IN, THROUGH AND BEYOND

A SPACE SCIENCE LEARNING CENTRE

BOALIA, RAJSHAHI

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ABSTRACT

The human civilization is not confined within the boundaries of the Earth anymore. It has been more than 47 years since the first man has stepped into the moon triggering the thirst of space travel. Human send probes to study and explore planets, satellites, comets and asteroids of solar system and has put space stations in the orbits to find the effects of microgravity and the possibility of further exploration. As a result for which new discoveries have been made at an ever increasing rate along with the advancement of science. Space science also plays a very significant role in our lives as we apply it for communication, weather forecast, disaster management, information technology, global positioning and so on. Hence, space science has become an essential part for the general education for the young generation. Realizing the necessity for space science, the first branch of Bangabandhu Sheikh Mujibur Rahman Novotheatre of the country has been opened in the capital heart of Dhaka in the year of 2004. To achieve the purpose of “Digital Bangladesh" by the year of 2021, it is necessary for the country to generate a scientific minded generation. As a result for which, the need to establish a similar space science learning centre on the core of Rajshahi city constructed. Thiswill be an institution of edutainment to popularize science among the public and create awareness. It will also guide the young generation of North Bengal towards science education as well as to provide entertainment to the citizens of that part of the country. This project is aimed to create a learning hub excellence for scientific knowledge and edutainment for the future generation of Rajshahi Division.

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CHAPTER ONE: INTRODUCTION

1.1 Background of the Project

Astronomy is one of the oldest natural sciences that can be traced back to antiquity. Its reflection can be found in historical, mythological, cosmological and calendrical practices and beliefs of prehistory. As far as it can be traced, the elements of celestial bodies were marked as gods and spirits, as human race did not have the answer of their presence and behaviour. Its application on human lifestyle made a mark when the movement of sun and moon was used to generate calendars to aid the agricultural societies track their harvesting period. Gradual advancements of space knowledge came along as time went by till the human race hit the enlightenment of Renaissance period. Nicolas Copernicus pointed out to the world that the Sun was the centre of the solar system and not the Earth while Galileo crafted the first telescope and started observing the sky for more. The beginning of space science started since and enriched further when Newton connected astronomy and physics through his law of universal gravitation. At present time, human has found answers to how the universe was created and further analysing topics of dark matter and energy to find the answers to the unresolved questions. With the present knowledge of astronomy, humans have move forward from superstitions and beliefs which dominated the culture beforehand. Its scientific application has advanced sectors of communication, weather forecast, disaster management, information technology, global positioning and so on. Thus it is very essential for the general people to have a scientific guided mind to move forward in the world we exist today. Space science learning centres provide the people with the platform to engage themselves to connect to the world of space science and create a hub to connect and generate new knowledge.

1.2 Project Brief

Name of the Project: In, Through and Beyond

Client: Ministry of Science and Technology

Location:Boalia, Rajshahi

Site area: approx. 6acres

1.3 Introduction of the Project

"Learning should come from curiosity, not authority. "

With the belief of the former saying, the project aims to create an informal learning centre for the citizens of Rajshahi to learn about the world beyond the blue sky. Space science plays an integral part of our daily lives and the emerging advancements in this field is going to create a digital world we look forward to. The motive behind the project is to light up the inquisitiveness on the minds of the visitors through its spaces and walkways so that they get more eager to learn about the limitless galaxies out there.

The site of the project is adjacent to the Rajshahi central zoo and the design involved integrating these two learning spaces by overlapping the zoo pedestrians through the learning centre. The integral functions of the project involve gallery spaces, space theatre, library and workshops. The concept of the project symbolizes the space theatre as a black hole which attracts the visitors through its spiraling orbitals. The gallery spaces are connected with circular ramps connecting from one floor to the other which terminates at the roof level where the visitors are taken to explore the sky with telescopes. The open spaces of the learning center open towards the lush green of the zoo and welcome the visitor with the halo of the planetarium from a distance.

The project does not aim to impose the knowledge on the minds of the visitors but light up their eagerness to know more and explore more. And as Robert Frost says,

"I am not a teacher, but an awakener."

1.4 Aims and Objectives of the Project

The foremost objective of the project is to create facilities for education through entertainment for general mass, especially for the students. Such a public space will turn into a scientific and digital space hub for the city of Rajshahi, generating interest in young minds to study science and technology. As well as it will help to fullfill the client's goal to establish the vision of " Digital Bangladesh" by 2021 by creating a scientific minded generation. Furthermore, it will impose positive scientific attitude in the public mind and help eradicate superstitions and blind faith from the society helping it to progress forward.

1.5 Programs

The program for this learning centre was marginalized into two sectors, one “under the dome” and second “outside the dome” (Fig: 1). “Under the dome” represented the planetarium which could be used both as education and entertainment purposes. Alongside this 3d visualization of galactic world, the visitors are provided with exhibition galleries. Furthermore, interactive spaces like libraries, seminar halls, workshops and astronomy classes were allocated in this learning centre. Functions were idealized in such a way so that people can learn, share their knowledge and advance their ideas to create something new.

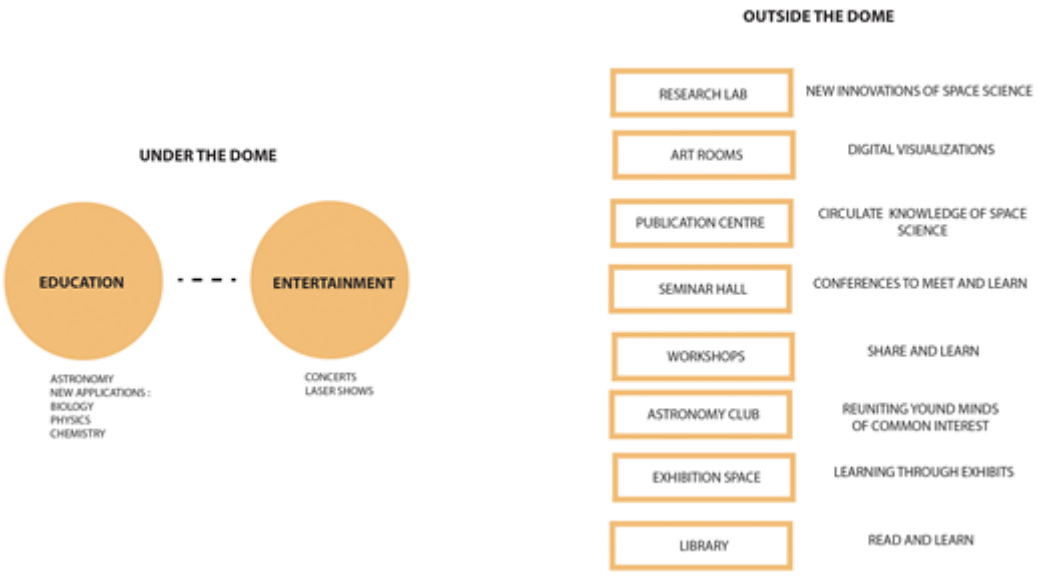


Figure 1: Program of the project[1]

[1] Author

CHAPTER TWO: SITE APPRAISAL

2.1 Background of the Site:

The city of Rajshahi is located on the north eastern part of Bangladesh located along the Padma River. It is one of the metropolitan cities of the country which is very profound for its silk and is named after it as "Silk city". Among the land of North Bengal, it acts as the major urban and industrial zone. The elevated terrains of Barind Tract surround the city from all sides. The city contains the University of Rajshahi which is one of the oldest public universities of the country.

2.1.1 Climate

The climate of Rajshahi is tropical wet and dry. The climate of Rajshahi consists of high temperature, moderate humidity and average rainfall.

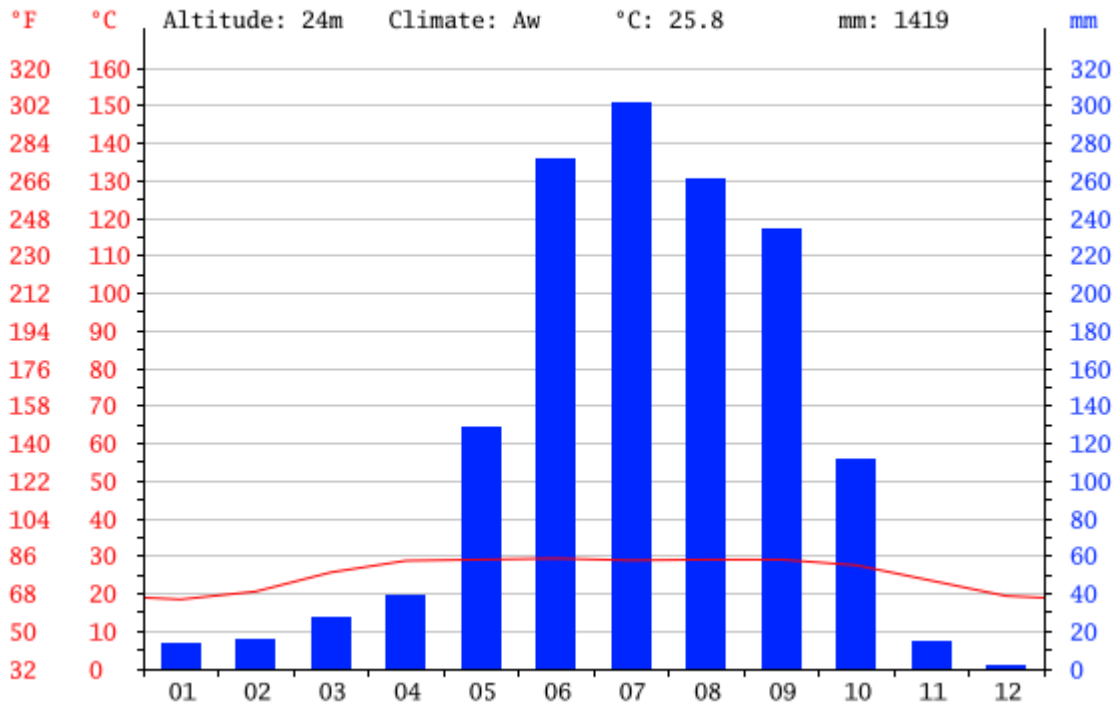


Figure 2: Precipitation graph of Rajshahi[2]

[2]http://en.climate-data.org/location/4307/

The precipitation of Rajshahi is maximum in July and the least in December with values of 301 mm and 2 mm respectively.

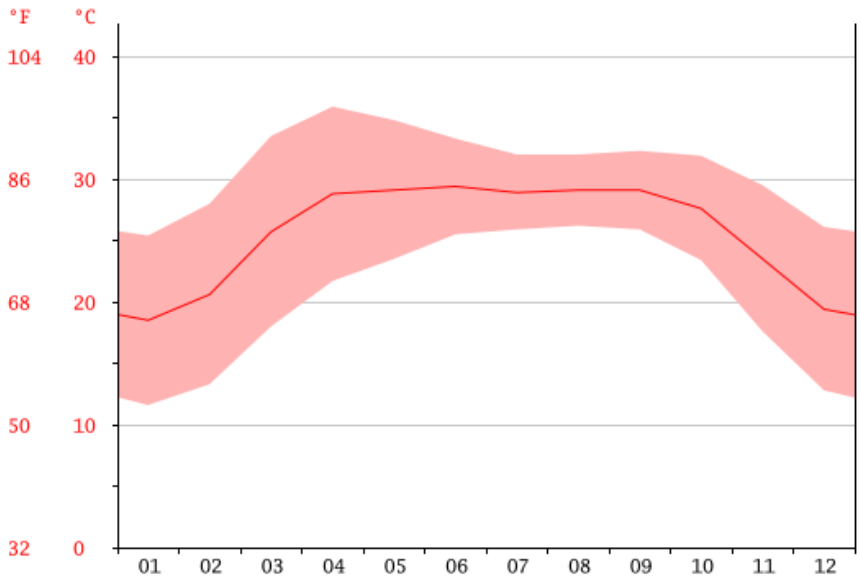


Figure 3: Temperature graph of Rajshahi[3]

The temperature of Rajshahi is maximum during June and minimum during January with an average value of 29.4 degree Celsius.

month	1	2	3	4	5	6	7	8	9	10	11	12
mm	13	15	27	39	129	272	301	261	234	112	14	2
°C	18.5	20.6	25.7	28.8	29.1	29.4	28.9	29.1	29.1	27.6	23.5	19.4
°C (min)	11.6	13.3	18.0	21.7	23.5	25.5	25.9	26.2	25.9	23.4	17.6	12.8
°C (max)	25.4	28.0	33.5	35.9	34.8	33.3	32.0	32.0	32.3	31.9	29.5	26.1
°F	65.3	69.1	78.3	83.8	84.4	84.9	84.0	84.4	84.4	81.7	74.3	66.9
°F (min)	52.9	55.9	64.4	71.1	74.3	77.9	78.6	79.2	78.6	74.1	63.7	55.0
°F (max)	77.7	82.4	92.3	96.6	94.6	91.9	89.6	89.6	90.1	89.4	85.1	79.0

Figure 4: Climatic condition throughout the year[4]

[3]http://en.climate-data.org/location/4307/
[4]http://en.climate-data.org/location/4307/

2.1.2 History

The name of Rajshahi is said to come from the ancient Hindu kings who were called 'Rajas' and 'Shahi' means royal and kingdom. Rajshahi is an ancient city of the Pundra reign of ancient Bengal. The administration district of Rajshahi was made during 1772, municipal corporation in 1876 and finally the city corporation during 1991. During the reign of British Raj, Rajshahi was selected as the factory centre for silk trade. It has faced the terror of the liberation of 1971 with the rest of the country and the largest mass grave of the country rests there. It is situated inside the Rajshahi University which was used as an army camp during the time of the war.

2.1.3 Art, Architecture and Culture

Rajshahi highlights exuberant cultural varieties of the people of Bengal. It is highly famous for its finest silk fabric and sweetmeats, which are not produced in the rest of the country. The neighbour of Chapai Nababganj is known to all citizens for its lustrous mangoes and lichis which are widely available in Rajshahi as well. It is home to Barenda Museum which exhibits the finest sculptures, artefacts and silk fabrics going back to medieval age. The inhabitants of Rajshahi consist of 86% Islam followers, 13% Hinduism followers and the rest 1% are Buddhists, Jains or Christians. The area consists of more than 5000 mosques, oldest of which were constructed during the 16th century. One of the most famous temples called the Shiv temple of Puthia, is also located in Rajshahi which highlights the ancient use of teracotta reflecting the mechanism of Jor-Bangla, a prominent architectural style of Bengal.

2.1.4 Air Pollution:

Rajshahi has made its name in the first position among the cities who had a massive drop of their PM10 particle concentration during the year of 2014-2016 (The Guardian, 2016). Before then, Rajshahi had its name in the world's top polluted cities. The dust crashing away from the dry riverbeds, roads and fields, the smoke from the brick kilns accumulated to create smog which was highly injurious to human health. With the help of a campaign to build a greener city, the PM10 particle concentration went down from 195 micrograms per cubic metre in 2014 to 63.9 by

2016. The campaign targeted a lot of strategies to help the city turn cleaner. The fuel and chimneys of the brick kilns were upgraded so the harmful effect of smoke emission would decrease. The city now have three wheelers as the main public transport which are run by batteries saving the city from petrol and diesel emissions. The campaign is administrated by the city's cheif engineer Ashraful Haque who states that the next step to their campaign is “zero soil programme" which involves complete removal of dirt from the streets and replacing them with trees, plants and pavements (The Guardian, 2016).This initiative will aid to improve lifestyle in the city as well as help tackle the air pollution.

2.2 Site at a Glance:

2.2.1 Location of the Site:

The site of the learning centre is located within the existing site of the Rajshahi central zoo in the Boalia thana of Rajshahi District. It lies adjacent to the Dhaka-RajshahiHighway connecting it with Shaheb Bazar, the main commercial zone of the town at a distance of 3.3 km. The bank of Padma River lies to the south of the site with a distance of just 86 m.

Not just the surroundings, the entire site of the zoo has a complex layout consists of children park, several pinic spots , the learning centre itself , altogether creating a huge public space for the dwellers. The site has spine of waterbody passing through its core with lush green pouring all over it.

Figure 5: Site Surroundings[5]

[5]Google Earth

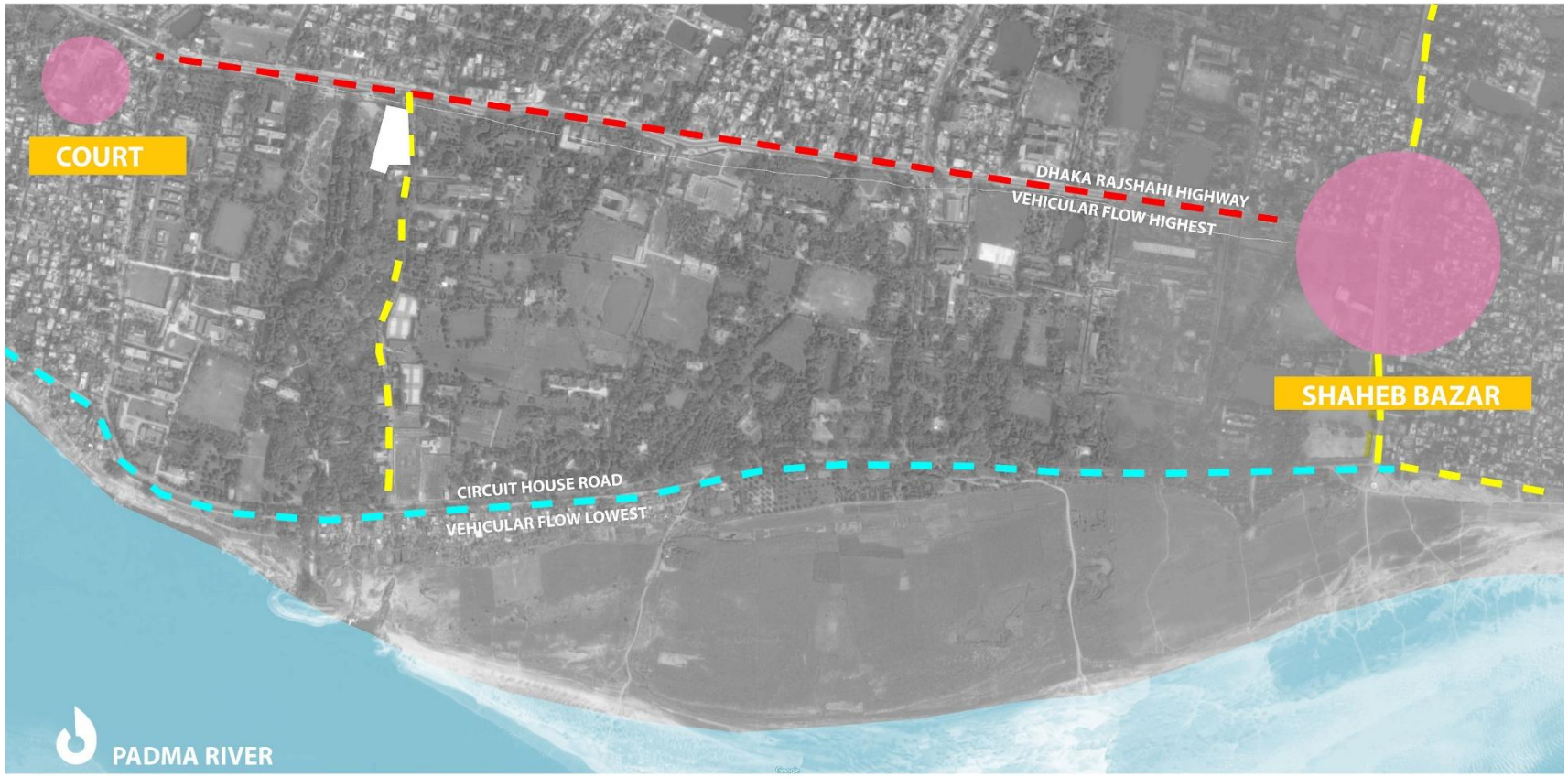


Figure 6: Site within the City[6]

[6]Google Earth

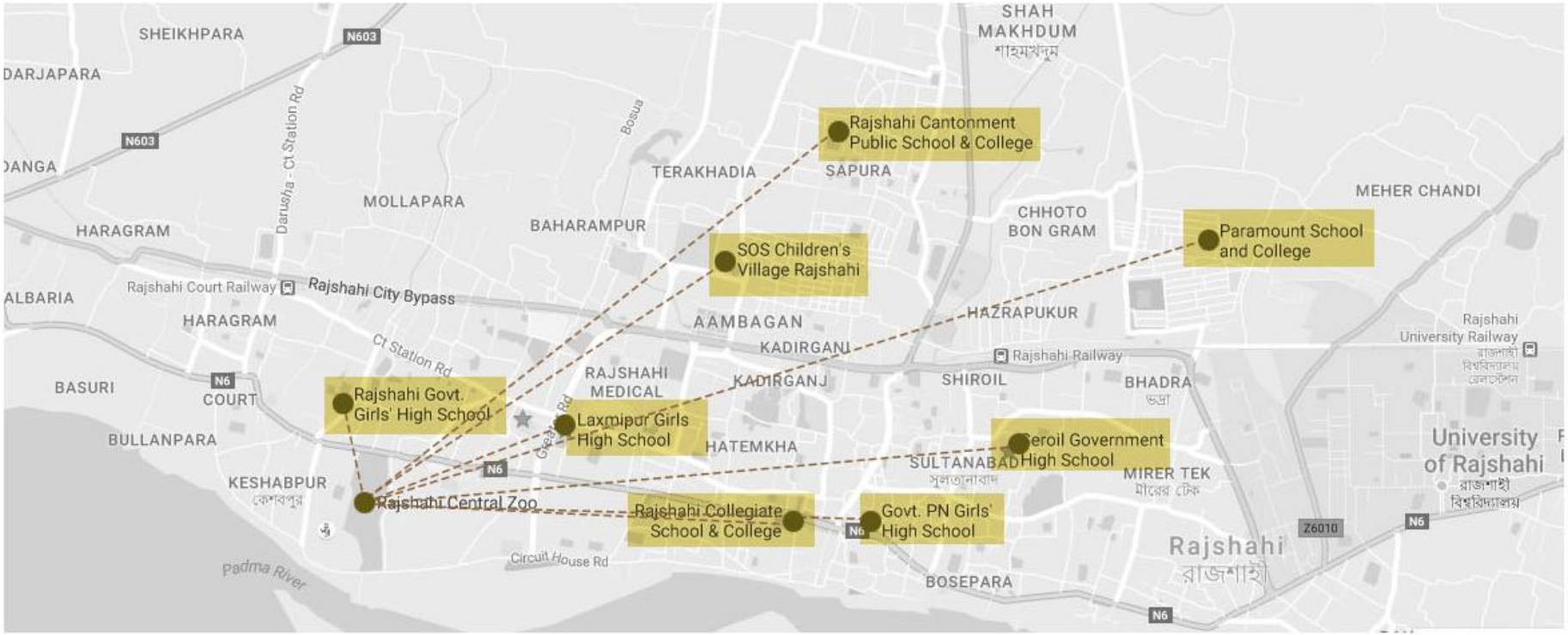


Figure 7: Schools in context with site[7]

[7]Google Earth

2.2.2 Size of the Site:

The site covers an area of approximately 6 acres (261,630 square feet).

2.2.3 Site Surroundings:

The site of the zoo is surrounded by cultural, administrative and religious buildings around it. It has the Rajshahi branch of Bangladesh Baptist Church Shangha on the east, Rajpara on the north, Court to the West. The profound tourist accommodation of Parjatan Hotel and the Rajshahi Shilpokola acaedmy lies in to the south-west of the site.

2.2.4 Site Maps:

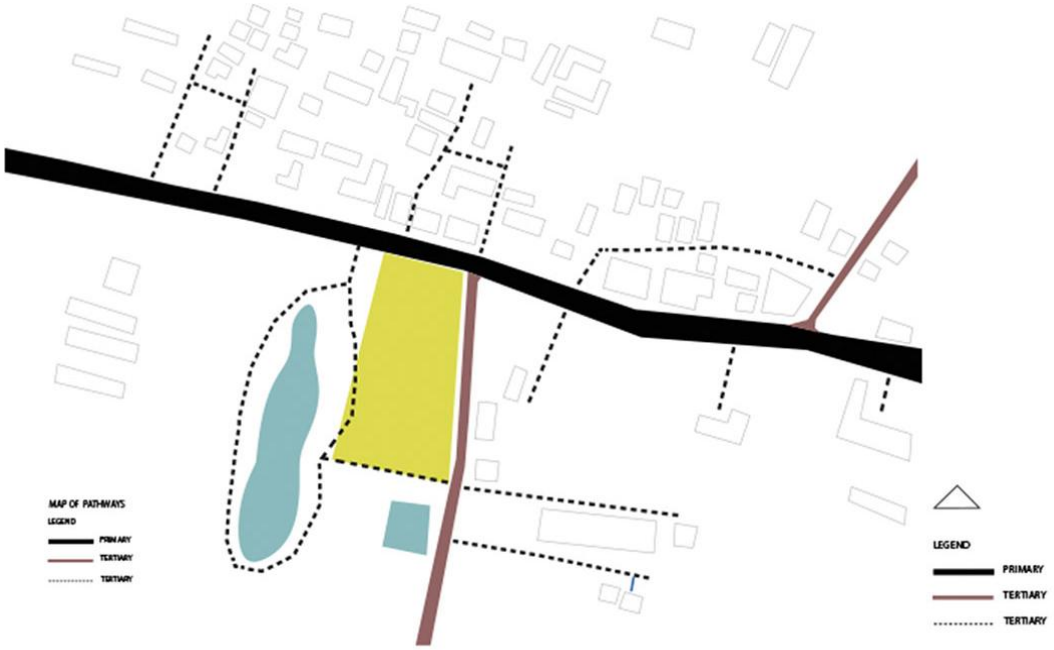


Figure 8: Existing Pathways[8]

[8] Author

Figure 9: Building Height[9]

Figure 10: Functional Zoning[10]

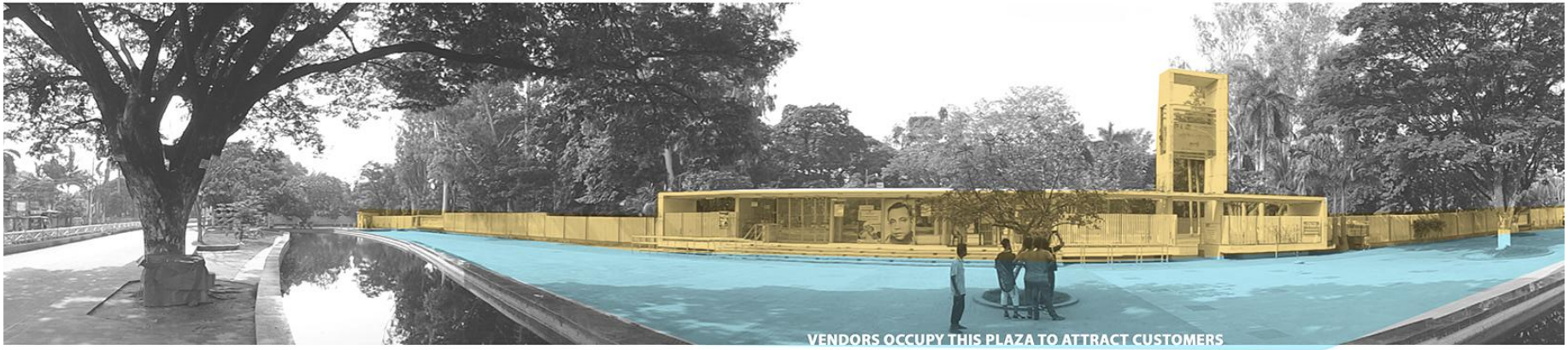
[9] Author
[10] Author

2.2.5 Site Images

1. SITE BOUNDARY CONNECTING WITH PARJATAN HOTEL

2. SITE CONNECTING WITH THE MAIN ENTRY OF THE ZOO

3. ELEVATION OF THE SHAHEED BAZAR ROAD FROM THE SITE



4. EXISTING ENTRY TO THE ZOO COMPLEX

Figure 11: Site photos[11]

[11]Author

2.3 Site Analysis

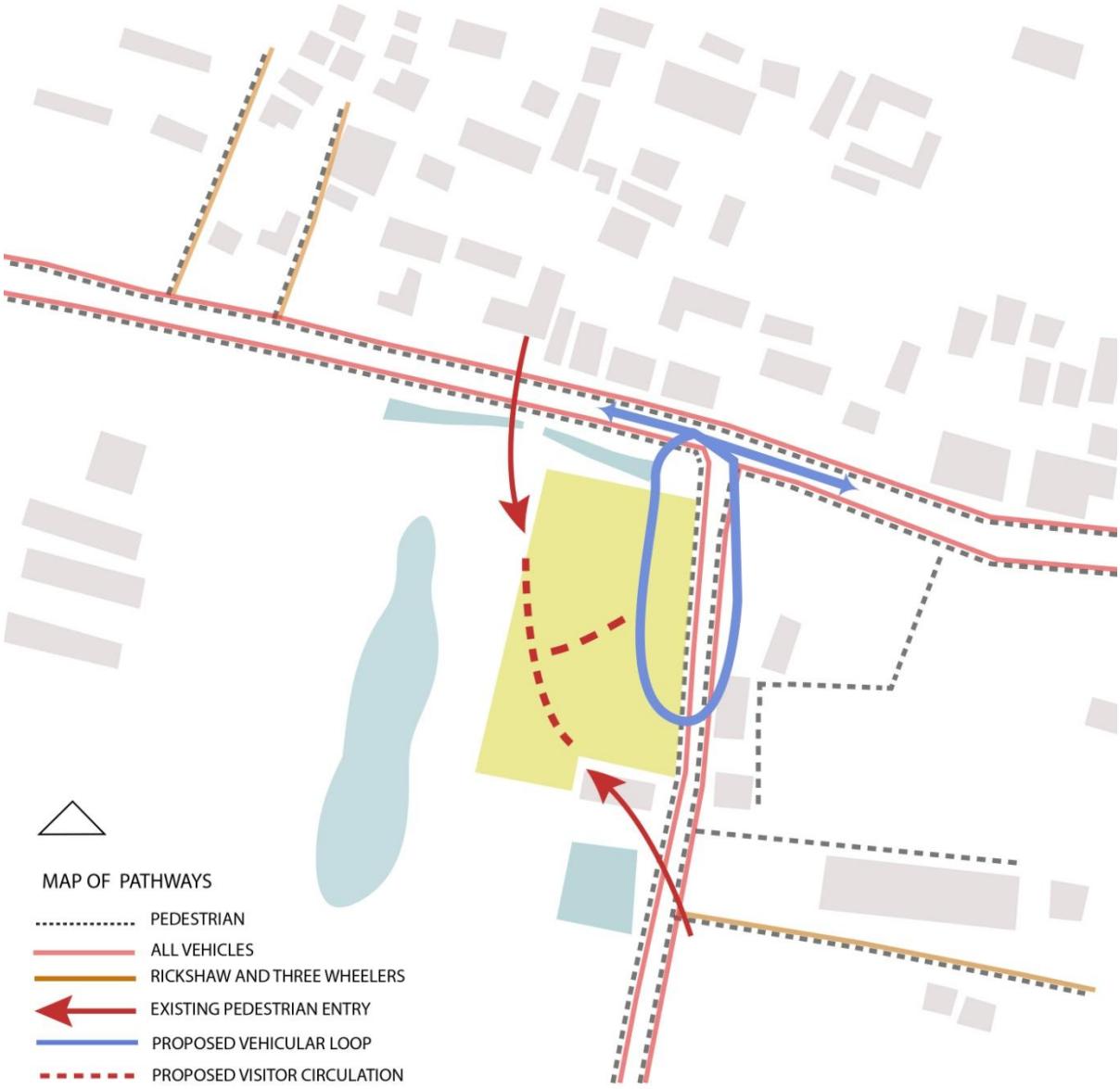


Figure 12: Site Analysis 1[12]

[12]Author

Analysis 1:

The main pedestrian sources to the planetarium are from the main zoo entrance and a secondary entrance connecting to the Parjatan Motel. The connection of the two pedestrian circulations is proposed to be connected in the main public plaza of the planetarium which will also connect the people by the vehicular entrance. The vehicular entry exit loop has been proposed per the diagram connecting to the primary Dhaka-Rajshahi Highway. This proposes that the basic massing of the planetarium should be divided into two blocks with a central meeting point at the plaza.

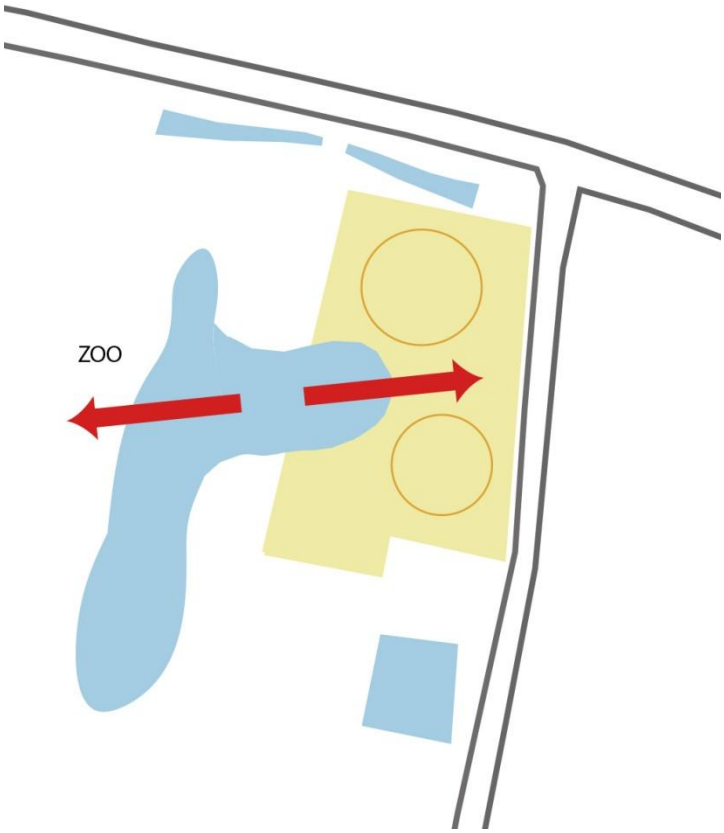


Figure 13: Site Analysis 2[13]

[13]Author

Analysis 2:

The water body existing beside the site will be expanded into the site of the planetarium to create a visual relationship with the zoo as well as maintaining a sense of separation.

2.4 SWOT Analysis

Strengths:

- The site has low rise buildings around it with Padma river bank on its south just 86 metres away.
- The accessibility of the site is good as it is adjacent to the primary road of Dhaka-Rajshahi highway, a road running through the centre heart of the city.
- The natural vegetation of the site if magnificent.
- The pedestrian access to the site is already well designed.
- As the site is adjacent to the Rajshahi divisional zoo, it is already profound as an attraction point to the citizens of Rajshahi.

Weakness:

- The site is elongated in East and West direction, allowing prolong exposure to sunlight all throughout the day.

Opportunities:

- The site is adjacent to the divisional zoo and the Parjatan Motel which provides access to both local and tourists to the learning centre.
- A relationship between the zoo and the learning centre can together provide the citizens a platform for children education.
- People visiting the learning centre can be made to overlook the night sky above the Padma River providing them with a surreal image.

Threats:

- The public gathering of the zoo and learning centre altogether can create huge traffic congestions on the nodal point.

The development shall disrupt the present green landscape of the site and can harm the environment if not addressed with proper design solutions.

CHAPTER THREE: BACKGROUND OF A PLANETARIUM

3.1 Planetarium at a glance:

Traditionally, planetariums are theatres for both education and entertainment which represent topics of astronomy and the night sky to the visitors. It presents a movie with an image that enrich an audience in science stories. At present time, the definition of planetarium has evolved as a multi-purpose centre which consists of a theatre, a classroom and interactive learning experiences which teaches people about space science as well as other regions of scientific knowledge (Petersen, 2005). The technology used in these planetariums has advanced since they were first constructed in United States and at present they can provide the audience with an experience of full dome animations (Fig 14). However, the planetarium field is undergoing further advancement to provide their audience with more realistic picture of the space world as professionals are revising their ways of producing and showcasing their work.

Figure 14: Hayden Planetarium[14]

[14]http://www.amnh.org/exhibitions/permanent-exhibitions/rose-center-for-earth-and-space/hayden-planetarium

According to Petersen (2005), a modern-day planetarium shows consists of three basic programs. Firstly, there is a lecture which is an interactive session with the audience where they teach about basic astronomy and update them about any recent discoveries. Secondly, pre-recorded documentaries are played which are very realistic using special effects, soundtracks and narration with a full dome animation experience. Thirdly, there are special concerts, laser shows, annual fair and meetings which take place from time to time in this edutainment centre throughout the year.

Planetariums can be built in different structural systems according to the need and context. Firstly, there are permanent planetariums which are usually have domes built with thin aluminium sections with a light skin. Then there are smaller permanent and temporary ones which are made of Glass reinforced plastic which generates acoustic, heating and ventilating issues creating inefficiency. Lastly, there are portable planetariums which are made of nylon reinforced, heat resistant and latex free which can take the experience to any school, library, museum or any public place at the most remote condition (Button, 2002). STARLAB constructed their first classic Star lab portable planetarium during the year of 1977 which was a huge mark in the field of planetarium development (Fig: 15). Since then portable planetariums have spread across ocean to different corners of the world (Smith, 1992). The discovery of portable planetariums have opened a new door for school teachers as many believe that with the help of portable planetariums and minor training, they can easily become planetarium directors.

Figure 15: RLABS first Portable Planetarium[15]

Figure 16: Stonehenge[16]

[15] Button (2002)
[16]http://www.history.com/topics/british-history/stonehenge

3.2 History of Astronomy:

Astronomy is the oldest natural science human civilization has been using since antiquity. Back in time, celestial bodies were identified as holy spirits and gods. Their movement was related to events such as rain, drought, seasons and tides. It is believed that first professional astronomers were priests. The first architectural monument related to astronomy is Stonehenge which was built back in 3500BC but no knowledge about the builders could be found out (Fig: 16). Astronomy later was used to generate calendars tracking the movement of the sun and the moon during 8000BC. These calendars were used by the agricultural societies to track their harvesting period. Around 600 BC, Pythagoras made his breakthrough with his theorem which has profound advancement on fields of maths and astronomy.

Around 100 BC, Ptolemy came forward with his theory that Earth was the centre of the universe and the planets used to rotate around it. The advancement on the field got slowed down during the Dark Age till the human civilization hit the enlightenment of Renaissance. Nicolaus Copernicus came forward proving Ptolemy theory wrong, pointing out that Sun is the centre of the solar system around which the planets revolve and not the Earth (Palmieri, 2008). Galileo constructed his first telescope and started observing the night sky which resulted in discovery of the moons of Jupiter, sunspots, Kepler's supernova and new knowledge about Milky Way. With all this tremendous contribution to astronomy, he renowned himself as the father of observational astronomy.Newton further advanced the field of astronomy as he linked the physics with his universal law of gravitation. During the year of 1957, the Soviet union launch the first artificial satellite named Sputnik-1 which revolutionized the method of gaining astronomical knowledge (Smith, 1992). This ignited the thirst of the West as science education became necessary for their survival which led to following footsteps on the field of astronomy for mankind.

As much as astronomy was popular among the West, it was equally flourished in the East part of the world. The use of astronomy can be traced in India during the time of Indus valley civilization back in 2000 BC to generate calendars. The oldest astronomical text is the Vedanga Jyotisha from the vedic period. The motions of the sun and the moon were tracked mainly for the purpose of the rituals of the religion. The golden age of astronomy in India was during the time when the Shinga empire

rule during which the calculation of motions of different planets and eclipses were discovered by the astronomers. Astronomy in the East Asia generated in the land of China and was used for timekeeping. The Chinese astronomers were able to precisely predict the eclipses and they were the first to detect ‘guest stars’ and ‘supernovae’. This shows that the application of astronomy was used by people from all corners of the Earth which supported the development of human civilizations.

3.3 History of Planetariums:

It has been nearly 100 years since the real time profession of planetarium has actually begun. At the present time, mankind is affiliated with advanced technology of full dome animations which create almost realistic digital view of the universe to the audience. However, the first evidence of a globe of the sky can be traced back to 6000 years ago was by the philosopher Anaximander (Smith, 1992). Then came Archimedes during the 3rd century BC creating a model depicting the slow movement of planets across the sky. During the same time, the Greek scientists invented the Antikythera mechanism to study the astronomical position and eclipses for enhancing their calendars (Fig: 18). Time went by during the middles ages with slower advancements of clocks and orreirs but no new discoveries.

During the middle of the 17thcentury, the first planetarium was constructed called the Gottorp Globe. The dome was made out of wood with a diameter of 4 metre accommodating seating for 6 people only. The surface of the dome was drilled with holes so that light could penetrate inside creating the image of a starry night. This dome was dependent on the light of an exterior source to create an impression of the stars on the inside. That model reversed when E. Hindermann from Switzerland developed Orbitoscope in the year of 1912 (Fig: 17). This model used a spring body to rotate two planet bodies around central point, the Sun. One of the planets had a small light on it which would generate the depth of light and shadow on the surface of the dome. The discovery of this Orbitoscope was the first footstep to the development of planetarium technology for the mankind.

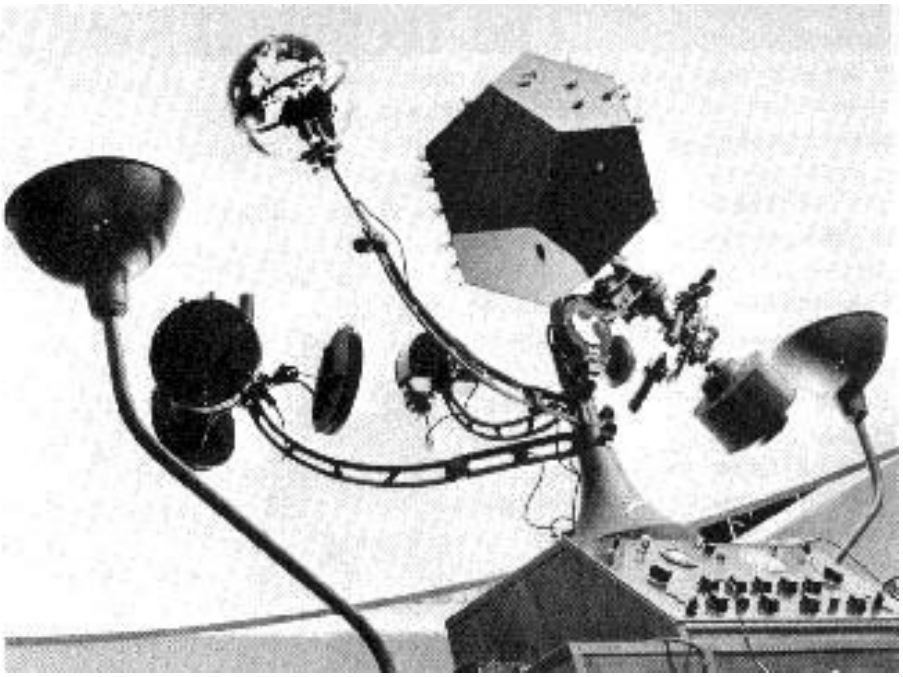


Figure 17: Orbitoscope[17]

Figure 18: Antikythera mechanism[18]

[17]http://phys.org/news/2014-11-antikythera-mechanism-clues-ancient-greek.html
[18]http://www.ips-planetarium.org/?page=a_chartrand1973

Then the next wave of development hit on the year of 1919 when Weather Bauserfeld from Germany's Carl Zeiss optical work invented the first planetarium projector. These projectors were to be installed in the middle of the dome to reflect the world of galaxy on the surface of the dome. These projectors kept on developing till the start of World war II and 24 sets of these projectors where installed all over the world in Japan, United Sates and Europe. Then on year of 1962, Armand N Spitz brought to the world the first planetarium instrument which could upload the galaxy not from the perspective of the world but from a different view point. This helped to present to the audience the different views of the universe, its three dimensional depth and volume. During 1983, Digistar 1 was launched as the world's first digital planetarium instrument and then came the latest technology of full dome animation during 1998 at the Burke Baker planetarium at Texas. As the planetarium technology advanced, the planetarians focused on how they could improve their presentations for their audience. They not only relied on the projector but also brought soundtrack and music to their clips to generate a story for their audience just like a movie producer would do. Even now, planetarians are trying to look out for more improvements to make their documentaries more realistic and interactive to the audience to produce a greater impact on the young minds.

3.4 Contribution of Planetarium on Astronomy education:

The subject of astronomy deals with three dimensional ideas and subjects which are impossible for the students to hold for a first-hand experience. This usually results in misconceptions among the young minds. Yu (2005) states that astronomy has always been a very challenging subject to teach inside the classrooms. The misconceptions cannot be recovered by standard class room textbooks. It becomes very difficult for the students to comprehend a three dimension model of the universe from 2d photographs and texts. Yu also mentions that many researchers have suggested the need for 3 dimensional models for astronomy lessons. This marks that planetarium has a huge role to play in the education sector for the young minds of the country to have a better understanding of space science.

According to the constructivist theory in education, human minds are not 'tabula rasa' or blank slates that take in knowledge from textbooks. Human minds builds

model of knowledge based on their past experiences and day to day life activities. Reflecting from the idea, the results of a study mentioned by Yu (2005) showed that most students modelled the shape of the earth based from the observation not on what they were taught in their classes. Their models viewed Earth as i) a flat rectangular plane with human settlements, ii) a circular flat disc, iii) a hollow sphere within which there was a rectangular plane, iv) a sphere flatten on top and bottom only where people lived, v) two Earths one of which was a rectangular plane and another circular at a distance and finally iv) the correct model of the Earth with people settling all over it. These models expressed that the students viewed the Earth as they could perceive it on real life not what they were taught to think like (Fig: 19).

Similar in another research by Turk and Kalkhan (2014) showed that students who have visited planetariums had a better three dimensional concept of astronomy. Their planetarium experience has enriched their knowledge about the relative motion of the celestial bodies with time even if that meant changing the reference observation point. The study also highlighted that students used their daily life experience to answer questions related to the changing position of the sun and the moon rather than scientific knowledge. Classroom students could relate their knowledge about seasons from their texts but lacked complete conceptual notion unlike the planetarium experienced students. Hence it can be concluded that, laboratories and classroom texts is not sufficient to develop astronomical knowledge among the young minds. Astronomical concepts are abstract including enormous physical scaled subjects for which planetariums and simulations are necessary to create a complete picture for the students. Hence, teachers should include planetariums trips a mandatory part of their curriculum to produce an effective astronomy lessons for their students.

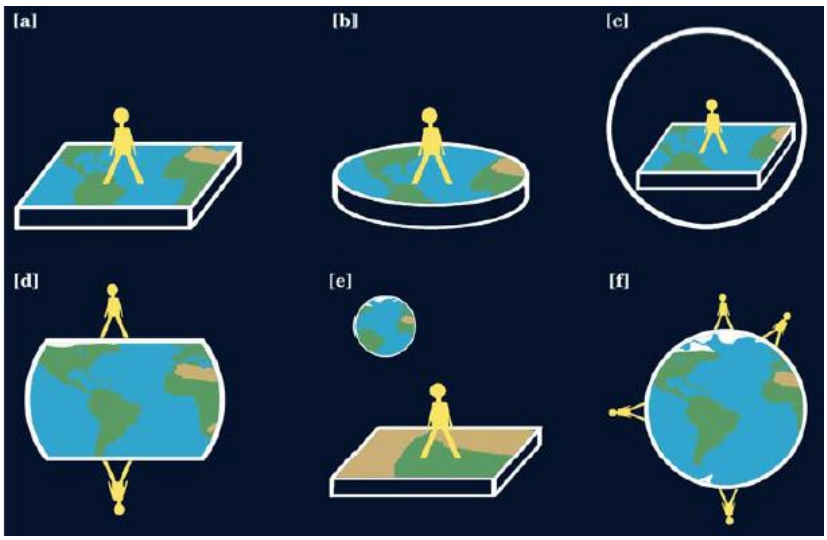


Figure 19 : Different models for the shape of the Earth[19]

3.5 Planning a Planetarium

A number of factors need to be considered when designing a planetarium. Smith (1992) states on his guide the essential factors which has a huge contribution in the making of a successful planetarium. The first factor is the location of the site. As the students are the prime users of the planetarium, thus the site should be location in close proximity to schools. Students of secondary schools can also serve as assistants in the planetarium helping the platform as well as build-uptheir own knowledge. Secondly, the lighting system inside the space theatre plays a crucial part in the experience of the visitors. The entrance to the space theatre must be designed in such a way so that it eliminates the distracting light from the exterior. This will make sure that a sudden entry inside the theatre in the middle of the show time will not cause sudden illumination inside, creating disruption to the experience of the audience. Usually, this problem is solved by introducing ‘light trap'. Light traps are two sets of doors just before the entrance to the space theatre. In this space, the person awaits for the first step of door to be closed before the second set is opened

[19]Yu (2005)

to enter the interior of the space theatre. These light traps also help to minimize exterior noise reaching the interior space.

Smith (1992) also suggests that the size of the dome of the planetarium depends on the following factors:

- Selection of the star projector
- The visual quality of the projection
- The estimated size of the audience
- The arrangement of the seating
- The use of space under the dome

He also highly suggested for a separate efficient HVAC system for the planetarium. As the planetarium is a silent zone, the ducts of the system should be designed in such a way to provide free movement of air without making any noise or disruption. HVAC is not just needed to control the temperature but the humidity and dust as well to maintain the efficiency of the electrical equipment.

The location of the planetarium should be isolated from noisy zones of classrooms and seminar halls to prevent the noise level increasing too high. Not just proper buffer systems, the sound system inside the planetarium should also be sensitive and highly advanced. To create the desirable and interactive learning environment for the audience, the presentation usually needs some music. Thus, the sound system should be another prime factor to be considered during the planning of the planetarium. The walls of the chamber should have low reflectivity to prevent reflections from the projectors which will create chaos on the visual experience of the audience. To solve this, usually the chamber walls are all painted black. The texture of the walls should also be non-reflective to sound waves preventing echoic chaos. The exit doors to the space theatre should be located in silent zones to prevent noise from entering the interior. Lastly, the seatings of the theatre should be comfortable to provide the audience with a complete experience. The mentioned factors should be examined carefully before designing and constructing the planetarium to produce a successful project.

CHAPTER FOUR: CASE STUDY

4.1 Local Case Study

4.1.1 Bangabandhu Sheikh Mujibur Rahman Novotheatre, Dhaka

Location: Bijoy Sharani, Dhaka

Architect: Ali Imam, constructed by PWD

Area: 5.46 acres

The Bangabandhu Sheikh Mujibur Rahman Novotheatre in Dhaka is the first planetarium of the country which was established by the Ministry of Science and IST of the Bangladesh government. The motive behind the project was also to educate the citizens of the capital about the astronomical science and open doors for research of space science and astronomy. This will further guide the citizens to evolve with a positive attitude and move past away from the traditional superstitions. It was opened to the public during October of the year 2004 (The Daily Sun, 2015). Like all other planetariums, it not only highlights topics of astronomy but also covers various topics of biology, geography, physics, history, industry and anthropology.

The form of the structure has an eye catching blue metallic dome which protrudes over the green lawn. The architect uses very distinctive architectural styles of columns, pillars and geometric shapes for creating the composition of the masses. The entry plaza has large water bodies which reflects the pillars on both sides of the metallic dome. The public staircases are present on two sides which are rise up as light wells balancing the composition of the geometrical shapes.

The planetarium has a space theatre of 270 seats which has a three dimensional screen where the dome is tilted at an angle of 120. With the help of powerful projectors, shows are displayed on the large curved screen of the metallic dome. This curved ceiling represents the sky which holds the images of moving planets and stars providing the audience a lifetime experience. The planetarium consists of three galleries which exhibit models of planets in the solar system, both scientific and digital exhibits and portraits of world renowned scientists and scholars. It has a seminar hall of 250 seats which is made available for holding scientific seminars and symposiums. The 215 000 square feet planetarium also consists of fountains a

grand lobby, food shops and a library. At the back of the mass is the four storied administrative building and it has an underground facility of parking 100 cars.

Figure 20: Entrance[20]

Figure 21: (a) City context, (b) Dome structure[21]

[20] Google
[21] Google

Project Analysis:

The main target audience for this project is the students of standard three to nine who come to the planetarium on study tours. The secondary main target audience are the middle, upper middle and high class urban families who will bring their children on weekends for edutainment. As it was the first planetarium of the country, it began to flourish rapidly at the beginning for its purpose and the structure of the building highly caught everyone's attention. Unfortunately, besides few artworks and models the huge building is partially empty and does not have much to provide to the visitors. It has not been updated since it was opened to the public back in 2004. As a result, the number of visitors per day has fallen rapidly. The maximum turnover is during the weekends but the purpose behind the visit is to enjoy the open space of the planetarium rather than facilities for edutainment. The turnover of study trips by students of different schools are also very few during the current moment.

However, the modern architecture of this planetarium still acts as a popular landmark to the citizens of the city but due to improper maintenance and improvement of the facilities, people have started to lose their interest. Ever since the time of construction, only two entertainment projects have been running and people gradually started to lose interest. Hence, the government should modernize and technologically advance the planetarium to bring back the popularity of the project among the heart of the citizens.

4.2 International Case Study

4.2.1 L'Hemispheric, The City of Arts and Science

Location: Valencia, Spain

Architect: Santiago Calatrava

Area: 85 acres

The project of "The City of Arts and Science" was facilitated by the government of Spain to create a centre of recreation and park for the dwellers of the Valencia city. It consists of a series of five elements out of which L Hemispheric serves as the planetarium. Calatrava's main concept behind this project was to connect the people with the history of the site. This site of Valencia is very close to the sea but after the flood in 1957 the river canal diverted leaving the site very dry. So Calatrava revived the water body in the site allowing people to reconnect with the history of the site (The City of Arts and Science, 2002). He lined the elements along the longitudinal axis of the site, offering the visitors a wider angle to the sea.

The form of the L'hemispheric has been derived for the eye. The pupil is the hemispherical dome of the IMAX which turns into a globe with its reflection on the pool. The pupil is covered by an elliptical shell structure which acts as the outer layer of the eye. During the day, the eye opens for allowing flowing of air and allowing the visitors with the views. However, during the unfavourable weather conditions they are shut to protect the visitors from the rain.

In the form of the planetarium, Calatrava mainly used three basic materials of glass, concrete and steel. To keep the cultural essence, he Graudiesque fragments of shattered tiles which are a very prominent production of the Valencian industry. The planetarium dome is composed entire of concrete with a structural of elliptical concrete vaults crossing over the form. The elliptical roof itself acts as a suspended beam at both ends. As the bending moment stress is maximum at the centre, the thickness increases in the centre. The lateral load on the roof is distributed to the ground by connecting braces.

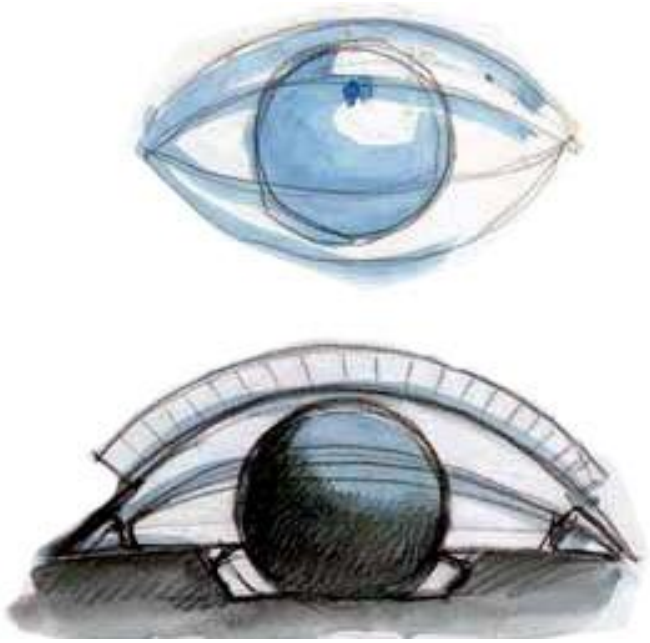


Figure 22: Conceptual Sketches[22]

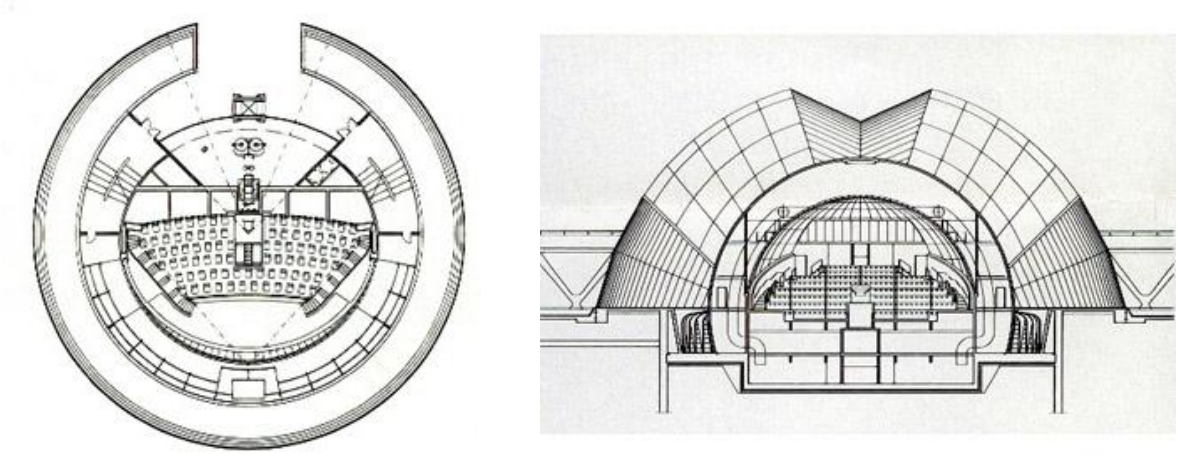


Figure 23: (a) Plan of the planetarium, (b) Transverse Section[23]

[22]http://www.idesignarch.com/lhemisferic-an-eye-catching-architectural-masterpiece-in-valencia/
[23]http://www.arcspace.com/features/santiago-calatrava/city-of-arts-and-science

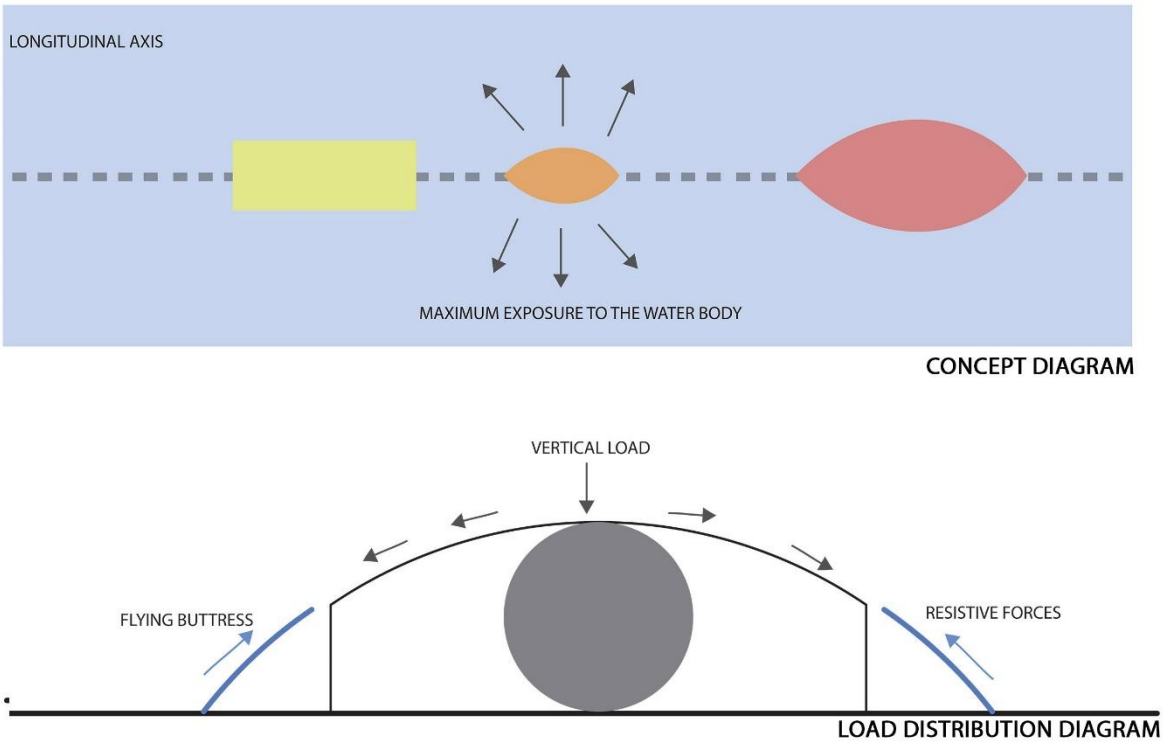


Figure 24: Study Diagrams[24]

Project Analysis:

The use of fine geometry in Calatrava's work has always been appreciable and L' Hemispheric is no exception. The complete exposure of structural elements makes the entire form complete sculptural elements. Even though his very fond of using heavy concrete, but the complimentary use of glass and steel makes the structure and form look light yet bold. The ambience of light passing through the structural elements in this planetarium will create a surreal sense of feeling for the visitors. His awareness to the site and the culture of Valencia embarks his sensitivity towards his projects.

[24] Author

4.2.1 Shanghai Planetarium

Location: Shanghai, China

Architect: Ennead Architects

Area: 40 9000 square feet

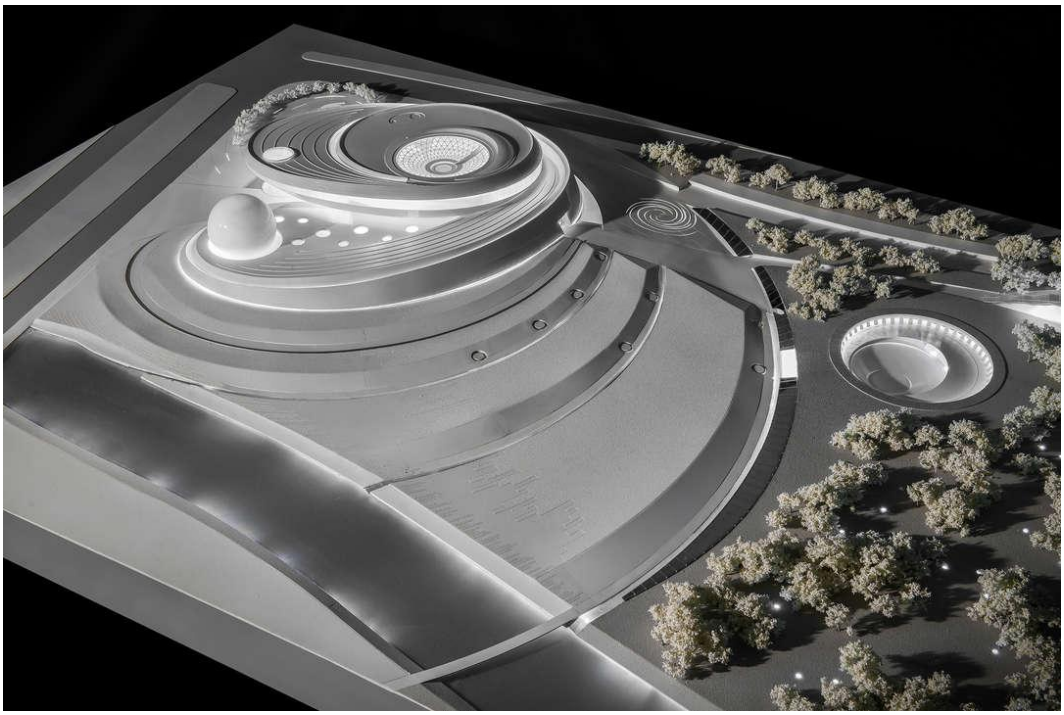


Figure 25: Model Photo[25]

Shanghai Planetarium design was won by the Ennead Architects in an international; competition and the construction is expected to be finished by the year of 2018. The purpose of this project was to educate and aware the citizens of Shanghai on the transformation of historical aspects of Chinese astronomy to the future innovations in science and research of space science. The prime functional elements of this project include a planetarium, IMAX cinema halls, solar telescope, observatory, youth observation camp and research centres. Karissa (2015) in her article quotes the Ennead Architects by writing, “Drawing inspiration from astronomical principles, our design strategy provides a platform for the experience of orbital motion, and utilizes

[25] Archdaily

that as a metaphorical reference and generator of form." The strong conceptual ideology behind this project binds the spaces and functional aspects creating a coherent impact on the minds of the visitors.

The architects introduced three highlighting elements in the form which are transformation of celestial bodies into architectural form – the oculus, the inverted dome and the sphere. The three components create an environment for astronomical observation in their unique ways. Their main aim was to connect the users to the mysteries of the space through different types of spatial qualities. The first element "The Oculus" is inspired from the oculus of Pantheon in Rome. This architectural element itself turns the entire building into an astronomical instrument. According to The Angry Architect (2015) the concept of time has developed from the movement of celestial bodies. The light through the oculus reflects the relationship between space and time as the circle of light changes direction with passage of time.

Figure 26 (a) Inverted Dome, (b) The Oculus[26]

Following the Oculus, comes the element of the Inverted Dome which creates a point of focus for the museum. It lights up the central atrium of the museum allowing natural light throughout the day and bringing down the night sky on the museum floors. The circular ramp of the museum turns around the space of the inverted dome enhancing the interior journey of the visitors. Complementing the inverted dome is the last element, "The Sphere". Throughout the concrete mass of the Shanghai Planetarium this planetarium stands out as a light crystal pearl breaking the boldness of the form. "The Sphere" functions as the space theatre itself creating the centre of attraction for the visitors. The Ennead architects reflects their sensitivity of the site by

[26] Archdaily

providing lush green for the visitors in the heart of the developing city of Shanghai which lacks open green spaces. The landscape spirals out of the main mass reconnecting the elliptical orbits of the planets around the Sun. This project together as a whole reflects an astronomical elements bringing the science and mass public together creating a hub of entertainment and education.

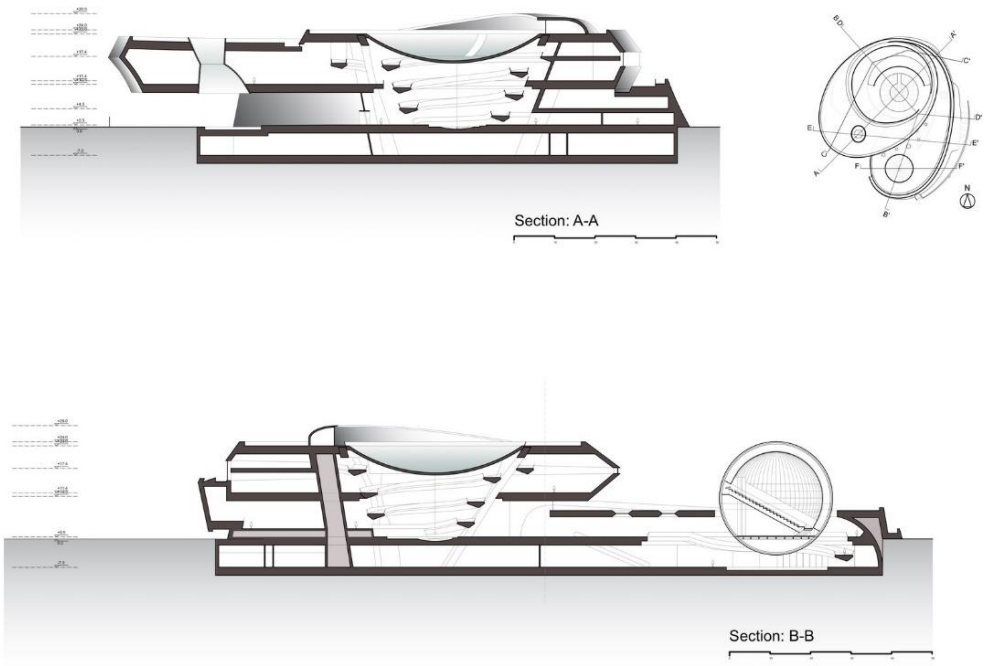


Figure 27: Sections[27]

Project Analysis:

The conceptual idea behind the project is highly appreciable. Not just the idea, the transformation of the ideas to the spatial qualities if also remarkable. The highlighting nodal elements stand out and provide the visitors with new ways to view the sky generating the urge to learn more about space science. The qualities of spaces create cohesion with the functional requirements of the spaces enhancing its efficiency. The awareness of the architects about the urban impact of such project showsthe sensitivity they have about the lack of green spaces in the busy streets of Shanghai.

[27] Archdaily

CHAPTER FIVE: PROGRAMME DEVELOPMENT

5.1 List of Programs

Program	**User**	**Square Feet**
ADMINISTRATION		
Director + Toilet	1	400
Personal Assistant	1	200
Deputy Director	2	300
Assistant Curator	1	100
Scientific Officer	2	200
Engineer	3	300
Assistant Director + Toilet	1	400
Accounts Officer	1	100
Public Relations Officer	1	100
Administrative Officer	1	100
Accountant	1	100
Upper Division Officer	1	100
Security Supervisor	1	100
Office Assistant	1	100
Office Attendant	5	300
Conference Room 1	10	120
Conference room 2	30	300
Prayer room	40	800
Ante Room	10	200
Ablution	10	150
Toilet	Female 2 - Male 2	200
Circulation (30%)		1400
TOTAL		6070

SPACE THEATRE

OPERATIVE TEAM

Assistant Programmer	1	100
Space Theatre Operator	1	100
Sub Assistant Engineer	1	100
Technician	2	200
Work Assistant	1	100
Computer Operator	1	100
Personal Assistant	2	200
Circulation (30%)		270
TOTAL		1170

RESOURCE CENTRE

LIBRARY		
Lobby		200
General Reading	50	350
Stack Area	5000 books	350
Librarians Office	2	200
Archive	1000 books	80
Archive Officer	1	100
Astronomy Club	30	500
RESEARCH		
Researcher's Room	2	200
Laboratory	10	1000
Documentation room	3	300
Photography room	2	150
Dark room	2	100
Video/ Audio Laboratory	1	100
Publication and Publicity	5	800
Artist	2	300
Art Room	2	1000
Toilet	Male-4 Female-4	400
Circulation (30%)		1839
TOTAL		8000

BACK OF THE HOUSE

Seller	10	600
Ticket Checker	10	
Store Keeper	2	
Driver	2	
Liftman	1	
Pump Machine Operator	1	
Security Guard	15	
Gardener	4	
Cleaner	8	
TOTAL	50	
Staff Locker	50 (Male-25 , Female-25)	400
Staff Toilet	5- Female 5- Male	500
Gardening Storage		500
Driver Waiting Room	30	300
Security Room		600 (300 X2)
Mechanical Room		500
Pump / Standby Generator		1000
Storage		2000
Loading/ Unloading		500
Service Lobby		500
Circulation (30%)		2040
TOTAL		8840

PUBLIC PROGRAM

Space Theatre	150	6000
Lecture Hall	150	2800
Exhibition space		
Outdoor Plaza		9000
Lobby		1000
Permanent Gallery		35000
Temporary Gallery		4000
Food court	100	1000
Kitchen		500
Store		250
Souvenir Shop		200
Area of Underground Parking		30000
Circulation (30%)		27525
TOTAL		119275
SUM TOTAL		146340

Following the BNBC, these calculations were recorded:

- Maximum Ground coverage – 50% of the Site area – 130,700 square feet
- Maximum number of floors – 13 floors – 130 feet
- Minimum rear open space – 3.0 m
- Minimum side open space – 3.0 m

5.2 Bubble Diagram

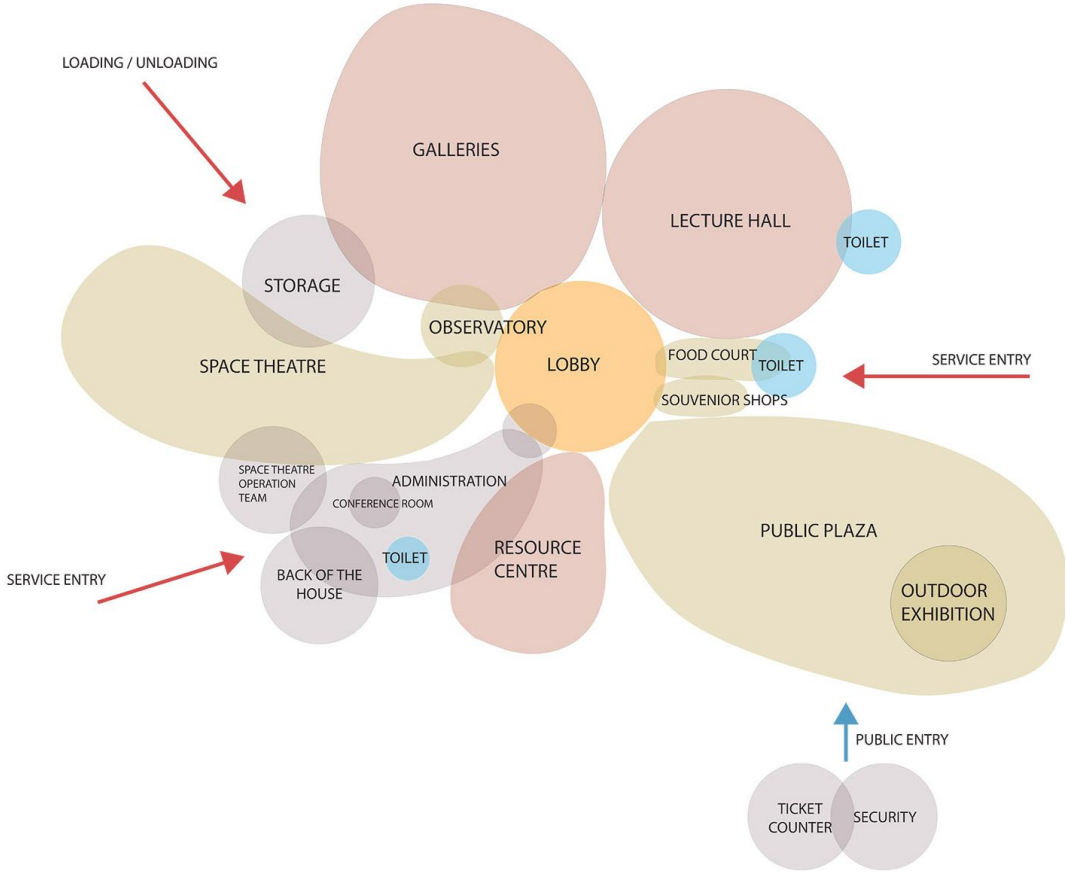


Figure 28: Bubble Diagram[28]

[28] Author

5.3 Functional Flow

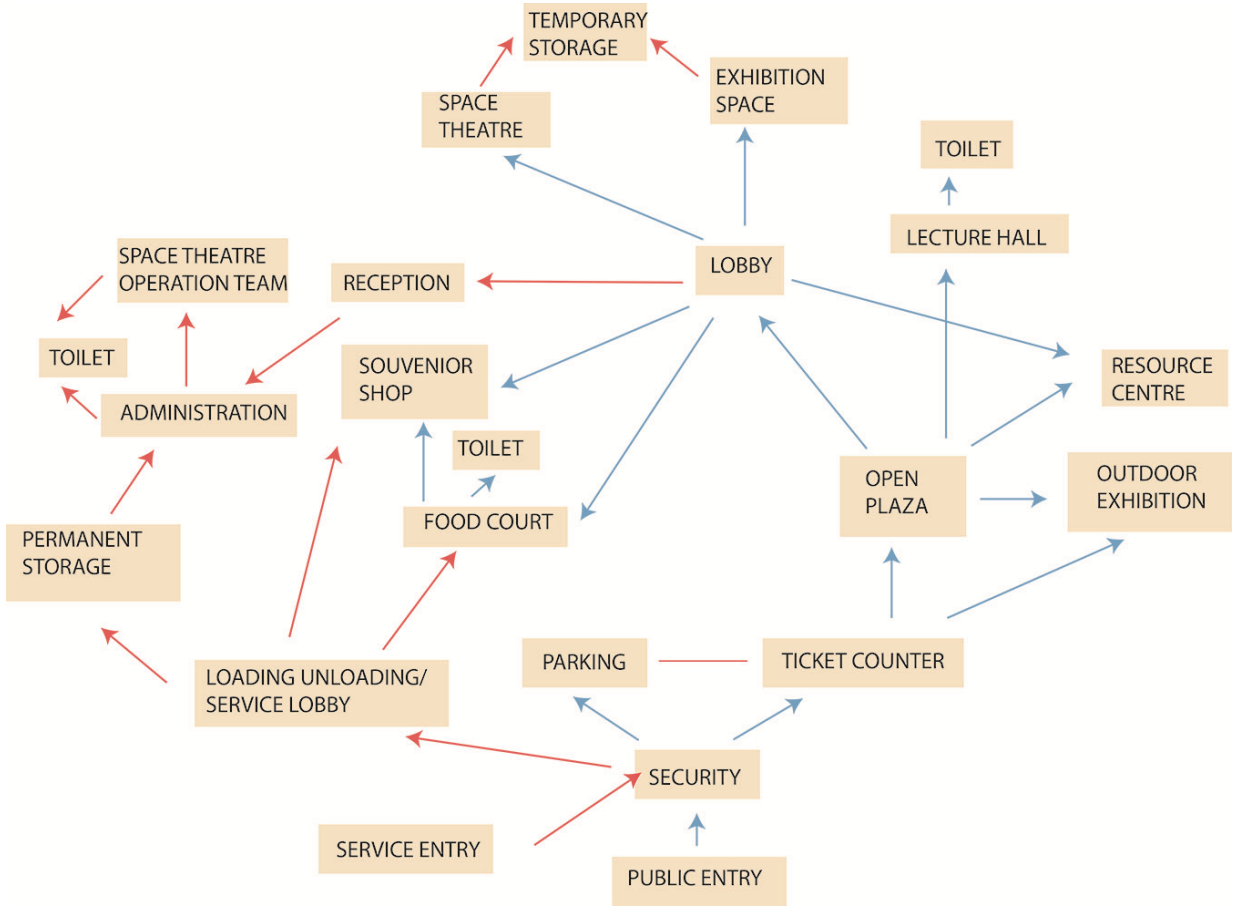
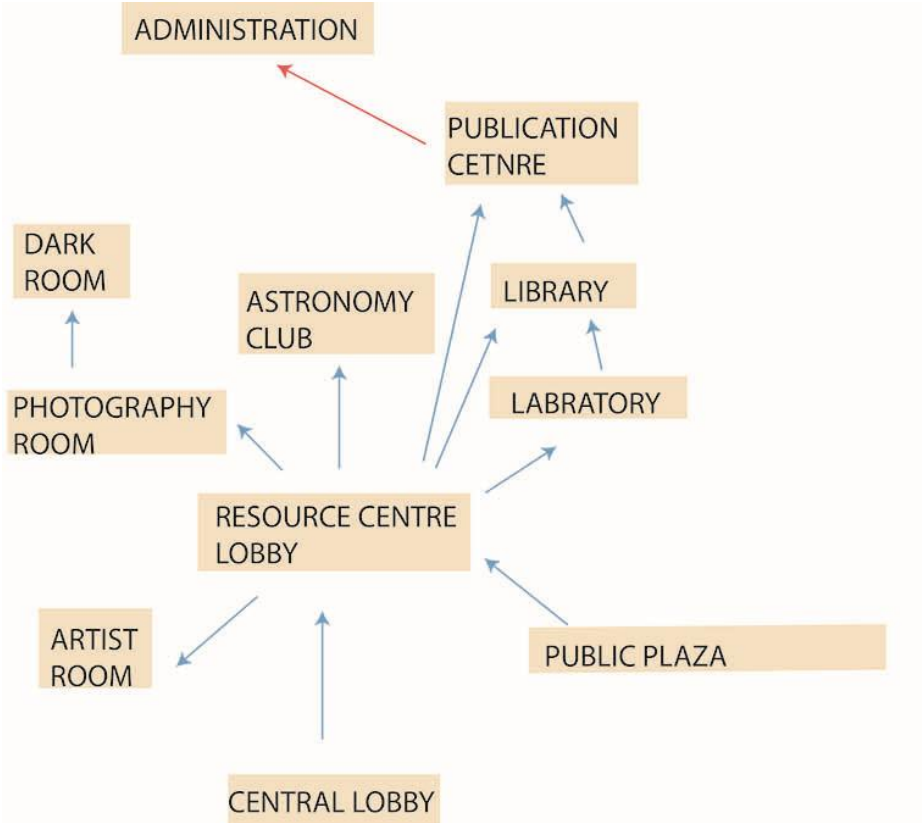


Figure 29: Functional flow diagram[29]



[29] Author

Figure 30: Resource Centre Functional Flow[30]

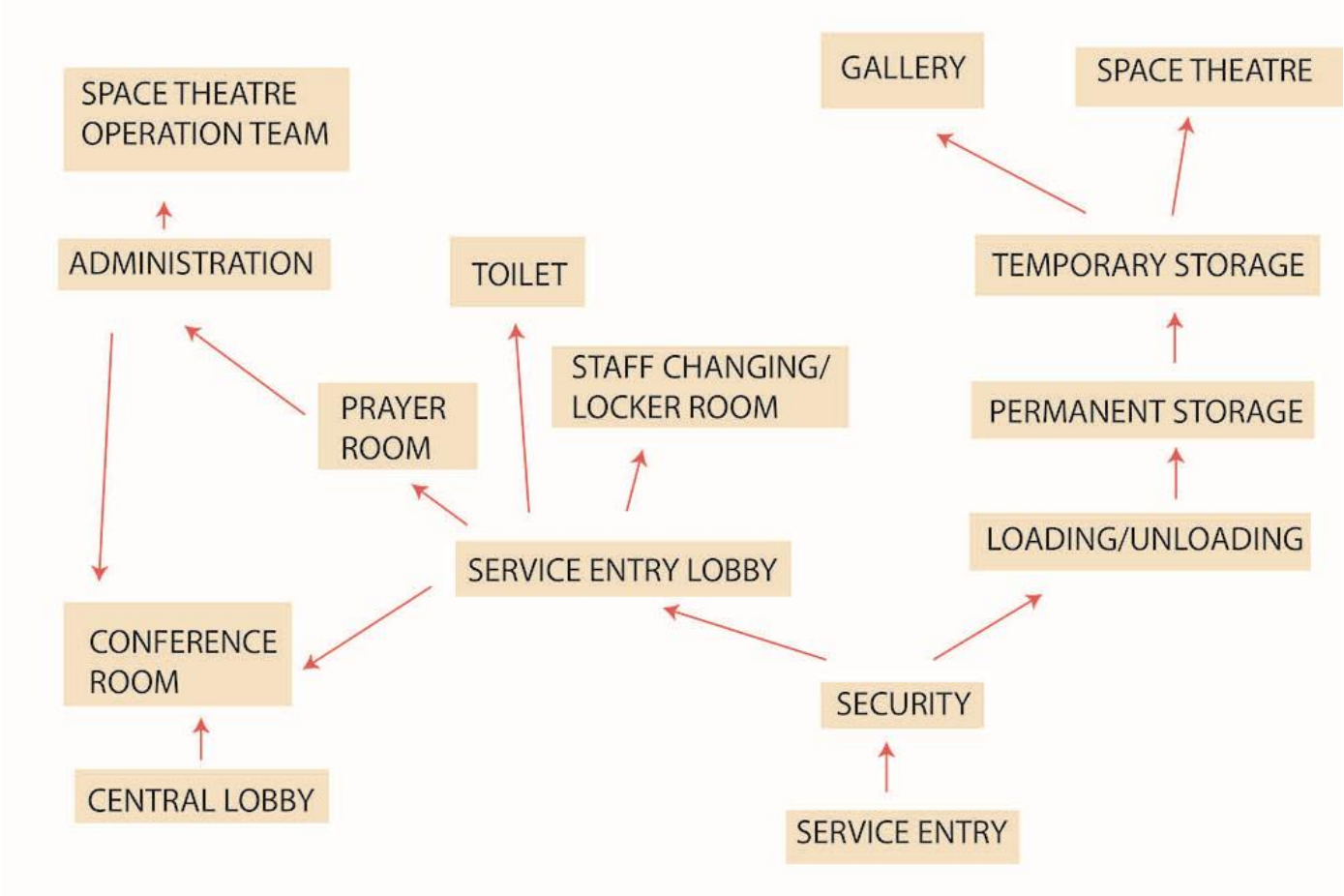


Figure 31: Administration Functional Flow[31]

[30] Author

5.4 Functional Zoning

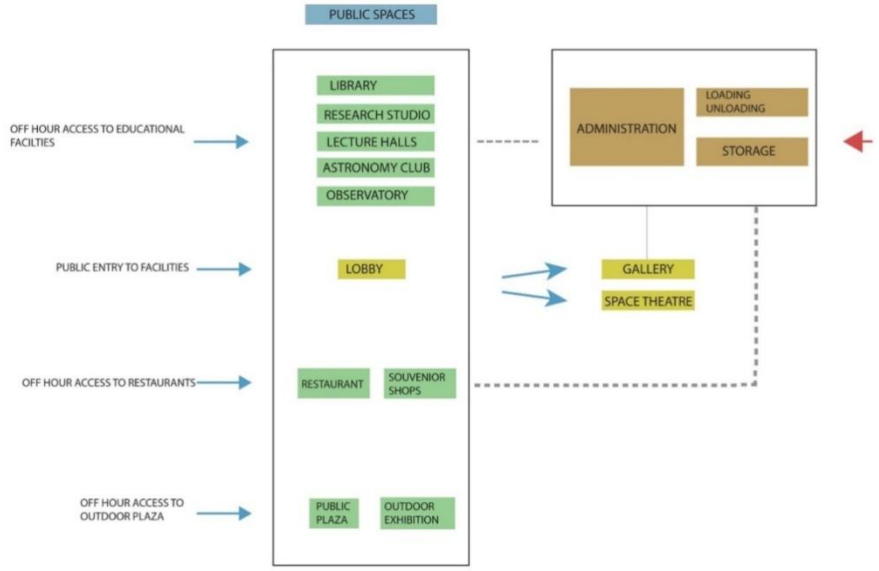


Figure 32: Functional Zoning[32]

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[31] Author
[32] Author

CHAPTER SIX: CONCEPTUAL STAGE AND DESIGN DEVELOPMENT

6.1 Introduction

The aim of this learning centre was to motivate people to learn about the concepts of space science rather imposing the knowledge to them. Such a learning centre should attract people through its spaces and take people through a walkway connecting them to the cosmos. Also, there is a need of interacting spaces where people can meet and learn from each other. It is necessary to create an informal learning space so that visitors learn through motivation and enthusiasm.

6.2 Aims of a space science learning centre

Learning centres provide the visitors with an informal learning environment which enhances the capability for them to pick up new knowledge in comparison with more formal learning spaces, such as schools and colleges. Robins (2014) states his idea about the future of education by focusing on three basic elements that he believes would enhance the efficiency of the education system. Firstly, he states the necessity of opportunities for inquiry based learning which will inspire motivation and curiosity among children. Secondly, he believes that the presence of parents as co- learners with their children enhances their efficiency of picking up new knowledge. Finally, all these should take place in presence of professional expertise who have background knowledge regarding the topics. Robins also mentions that these three elements can be coherently found together in places such as museums and learning centres. Thus, the need for such learning centres is crucial to create an efficient education system for our future generation.

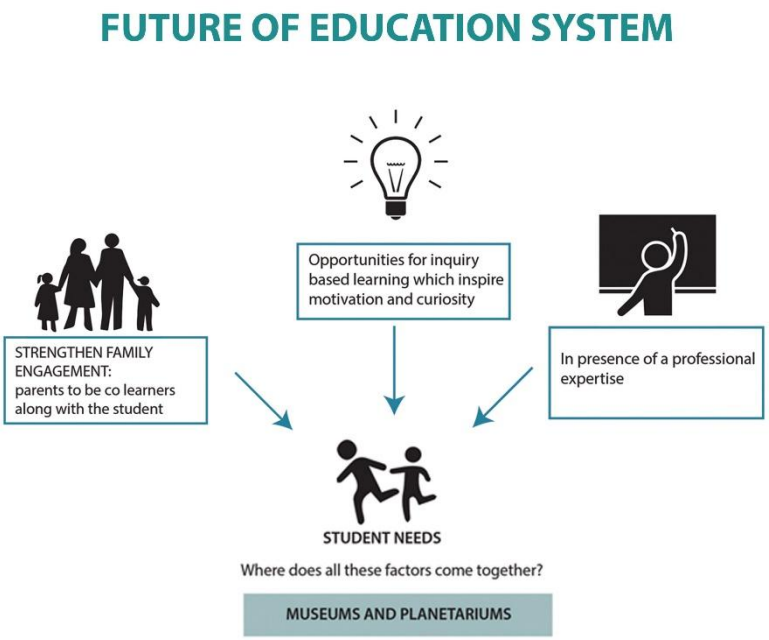

Figure 33: Elements required for the Future Education System[33]

Following the need for learning centres comes the understanding why we need to know about space science. Space science has accelerated our communication systems and technology making our lives simpler and easily every day. In our daily lives we use the technology of space science in almost everything. Starting from our internet connect to our mobile network, all the smart devices that we use run through the applications of space science. Furthermore, new discoveries in this field will create a digital world in the future for which the citizens of Bangladesh need to be prepared. Thus this space science learning centre will help the citizens of Rajshahi to take a step ahead and prepare themselves for the futuristic world that lied beyond us.

This learning centre will be a common platform for different educational institutions to co-learn and share knowledge with each other. Students from primary, secondary, colleges and universities will use this learning centre to exchange information and help each other out regarding the topic. Weekly lecture classes, tutorials can be taken to teach the ones who are interested. Seminars and lectures can be carried

[33] Author

out on the multipurpose hall. Exhibitions of student's science projects from schools all over Rajshahi can be exhibited to the public mass through this learning centre. The learning centre will act as a core connecting all education institutions through it.

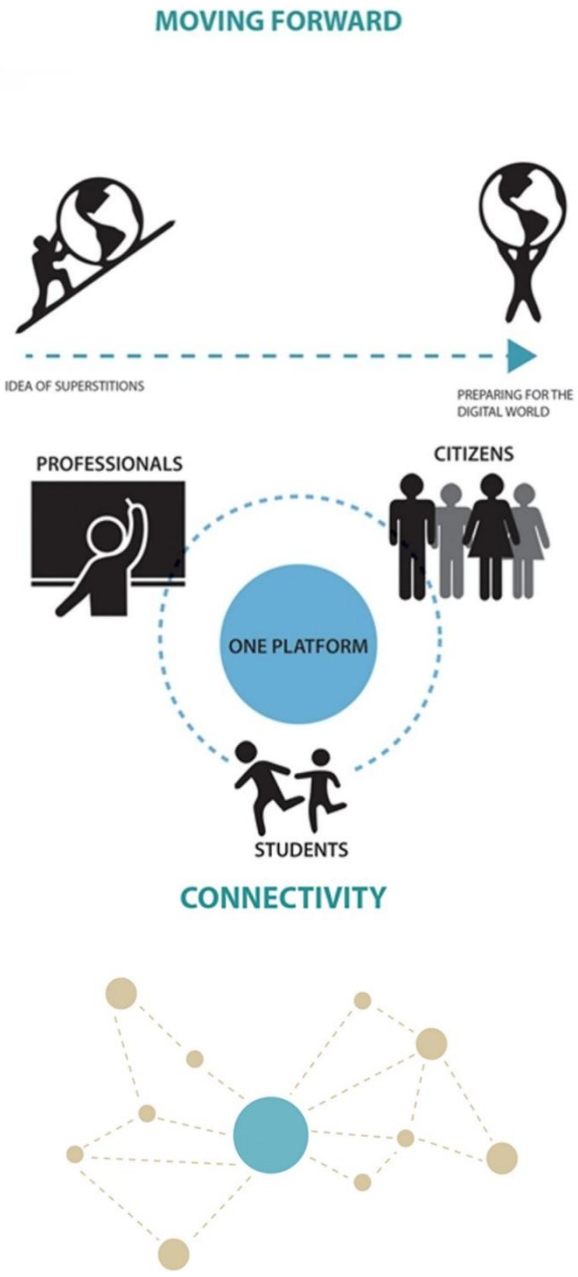

Figure 34: Aims of the space science learning centre[34]

[34] Author

6.3 Concept

The concept for this learning centre was to take the visitors through a walkway transitioning from the ground and slowly spirally upwards to the cosmos. The scale of the spaces are grand connecting each other spiral ramps and bridges to create an impression of galactic orbital floating on the infinite space.

The planetarium, for instance, was considered to be a critical part of the learning centre. It was symbolized as a black hole of the galaxy generating a strong core of attraction for the visitors. A black hole is a celestial body which has high gravitational field strength. When any foreign celestial body comes nearby its gravitational field, the black hole attracts it with tremendous force towards its core and slowly sucks it in. Similarly, the human circulation spaces of the learning centre revolved around the planetarium spirally up to the sky.

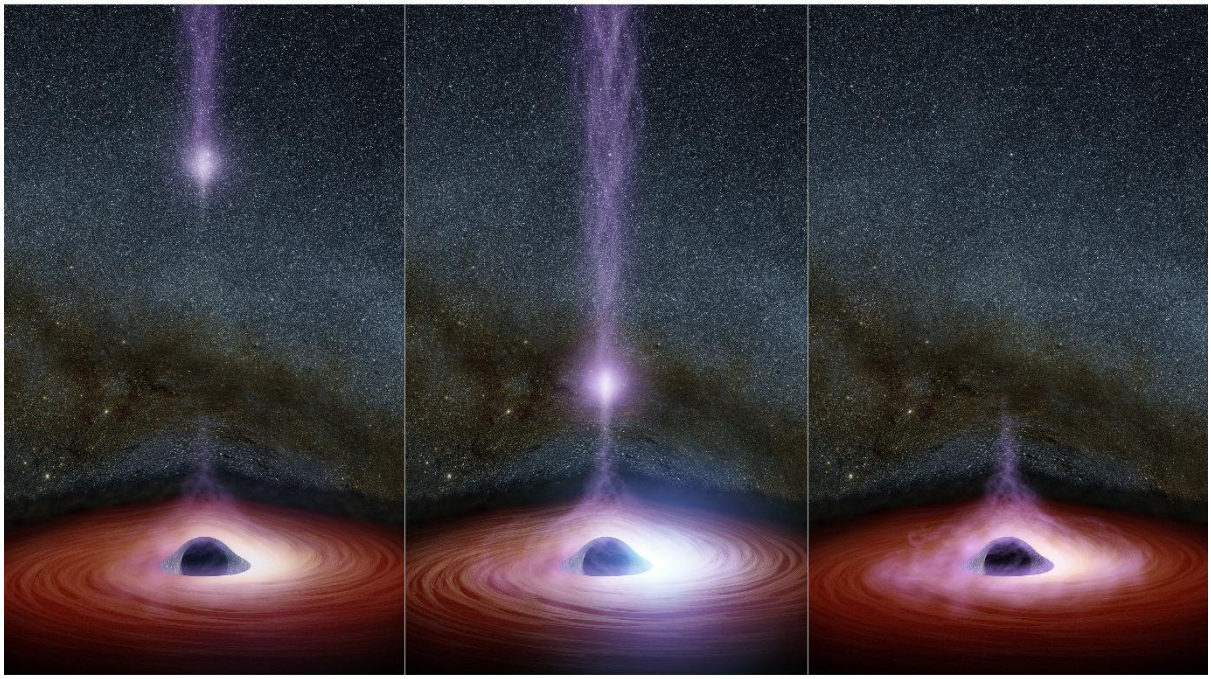

Figure 35: Gravitational strength of a black hole[35]

[35] Google

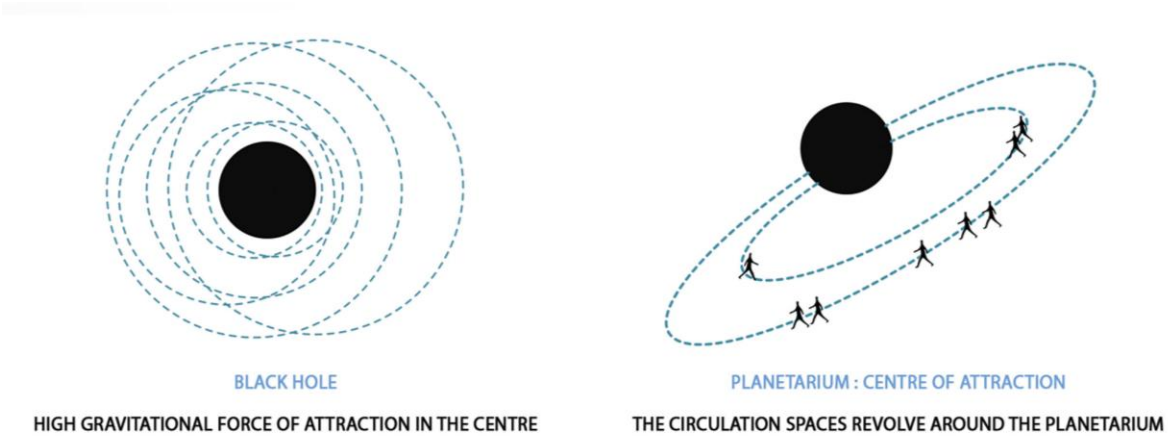

Figure 36: Conceptual Diagram[36]

The gallery spaces of the learning centre connected with spirally ramps taking the visitors from one floor to the other and finally ending the journey on the roof. A large roof is open to the sky with telescope fields so that people can enjoy the night sky and as well as view the lush green of the zoo from it. There are five distinctive galleries which are named sequentially. These include “Travelling through space and time” , “Start mission: Space portals”, “Astronomy and culture”, “Solar system” and finally “ The future digital world”. The theme of the gallery spaces were set in such a way that the visitors are taken back in time at the beginning, slowly progressing towards the present and finally foreseeing the digital world that beholds in their future.

[36] Author

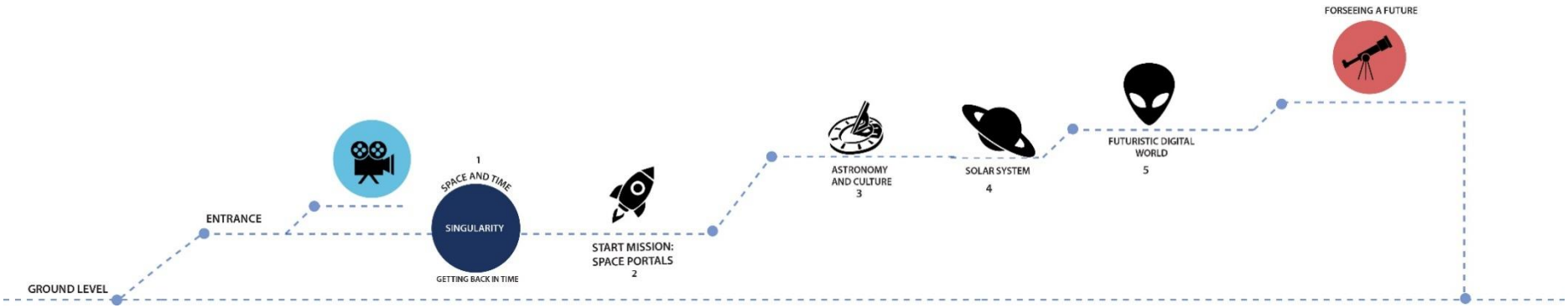

Figure 37: Museum journey[37]

[37] Author

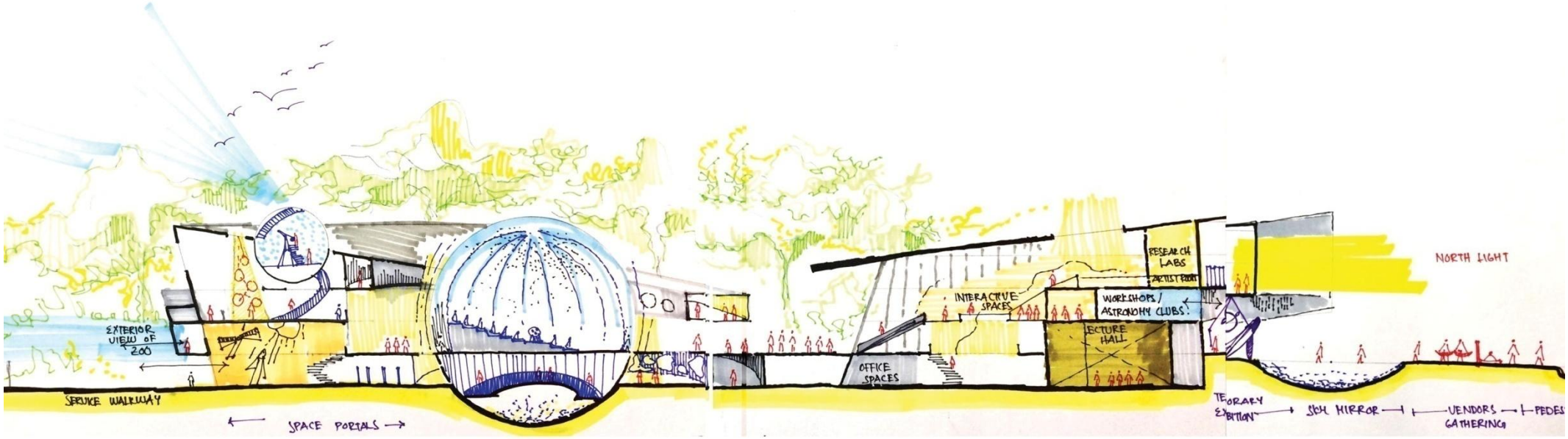

Figure 38: Conceptual Section[38]

[38] Author

6.4 Form Development

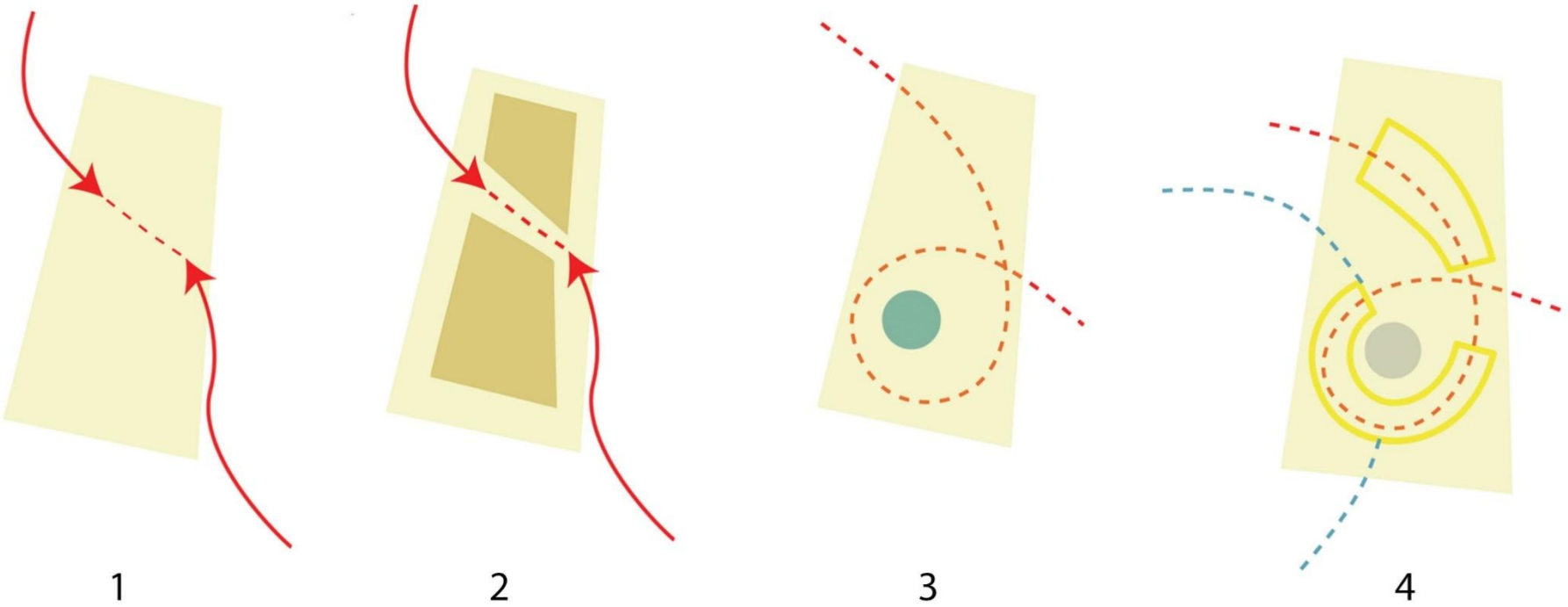

Figure 39: Form Development[39]

[39] Author

1. The critical pedestrian sources to the site is from the zoo entry gate and secondly from the Parjatan Hotel and Shilpokola Academy node. These two pedestrian circulations are proposed to intersect in the main public plaza of the learning centre which will also connect the people accessing by vehicular road.

2. As a result of the first analysis, the form of the learning centre breaks into two distinct forms with the meeting plaza resulting in the centre. People accumulating in the plaza can have access to different functions according to their needs.

3. The flow of the visitors is then proposed to overlap each other through a loop. This loop will also orbit along the periphery of the planetarium. This will forcefully make the passer by walk through the spaces of the learning centre so that they are motivated to visit it next time. This will encourage the curious minds of the people who are visiting the zoo or just walking through the learning centre.

4. Furthermore, new pedestrian pathways for the zoo were proposed interconnecting with the learning centre. This made the learning centre a part of the exhibit of the zoo, together functioning as an integrated system.

6.5 Architectural Drawings

Figure 40: Site Plan

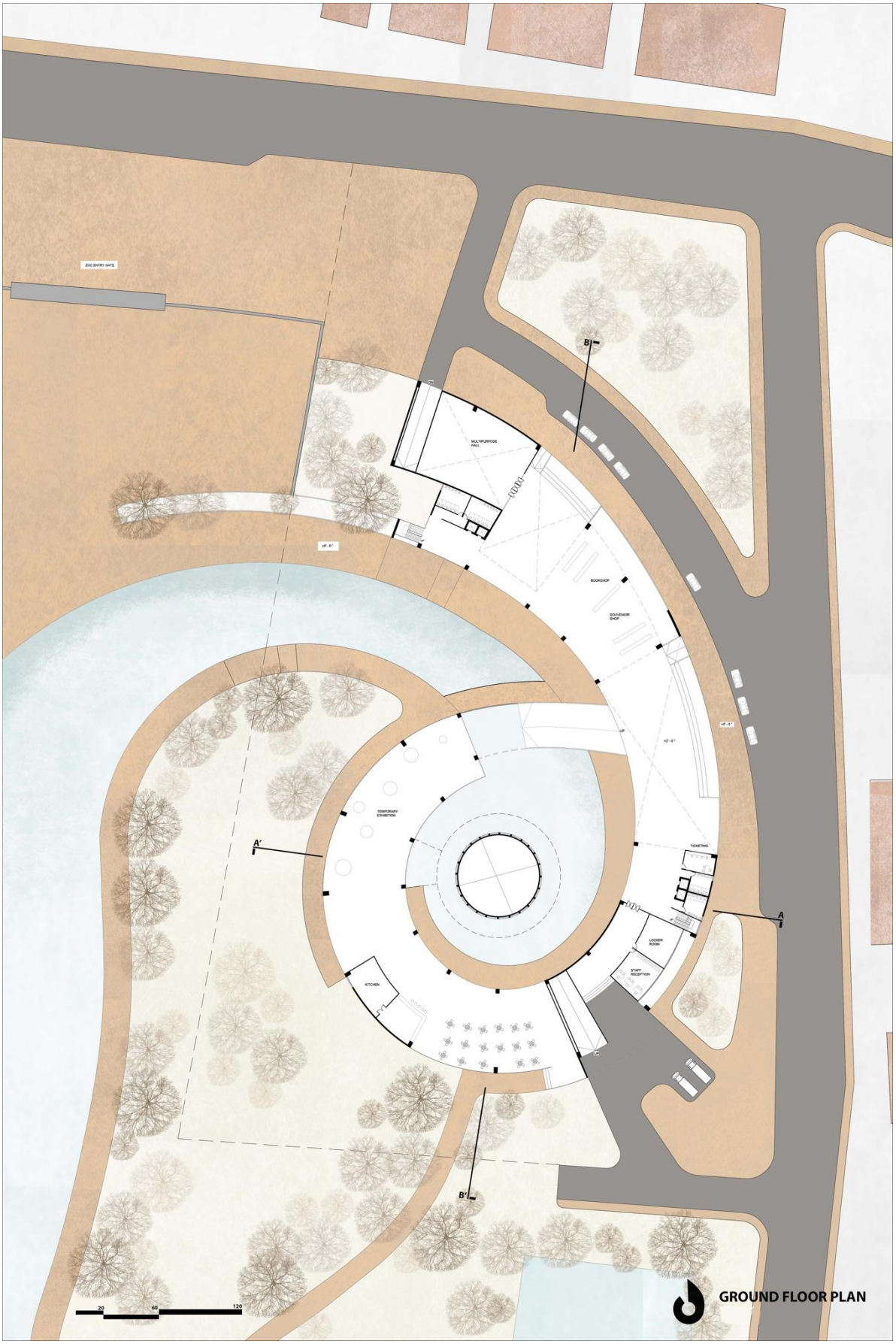

Figure 41: Ground Floor Plan

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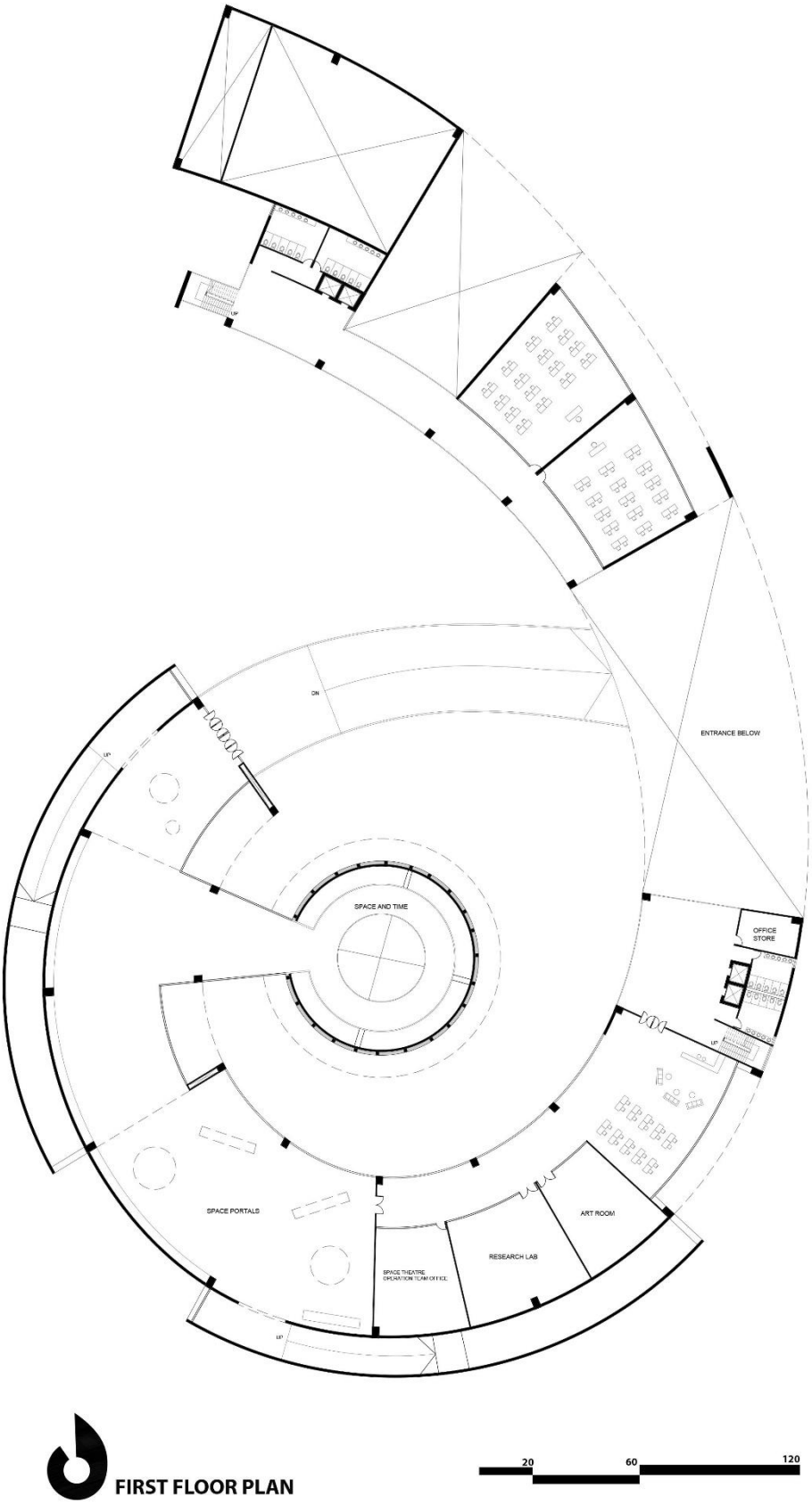


Figure 42: First Floor Plan

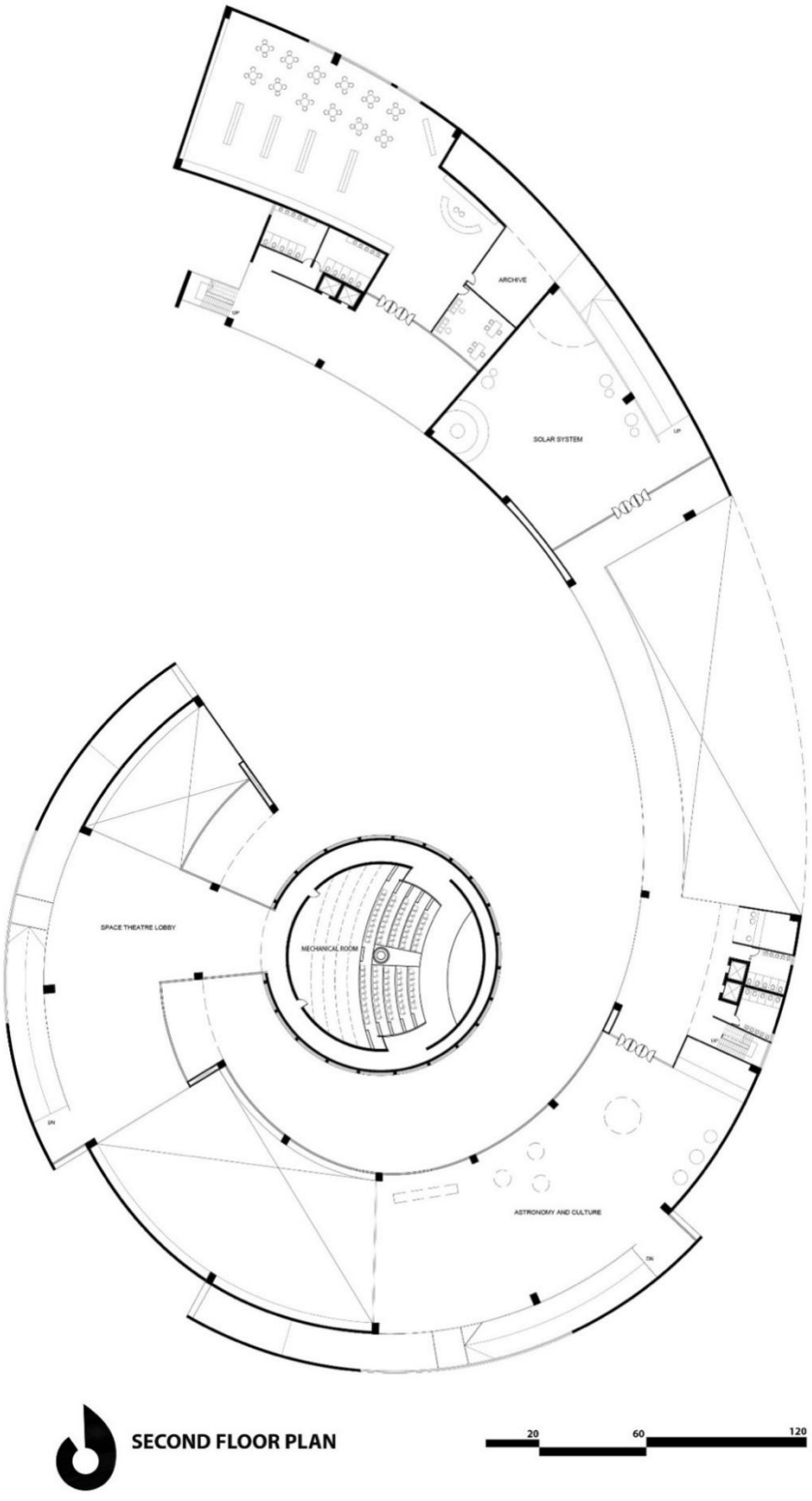


Figure 43: Second Floor Plan

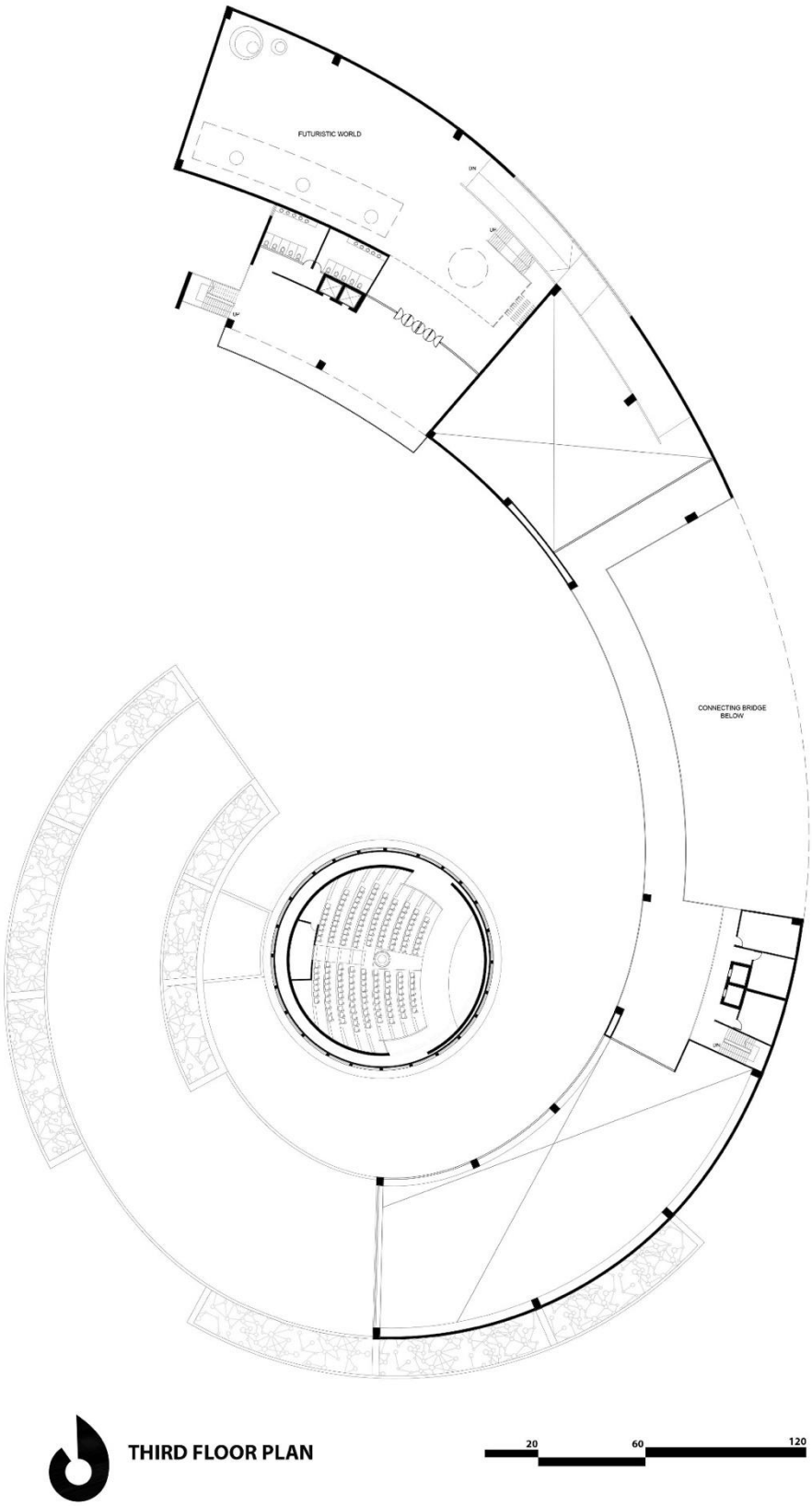


Figure 44: Third Floor Plan

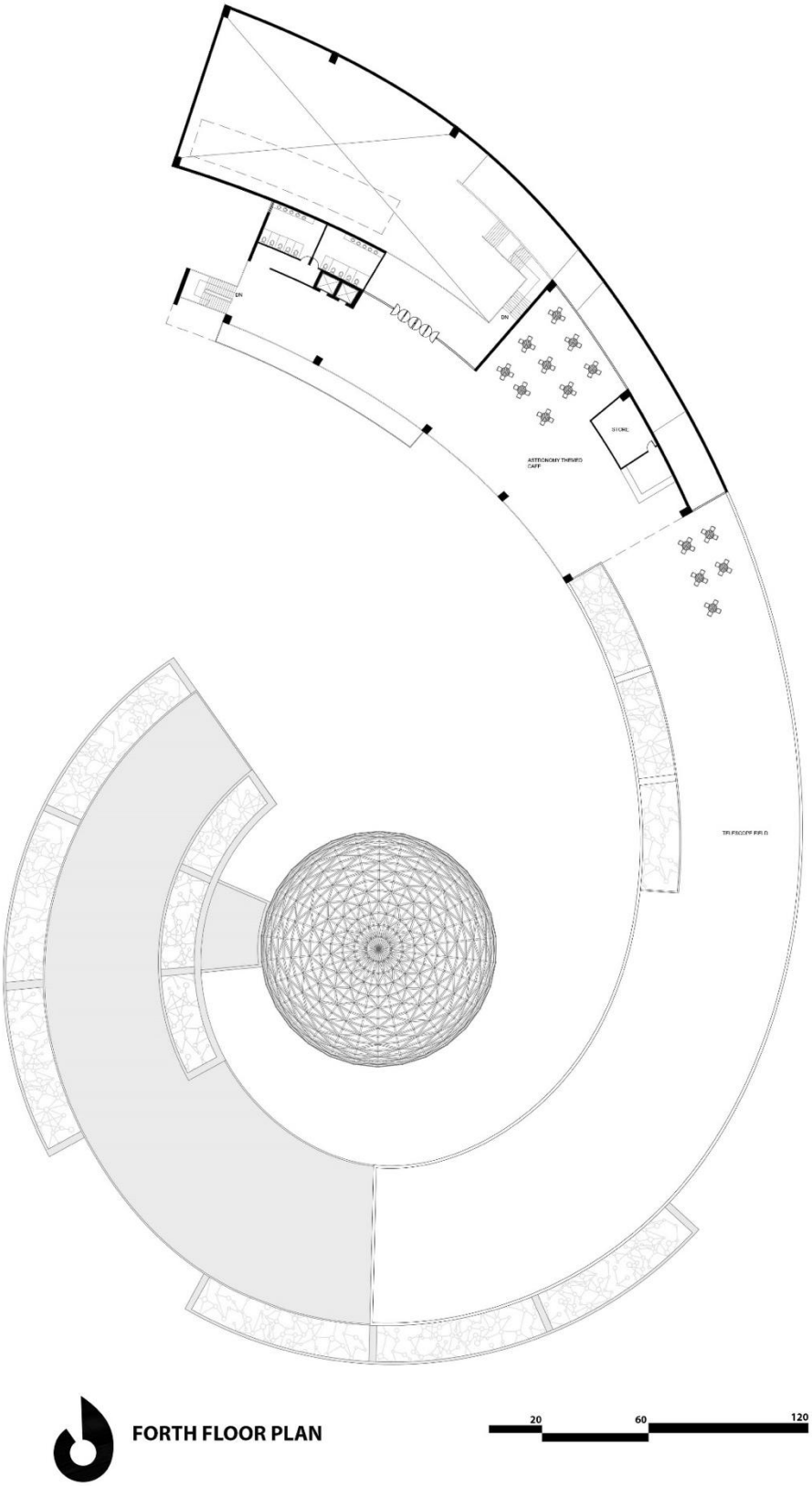


Figure 45: Fourth floor plan

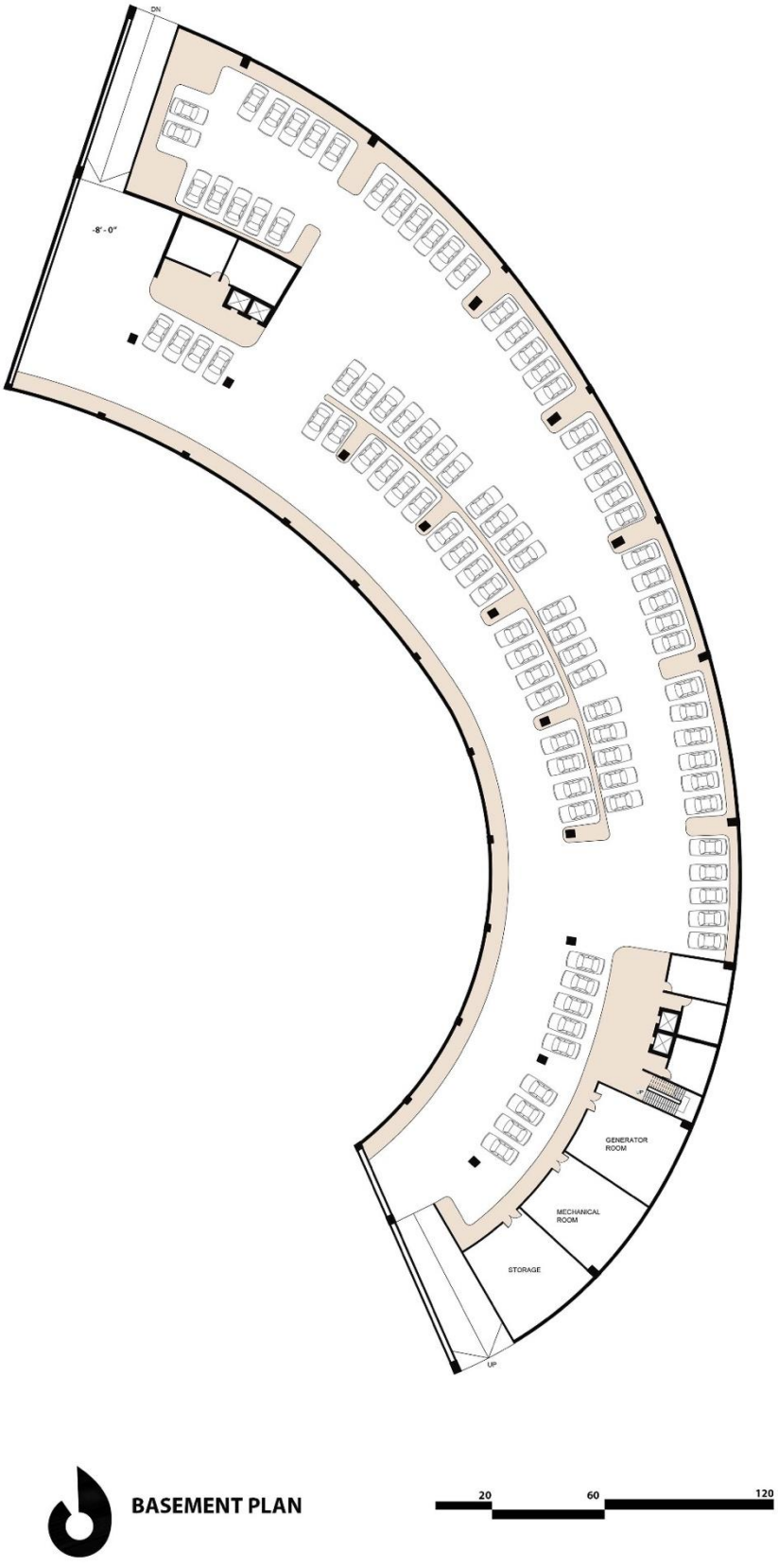


Figure 46: Basement plan

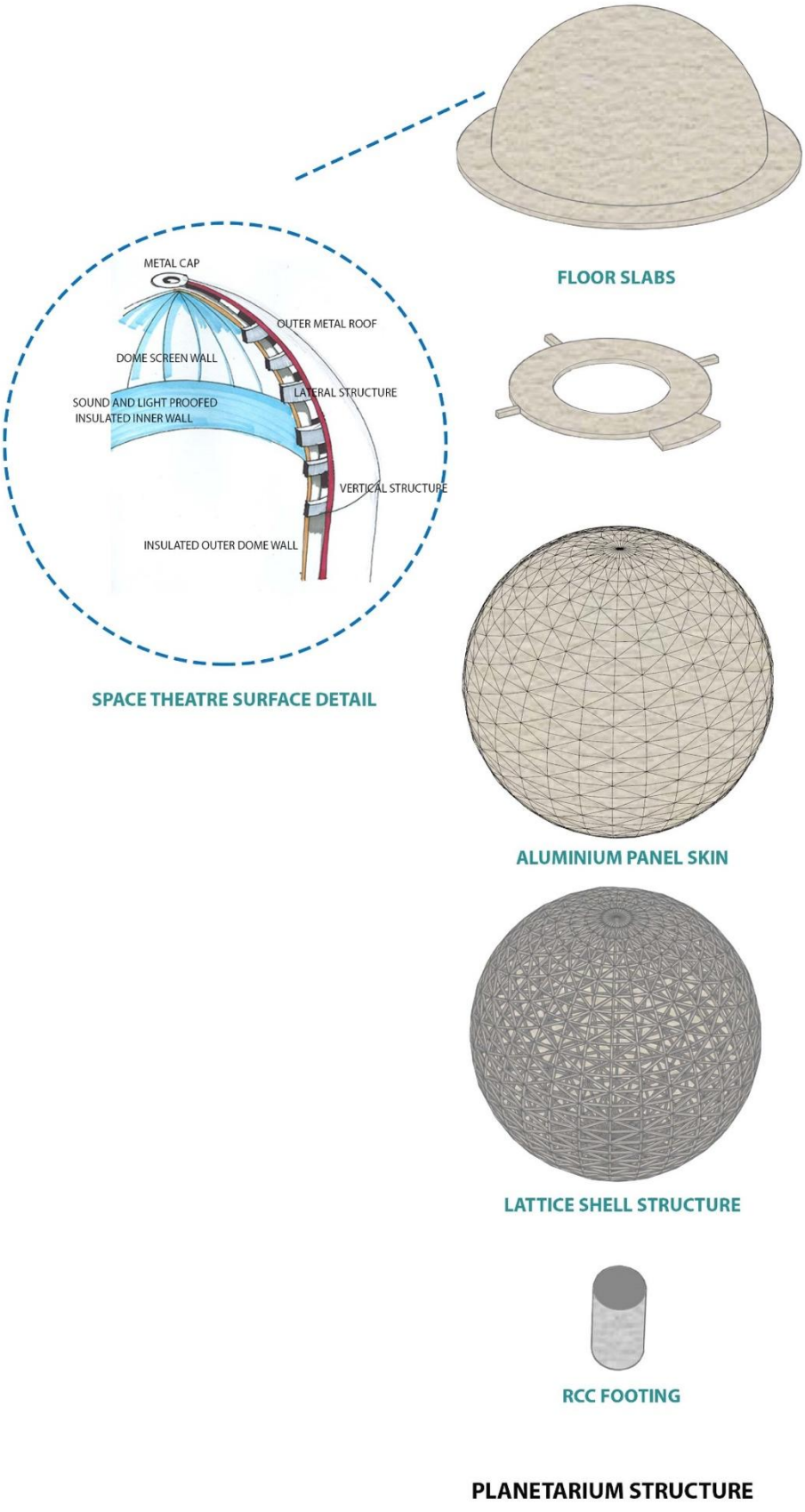


Figure 47: Planetarium structure

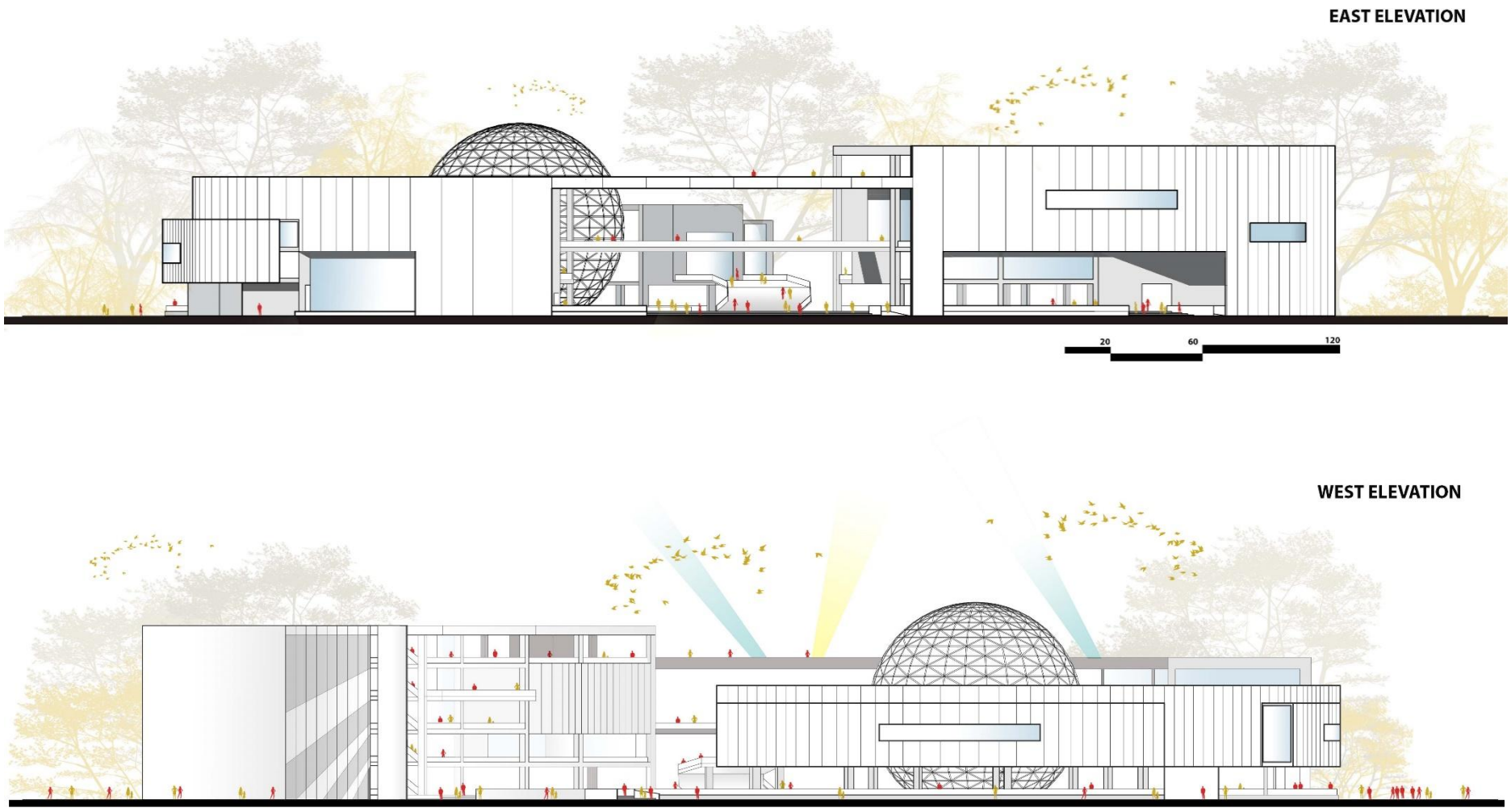


Figure 48: (a) East Elevation, (b) West Elevation

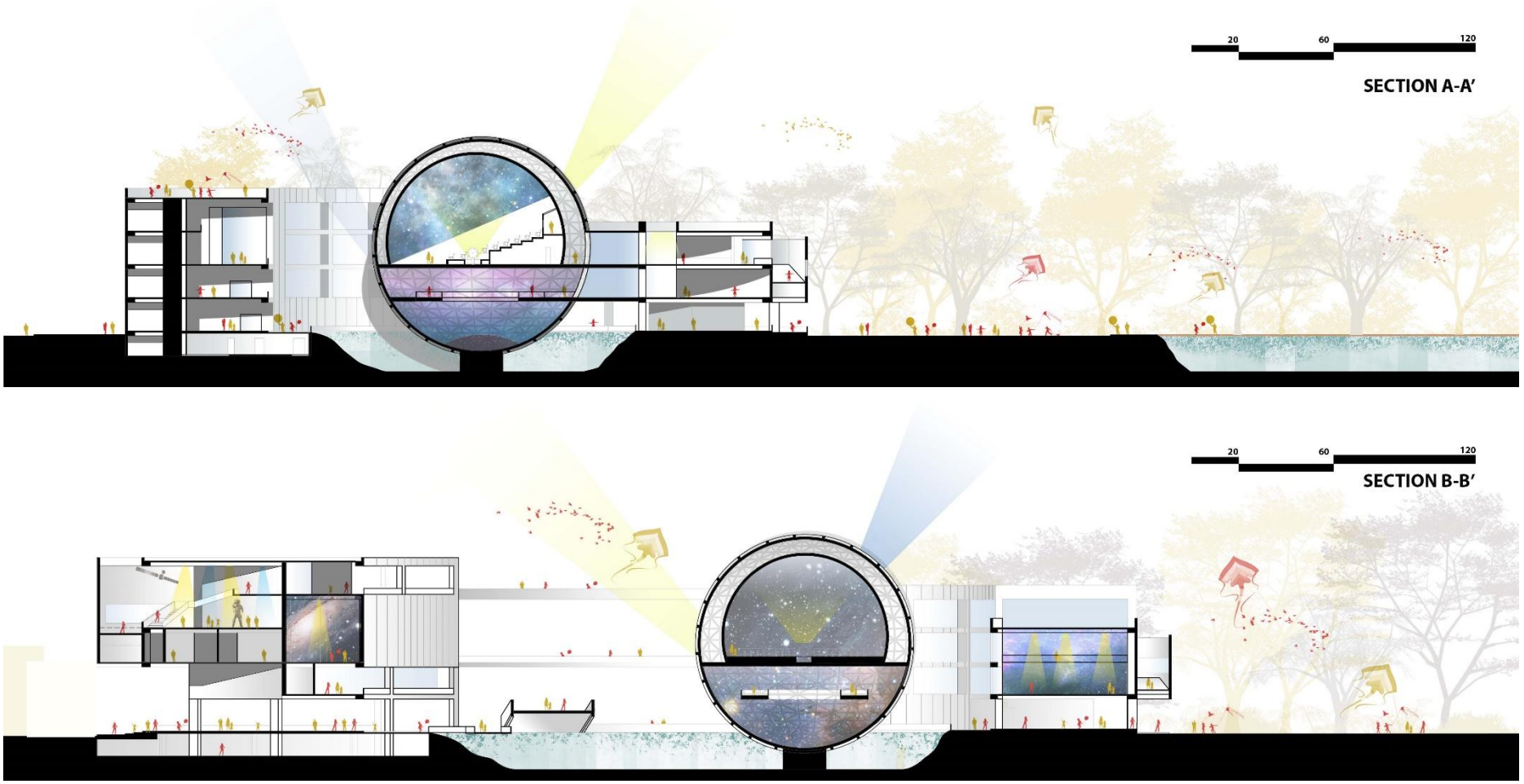


Figure 49: (a) Section A-A', (b) Section B-B'

6.6 Renders

Figure 50: The Futuristic Digital World Gallery

Figure 51: Night Render

Figure 52: Entrance from the zoo

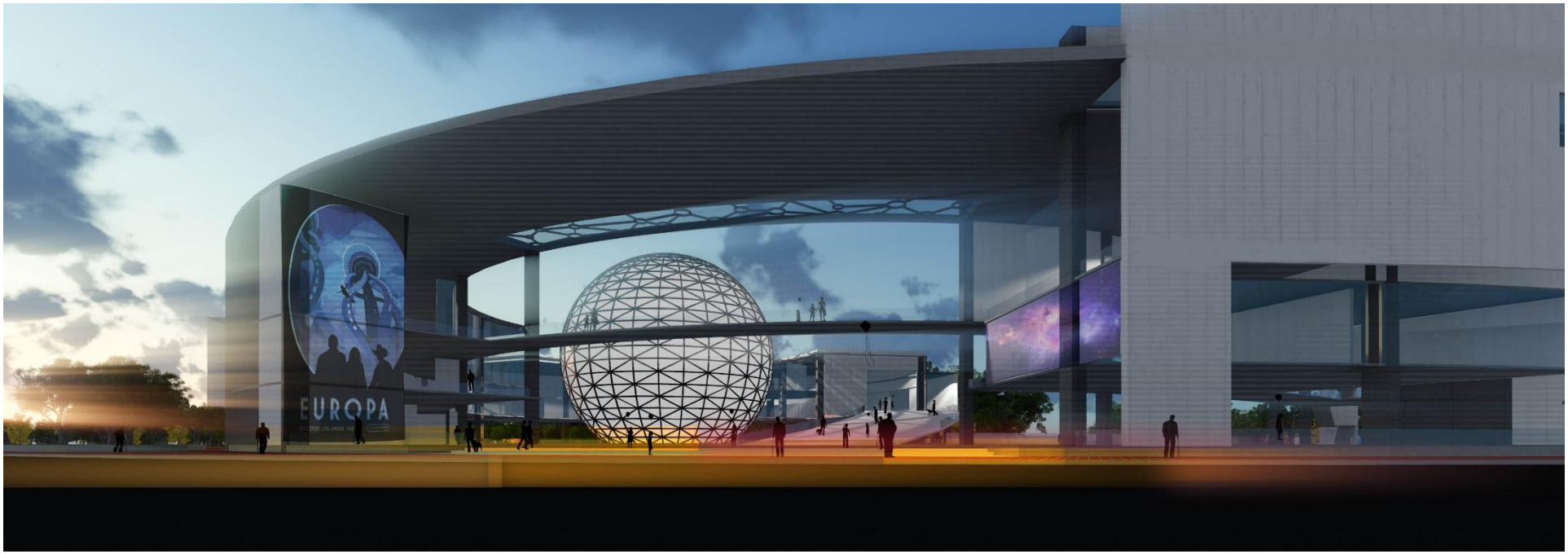
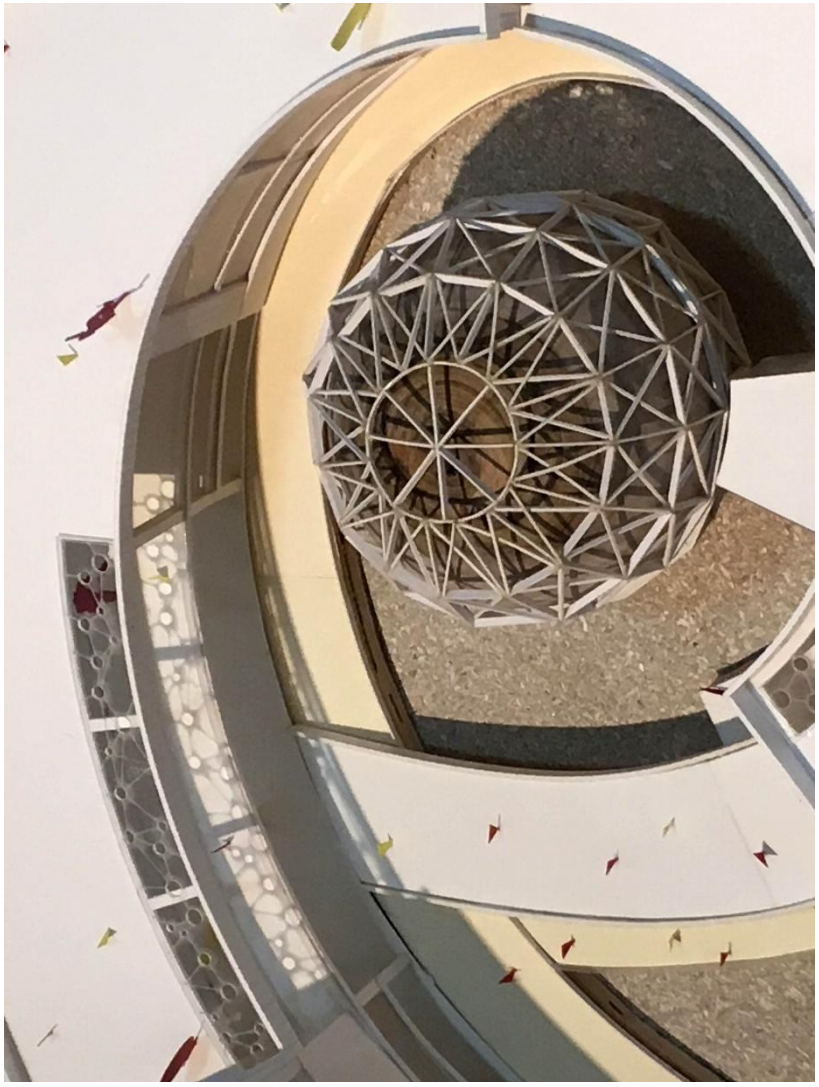
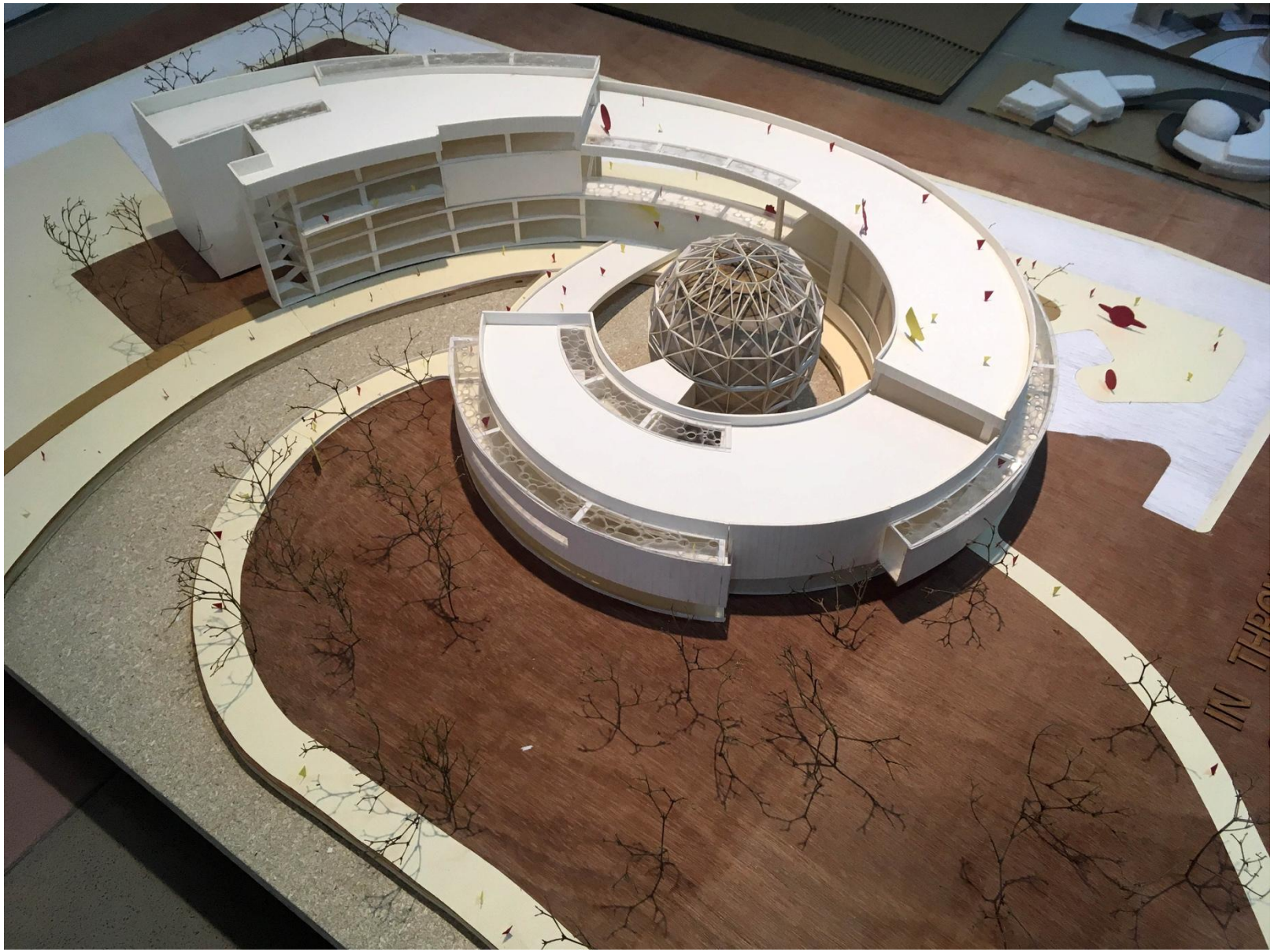


Figure 53: Main entrance

6.7 Model Photos





CHAPTER SEVEN: CONCLUSION

It is important for the citizens of Rajshahi to develop a scientific minded approach to prepare for the digital world that beholds in our future. Furthermore, advanced citizens will help develop the country as a whole, helping it to fight new problems and create new discoveries in the world of space science. Such learning centres will ensure that young minds are motivated to learn, share knowledge and explore new things. It will help enlighten the visitors to know further, explore further and break all boundaries of undiscovered galactic knowledge.

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