

It should be noted that it is the relationships between colors and how they appear when they are placed next to one another that makes them easier or harder to differentiate. Also, colors that seem easily discernable to a sighted person may not be as easy to discern to a visually impaired person. Designers can help visually impaired people more easily distinguish different colors by creating combinations of colors that vary widely on all three attributes of color (Effective Color Contrast 2009).

Glare

Some visually impaired people’s eyes are not able to modulate light. When this happens, glare off of reflective surfaces such as snow or water may become a problem. There are special glasses that visually impaired people can wear to help cut down the glare. Blue blocker glasses eliminate some of the blue haze around bright objects and polarized sunglasses reduce the effects of glare on horizontal surfaces (Lighting for Low Vision 2003). While glare is often considered a bad thing it is nonetheless something that visually impaired people can see and do respond to. Under the right conditions and circumstances it may be able to be used as a way-finding tool as well as a means to experience a space. However, any design incorporating glare would need to be scrutinized very closely to ensure that it does not become an annoyance or a hazard to visually impaired individuals.

Seeing Eye Dogs

Some blind and visually impaired people choose to let guide dogs see for them. Seeing eye dogs undergo months of intensive training so that they may become an effective tool that blind
people use for navigation. The dogs are trained to recognize and react to curbs, stairs, streets, and many other obstacles that are found in everyday life. It should be noted that, while the dog acts as a pair of eyes for a blind person, the owner is always in charge. The dog will react to obstacles and the owner will tell it how to respond. For instance, a guide dog may sit when it reaches a curb and when the owner does not hear any traffic coming, he or she will tell the dog that it is okay to go. Unfortunately guide dogs can only help the blind navigate. They cannot help them experience.

Sensory Gardens

According to Melanie Radzicki McManus (2001) sensory gardens are gardens, either public or private, that appeal to all five senses. The gardens are most often targeted to people with various disabilities but they can be enjoyed by all. In cultivating a sensory garden one must consider the five senses and determine the best way to design the garden so that even those with dulled senses can enjoy it. When considering visual stimulation, it is best to pick large, brightly colored plants and place plants with highly contrasting hues next to each other. If a visually impaired person is going to see a color, it will most likely be yellow. Thus choosing plants with yellow hues can become highly effective (McMaus 2001).

For sound, many gardens incorporate falling water or wind chimes, but plants can also add sounds to the space. Many plants produce seed pods that rattle when shaken or move on a windy day. Likewise certain species of trees will rustle under even the slightest breeze (McMaus 2001).

Touch may be the easiest sense to design for in the garden. Different plants display a wide variety of textures. The bark of a tree feels very different than a plant with a fuzzy leaf or a flower.
petal. Not all textures belong in a sensory garden though; cacti, thorny plants, and grasses with razor sharp edges could be hazardous to visitors (McMaus 2001).

Smells emitted from the garden can be of great interest to visitors who are both blind and deaf. It is easy to find plants with a wide variety of smells to add to the garden. Lastly the sense of taste can be added to a sensory garden by incorporating plants such as blueberry bushes and fruit trees (McMaus 2001).

Phenomenology

“In simplest terms, phenomenology is the interpretive study of human experience”. The aim is to examine and clarify human situations, events, meanings, and experiences “as they spontaneously occur in the course of daily life” (von Eckartsberg, 1998, p. 3). The goal is “a rigorous description of human life as it is lived and reflected upon in all of its first-person concreteness, urgency, and ambiguity” (Pollio et al., 1997, p. 5). Designs of the phenomenological movement in architecture concentrate on how people interact with the building; how they experience the various building materials and how they come to know and understand the building through different sensory properties. For the most part phenomenological designs are uncomplicated and clean. It is a design methodology that is very personal and inward focused.

Orientation and Mobility Training

To design a building in which the blind and visually impaired can easily navigate and experience one first must know how they are taught to navigate. Many blind people receive orientation and mobility (O & M) training. O & M training
“…helps a blind or visually impaired child know where he is in space and where he wants to go (orientation). It also helps him be able to carry out a plan to get there (mobility).” (Orientation and Mobility Training 1998).

In O & M training a child learns how to gain information about his or her surroundings through senses of smell, hearing, and touch. The child is taught about special concepts such as the fact that objects exist even when they are not heard or felt and that relationships exist between different objects in an environment. Lastly the child is taught various ways to move through the environment, such as independent movement, which can be anything from rolling to walking, using a sighted person to get to a destination, and using a cane to move through an area, clear a path, or locate objects (Orientation and Mobility Training 1998).
In my research I studied in depth the various senses, how the blind and visually impaired use their senses to navigate and explore different environments, and things we as designers can do or incorporate into our buildings to assist the visually impaired in both way-finding and experiencing the built environment.

It is understood that in the absence of sight people rely more on their other senses; in fact, many blind people receive orientation and mobility (O & M) training, which helps them learn how to prioritize and react to the sensory information and cues they collect. Knowledge of O & M training methods and techniques can play a huge role in deciding what sensory cues should be used, where they should be placed, and how people will interact with them.

The use of textural components as way-finding tools in a building is the most effective and most widely used because they are capable of helping blind people as well as blind and deaf people navigate through a space. Many blind and visually impaired children today were born premature and often have other physical or mental problems, so it makes sense to consider people with other disabilities when designing a building for the blind.

Although sound cannot help people who are both deaf and blind find their way it can still be an excellent tool for the blind to use. Research has shown that blind people are better able to both track sound and pinpoint the location of a given sound. Sound can be heard from a distance and followed to a source, making it a great navigational tool. Sounds that could be incorporated into a building could be as direct as a tonal beep for a specific classroom or as subtle as the hum of fluorescent lights.

The sense of smell is an experience as well as a navigational tool. Pallasmaa (2005) talks about walking down an old town...
road, smelling the different odors that come out of the shops and daydreaming about all of the long forgotten memories they conjured up. The same principles could be applied to walking down a hallway in a building. People could smell old books as they walked past the library, food being prepared as they walk by the cafeteria, the smell of paint as they walk by the art room, and all these odors could produce memories of past, experiences, which would help them know where they are and experience the space.

It must not be forgotten that all visually impaired people are not completely blind, so sight, light, and color can also play a role in how the building is designed. When using color in a design intended for the visually impaired, it is best to pair highly contrasting colors with one another because it is the contrast between colors, and not the color itself, that makes a hue easy or hard to see. Some visually impaired people have problems with glare coming off reflective surfaces so it becomes essential to design the lighting in such a way as to minimize glare.

Sensory gardens can be a source of information when trying to design a building that appeals to all the senses, because they have been carefully designed and planned to create an experience that forces one to interact with a space or environment on a deeper level. They create environments in which each sense is celebrated but the full experience is not realized until one uses all their senses to gather information.

All of the research has given insight as to how the blind and visually impaired move through their environment, as well as what types of strategies might be employed within a building to help them. As with any building it should be an enjoyable and exhilarating place for its inhabitants. With normal buildings and occupants these qualities are easily established in the design through the use of
openings to let in light, stimulating color pallets, and other architectural elements that are meant to be seen, but with this typology all of these aesthetically pleasing visual elements must be designed in such a way that the visually impaired can enjoy them as well.
CASE STUDIES

Therme Vals p33

W. Ross MacDonald School for the Blind p37

MIT Brain and Cognitive Sciences complex p41
Introduction

Therme Vals is a thermal bath or hydrotherapy center located in the small town of Vals in southeastern Switzerland. Designed by Peter Zumthor and completed in 1996, the building sits in the middle of a hotel complex built in the 1960s at the point where the hot spring surfaces on the mountain. The building consists of various baths differing in shape and size, changing and showering areas, massage spaces, rest areas, and water treatment rooms. This case study is distinguished by the fact that it is not a facility specifically designed for the visually impaired (Hauser 2007).

Findings

The building is set into the mountainside so that from the upper slope one can scarcely see where the mountainside ends and the roof begins.
Visitors must enter the building by going down to the cellar of one of the hotels and walking through a long underground tunnel. This entrance sequence was undoubtedly created to make visitors feel as if they are going down into the depths of the mountain. To add to the feeling of being inside the mountain the major building material used in this project was Valser quartzite, a stone that is native to the region. The main space in the building feels like a large cavern divided up into many smaller areas by large rectangular pillars that both visually and structurally hold up the roof.

As far as other case studies dealing with the senses, this one shares the same attention to creating a space that is experienced on multiple levels. When in the building one not only sees the spaces but also hears the echoing of visitors’ voices bouncing off the stone walls and the ever-present sounds of water running, dripping and splashing throughout the facility. One feels the varying temperatures of water in the different baths, the dampness and humidity accustomed to a building with so much water in it and the walls of thinly cut stone stacked layer upon layer.

What differentiates this building from other case studies is the fact that none of the cues are used as navigational tools and I believe with this building that is okay. It is a spa, a place where people go to relax, a space that is not meant to be navigated but explored.

**Analysis**

The structure of the building is made up of load bearing concrete walls. Large rectangular masses are formed from these walls in a way that leads one to believe the void spaces were carved away from a single solid mass. The walls are set up in such a way that they loosely define smaller spaces within a larger whole and completely surround even smaller spaces. Circulation is also defined by these large masses of structural wall though in a less formal way than most other
buildings. When looking at the plans and sections rigid geometry appears to be one of the common themes which runs throughout the building. Everything about the building, from the bearing walls and large rectangular forms to the openings in the façade, is tight and rigid; all straight lines and 90 degree angles. Natural light in the building is present but highly controlled. Depending on the time of day spaces can be well lit with natural light but views out of the building are kept to a minimum because the experience is meant to be inwardly focused.

Conclusion

This building shows how one can develop a design that serves all the senses. It not only does this but does it in a way that feels natural; it makes sense that the space would seem like a cave because it is built into a mountain, and seeing as how a spring emerges from the spot it is only natural for the building to be wet. Our mind accepts the fact that the space echoes because the walls are made of stone and we believe the stone is supposed to be there because the building is integrated with the earth.
Introduction

The W. Ross Macdonald School for the Blind, located in Brantford, Ontario, was designed by Toronto architect Bruce Stratton and was completed in 2004. This 30,000-square foot building acts as both a place of residence and a primary school for 32 blind and deaf/blind and visually challenged children. Though the building was designed primarily with the blind and visually impaired in mind it also serves as a working environment for a staff of 40 people, most of whom can see, and the Brantford community often utilizes the school’s facilities. Thus it was important that the school be aesthetically pleasing to the eyes as well (Jen 32).

The building is characterized by large open hallways, an abundance of indirect natural lighting, an exposed structural system and the use of many cubic geometric blocks which, when viewed from outside the building, hint at the spaces created in the interior. Spaces on the interior include: student residences, classrooms, a health services center, a multipurpose room, music practice studios, an entrance atrium, offices, meeting rooms and teaching pods.
Findings

This case study is unique because it is the only case study that is a school for the blind and in fact the only building that was designed specifically with the blind, blind/deaf and visually impaired in mind. Because of this it is also the only case study that provides sensory cues such as tactile signs to assist with navigation. Such cues include concrete block walls surfaced in spots with smooth ceramic tiles, an elegant rail system, and variations in floor materials at the intersections.

The building is similar to others researched in that it deals with all the senses. As mentioned before, sight was not ignored in the creation of the project. When inside the building one not only sees the space but can feel the ceramic tiles as they guide you through the building and hear the different sounds your footsteps make as the flooring material changes.

The building was placed on a site defined by residential streets and bluffs that roll gently down to the Grand River a block away. It was situated in such a way as to complete a courtyard already mostly formed by other buildings on the campus. The courtyard contains pine trees which emit a great aroma, and it also provides a safe place with clearly defined boundaries for all the students to socialize and play.
Analysis

The structure of the building is made of exposed steel members, which are for the most part painted, but some steel members have a weathered patina which adds an interesting texture for the student to find and explore. The steel tube columns, located throughout the building, would also produce a very unique sound if an inquisitive child should happen to knock on it. Elements of massing are apparent when studying the exterior views of the building. The building has the feeling of blocks of rectangular forms that were pushed and pulled, raised and lowered until it created the unique form of the final building. The best part about the massing is that it makes sense when looking at the plans and sections. Rooms were bumped out where they needed to be, and the entrance and entrance atrium were raised up to establish the dominance and importance of these areas. Natural light is brought into the building with great care and concern so as to not create bad situations for those students who have problems with glare. Almost all the light is indirect and filters in through clearstory windows and other shaded openings. Light brought into the rooms on the exterior of the building is allowed to penetrate into the central hallway through translucent and transparent glass. The corridors are 10 feet wide, larger than normal to allow quick and safe travel. They are arranged in a simple linear layout which adds to the ease of navigation throughout the building.

Conclusion

This case study shows ways in which existing buildings use textural cues to help the blind and visually impaired move throughout the building. The way-finding elements designed into this building can act as a starting point and something to build off of.
plans and sections from Canadian Architect magazine
Introduction

The MIT Brain and Cognitive Sciences complex located in Cambridge, Massachusetts was designed by Charles Correa Associates. This seven-story 412,000 square-foot building is "the world’s center for neuroscience research; it is also an elegant example of leading-edge laboratory design" (Architectural Record 07-06 p 138). Some of the programmatic elements in the building include more than 40 wet and dry laboratories, and spaces for all kinds of specialized equipment, including autoclaves, cold rooms, hat rooms, centrifuges, electrophysiology rings, magnetic resonance imagers, etc. The building was also required to have several communal areas which would support researchers socializing and collaborating on various projects (Levinson 138).

The most distinctive difference in these case studies was the typologies as mentioned above. Another uncommon characteristic was the site locations. The Therme Vals was
located in a rural setting, while the school for the blind bordered a residential or suburban neighborhood and the cognitive center is in an urban setting. Sites play a hugely important role in any design project and for their specific typologies all the buildings seem to be sited in the location of environment that works best with them. The one case study with the same typology as my thesis project, the school for the blind, was located in a suburban environment. This site location is congruent with the one picked for my thesis project.

Findings

This case study, like the others, deals with how we experience our surroundings but in a completely different way. The building is home to cognitive research laboratories where researchers delve into and study the thought processes of human beings. It was not designed specifically for the visually impaired, and is not a destination point for those seeking a multisensory experience but a place of work, study, and learning.

As mentioned before the building sits on an oddly shaped triangular lot which is how it received its basic shape. The building also bridges over a set of train tracks that run through the site. The fairly simple façade made of limestone and green tinted glass was kept subtle so as to not compete with Gahry’s Stata Center across the street.

The success of this building lies not just within the beautiful design but also in the fact that the building truly knows its place. Its triangular form was developed to be congenial with the sight boundaries, the tunnel through the building was done to accommodate train tracks which predated the project, and the flat, non-flashy exterior was designed to pay tribute to the more curvilinear and flamboyant Stata Center.
Analysis

When looking at the plan’s sections and exterior views the massing of the building quickly becomes apparent. The building can be thought of as one large mass with void forms, both on the exterior and interior, cut away from it. One of the biggest void forms is the five-story atrium space cut out of the middle of the building. It acts as a central hub for all of the circulation spaces throughout the structure with hallways radiating off of it and more hallways breaking off from them. Even though it is a huge, dense building the architects found ways of getting natural light to all of the larger more public spaces and rooms. The central atrium is flooded with natural light that streams down through an enormous glass roof, and huge glass expanses punched into the exterior walls ensure that plenty of light gets into the building.

Conclusion

This case study speaks more to the scientific research that is being conducted in the areas of sensory perception. This huge complex completely devoted to cognitive research portrays how vast and extensive the workings of the human mind really are and how little we currently know about it.
DESIGNING FOR THE SENSES

In this series of case studies three buildings were researched, Therme Vals in Vals Switzerland, The W. Ross Macdonald School for the Blind in Brantford, Ontario and the MIT Brain and Cognitive Sciences complex in Cambridge, Massachusetts. All three buildings are of different typologies, a thermal bath house, a school for the blind, and a cognitive research center. Yet all convey important aspects of sensory perception. All the case studies researched seemed to support the theoretical premise of this thesis.

Common characteristics of all three buildings included the use of natural light throughout the spaces. The natural lighting was carefully thought about in all three instances and the three different typologies of the case studies led to three different methods of dealing with the natural light. Attention to the senses and designing for them was an aspect that also showed up in all the projects, but more so in the Therme Vals and the school for the blind. The architects for these projects really studied how different forms, building materials, lighting, etc. were experienced on multiple sensory levels and then incorporated their findings into the final designs; the result being buildings that we, as people, are better able to experience and understand. These case studies show that it is not only possible to design a building for all the senses to enjoy, but that it has been done before.

The most distinctive difference in these case studies was the typologies as mentioned above. Another uncommon characteristic was the site locations. The Therme Vals is located in a rural location, while the school for the blind borders a residential or suburban neighborhood and the cognitive center is in an urban setting. Sites play a hugely important role in any design project and for their specific typologies all the buildings seem to be sited in the location of environment that works best with them. The one case study with the same typology as my thesis project, the school for the
blind, was located in a suburban environment. This site location is congruent with the one picked for my thesis project.

All three projects dealt with cultural and social contexts. The thermal baths are all about healing and rejuvenating, as well as socializing, thus explaining the inward focus of the design. The school for the blind brings together people with similar disabilities to grow and learn from one another. Likewise the cognitive center brings together people with similar educations, skills, and interests to conduct research. Each building offers something different and each building attracts like-minded people to socialize, grow, and learn from one another.

Spatial relationships vary between case studies. Both the cognitive center and the school for the blind have more traditional spatial layouts with clearly defined central double loaded corridors leading to various spaces. In these two buildings there is a little blurring of the line such as the large entrance area in the school for the blind, or the huge multilevel atrium in the cognitive building, but for the most part visitors would know whether they are in a circulation space or a room. The thermal baths are a completely different story. The different baths themselves could be considered destination spaces and by default everything else would be a circulation space, but as the baths are open to the rest of the space in many areas it becomes hard to tell where the circulation ends and the room begins.

Each of the three case studies provides insight into the theoretical premise. While comparing three different typologies is not easy, the comparison does offer an array of different vantage points from which to study the theoretical premise resulting in a more thorough and complete investigation.
DESIGNING FOR THE SENSES

HISTORICAL CONTEXT
The world’s first school for the blind was the Paris Institution for the Blind, founded in 1784 by Valentin Hauy. One day Hauy suddenly realized that the blind could be taught through touch after giving a young blind beggar a coin and watching him feel the raised markings on it to determine which coin it was. He took the blind boy in and taught him to read using wooden blocks with raised letters and soon after founded the first school for the blind where his pupils both learned and lived. During the French Revolution Hauy gave up his position at the school, left France and started another school for the blind in St Petersburg. By this time his work was quite well known and schools for the blind were opening in countries such as Denmark, Austria, the United Kingdom and Germany. Hauy later returned to France and his school but soon after died (Valentin Hauy and the Royal Institute for Blind Youth 2009).

The most notable scholar at the Institution of the Blind was Louis Braille, the inventor of the Braille alphabet which is still used today. Letters in the alphabet consist of raised dots which the blind and visually impaired can read with their fingers (Valentin Hauy and the Royal Institute for Blind Youth).

In studying the history of schools for the blind in the United States there is no better place to start than Perkins School for the Blind, originally called Perkins Institution for the Blind, located in Watertown, Massachusetts, near Boston. After visiting the Institution for the Blind in Paris, Dr. John Fisher quickly realized the benefits of the school as well as the need to establish an educational center for the blind in the United States. Upon his return to the states he applied for a charter from the Commonwealth of Massachusetts in an effort to create a school for the blind. The school opened its doors in 1832 with classes taught
in spare rooms of director Samuel Gidy Howes father’s home (Perkins School for the Blind 2009).

After only one year, the school had to be moved to a larger facility, a home owned by Thomas Perkins, to accommodate all the incoming students. One of the incoming students was a young girl named Laura Bridgman. Through persistence and dedication Howe was able to teach her how to communicate using tactile signs. Bridgman is widely regarded as the first deaf/blind child to receive an education (Perkins School for the Blind 2009).

A short six years after the school had moved to its second home, enrollment in the school reached 65 students and they were again looking for a larger building. Perkins generously sold his home and donated the money to the school so it could procure a larger building (Perkins School for the Blind 2009).

Howe strongly believed that it was not enough for the blind to just be read to, and it was his ambition to develop a way for blind people to read and enjoy books on the same level as everyone else. In 1835 Howe established a printing department within the school. The department first printed books using embossed letters in an alphabet developed by Howe. The letters Howe designed were compact and thought to be simple to read by
touch. Later the department abandoned embossing books and started printing them in Braille (Perkins School for the Blind).

In 1880 the school founded the Samuel P. Hayes Research Library. The library was, and still is to this day, considered to be the most extensive and complete collection of the nonmedically related aspects of both blindness and deafblindness. Today the library has over 40,000 publications including books, journal articles, pamphlets, dissertations, multimedia materials, newspaper clippings, and conference reports (Perkins School for the Blind 2009).

By this point in time the school was becoming very successful at educating visually impaired children and, as a result, opened the United States’ first kindergarten for the blind in 1887. The very next year the school’s most famous student, Helen Keller, moved from Alabama with her tutor Ann Sullivan and started attending classes (Perkins School for the Blind 2009).

In 1910 the school once more felt the need to expand due to an ever-growing student body. The school bought 38 acres next to the Charles River in Watertown, Massachusetts and began building the campus that they still utilize today (Perkins School for the Blind 2009).
In 1923 the school developed the Hayes-Binet test which proved that blind are just as intelligent as sighted people, and in 1931 it opened its Braille and talking book library. It is one of about 19 libraries located around the United States which creates a national library network for the visually impaired. In 1951 Perkins produced the first Perkins Brailler, a kind of typewriter that types in Braille. The typewriter is still in use today and, as of 2005, the school had manufactured over 300,000 and distributed them to more than 170 countries (Perkins School for the Blind 2009).

In recent years the Perkins School has, through various outreach programs, expanded its services to cover the U.S. and more than 60 other countries throughout the world, providing services to nearly 90,000 visually impaired children. The Perkins School for the Blind has been instrumental in not only the education and development of visually impaired children but also in the development of new technologies for the blind and the creation of a better overall quality of life for the visually impaired. While our methods and areas of study may be varied our goals are the same; I too wish to help develop a better quality of life for the visually impaired by coming up with new and innovative design ideas that help the blind to navigate through and experience the buildings they live and work in more easily and effectively (Perkins School for the Blind).
Public Schools vs. Schools for the Blind

Before schools for the blind, few if any blind people received formal educations. Schools for the blind were instrumental in proving to the world that visually impaired people could become active, participating members of society. For well over 100 years these specialized schools were the only way in which the blind could receive a formal education, but with the passing of public law 94-142 in 1975 (first called Education of All Handicapped Children Act and later renamed Individuals with Disabilities Education Act) implementation of special education programs has grown significantly (Simon 1998). Today social trends lean toward mainstreaming students with all different kinds of disabilities into public schools, but the debate rages on as to whether it is better to send visually impaired children to public schools or schools specially equipped to meet and deal with their needs (Simon 1998).

Author Michael Gandy (1992) tackles this question by interviewing blind twin sisters who attended both a public school and a school for the blind from 1961 to 1972. Lina Hale, a current graduate student at Jackson State University, and Dinah Smith, a stay-at-home mother of two, were both born legally blind. They attended their first year of schooling at a public school and after realizing that the girls were not progressing at the same level as the rest of the class, their parents and their principal agreed that it would be best for them to attend a school for the blind. The women stated that their year in public school was marred with ridicule and teasing from the other children. Both agreed that it was very hard on them emotionally, and Lina stated that to this day she will not wear thick gasses because of the teasing she received (Gandy 1992).

At the age of seven they left home to attend a school for the blind. Both women agreed that it was
a difficult adjustment but, while Lina said that she eventually adjusted and seldom felt the need to go home, Dinah stated she never fully adapted to being away from home. During the girls’ schooling their parents and siblings rarely ever visited them, and as a result they gradually grew further and further apart. Their teachers and classmates became much more of a family to them. Lina even stated that there was a staff member she thought of as a second mother and added that she would call her, even today, before calling her own mother (Gandy 1992).

The women stated that they received many positives from attending the school for the blind, including their values and beliefs, structure, and an education more suited to their needs, but there were also negatives. For Dinah the biggest negative was the lack of physical bonding, and Lina believes that the biggest negative was the lack of social interaction with people outside the school. Despite the negatives both women would send their kids to a school for the blind if they were visually impaired. Dinah added that, unlike her parents, she would move to the same city so she could see them on a daily basis. Lina said that she would have her children receive their elementary education at a school for the blind “…so that they could get the basic adaptive skills” after which she would place them in a public school for grades seven through twelve (Gandy 1992).

Schools for the blind are continuously evolving and improving; since Lina and Dinah attended school in the 1960s many improvements have been made. One of the main problems the girls had, Dinah in particular, was never seeing their family. Today, at the School for the Blind and Visually Impaired in Aberdeen, South Dakota, family visitation is not only encouraged but mandatory. Some of the students have parents who live in the same town and see them every day. Students whose parents do not live in town often go home every weekend or every other weekend and
the school requires that at least once a month the students take a long weekend to go home and see their family. As for the lack of socialization with people outside the school, that has improved as well.

Today schools for the blind go to great lengths to organize class trips and create community programs which give the students a chance to interact with the community, as well as educate the community about the visually impaired. For example, the school in Aberdeen hosts an event called dinner in the dark in which members of the community are invited into the school blindfolded and served a meal prepared by the students. It helps the students interact with the community and teaches the community a little something about being blind. Interaction with peers and the community is also something I considered when choosing the site.

The site I chose for my project is located just across the street from a high school. This provides a unique opportunity for the older kids attending the school. If they so desire, they can go to the high school to attend more specialized classes not offered at the school for the blind while still taking their core classes and receiving specialized help from experts at the school for the blind. The debate over public schooling vs. schools for the blind will continue but I believe that this idea combines some of the best aspects of both.
History of Anoka, MN

According to the city of Anoka’s website the first explorer to visit the site where the city of Anoka now stands was Father Lewis Hennepin in 1680. However, the site was not settled until the mid 1800’s. Prior to the arrival of settlers in 1844, the area was claimed by both the Dakota and Ojibwa tribes. Joseph Belanger became the area’s first settler when he built a log cabin near the mouth of the Rum River and used it as a trading post with the Native Americans. A few years later the area’s first logging operation was started. The Rum River was utilized to transport logs to the Mississippi River and down to a sawmill located in St. Anthony. In 1853 a dam was constructed on the Rum River and the area’s first sawmill opened just a year later. Many more mills, cooper shops, barrel makers, and wood working plants quickly followed using the flowing water of the Rum River as a source of power. For the next two decades milling was a central part of the Anoka economy. Later other businesses such as a potato starch factory, and a shoe factory would fill the void left by the decline of the saw mills (city of Anoka web site 2009).

Anoka’s history and development has been marred by several fires. It experienced five large fires between 1855 and 1884. The fire in 1884 was by far the worst, destroying over 80 buildings in the small community. The town pulled together and rebuilt the area but devastation came to the community once more in 1939; this time in the form of a tornado. Again, the town pulled together and rebuilt (city of Anoka website 2009).

Anoka’s claim to fame is being the first community to celebrate Halloween. In 1920 citizens of the town decided to throw a big Halloween party with free candy for all of the children in an effort to stop Halloween pranks. Except for two years during WWII the party has been thrown every year since (city of Anoka website 2009).
GOALS

Academic

An Insightful Theoretical Premise
The theoretical premise is the catalyst for the entire thesis project. It provides a problem to be researched and solved through the course of designing a building.

A Thorough Thesis Proposal
The development of a well thought-out, well researched proposal is crucial to the success of the entire project. Completing this portion of the thesis on time will provide a collection of invaluable knowledge to look back on when in the design phase.

A Design that Fits the Theoretical Premise
In order for the project to be considered a success it has to come full circle. It is imperative that the final design provide answers and solutions to the questions and problems developed from the Theoretical Premise.

A Professional Quality Presentation
Drawings, renderings, and board layouts should all be of the highest quality possible. In addition to the boards, a well prepared and organized oral presentation is essential.

A Thesis Book of the Highest Quality
The thesis book is the only publicly available source documentation for the project and may be used by future students as a research tool, so it is imperative that it be of the highest quality.

Professional

Improve Upon Computer Skills
When searching for a job every advantage one can obtain will help immensely. More and more firms are looking to recent graduates to help them make the transition from CAD to Revit. Improving my knowledge and understanding of this program can only help when looking for employment.
Increase Understanding of Building Construction
Building construction methods, mechanical systems, electrical systems, plumbing, etc. are all aspects of architecture that cannot be ignored. Understanding these systems, implementing them into the project and documenting them in the final presentation conveys to potential employers an understanding of these building elements.

Develop a High Quality Design
Architecture is, after all, an artistic profession. A portfolio of work is one of the first things architects look at when they want to hire a recent graduate, so it stands to reason that having aesthetically pleasing design work will increase one’s chances of employment or at the very least getting an interview.

Personal Design a Meaningful Building
One of my most important goals in doing this project is to design a building that could actually help people and improve their quality of life. I hope to explore new ideas and implement new strategies into the project which both help the blind navigate through the building and enjoy it. It should be a place where all people, whether they are blind, deaf, disabled in any other way or completely healthy can go and fully experience a building and its individual spaces with whatever senses they have available to them.

Produce a Project I am Proud of
As my academic career draws to an end I realize that this could be the last project I design in which I have complete and utter control over all of its parameters. Never in the professional environment will I have so much freedom on a project and I fully understand how great a gift this freedom is. I intend to embrace it, reach into the depths of my imagination and produce a design uninhibited by present limitations of construction, the economy, etc.
SITE ANALYSIS

Narrative

Even though it sits directly north of county highway 116, a fairly busy road, and one can hear the ever-present sounds of cars and trucks passing by, the site still conveys a sense of calmness and solitude. This is due in part to the fact that the site sits about 15 to 20 feet higher than the road. The site itself, while relatively flat with a few small rolling hills, drops off dramatically at its southern edge to meet the road below. This rather abrupt change in elevation, coupled with the fact that there are very few trees on this side of the site, creates great southern exposure with vibrant and intense natural light and the potential to utilize the sun for both light and energy.

While in an urban area the site itself shows relatively little evidence of human intervention. A few birdhouses mounted on poles on the eastern edge of the site, a narrow dirt path meandering along the length of the north edge, and a fire hydrant in the center of the southern edge are the only indicators of human existence.

A variety of different types of tall grass grow abundantly throughout the site. Some species grow in large clumps dominating a specific area, while in other areas a variety of grasses grow interspersed with one another. Walking through this grass one experiences the sound of the long blades brushing past his or her body and the sound of dried grass crunching under his or her feet. It is these close and present sounds that remind you that you are visiting a natural site while the more distant sounds of cars let you know that you are mere moments away from civilization.

Aside from the grasses, the only other plant life on the site consists of a slender row of evergreen trees which starts at the center of the southern edge, of the site and runs about halfway to the north edge effectively splitting the site into two distinct parts.
This division of the large site really helps to define the two different areas and brings the site down to a more intimate and comfortable scale. They are the one feature of the site that can help to block the harsh Minnesota winds. These trees also produce the only shadows visible on the site; in the morning casting a shadow on the space directly to the west of them and in the afternoon casting a shadow to the east.

To the north of the site, in stark contrast to the open treeless site is a large wooded area complete with loosely defined walking paths. Walking into the woods from the site one becomes conscious of the trees and space closing in. You can no longer see for long distances as you were able to do back on the site just moments ago. The dense vegetation of shrubs and large trees force you to focus on your more immediate surroundings.

Following one of the smaller trails will lead down to the Rum River bank and a small but nicely secluded beach where one can wade in and feel the cool water slowly flowing down river. Just south of the beach one can follow the Rum River downstream on a wide paved bike path. Walking for a little while on the path will bring one to the northwest corner of the site and moving down the western edge of the site one can still catch glimpses of the river through the trees that grow on its banks.

Overall, the site seems vary pristine with no largely visible signs of distress. When on the site, one is struck by a feeling of solitude in the midst of a larger whole. The site is an island of nature surrounded by a sea of urban sprawl. It provides a temporary escape from the seemingly never-ending city. The most challenging thing about working with this site will be the struggle to keep its integrity.
**Soil**
According to a soil survey conducted by the USDA the site contains two types of soil: nymore loamy sand at slopes of both 2 to 12 percent, as well as hubbard coarse sand at slopes of 2 to 6 percent. The survey states that both of these soils are well suited to urban development.

**Utilities**
Besides a fire hydrant in the center of the southern edge of the site there are no visible utilities to speak of. However, the Anoka Public Library is located on the lot directly to the west of the site so tying into existing utilities should not be a problem.

**Vehicular Traffic**
There are no roads on the site and the only road that borders the site is county highway 116, a four lane road that maintains a steady flow of traffic throughout the day.

**Pedestrian Traffic**
There is a paved bike path running the length of the site’s western boundary and a small, loosely-defined dirt path runs along the north end and connects to the bike path. It seems that the few pedestrians that would walk on the site would stick to the path as there is really no reason or benefit to be gained by cutting across the site, and the tall grass is more difficult to walk in.

**Topography**
The soils survey of the site indicates that, aside from the steeper slope on the south side, slopes on the site range from 2 percent to 12 percent. Most of the site, however, seems relatively flat with slopes in the 2 to 6 percent range.

**Site Character**
There are no blatant signs of change on the site. There are no signs of erosion, muddy water, and only a dead tree in the tree line on the site.
DESIGNING FOR THE SENSES

SITE ANALYSIS

KEY
- **BOUNDARIES**
- **ROAD**
- **BRIDGE**
- **NATURAL GRASSES**
- **WALKING PATH**
- **RUM RIVER**
- **TREES**
CLIMATE DATA

Average Temperature

Humidity

SITE ANALYSIS
**Designing for the Senses**

**Site Analysis**

**Precipitation**

![Graph showing precipitation levels over the year.](graph1)

**Cloudy Days**

![Graph showing percentage of cloudy days by month.](graph2)

**Site Analysis**
SUN PATH AND SHADOW DIAGRAMS

Morning   Noon   Night
March

June

September

December
PROGRAMMATIC REQUIREMENTS

**Administration**
Waiting room 400sf  
Reception 200sf  
Principal 150sf  
Assistant principal 150sf  
Conformance room 250sf  
Work room 500sf

**Classrooms**
Typical classroom 6 at 600sf  
Multipurpose room 2,000sf  
Music room 500sf  
Library 2,000sf  
Gymnasium 8,000sf

**Living space**
Dorm rooms 18 at 200sf  
Living area 6 at 400sf  
Kitchen 6 at 150sf

**Other**
Kitchen 1,000sf  
Storage 500sf  
Outdoor learning space 5 at 600sf  
Sensory garden 1,500sf
REFERENCE LIST:


Perkins School for the Blind, 4 Dec 2009 <http://www.perkins.org/>


“The boy who can see through sound” Early Show. John Blackstone CBS

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Quote about NDSU
I have enjoyed my experience and time here immensely.