

Leen Hariri

Sensory Design in Educational  
Buildings

Elementary School  
Inclusive for Children with ASD

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Elementary School Inclusive for Children with ASD

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Thesis submitted to the faculty of Virginia Polytechnic Institute and  
State University in partial fulfillment of the requirements for the  
degree of

Master of Architecture  
In  
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From Interview with Herman Hertzberger

“Those memories contain the deepest architectural experience that I know. They are the reservoirs of the architectural atmospheres and images that I explore in my work as an architect”

– Peter Zumthor, *speaking of his childhood memories in Switzerland*

## Abstract

Sensory Design in Educational Buildings, Elementary School Inclusive for Children with ASD  
Leen Hariri

Designing a school turned out to be far more enriching for me as an architect and as a person; it is a process that investigates the deep connection with one's childhood memories and helps in realizing how much impact the school environment has had on shaping the people we become.

(In his book *The Child, The City, The Artist*) Aldo Van Eyck says: “ In my beginning is my end ... In my end is my beginning.”

The design of a school should be addressed as a place where childhood memories are created, where our understanding of play, social interaction, independence and awareness of ourselves and our architectural surrounding starts. It adds responsibility on the architect to make that space a perfect platform for learning, curiosity and creativity. As a child, going to school is a long process that may hold many obstacles. We can't imagine what it is like for someone on the Autism Spectrum. One to every 160 children in the world and one in every 59 children in the US are diagnosed with Autism Spectrum Disorder ASD. This high rise in the number of ASD diagnosis should urge architects to think of providing the infrastructure for those children to grow and adequately engage in their communities. This group of schoolchildren have the ability to blend with other neuro-typical children if the school was supportive of this merge both administratively and architecturally. Coming from a country that does not have enough support for such children was a big motivation for my thesis. I felt that we as architects can play a major role in supporting them and even raising awareness about ASD. In my thesis I have designed a school encouraging the inclusivity of students with ASD where the architecture facilitates the co-existence of two groups of children that have different yet complementary capabilities. It is my firm belief that an architecture that can embrace the challenges of such a group of children enriches the social and intellectual growth of both groups simultaneously.

To Majd ...

## Acknowledgments

I would like to start by appreciating our family's blessing, my nephew Majd. He was my inspiration to choose this thesis. My experience with him directly influenced my approach to this thesis.

A big thanks to my family and friends from Lebanon who were supportive and eager to see how my thesis would turn out.

Mahmoud, my husband, was the biggest witness on the hard work put into this project. I would like to thank him for always believing in me and making my dreams tangible.

A special thanks to my committee members for their effort and valuable conversations that led to the successful completion of this thesis.

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## **References**

# Architecture & Autism

“Architecture is the science of environment creation, the manipulation of spatial organizations to fit the needs of its users. Architects commonly use the sensory environment - i.e. the auditory, visual, tactile and air quality characteristics of space- to convey meaning and messages to users hence facilitating functions and activities within a space, particularly in the case of special needs users.”

*Malik.S, The Meaning of Architecture as Total Experience*



In my case, the special need users are children with Autism spectrum disorder. ASD has been described as a neurological and development disorders that can cause significant social, communication, and behavioral challenges that affect academic achievement. (CDC: Center for Disease Control and Prevention, 2016). So it is a developmental disability caused by differences in how the brain functions. People with ASD may communicate, interact, behave, and learn in different ways.



The interaction of autistic children with objects, surfaces and spaces is very particular and their responses range from hyper stimulation to hypo stimulation. Hence a building for children with ASD should be adapted to their sensory needs and help regulate their sense of space.

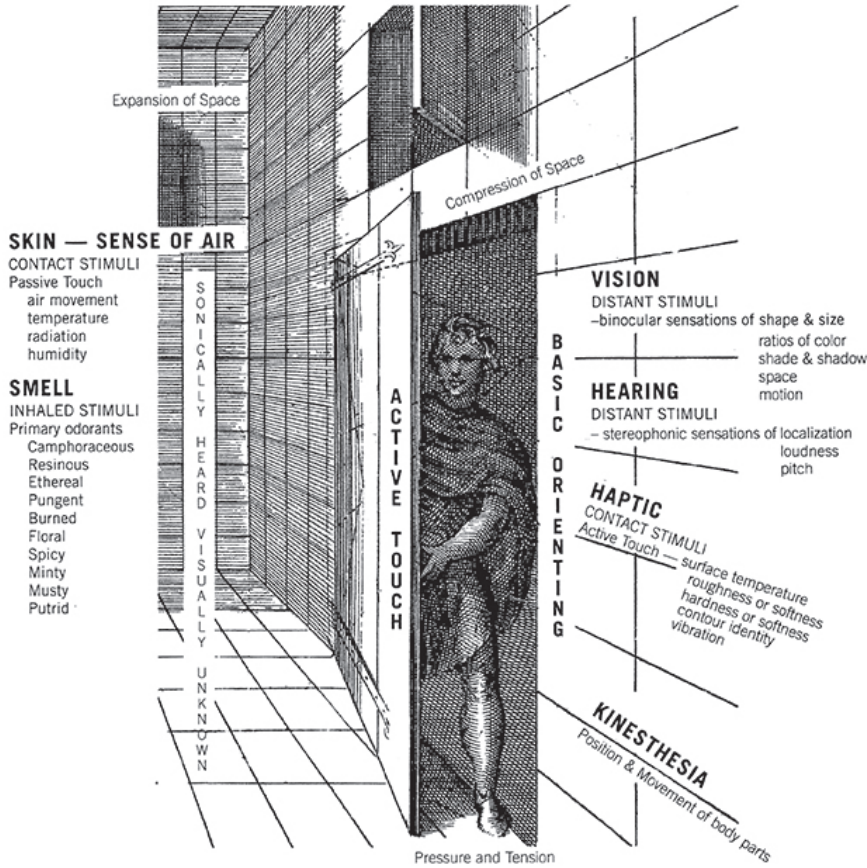
# ASPECTSS™ Index

One of the few studies that aimed to initiate guidelines for designing for individuals on the spectrum was conducted by Prof. Magda Mostafa while doing her Phd in the American University of Cairo. Her study "Architecture for Autism" suggested an index called aspectss™ corresponding to the different sensory and cognitive elements in spaces for children with autism.

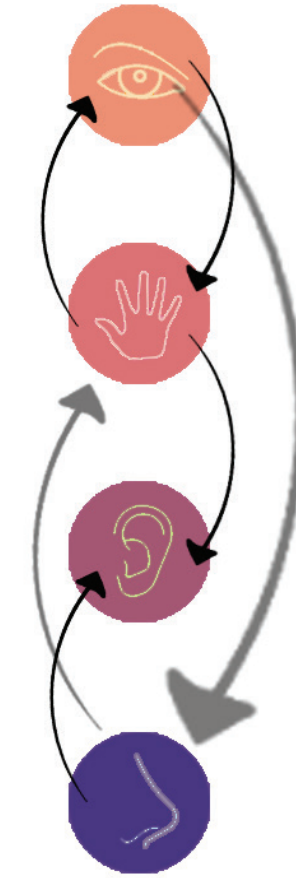
- A*coustics
- SP*atial Sequence
- E*scape Zones
- C*ompartmentalization
- T*ransition
- S*ensory Zoning
- S*afety

# Sensory Design

"Our senses act as learning portals. All raw information enters our brains through those learning portals"  
 - Hurt J., 2012



"People with Autism More Likely to Hear Colors, See Sounds"  
 - Gholipour, 2013



The additional aspects for the index are Color and Materiality, associating vision with touch to enhance children awareness of space and function.

- A*coustics
- SP*atial Sequence
- E*scape Zones
- C*ompartmentalization
- T*ransition
- S*ensory Zoning
- S*afety
- + *Materiality*
- + *Color and Light*

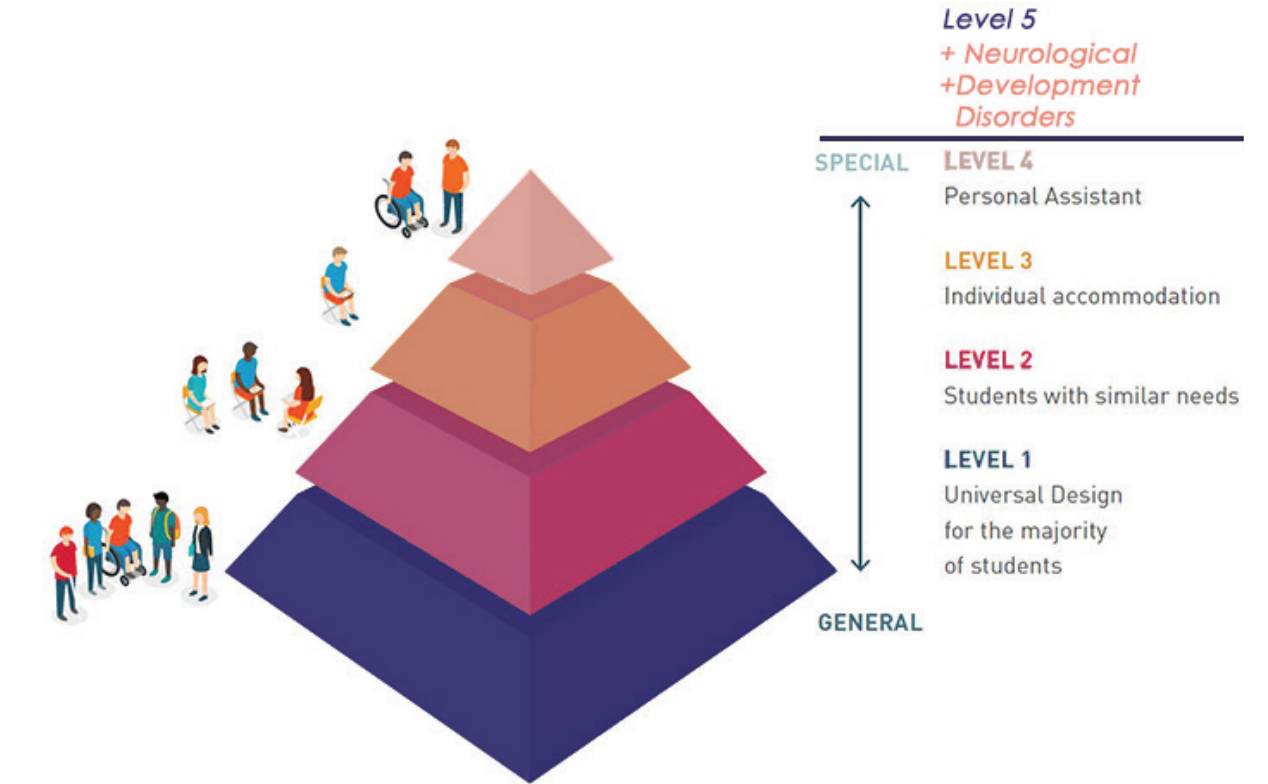
# Inclusive School Design

The program of the project had to be one that provides a platform to explore the concepts I've mentioned and the interaction of children with their habitual surrounding. So I found that an elementary school would be the perfect medium to experiment my thesis in. Where schooling is crucial for children with ASD as they need constant guidance and support. Many studies showed that merging neuro-typical students with non-severe autistic students in a school improves the social skills of the later and helps in the transition from a protected environment to the real world. Early intervention is essential for ASD. So the choice of elementary education is mainly because at this young age autistic children are growing and their ability to adapt to new environments and grasp new skills is at its peak. Therefore, trying to design a school that is inclusive to children with ASD can have a great impact on their ability to grow and socialize.



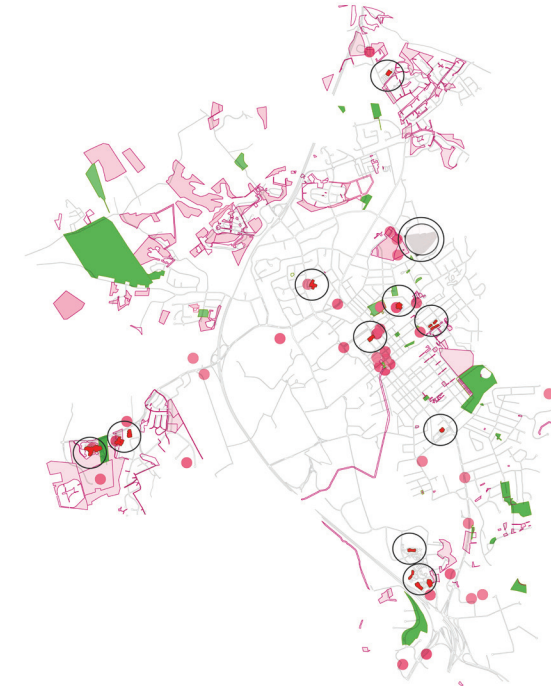
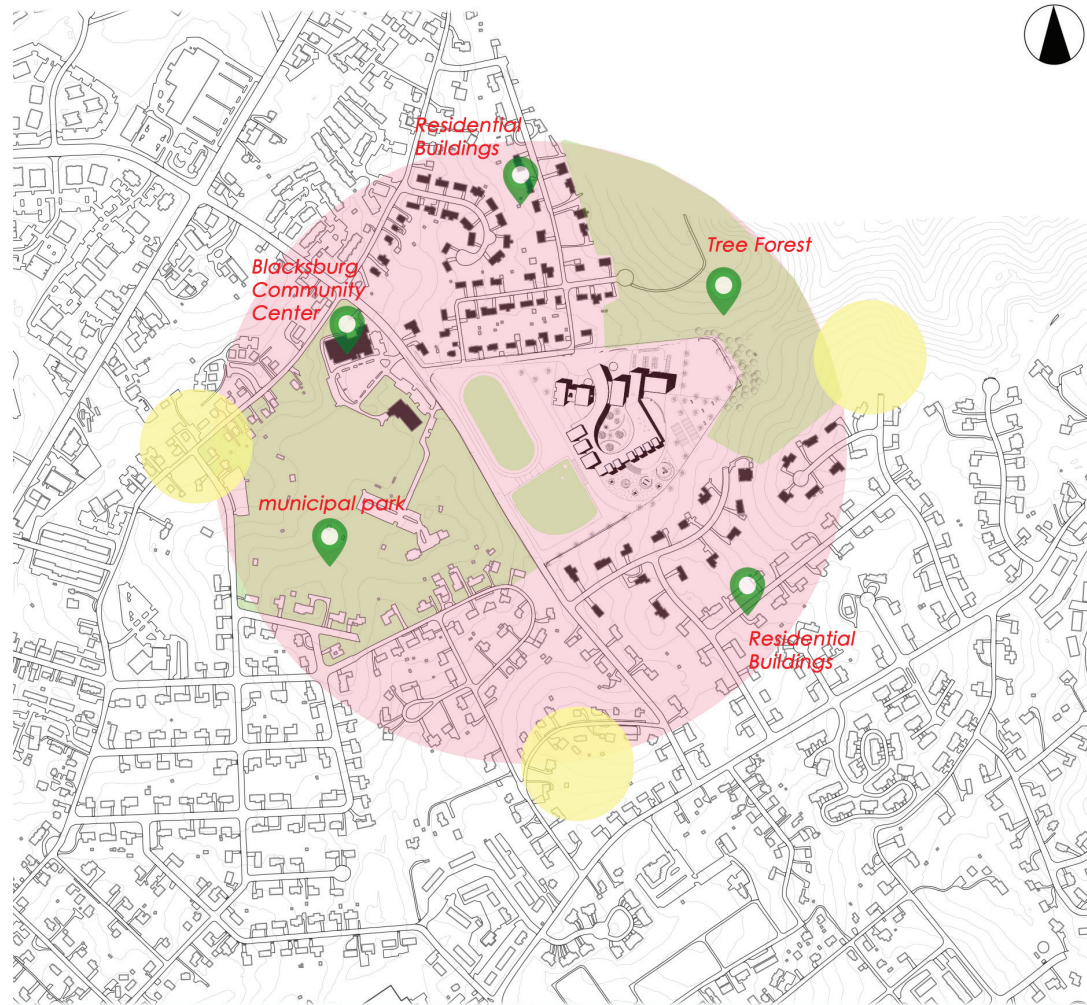
If not designed and managed properly, the integration of an autistic child in a school with neuro-typicals could be a huge challenge, it requires that the school embraces the different capabilities of students. And it is up to us as architects to provide the appropriate sensory context for children with ASD to facilitate their experience of the space.

As Universal Design is part of the guidelines in designing our buildings. I am hoping that my Thesis is one of many that call for including sensory design guidelines for our buildings to support people with neurological and development disorders and encourage their integration in the society and gives them a chance to become an effective member of their communities.





# The Site



- Areas of Interest
- Open Spaces
- Parks
- Pavements
- Chosen site

The project site is in Blacksburg Virginia, on land once occupied by the now-demolished Blacksburg High School. The site context is already appropriate to host a school. It is a quiet residential neighborhood on a slower route (Patrick Henry Drive). Adjacent to the site, on the northern and southern side, are residential single-family houses. On the western side is a recreational center and on the eastern side is wooded land. The lot is 2.6 miles from Virginia Tech's Drillfield and 1.2 miles from



The Running Track

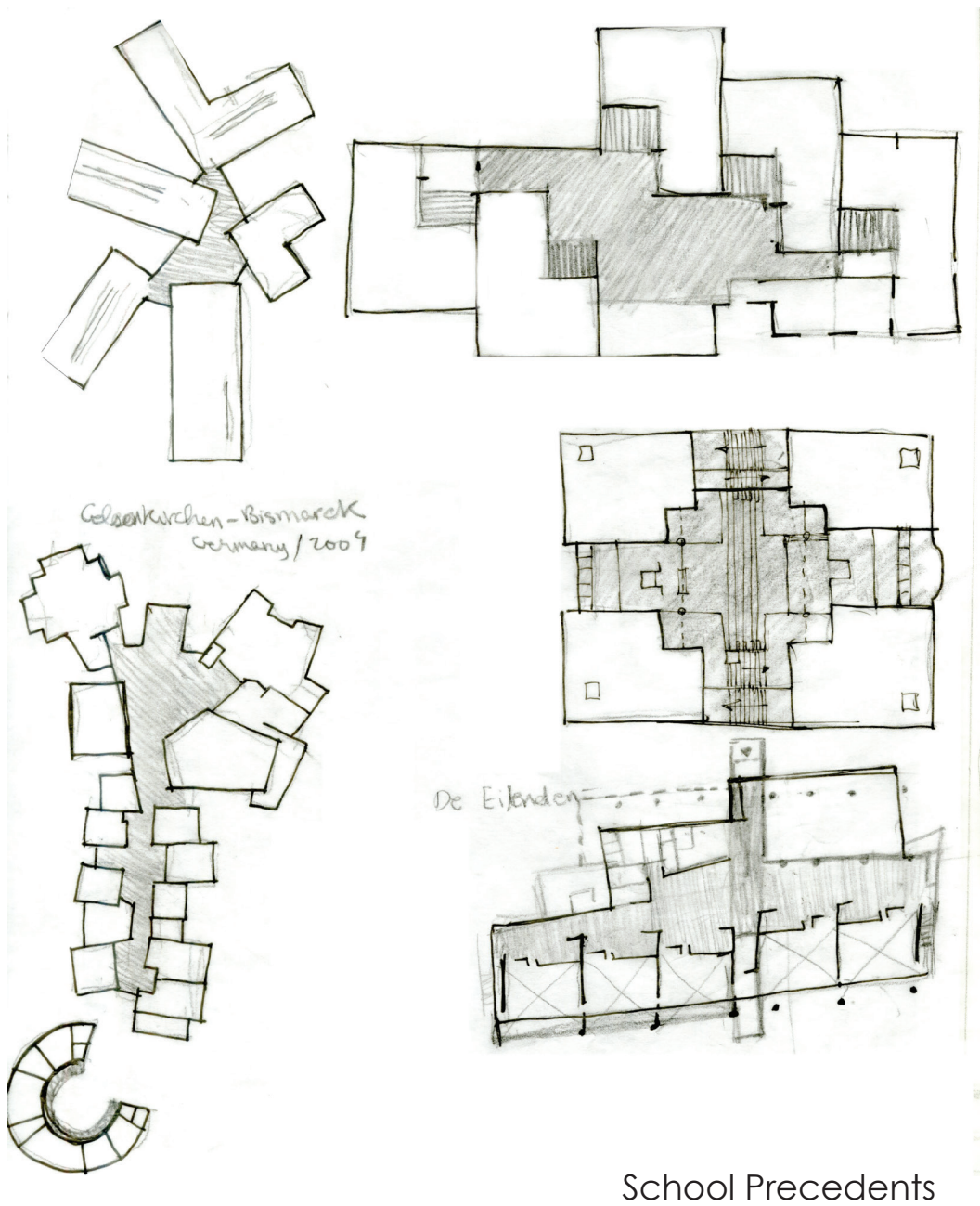


Project's ground



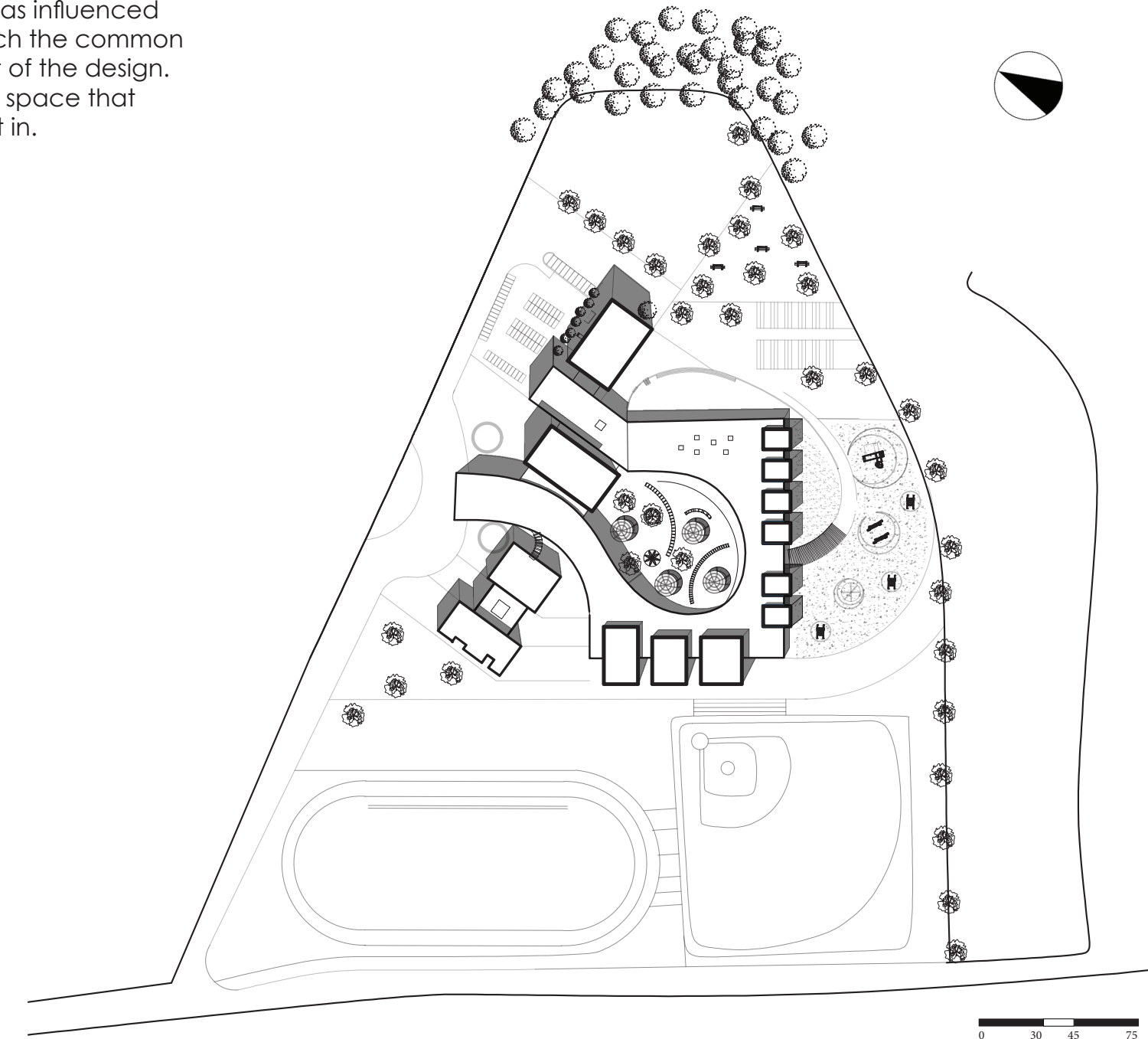
Road to Baseball Field

# Massing

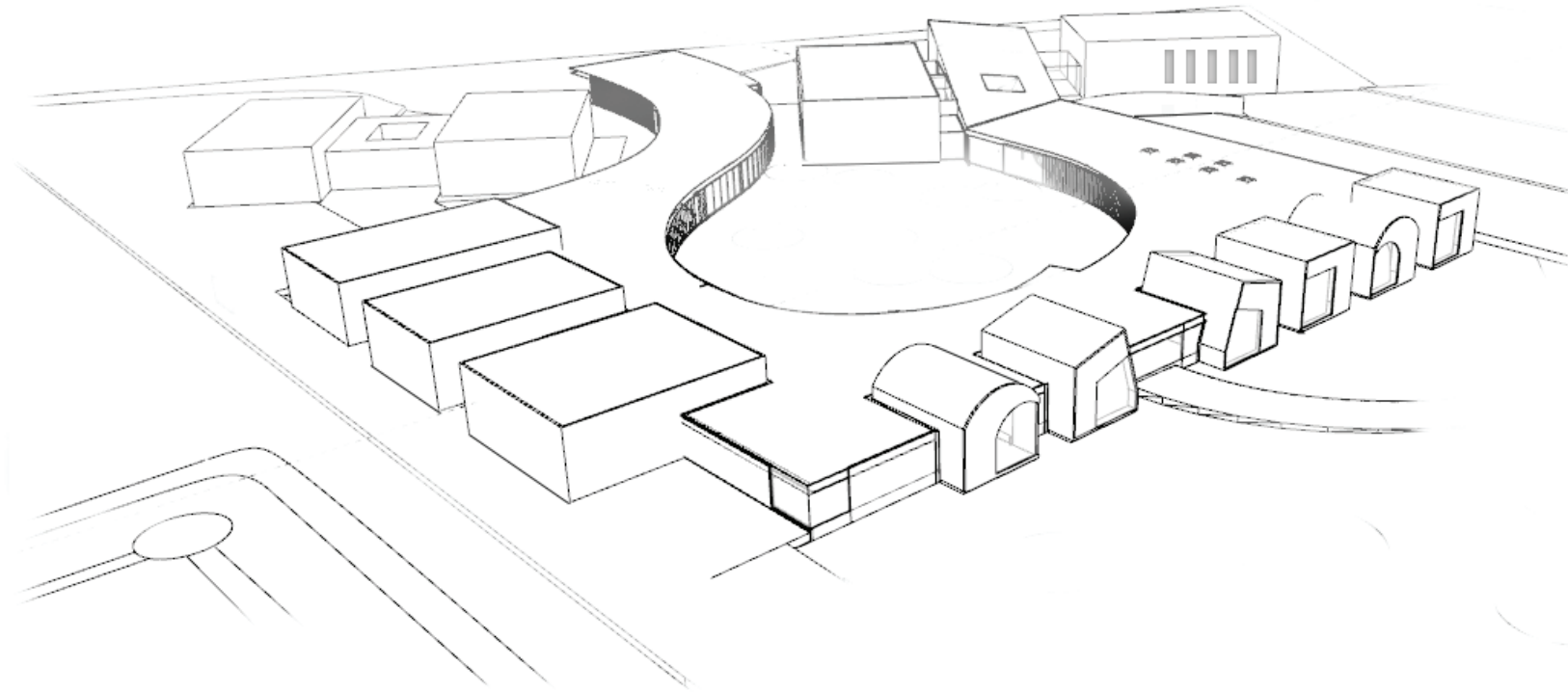


The massing of the school was influenced by many precedents in which the common space was a major element of the design. Where it serves as the social space that most of the children interact in.

Mass plan

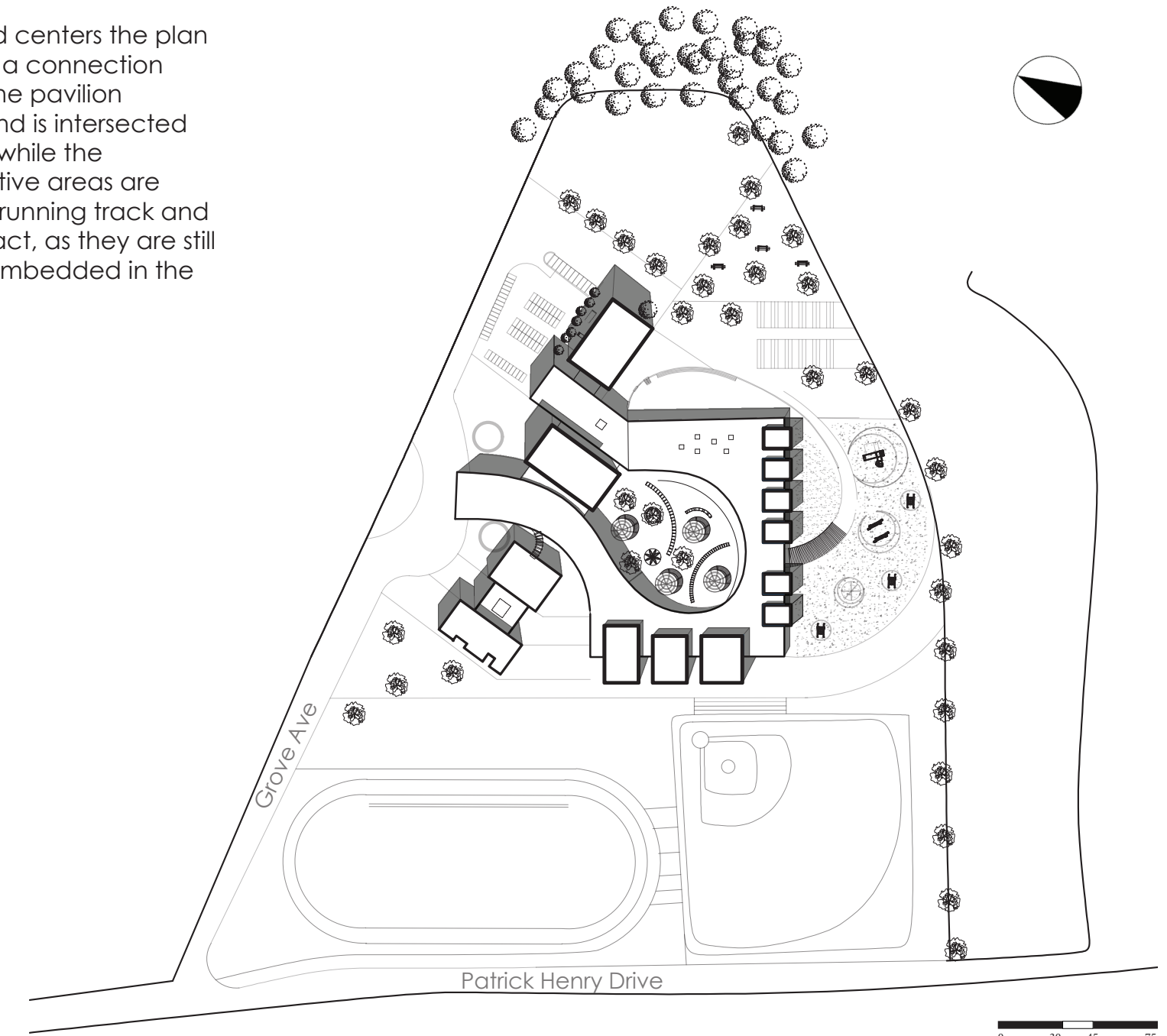


# Massing



In my design the courtyard centers the plan and the pavilion serves as a connection between all the masses. The pavilion overlooks the courtyard and is intersected by the classroom masses, while the administration and the active areas are independent masses. The running track and baseball field are kept intact, as they are still visited by locals and are embedded in the community.

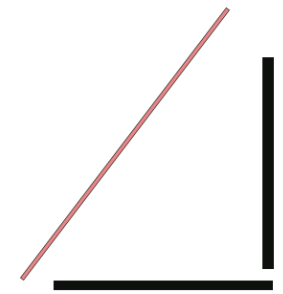
Mass plan



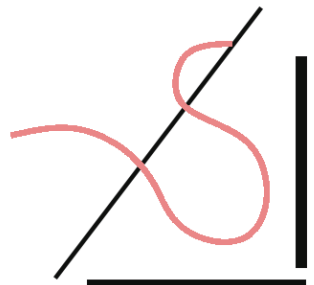
# The Plan



Classrooms & Labs

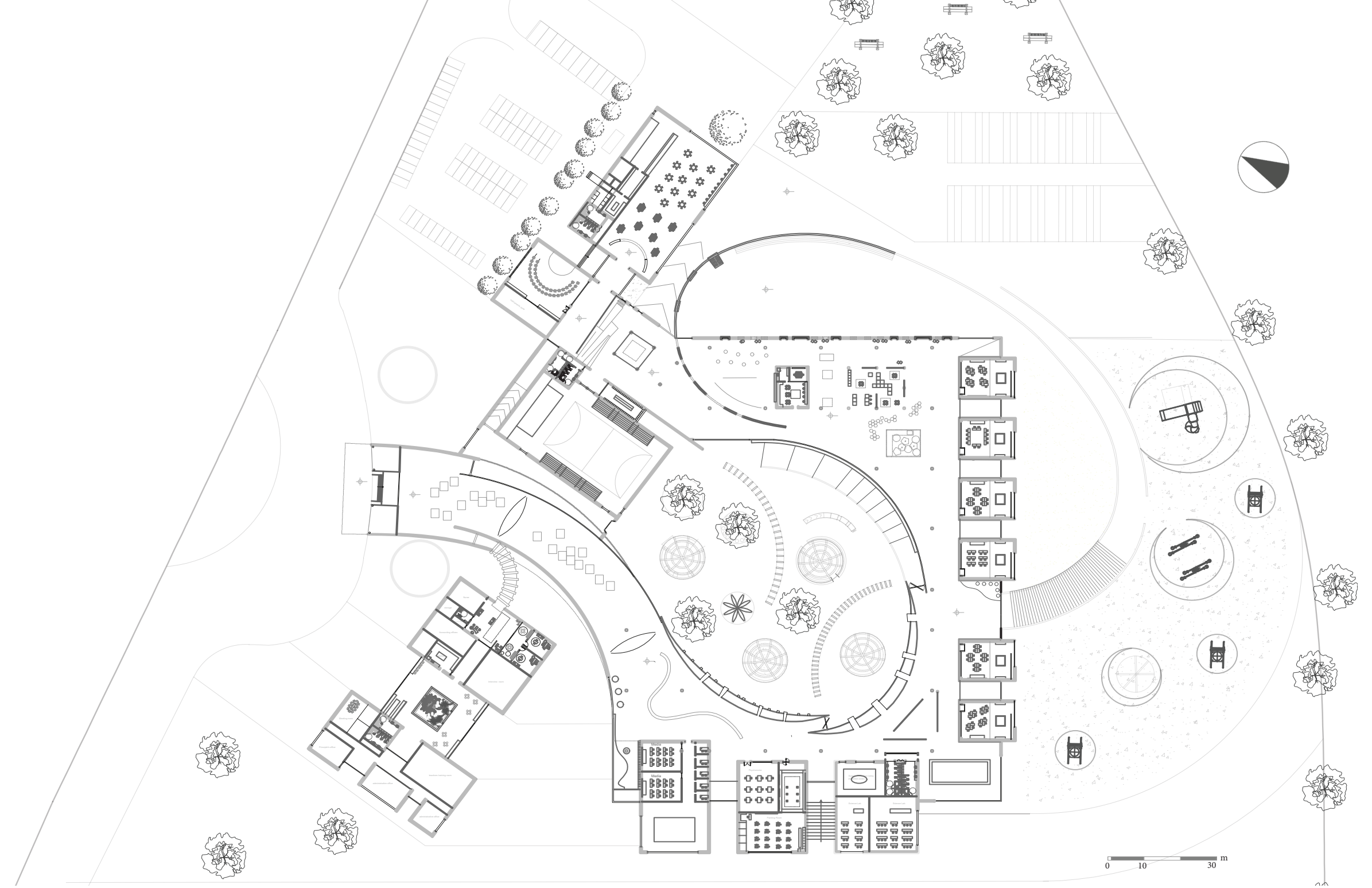


Activities & Admin

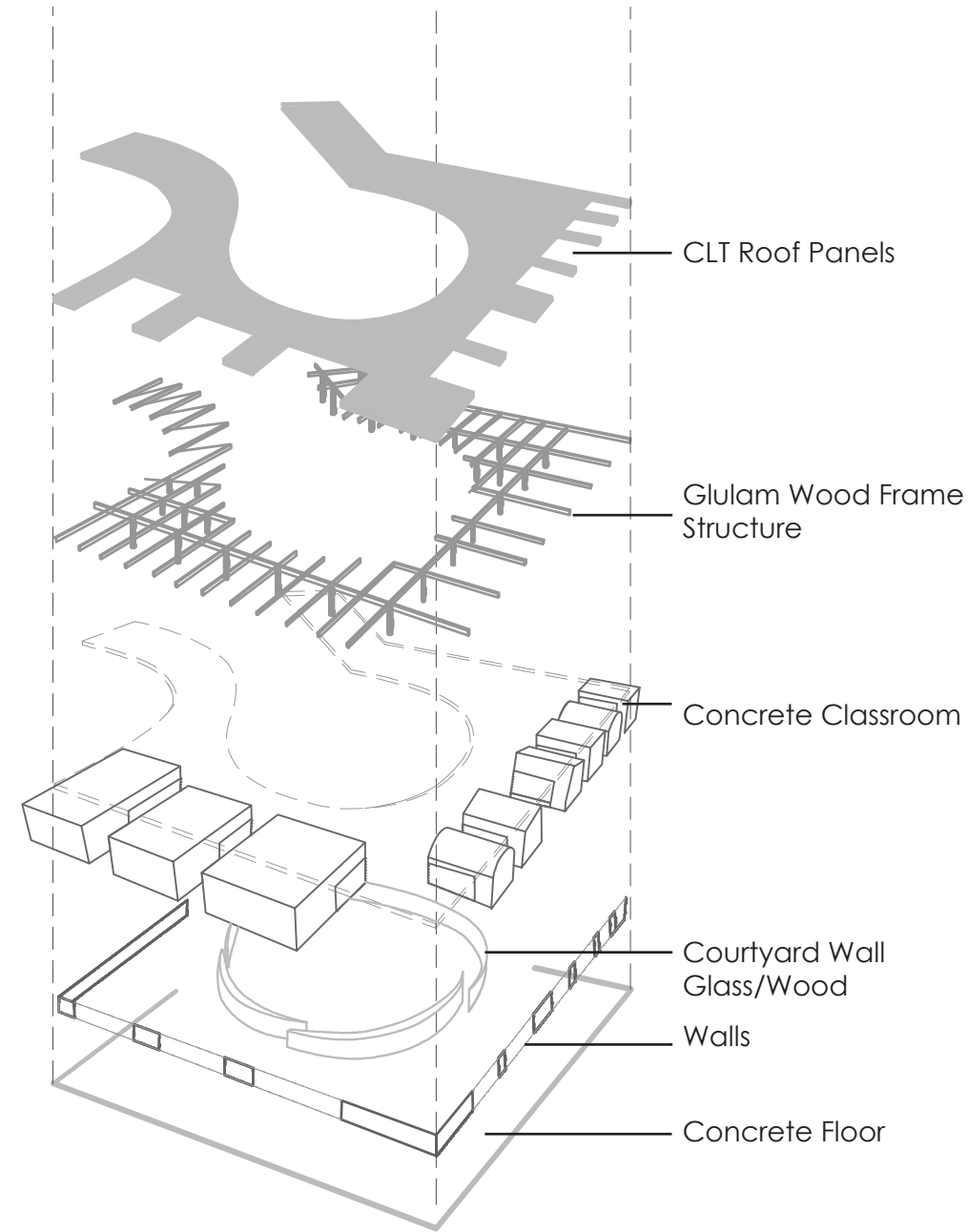


Play Area

Ground Floor plan

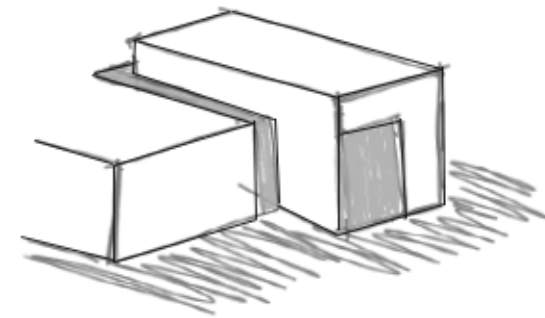
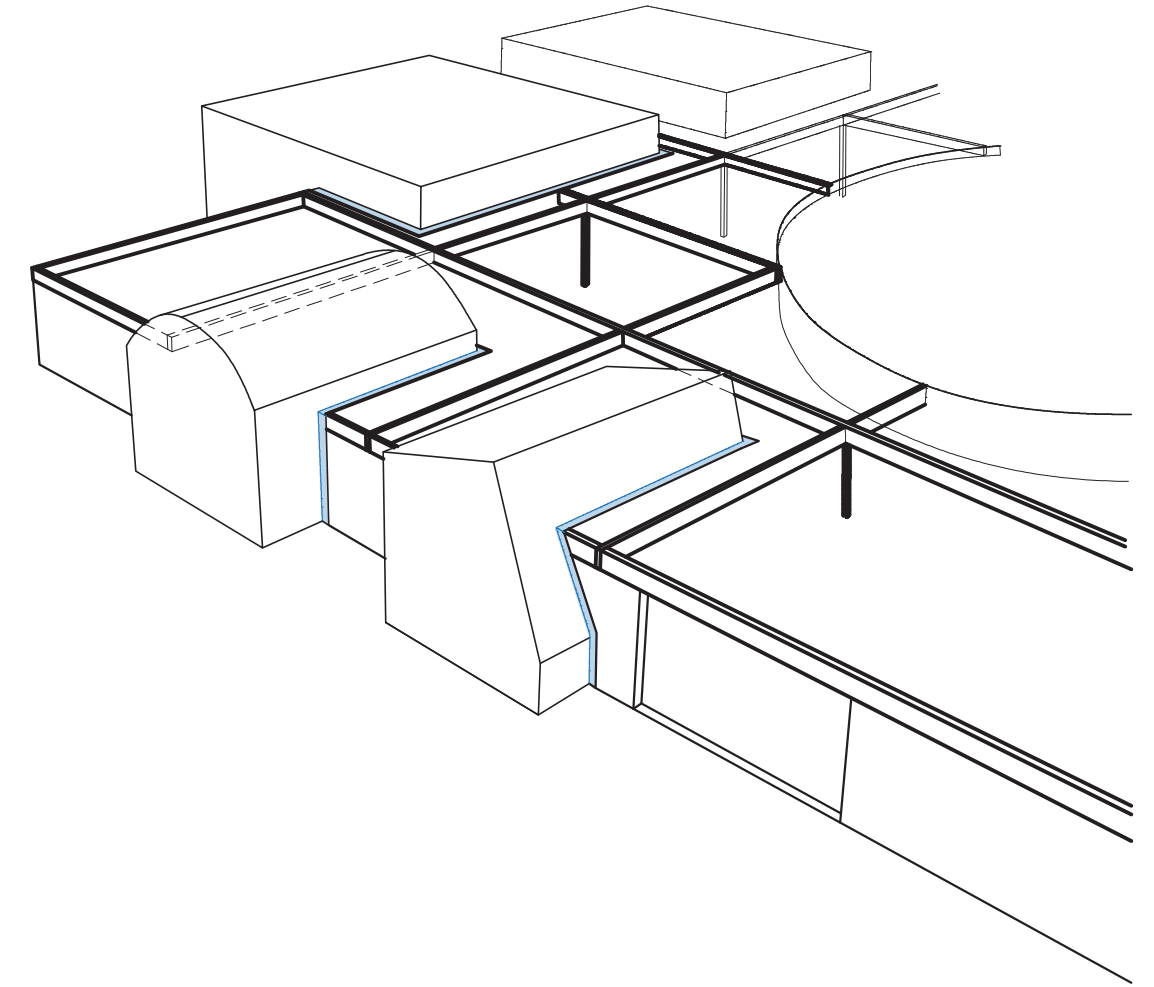


# Structure



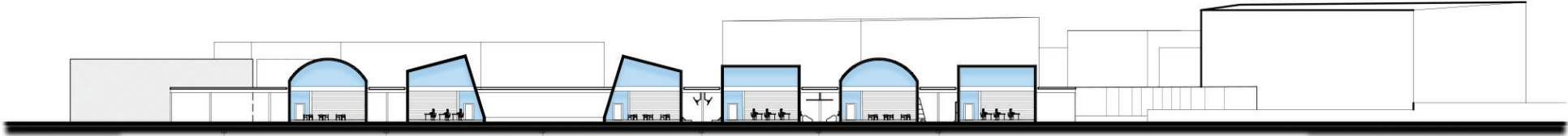
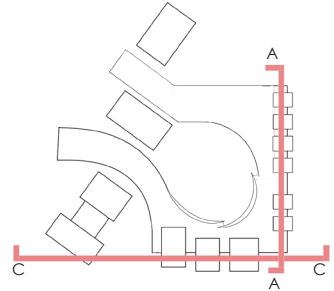
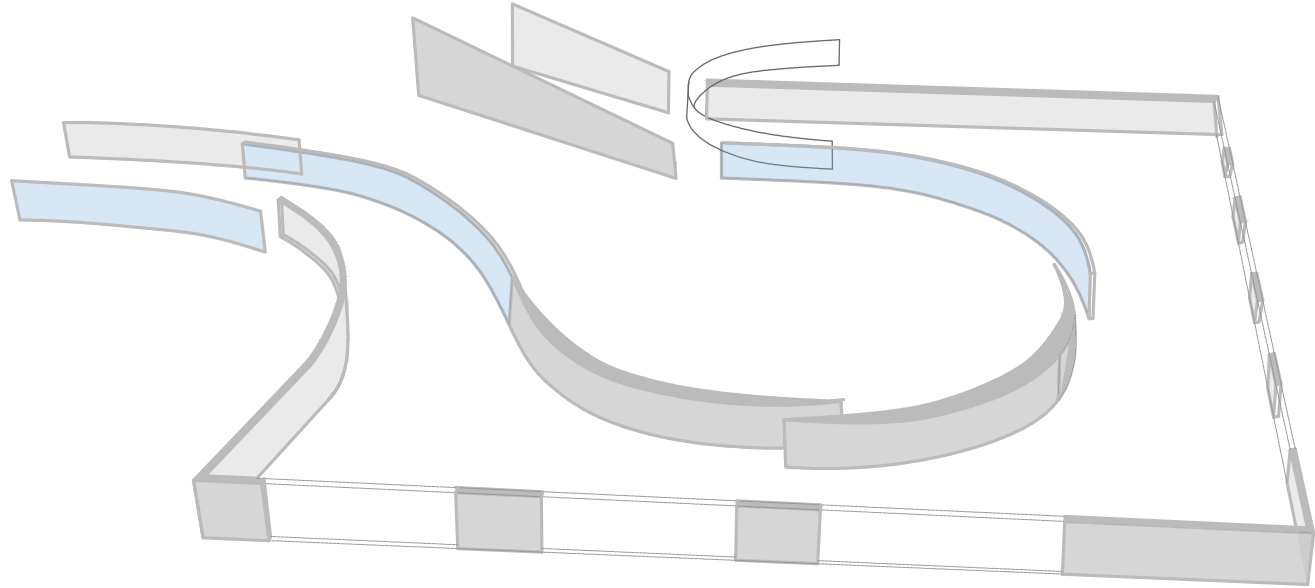
## Frame & Columns

Two structural systems exist to form the building. The first one is the wood frame structure supported by columns that forms the pavilion space. The system is laid on a concrete slab and topped by CLT wood panels. The classrooms are concrete boxes inserted within the wood frame puncturing the roof panels as shown in the figure. The insertion of the classroom in the volume with the lighting gap expresses independence in presence. So the classrooms are independent both visually and structurally.

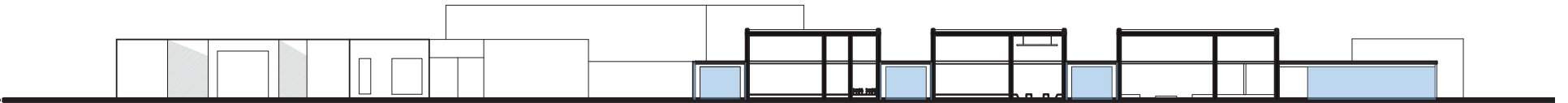


# The Walls

The other system is that of walls. Where the walls serve as the enclosure of the space. The walls transition from solid to opaque as the spaces vary in interior quality.

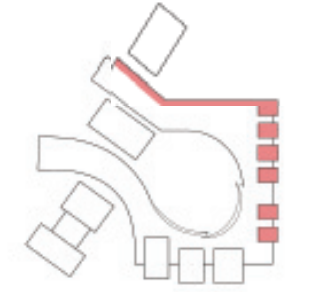


Section AA



Section CC

# Elevation Study



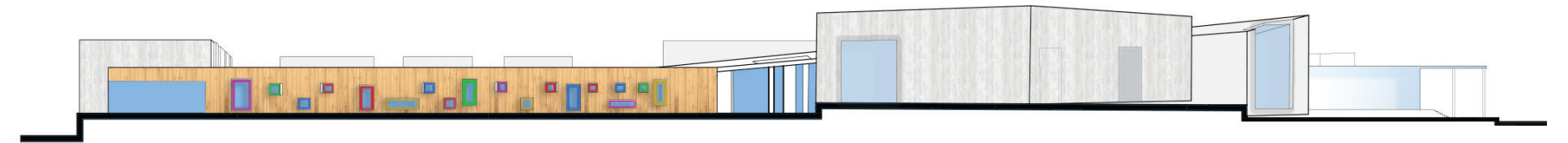
The elevation indicates structural hierarchy, as it expresses the classrooms' independence and adjacency to the main structure.

Many iterations have been tested to decide on the language of openings in the elevation in order to create a discreet formal expression.

The different forms assigned for the classrooms act as visual aids for children in the playground where each can identify his own classroom. It also helps children recognize their classrooms when accessing them from the hallway.

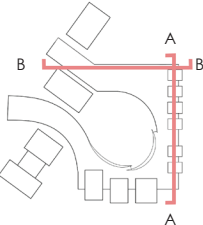


South East Elevation

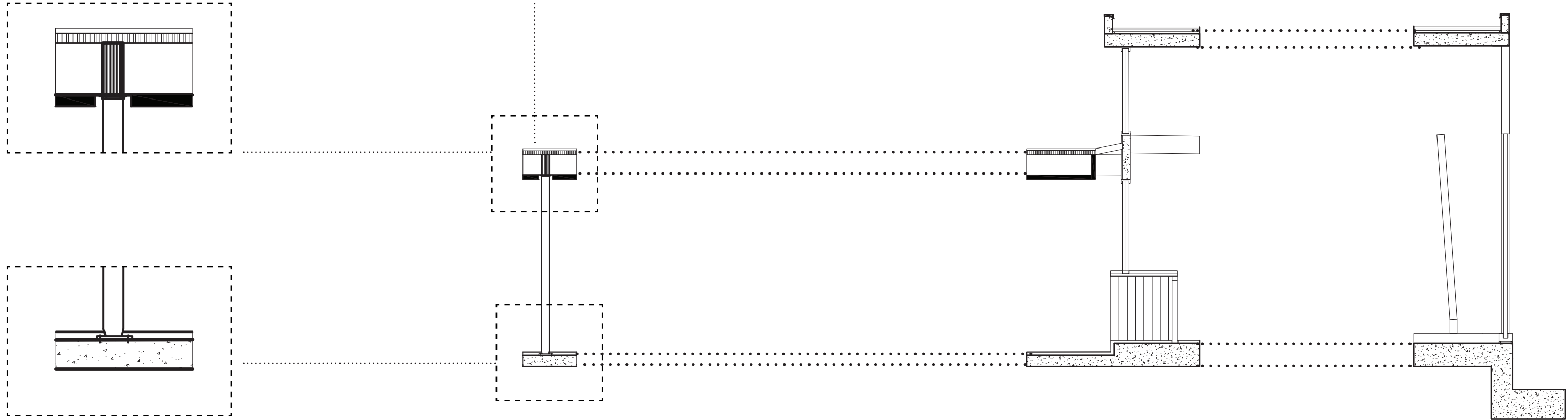


East Elevation

# Details

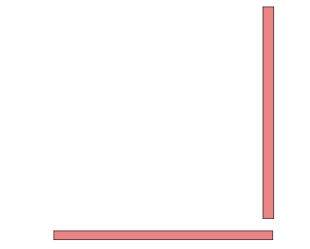
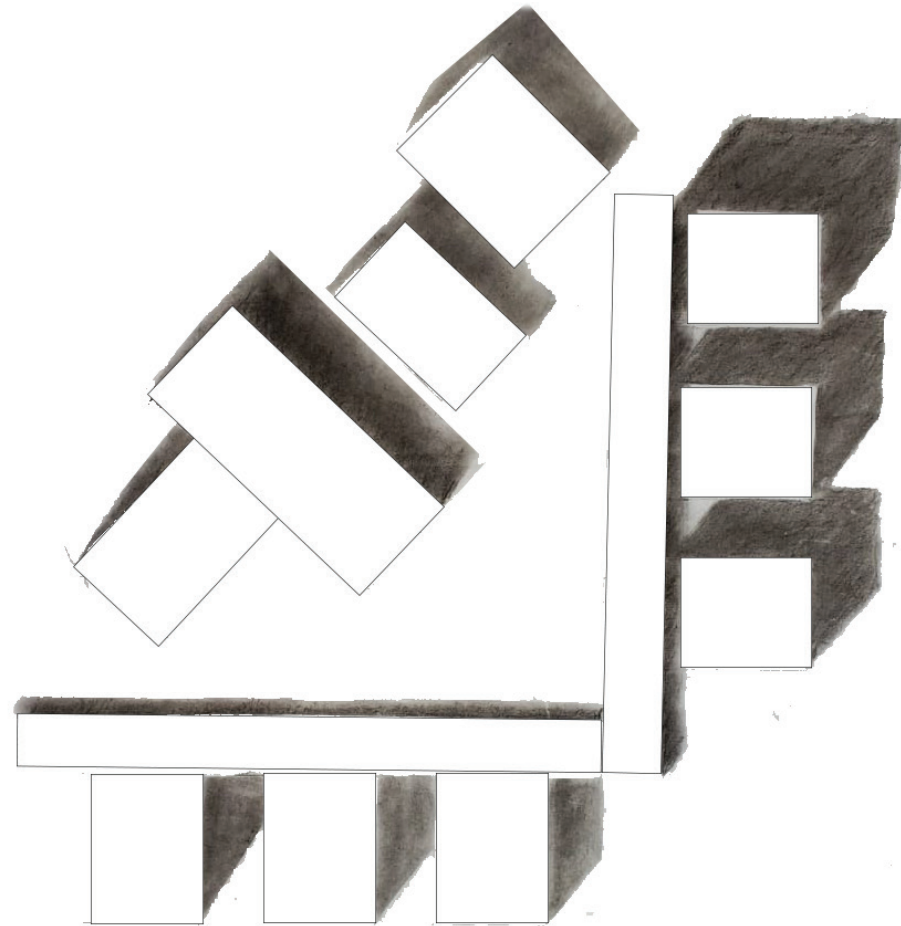


Section BB





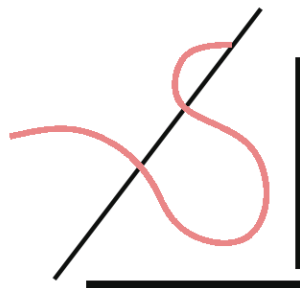
# Sensory Zones - Stimulus Areas



Classrooms & Labs



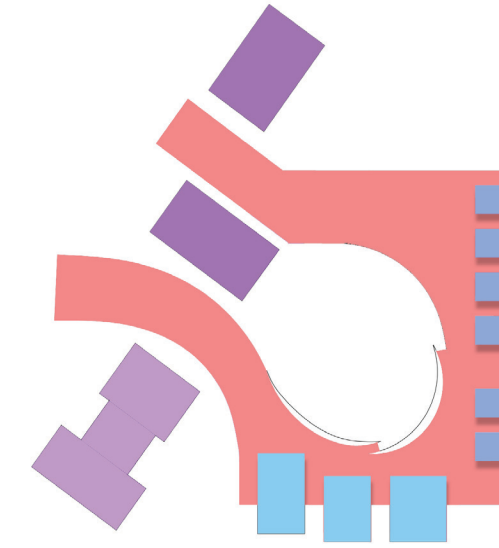
Activities & Admin



Play Area

The design suggests 2 sensory zones; grouping all low-stimulus activities such as classrooms and labs in a straight grid, and the high-stimulus activities such as cafeteria and music room are in an oblique grid. The two grids are connected together by a curve that clearly defines the trajectories and bounds the play zones.

The stimulus zones also respond to the flow of people in the respective spaces. The low-stimulus zones are areas for smaller gatherings and the high-stimulus zones are for larger groups.



## Stimulus Zones

- |               |   |
|---------------|---|
| Low Stimulus  | <span style="display: inline-block; width: 10px; height: 10px; background-color: #0070C0; border: 1px solid black;"></span> Classrooms        |
|               | <span style="display: inline-block; width: 10px; height: 10px; background-color: #00B0F0; border: 1px solid black;"></span> Labs              |
| High Stimulus | <span style="display: inline-block; width: 10px; height: 10px; background-color: #6A329F; border: 1px solid black;"></span> Administration    |
|               | <span style="display: inline-block; width: 10px; height: 10px; background-color: #800080; border: 1px solid black;"></span> Active Zone       |
|               | <span style="display: inline-block; width: 10px; height: 10px; background-color: #E41A1C; border: 1px solid black;"></span> Play Common Space |



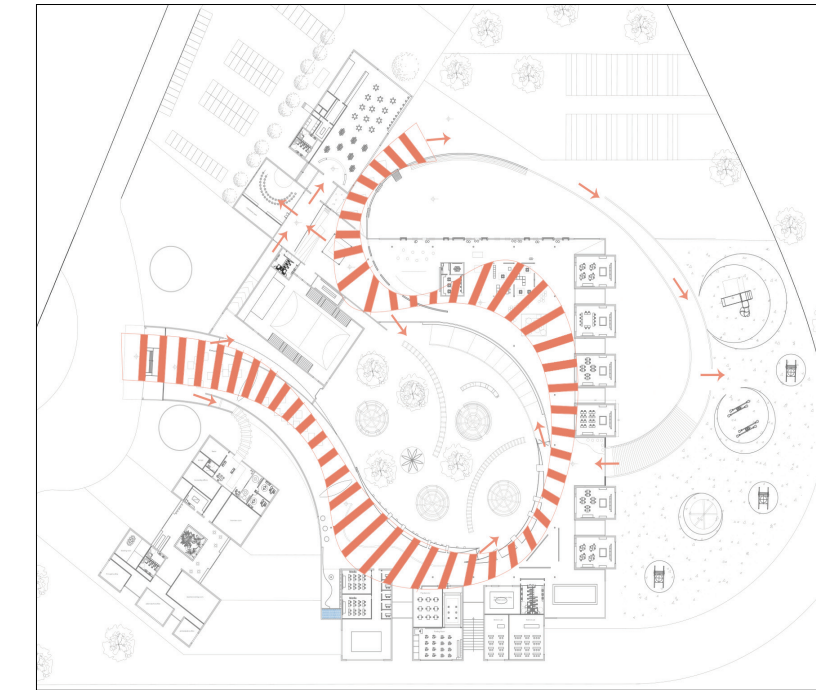
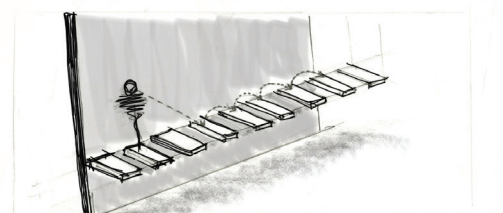
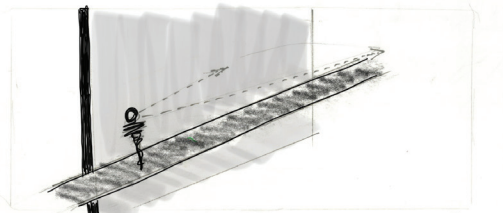
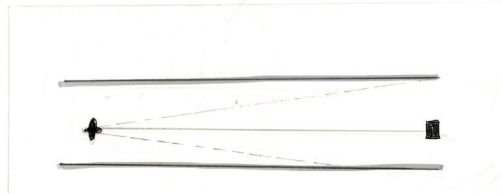
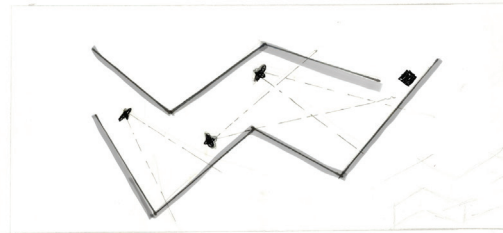
## People Flow in Space

- 1-5 people
- 6-15 people
- 16-20 people
- 20+ people

# Spatial Sequence

“When coupled with sensory zoning, the issue of conducive way finding and navigation may greatly aid the special needs user in gaining various skills and independence while freeing staff and faculty.”  
(Mostafa, 2014)

This aspect is especially important in the process of laying out the program and areas. Children with autism have an affinity to repetitive patterns and may have problems if the flow of their routine was interrupted. This is why we see in the plans a one-way non-obstructed circulation and clear points of entry and exit. It is important to keep the layout of the program in a sequence that supports the schedule of the day. Leaving a space for flexibility and user's intervention to edit those spaces programmatically and spatially.

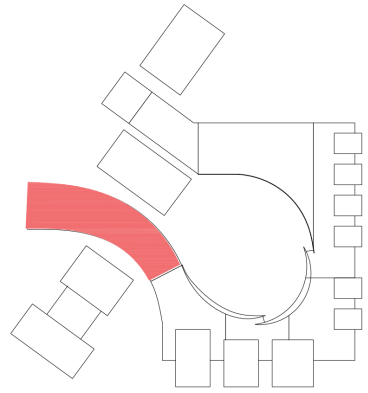
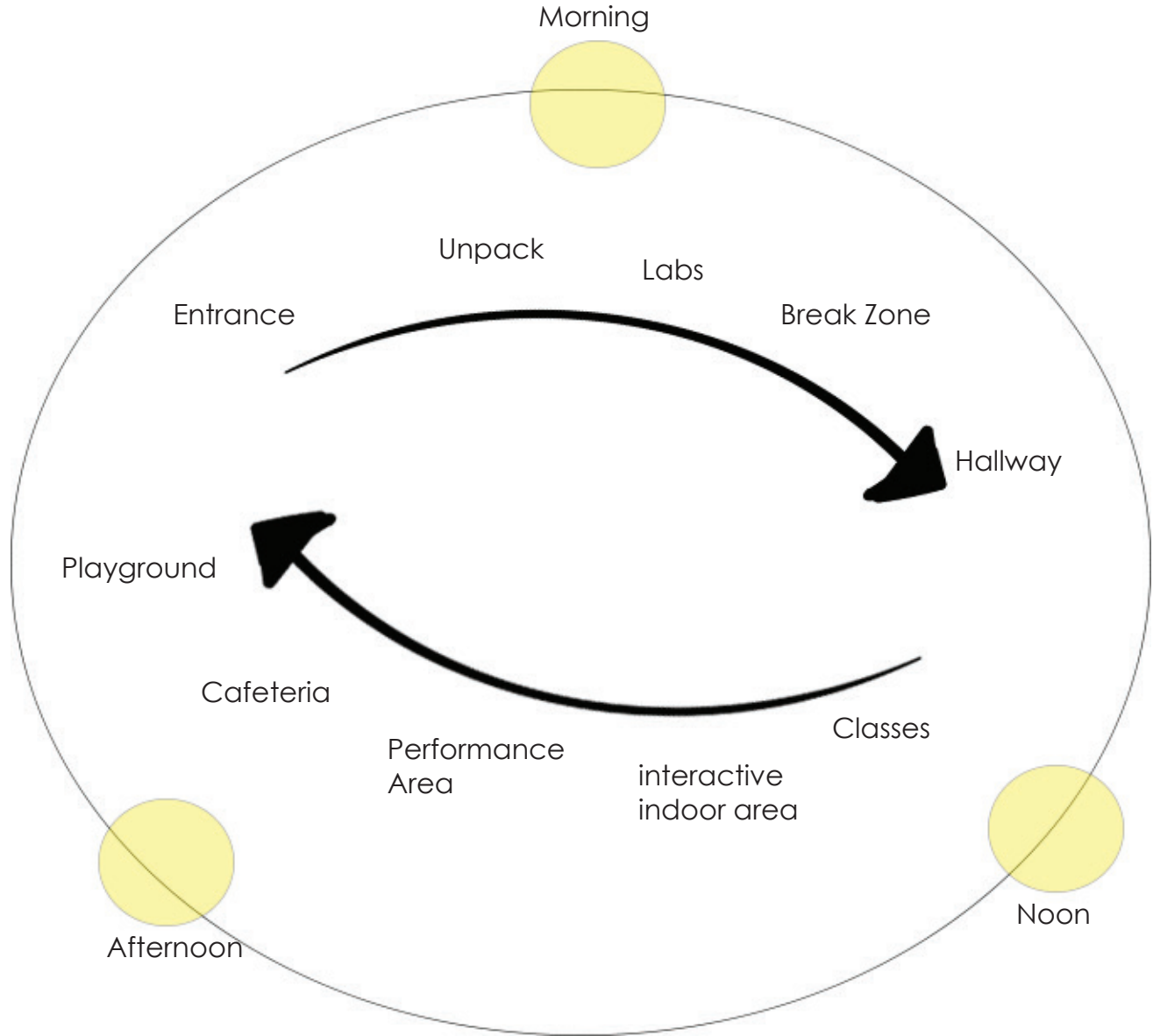


General Circulation

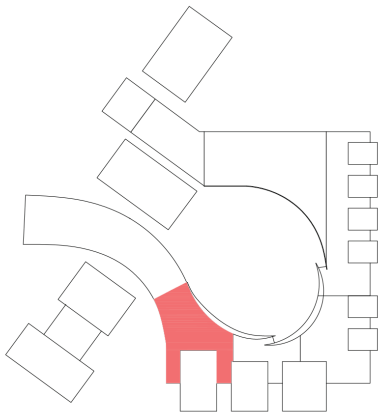


Points of Entry & Exit

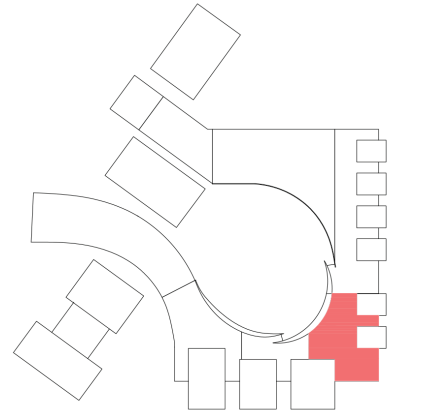
# Zoning Response to Daily Schedule



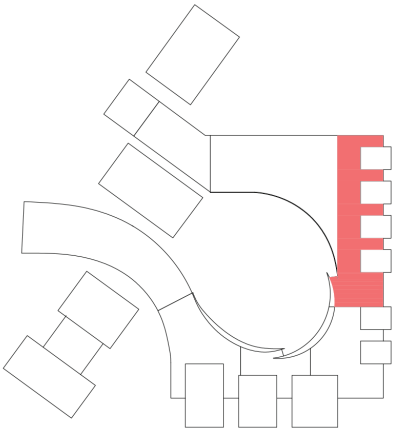
Entrance/ Exit / Waiting Area



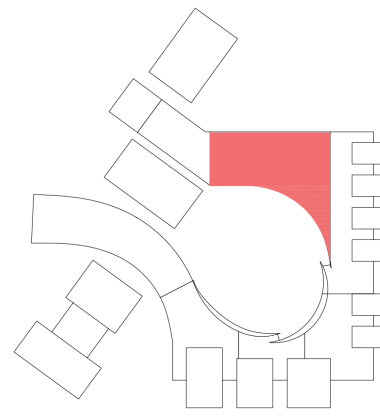
Transition part  
Exits to outdoor



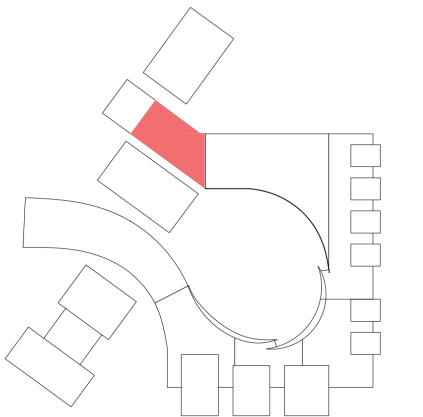
Space to exhibit children work



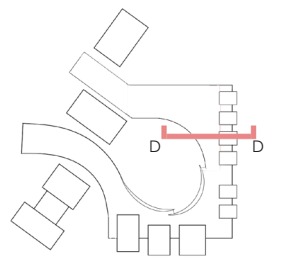
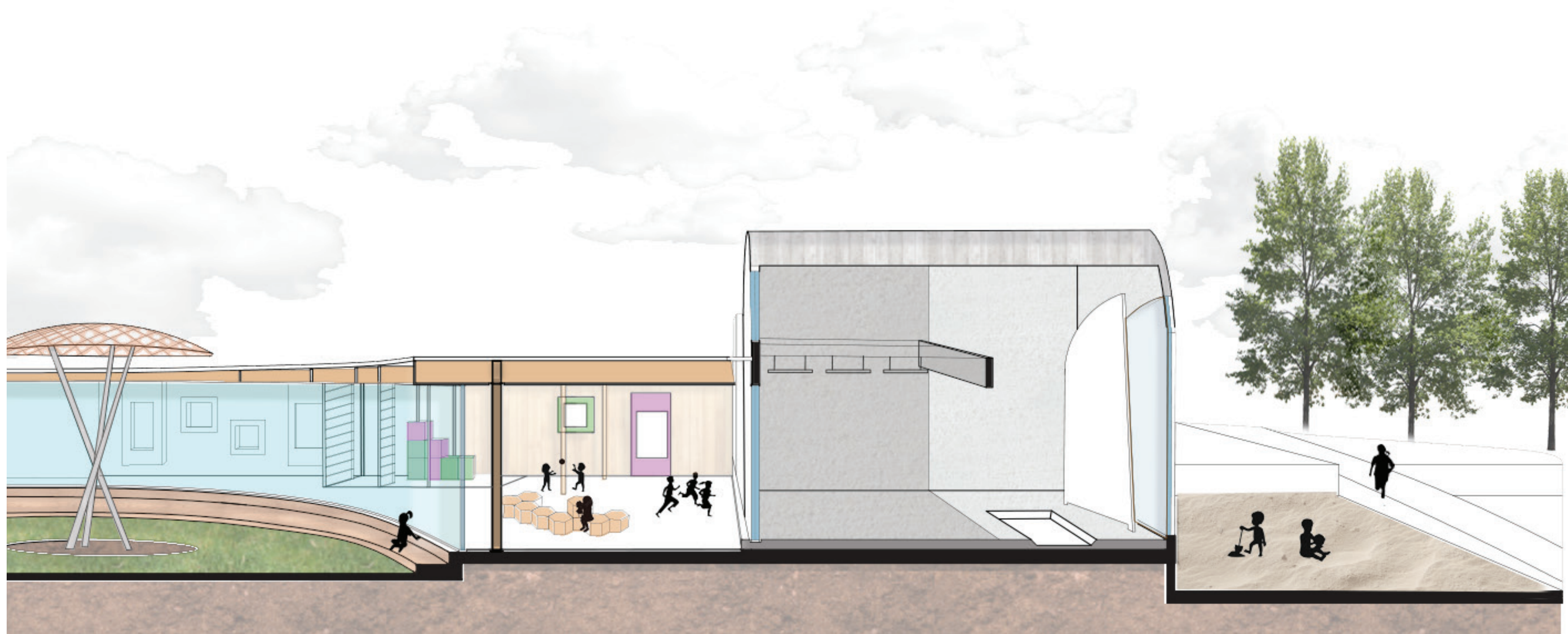
Hallway  
Escape Zones



Performance Area



Indoor Play Area  
Library  
Teachers Room



Section DD

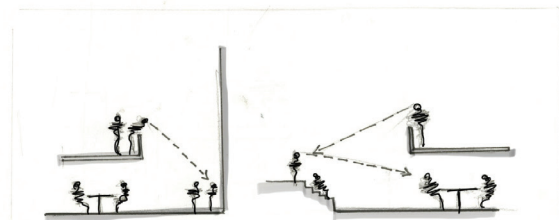
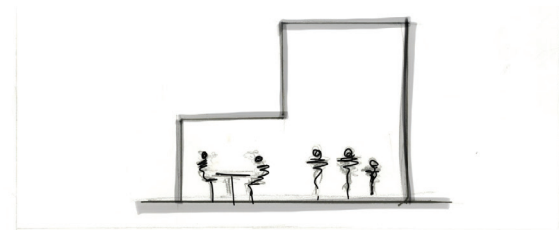
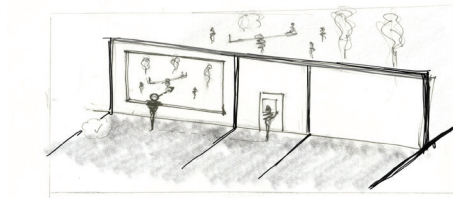
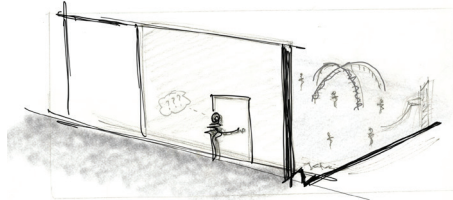
# Transition Zones

“Working to facilitate both Spatial Sequencing and Sensory Zoning, the presence of transition zones helps the user recalibrate their senses as they move from one level of stimulus to the next.”  
(Mostafa, 2014)

As students propagate from one space to another, the transition zones are located where a shift in activity occurs. Visual transition is very important for the students. It is helpful that students have a hint of the space they are going to enter, to eliminate ambiguity. The diagram above shows that the all shift in spaces is gradual and never abrupt.

The Transition concept is expressed on different levels:

- The Plan
- The Rooms
- The Elements



high stimulus



Transition zones

low stimulus



Gradual transition



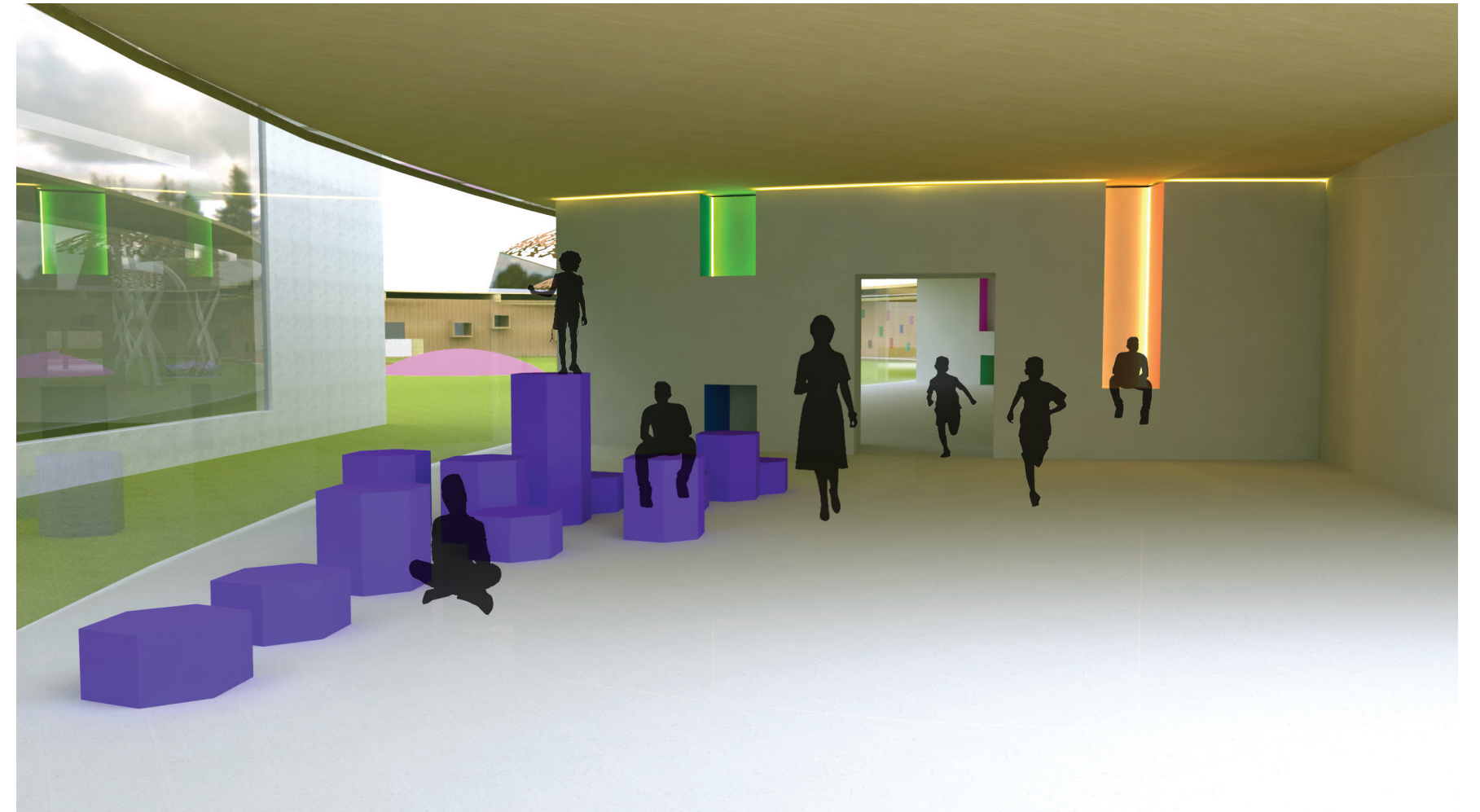
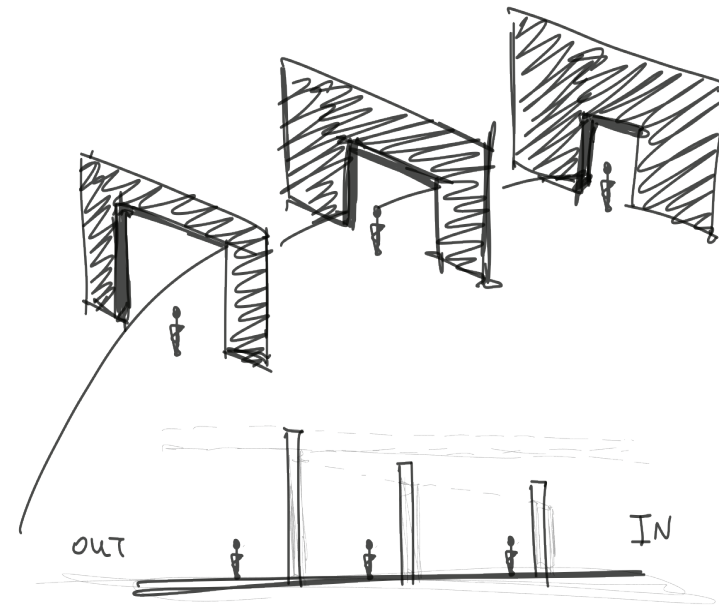
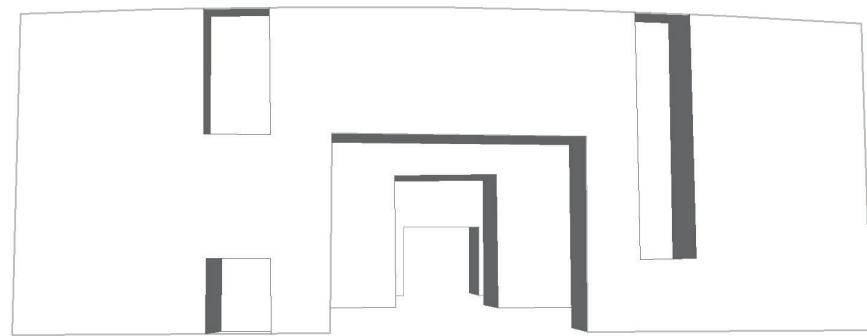
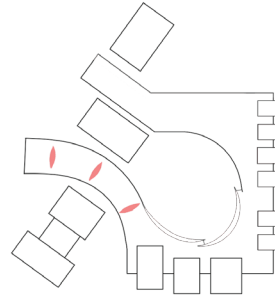
Transition Areas Studied

## Transition : Gradual Entry

The entrance is the first perception of the school. It marks the transfer from the outer world to a more protected environment that students will spend most of the day in.

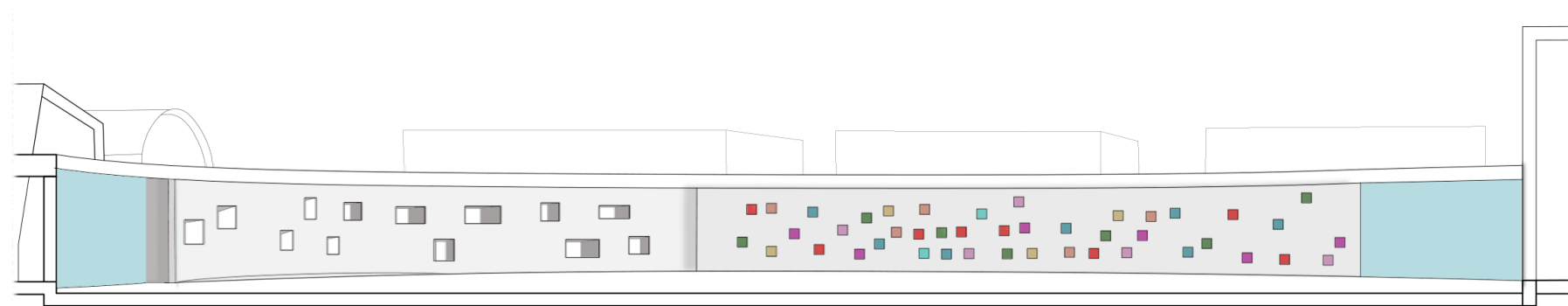
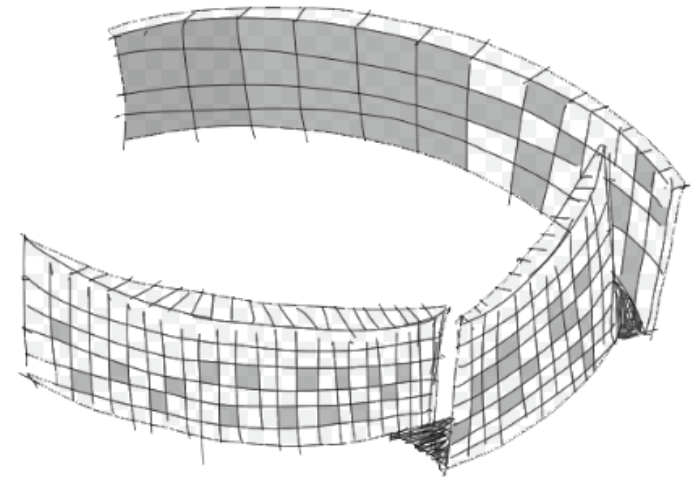
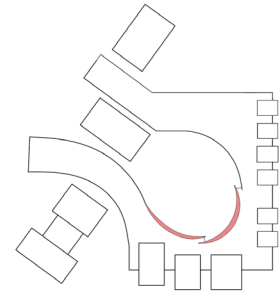
The gradual reduction in the scale of the entrance opening serves to make the student more aware of the shift of environments.

The entrance walls also can host seating and lighting features as they serve as visual cues.



# Transition: Courtyard Wall

These threshold zones help the users adjust their senses as they move from one level of stimulus to the next and are especially important as they transition from low-stimulus to high-stimulus areas. This wall gradually reveals the courtyard where it becomes fully transparent when adjacent to the indoor play area.

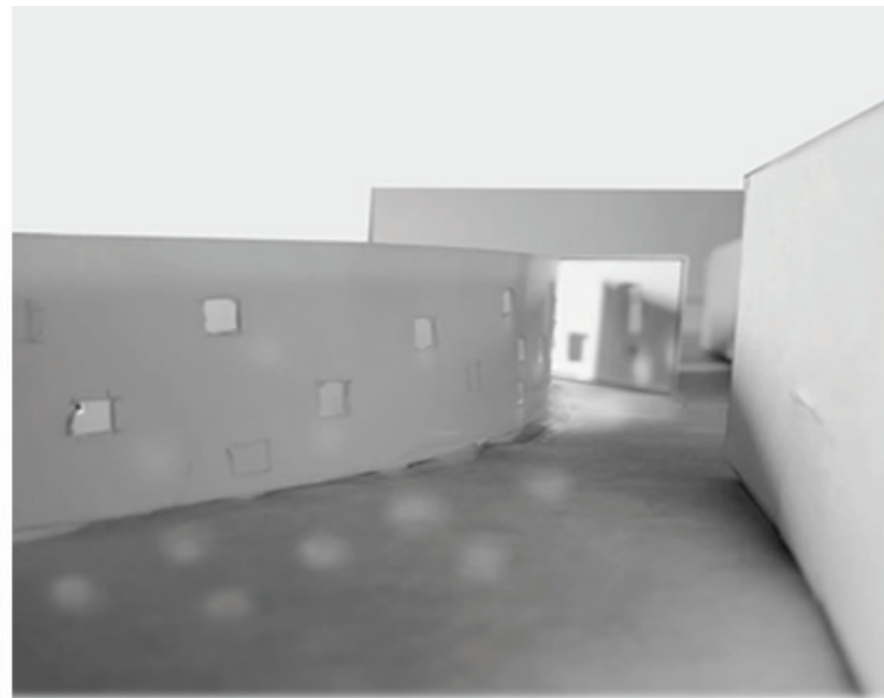
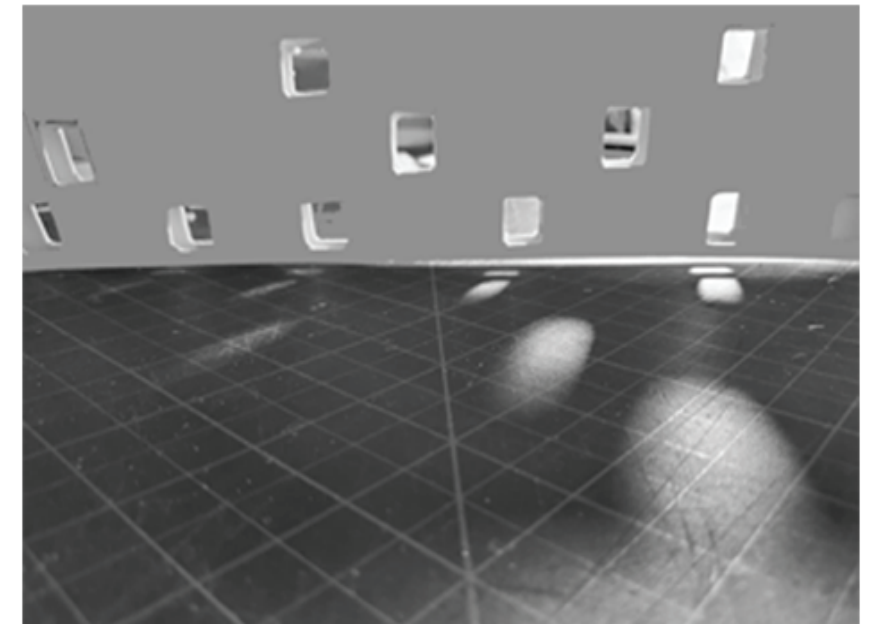
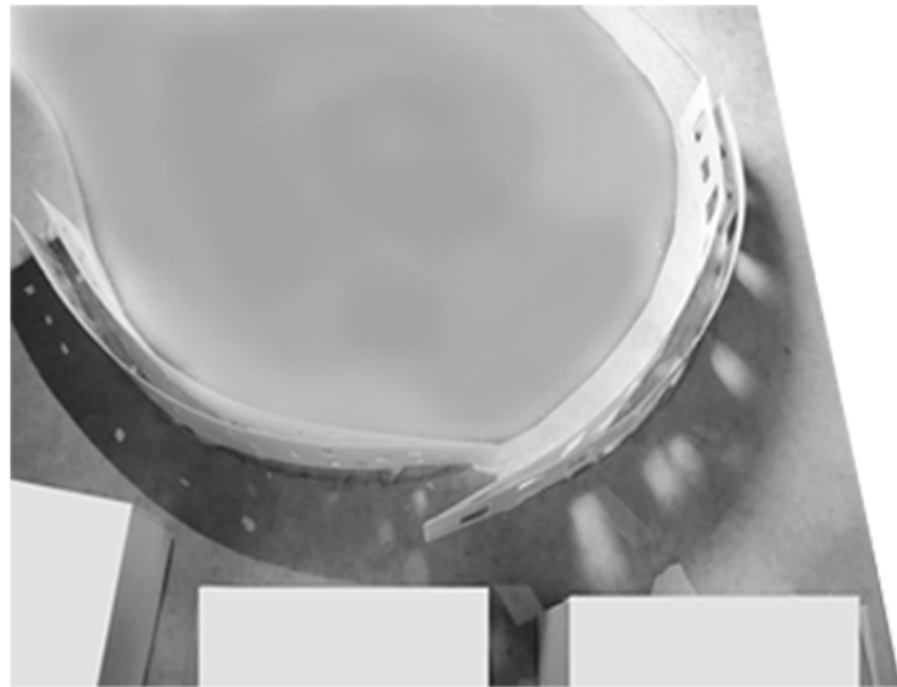


view from the courtyard



# Transition: Courtyard Wall

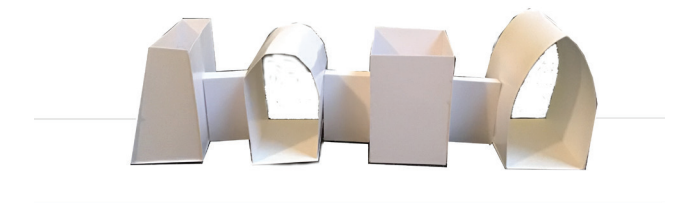
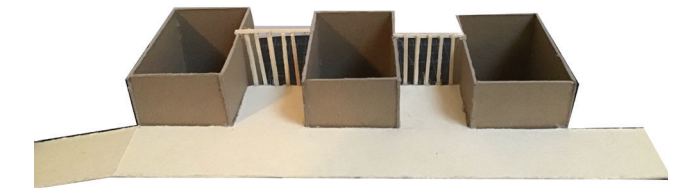
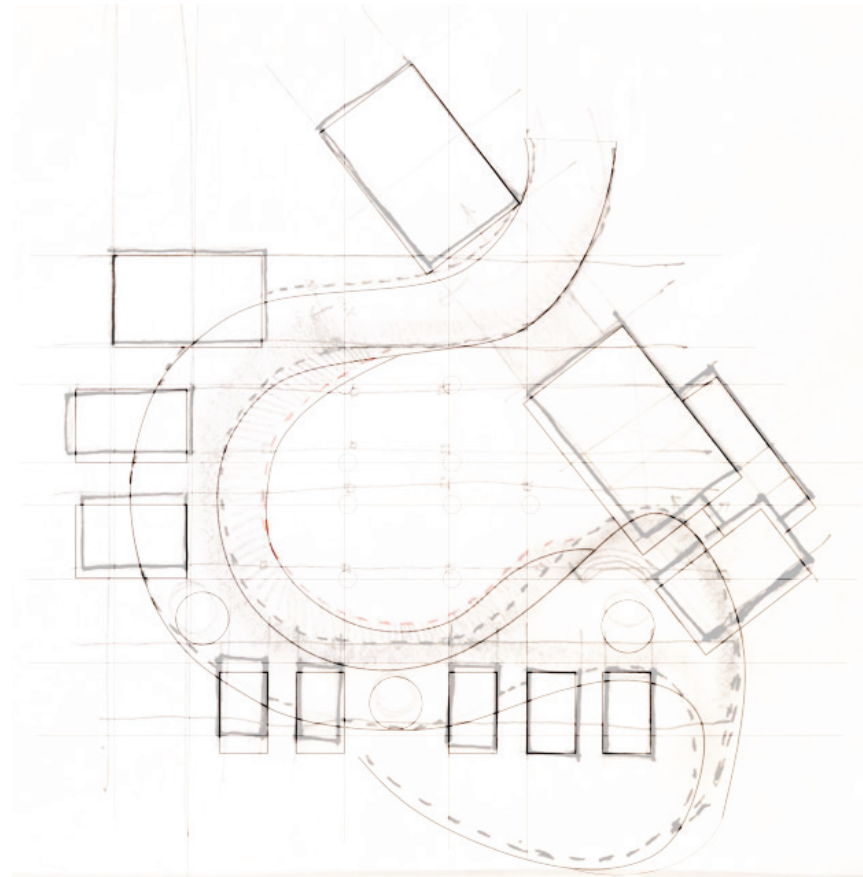
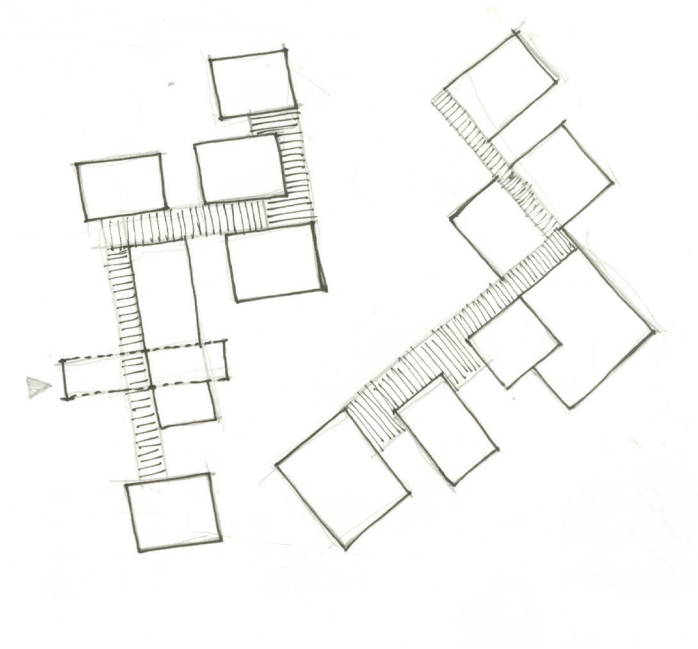
Physical Model





# Compartmentalization

This aspect was also tackled on many levels, starting with the massing. The classrooms and Labs are defined as isolated zones. The play zones are embedded within the general circulation. To provoke spontaneous play opportunity for the children.

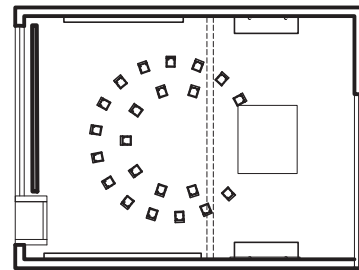
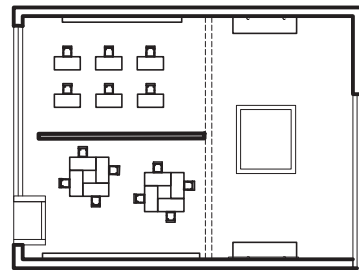
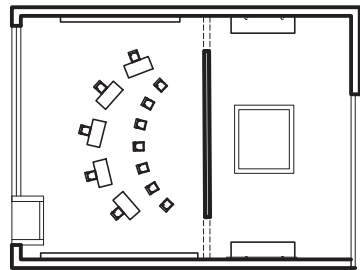
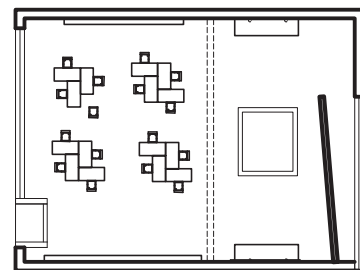
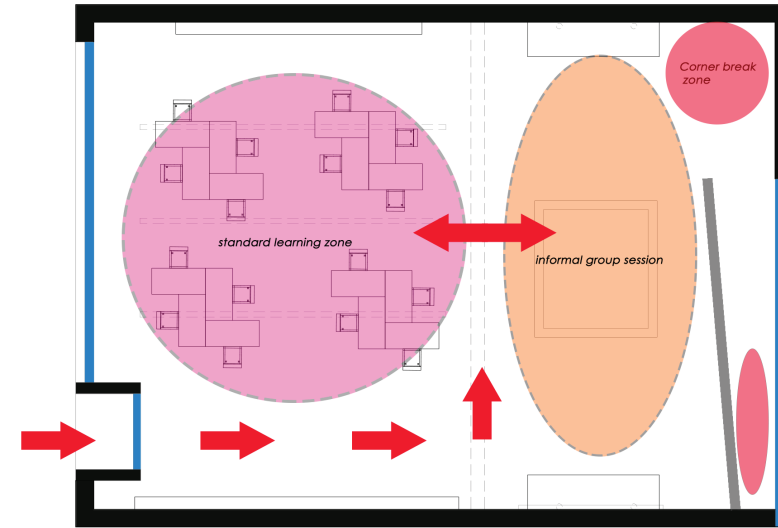


Classroom Grouping- Physical Models

# Compartmentalization in Classrooms

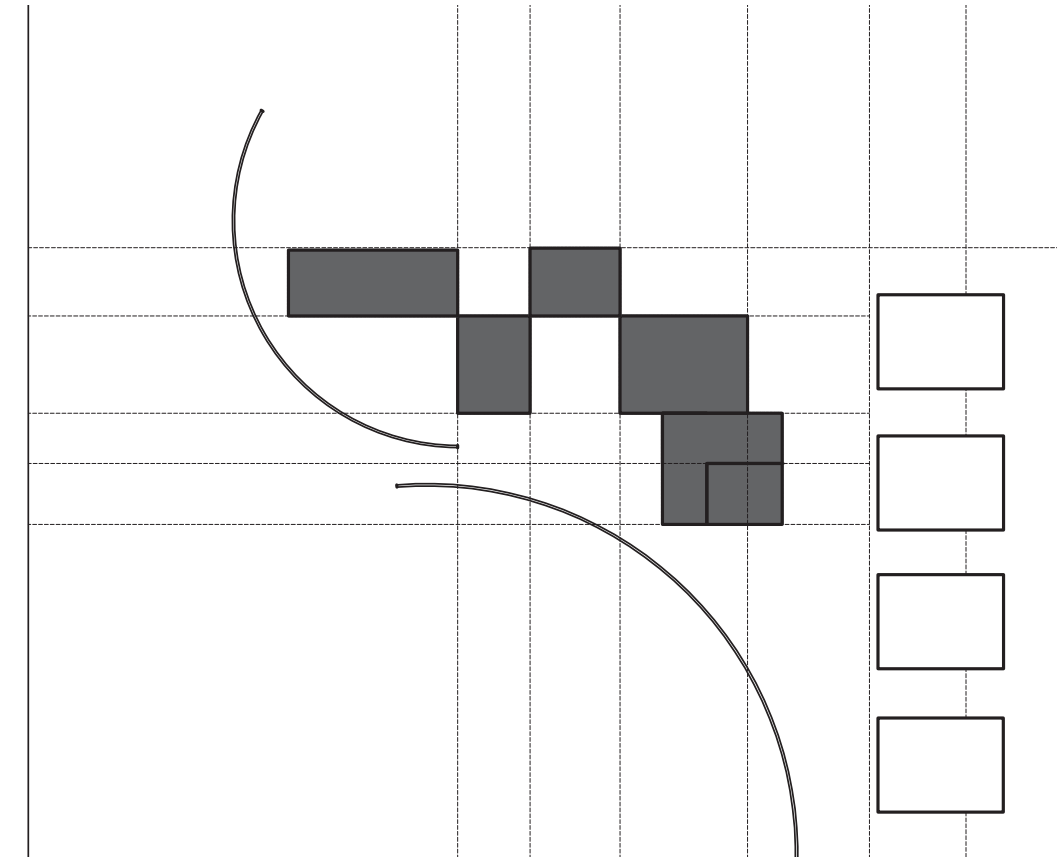
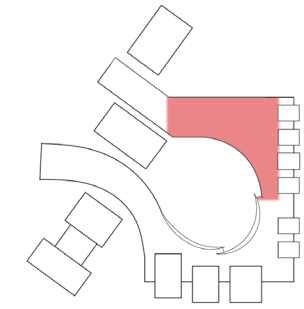
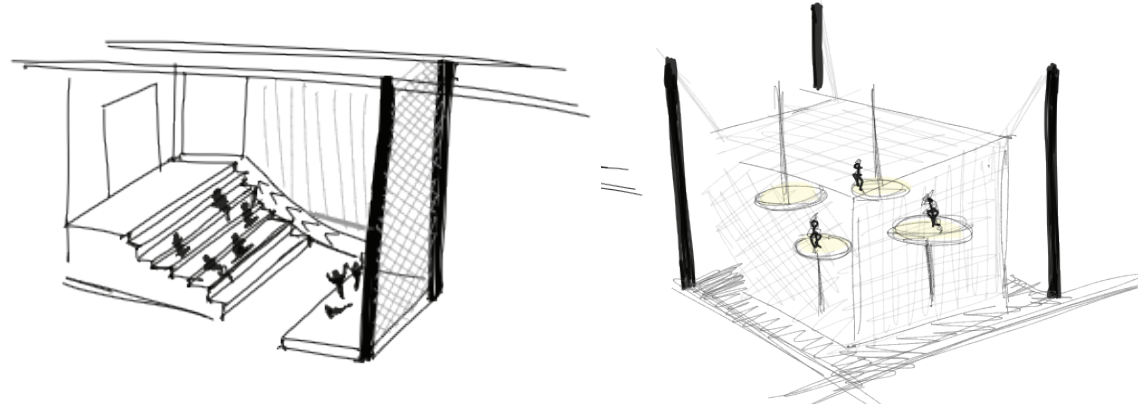
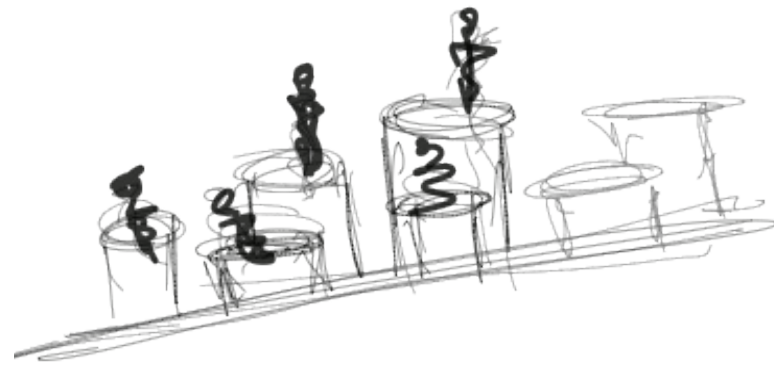
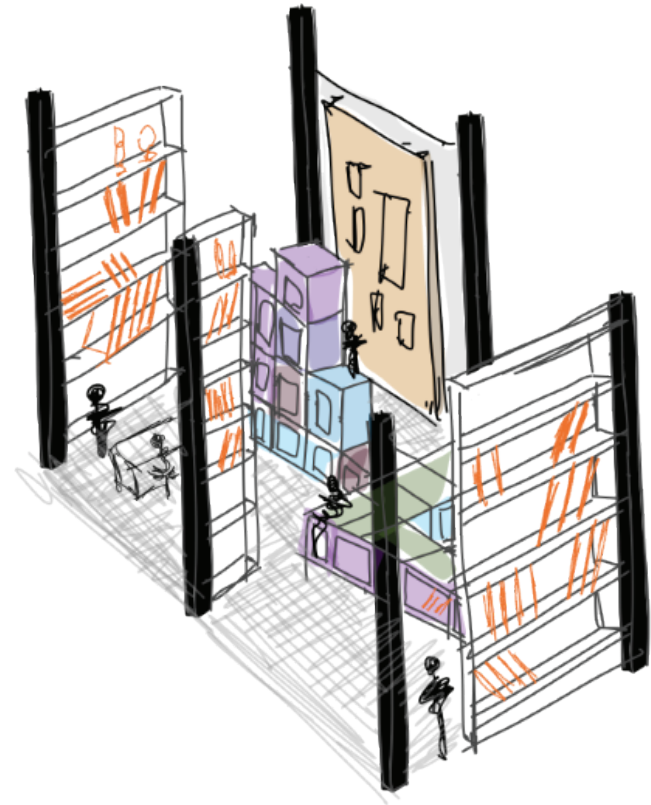
The classroom itself is divided into 2 main zone; the focus and the informal zone. It is a flexible space, where its configuration can be modified by the teachers and used in diverse ways by the students.

The board in front of the window serves as a mobile partition that can help in the reconfiguration of the room as shown below. The space includes escape zones in the corner and behind the board.

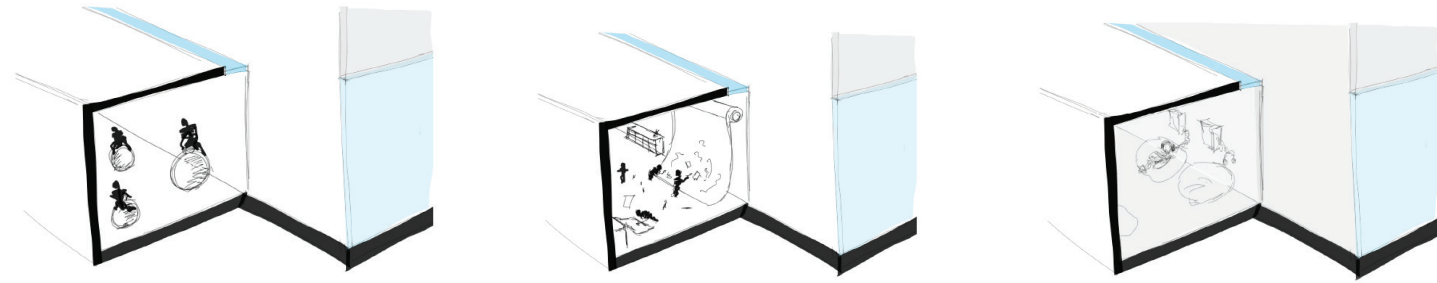


# Play and Escape Zones

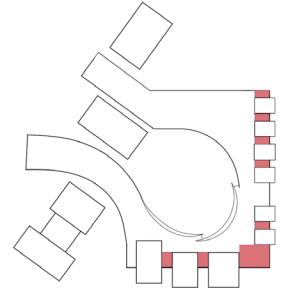
While designing indoor play zones, I regarded them as opportunities for social interactions. I remember my nephew would communicate with strangers over a game of puzzle. And after researching that issue, it appears that children with autism are more likely to connect with other people over an activity they feel comfortable doing. So the play zones are places of familiar and fun activity that help them connect with others. This is why it is weaved into common and circulation spaces and not isolated, allowing higher chance for



# Escape Zones



These are more introverted spaces that are distinguished from the common space. These zones can fulfill various functions; it creates a room of intimate scale allowing students with delayed social skills the chance to interact with smaller groups of children and a refuge from over-stimulating incidents.

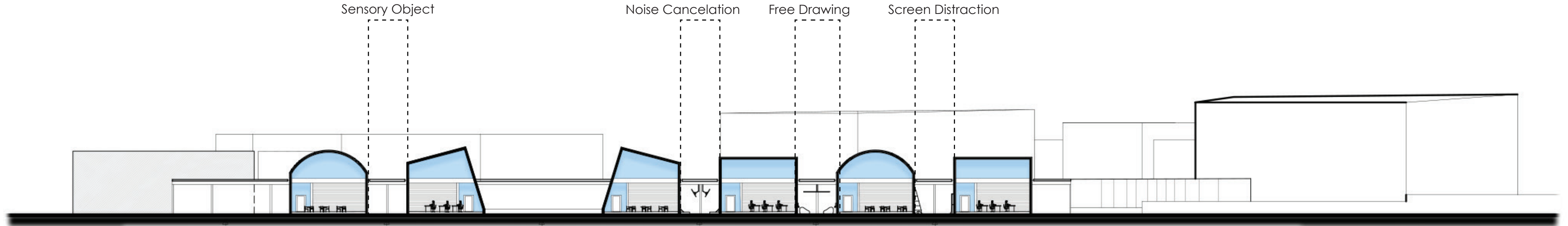


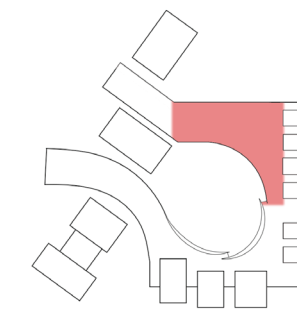
Sensory Object

Noise Cancelation

Free Drawing

Screen Distraction

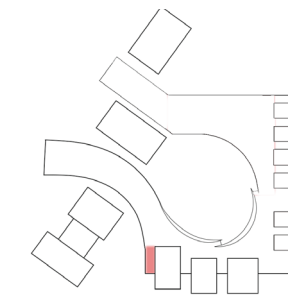




The Library Area

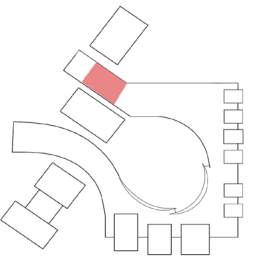


Break/Waiting Zone





Performance Area



# Safety

Safety is a main concern in schools where children have to be under constant supervision.

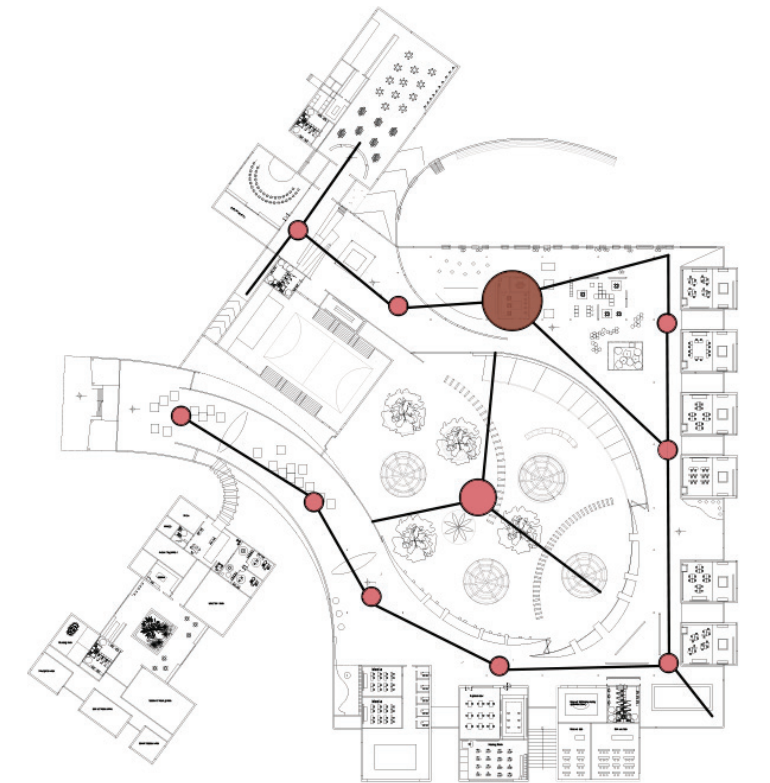
The first plan shows egress exits.

The second plan shows the visual line that connects different points of supervision. It also shows the teacher's room placed amidst the indoor play zone and approximate to classrooms.

The design is fully accessible given that it is on one level, and any steps have alternative ramp access.



Egress



Supervision Points



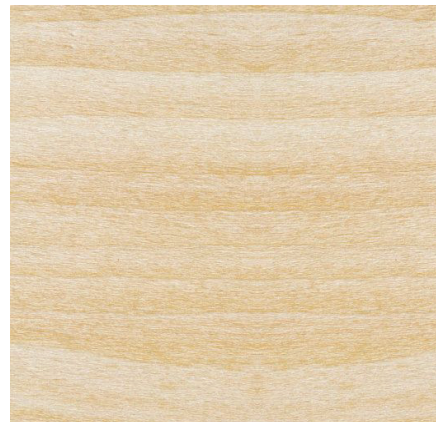
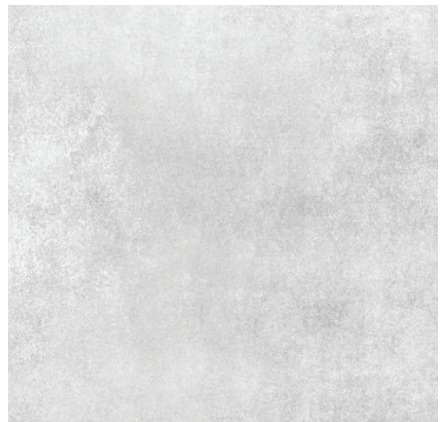
## The 8th Aspect : Materiality

“Material arouse particular associations that can influence the way places are used ... Material that is impossible to damage will not teach children to treat it with respect and to recognize what you can and cannot do with it.”

Herman Hertzberger, *Space and Learning*



## The 8th Aspect : Materiality



Material is particularly significant in such a project where children associate touch with sound, smell and color. Assigning material to a wall in this school is tied to orientation and awareness of space. This project chooses a limited material palette for discreteness yet it provides diverse texture to allow different sensation of space and surfaces. The classrooms for instance have rough exterior finishes. The interior includes 2 parts, the first part is of darker concrete for the focus zone, and the other part is of smooth white concrete finish for the informal learning zone and for reflection purposes. The play areas are mostly of wood surfaces, where wood is a more fragile material that could be more responsive to children's activities.

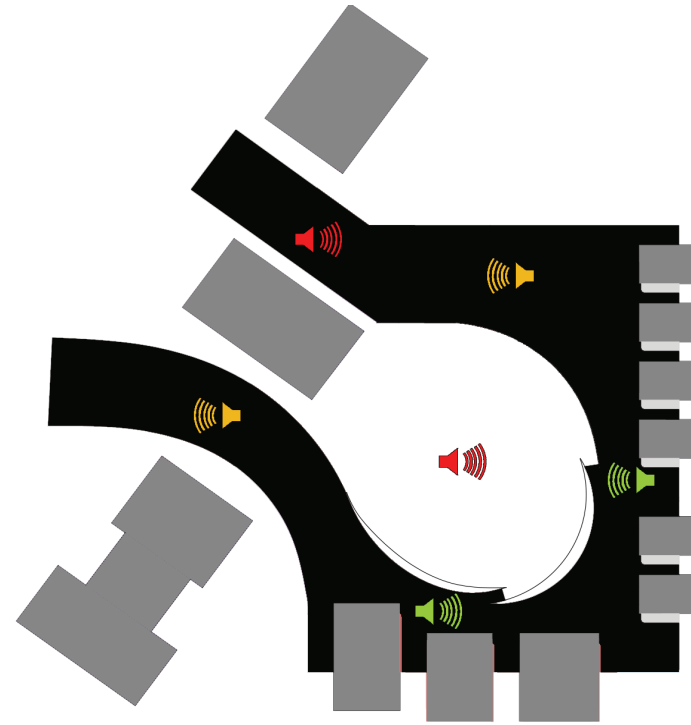







The choice of material also affects the impression of the space. As you may see in the different renderings, the change in the directionality of the material implies various things about the structural hierarchy. The choice of vertical studs for the wall, large panels for the ceilings and smooth concrete slab for the floor, gave the intended impression of hierarchy where the ceiling is held by the columns sitting on the wall enclosure.



# Material and Acoustics



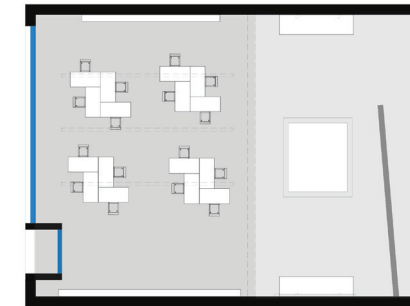
## Acoustic Zoning

-  Low Noise
-  Medium Noise
-  High Noise

In studying material it was an opportunity to think of engaging all the senses. As material is not only related to sight and touch but also to sound.

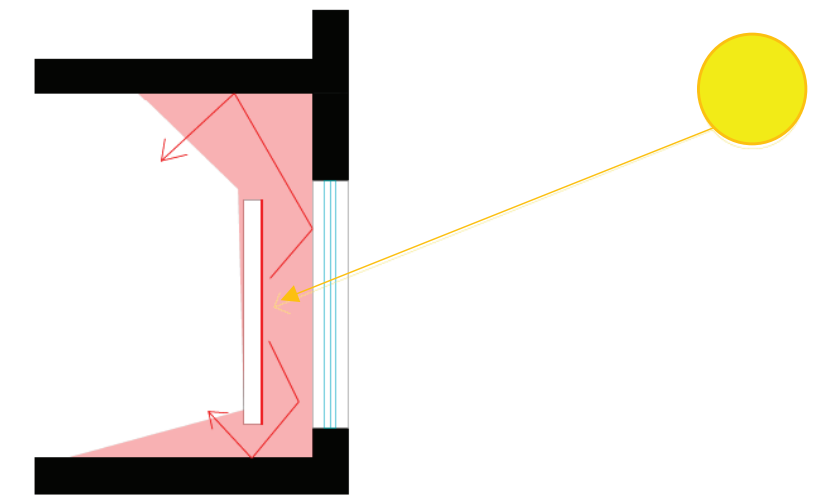
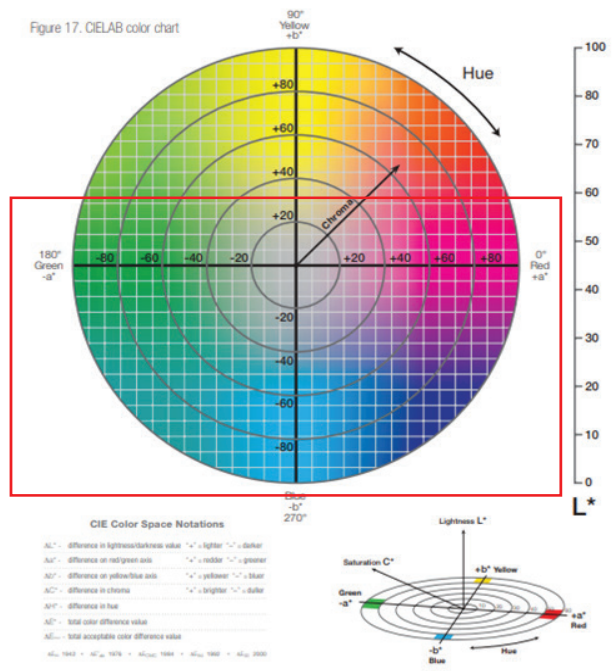
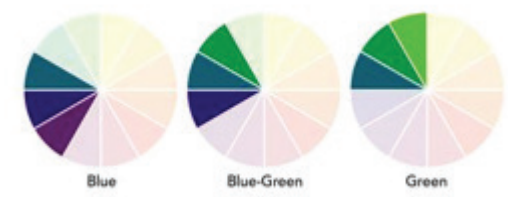
Acoustic zones define the areas of low and high noise on the plan. There is gradual transition in noise level in relation to stimulus zones. The spaces with high noise are mostly play area with large gatherings and high activities.

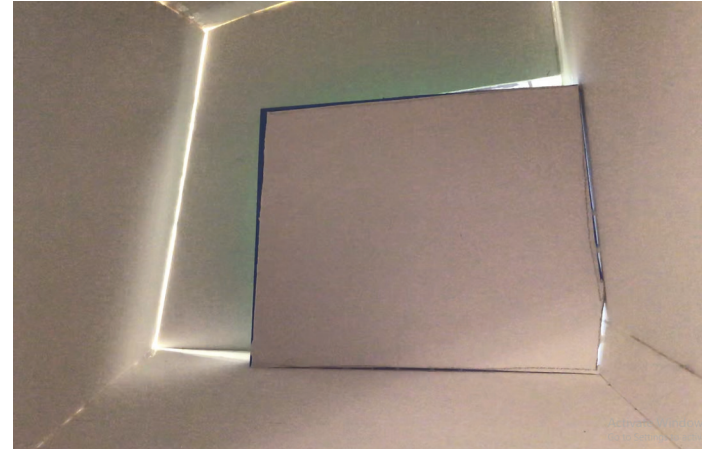
Materials have been placed with attention to their acoustic properties. Play zones have been distinguished from focus zones by change in material, bearing in mind the difference in sound made stepping and touching this material. Stepping on wood makes sound and stumping on it makes music, I wanted the play areas to be interactive zones that embrace the active movement of children. While the spaced wood studs on the walls help in mitigating sound to avoid noisiness. On the other hand, concrete walls are placed in classrooms that reduce exterior sounds coming into the class. And the difference in texture of the concrete within the classroom help reduce echo. Concrete floors help mute the sound of steps which reduces distractions during activities.



Material plan

# The 9th Aspect: Color and Light

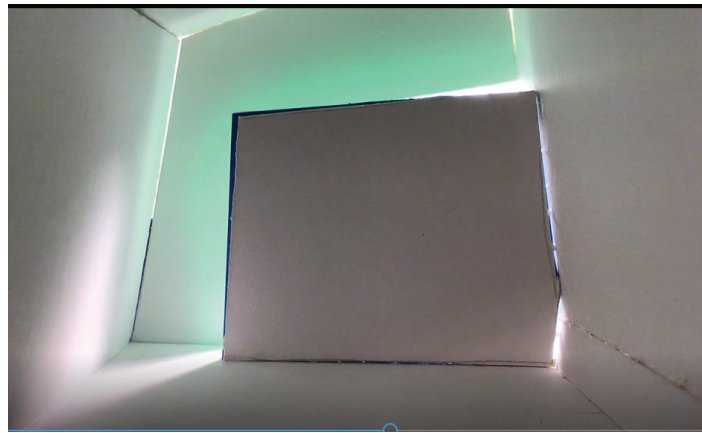




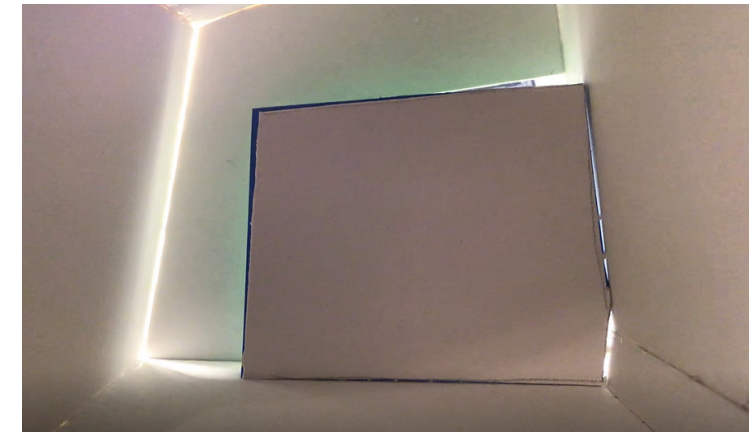
Morning



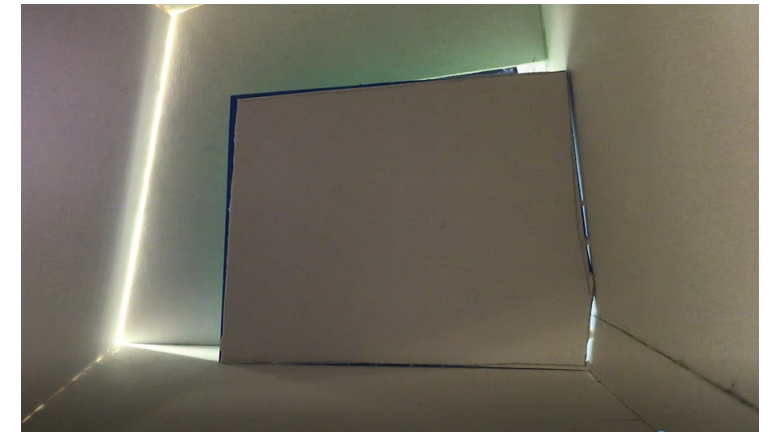
Noon



Afternoon



Late Afternoon





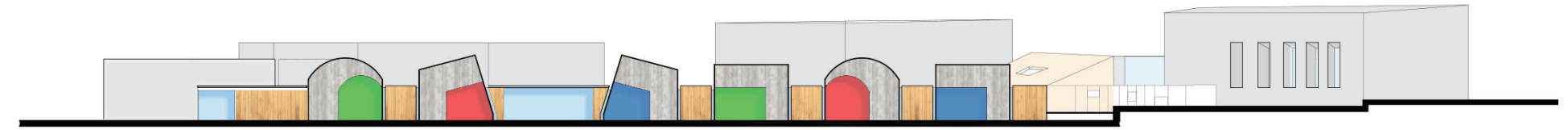
In setting up the color and lighting scheme in the classroom, I've placed a reflective board in front of the window which can also help with eliminating exterior distraction. This board reflects the saturated color facing the window and creates diffused shades of that color on the interior smooth walls. Through experimenting with physical models, it turned out that if different colors were layered on the board it results in a mix of those colors. Not just that but the reflections change as the sun direction changes to indicate different times of the day; this would enhance awareness of different times of the day that are linked with daily activities.



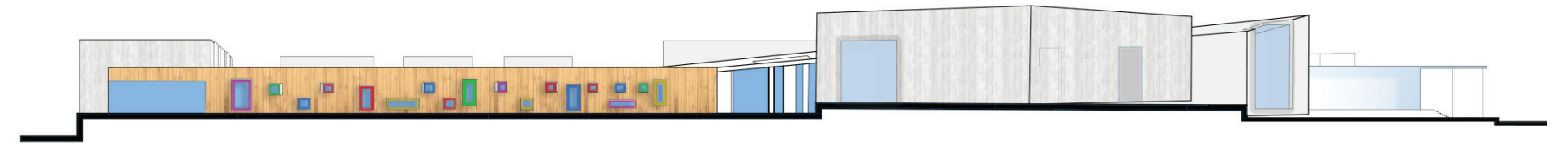
# The 9th Aspect: Color and Light

Lighting can affect the ambiance greatly, so it is suggested that the lights are controlled where it can be dimmed and brightened as required. The use of LED light is advised as well since it was realized that fluorescent light could be distracting because of its flickering quality.

The play of color is shown in the elevations here, where each class is unique by the combination of a color and a form. The other elevation shows the link of a pattern and color that extends from the interior to the exterior.



South East Elevation



East Elevation



“The architecture we encounter as children - be it the stacks in the library where you played hide-and-seek or the door handle you had to stand on tiptoes to reach - can have a great impact on your perspective of the world.”

- Tom Dobbin, *Shaping the Future: What to Consider When Designing for Children.*



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Thank You!



Herman Hertzberger, *Space and Learning*