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ASTRO WORLD EXHIBITION AND PLANETARIUM

Rahaf Al Hadhrami[1], Haitham Samir[2]

[1,2]College of Architecture and Design, Effat University, Qasr Khuzam St., Kilo. 2,Old Mecca Road. P.O.BOX 34689, Jeddah 21478, Saudi Arabia.
E-mail: [1]roalhadhrami@effatuniversity.edu.sa, [2]hahussein@effatuniversity.edu.sa

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Abstract
This work has proposed the development of Astro World Exhibition and Planetarium center at Jeddah, Saudi Arabia. For this work, three case studies related to astronomical center were analysed. Based on the analysed case studies, for the planetarium center, the estimated gross floor area of the building is 8304 m2. This planetarium center is comprised of few zone, which are administration, exhibition, public zone, educational zone, IMAX theatre, and planetarium zone. Furthermore, in this work, two sites were proposed for constructing the planetarium center. Site evaluation analysis was carried out to determine the most suitable site. Few criteria's were evaluated, which are location, accessibility, shape, area, connectivity, land use, and orientation. Based on the result of the site evaluation analysis, site 1 attained the highest score of 55, compared to site 2 with evaluation score of 25. Thus, site 1 was selected as the proposed development site. In terms of architectural concept, the planetarium center was designed based on black hole concept. The Astro World Exhibition and Planetarium Center is expected to contribute to the local community in terms research in the field of astronomy in Saudi Arabia and to produce a nation that is well versed in the field of astronomy and space studies.

Keywords-- astronomy, space, science, planetarium, Saudi Arabia

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INTRODUCTION

Astronomy is considered to be the oldest natural science in history [1]. Astronomical observatories were built long before telescopes were invented [1]Starting with ancestral astronomy, it was based on the most precise explanation of the movements of galactic objects detected with the human eye, such as the stars, and primarily the planets, such as the Sun and moon [2]. Astronomical observatories continued their observation with the naked eye throughout the century, until the beginning of the 17th century, when the telescope emerged [3].

The plan of these early redirecting telescopes consisted of a curved eyepiece and an arched target focal point. This invention has contributed a lot to the science of astronomical observations [3]. After the telescope was invented, the observatories began to change [4]. In 1671, the French National Observatory was established in Paris and, four years after its establishment, the Royal Greenwich Observatory was established in England [5]. The idea of using telescope lances as reflective objects continued to develop as a single telescope, until Isaac Newton designed a building that was the first practical reflector in 1668 [6]. After that, Newton's design influenced astronomers in creating larger telescopes for astronomical studies [6]. The need for larger telescopes that would gather more light was a stepping stone to study both the composition and motion of the stars. This led to the development of dedicated science centers or planetariums around the globe for the purpose of astronomical studies [7].

The Astronomy expiation and planetarium is a place that will educate people and the young generation about astronomy and space. Furthermore, it will help to promote a concept of education that will lead to a better society. Having a dedicated planetarium center in Jeddah will have an impact on people's knowledge in the science field. It will also create awareness and curiosity for the Saudi Arabian community to learn about the creation of the world and the Islamic contribution to astronomy. Therefore, this work presents the development of Astro World Exhibition and Planetarium center at Jeddah, Saudi Arabia.

CASE STUDIES

Three case studies with reference to astronomical center have been examined in this work. The details of the analysed case studies are stated as follow:

a. Taipei Astronomical Museum
b. Shanghai Planetarium
c. House of Astronomy

Taipei Astronomical Museum

Taipei Astronomical Museum is located at Shilin, Taipei, Taiwan (Figure 1). This building was designed by architect Dr. Hsin Chang Chen. This building has an area of 18000 m^2. The museum offers education and knowledge about astronomy to thousands of visitors every year. The main aim of this museum was to increase astronomical education for tourists and to build a bridge between the study of astronomy and culture, which would stimulate the public's desire to learn more about astronomy. In this building, the exhibition area covers three floors, from Floor 1 to 3. Furthermore, it has a 4th floor which accommodates the Cosmic Adventure Facility. This area holds more than 180 models, pictures and description, with exhibition area of 6000 m^2. Moreover, the exhibition area covers 9 different themes, which are ancient astronomy, space technology, the earth, celestial sphere and constellation exhibit, solar system, telescope observatory area, the galaxies, cosmology, planetarium and 3D theater. The ground floor is located on the street level and has two main entrances and parking for the basement of the museum. The ground floor is divided into three exhibitions (ancient astronomy, space technology, the earth), administration area, reception hall, souvenir shop, supporting services and IMAX Theater. The first floor consists of three exhibition themes (celestial sphere and constellation exhibit, solar system, telescope and observatory area), food resting area, administration, I-MAX dome, library and rainbow tunnel. The second floor contains three exhibition themes (stars-galaxies-cosmology), special exhibition area, reading rooms and administration area. The third floor contains the observatory area and the cosmetic adventure area.

Figure 1. Taipei Astronomical Museum

Shanghai Planetarium

Shanghai Planetarium is located at Shanghai, China (Figure 2). This building was designed by architect Thomas Wong. The construction area of this building is 38000m². The building is designed with the concept of journey through space, time and human innovation. Furthermore, the design represents both the great history of Chinese science and the future desire of China's space exploration program. The facilities of this building includes exhibit galleries, temporary exhibit galleries, 68 foot diameter digital sky theater, 60 foot diameter optical planetarium, IMAX theater, education and research center, solar telescope, youth observation camp, and observatory. In the ground floor there are the most important components, which are expiation, planetarium starry sky, theatre, shops and restaurants. The building has 4 entrances and the main entrance is from the secondary street. The first floor is for expiations area with floor services only. The second floor is a private floor for employees and staff only. It includes offices and meeting rooms. The structure of the building is mostly a space truss covering a large expiation area and a planetary area.

Figure 2. Shanghai Planetarium

House of Astronomy

House of Astronomy is located at Heidelberg, Germany (Figure 3). This building was designed by architect Bernhardt and Partners. The building area is 250 m². The structure type is concrete slabs with core cantilever. In the reflection of space and galaxies, the design and unique shape of the House of Astronomy was inspired by the essential shape and arms of a spiral galaxy. The paths in which stars, gas, dust and dark matter rotate around the center of the galaxy have played a key role in the design. The building is designed as a core in the middle of the auditorium and is surrounded by offices and seminar rooms that surround the central auditorium. The auditorium has approximately 100 seats. As an educational building, the House of Astronomy hosts lectures to interact with scientists and people who are interested in astronomy to spread knowledge and, in particular, to school students who are passionate about exploring and learning more about space. The plans are divided into large lecture rooms, workshop rooms and exhibitions on the ground floor and small lecture rooms, meeting rooms and a telescope observatory room on the first floor. The rooms are rotated around the central core, which includes a large auditorium with a capacity of 100 seats. Night observation sessions are held in the auditorium. The twisting spiral arms of the building are moved by a half story. This provides the structure extra support because of the rotational movement around the core. This has created cross-links between the levels. The building structure is provided with concrete slabs supported by a central cantilever projecting towards column-free facades. The massive beam and the box girder rest on the central columns of the core. The ramps are designed to hold the auditorium in the centre, leading to different levels and functions of the building. The facade of the building is erected as massive concrete slabs with a recognizable distance. Glass exterior walls act as a support and the climate shield takes over the loading and transfer of dead loads.

Figure 3. House of Astronomy

PROGRAM ASSUMPTION AND SPACE DETAILS

For the Astro World Exhibition and Planetarium center, the estimated gross floor area of the building is 8304 m². Based on Table 1, the planetarium center is comprised of few zone, which are administration, exhibition, public zone, educational zone, IMAX theatre, and planetarium .

Table 1. Space details

Zone	Gross floor area (m²)
Administration	195
Exhibition	4335
Public zone	1419
Educational	1145
IMAX Theatre	295
Planetarium	915
Total	8304

PROPOSED SITE

Proposed site: Site 1

For site 1 (Figure 4), this site is located at Southern Abhor road ,Jeddah, Saudi Arabia. The site has a total area of 18000 m².

Proposed site: Site 2

For site 2 (Figure 5), this site is located at Southern Kornesh road, Jeddah, Saudi Arabia. The site has a total area of 19000m².

Figure 4. Site 1

Figure 5. Site 2

SITE EVALUATION AND ANALYSIS

In this work, for the development of Astro World Exhibition and Planetarium center, two potential development site were proposed. Thus, site evaluation analysis was done to select the most suitable site. The evaluation was done based on few criteria's, which are location, accessibility, shape, area, connectivity, land use, and orientation. Table 2 shows the site evaluation results. Based on Table 2, it is observed that site 1 has exhibited the highest score of 55, compared to site 2 with evaluation score of 25. Thus, site 1 was selected as the proposed development site.

Table 2. Site evaluation

Criteria	Site 1	Site 2
Location	5	10
Accessibility	10	5
Shape	10	0
Area	10	5
Connectivity	10	5
Land use	5	0
Orientation	5	0
Total	55	25

The site is accessible from two main streets of Alkornesh Street, King Abdul Aziz Street and the secondary Taher Algazone Street. In terms of traffic, the traffic is high on Kornish Street because it is close to the sea and medium to King Abdul Aziz because it is a highway. In addition, the site is surrounded by commercial and entertainment zones. The landmarks near the site are Alrawaq Alamawe Restaurant and Abhor Park. The site is exposed to good climate throughout the year. The location of the site is appropriate for the Astro World Exhibition and Planetarium center and meets the key design criteria. The site is located on a liveable public road that has hosted some of the most visited entertainment venues in Jeddah.

PROJECT DESIGN

The Astro World Exhibition and Planetarium center is designed based on black hole concept. The center has three main functional zone, which are planetarium, exhibition zone and theatre zone. For the exhibition area, the entrance is placed at the ground floor. Furthermore, the exhibition space has a free flowing and circulation space. It is designed to be easily accessible for exhibitors and also the visitors. For the planetarium, it is fitted with large dome-shaped projection screen. Planetarium arches vary in size from 3 to 35 m in width, and can accommodate 1 to 500 people. Arches are made from thin aluminium areas with ribs that provide a supporting structure behind a space bracket that can cover a wide range. The use of aluminium makes it easy to puncture the arch with a large number of small openings. This reduces the reflectivity of the sound back to the gathering of people (giving better acoustic qualities), gives a sound framework a chance to extend from behind through the arch (offering sound that appears to originate from the fitting headings identified with the show) and allows air to be diffused through the projection surface for atmospheric control. In addition, slide projector, video and full dome projector systems and lasers are different technologies that are used to create the celestial scenes of the dome. The main objective of the technology used is to create accurate relative motion of the sky. Typical system can be set to display the sky at any point in time and at any point in latitude on Earth. For the theatre zone, its is design with I-MAX theatres. An IMAX dome provides a hemispherical screen that wraps the entire theatre. The size of the dome is 30 meters in diameter. These theatres are designed to increase the angles and openup the field of view to an average in 70 degrees. The exterior of the building is designed with glass shading. The planetarium is located at the center of the whole structure. The other key facilities of this building includes library, café, administration, Muslim astronomer exhibition and gallery exhibition. The architectural design of the Astro World Exhibition and Planetarium center is shown in Figure 6 to Figure 10, respectively.

Figure 6. Overview of Astro World Exhibition and Planetarium center

Figure 7. North elevation Astro World Exhibition and Planetarium center

Figure 8. South elevation Astro World Exhibition and Planetarium center

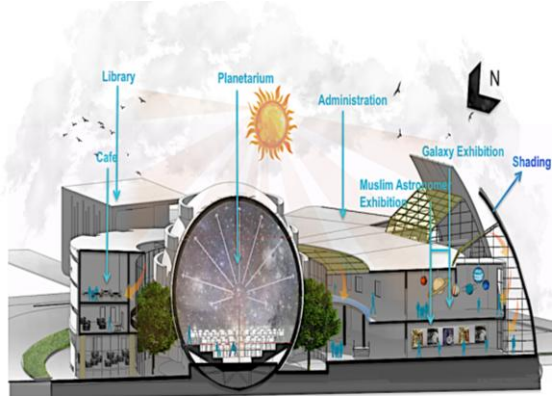

Figure 9. Cross section view of Astro World Exhibition and Planetarium center

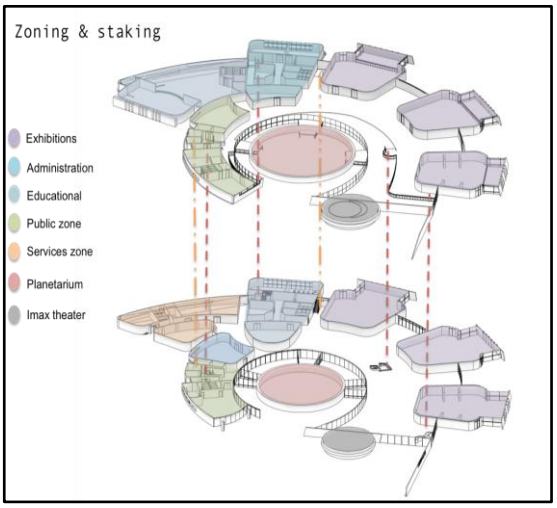

Figure 10. Zoning of Astro World Exhibition and Planetarium center

CONCLUSION

This work has presented the development of Astro World Exhibition and Planetarium center at Jeddah, Saudi Arabia. The estimated gross floor area for this center is 8304 m^2. In addition, the planetarium center is comprised of few zone, which are administration, exhibition, public zone, educational zone, IMAX theatre, and planetarium zone. The development of the Astro World Exhibition and Planetarium Center is expected to spread knowledge about astronomy and space science in the Arab world in general and in the Kingdom of Saudi Arabia. Furthermore, tt will also be a platform that promotes studies and research into astronomy, which is now in continuous development around the globe, and will make the nation of Saudi Arabia to excel in the field of astronomy.

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