

# Aviation Hub and Expo Development Design Plan

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**Abstract** The Aviation Hub and Expo, in addition to the School of Aircraft Engineering, is a timetable that can preview the history of aircraft to date, and develop or plan air navigation technologies or foundations, and develop the air transport industry to ensure its safety, security, and growth. This study collects different types of information and studies about Aviation Expo around the world and in Saudi Arabia. In specific, this study investigates case studies and analysis, identifies project components for zoning, provides space program as well as determines the appropriate project location based on the site evaluation criteria. This project is under the category of education and entertainment building. The proposed zoning plan includes the main lobby, administrative areas, education areas, museum and gallery areas, Skydome cinema and service areas. Based on the site assessment, the proposed location for the project is in the Obhur Al-Shamaliyah area of Jeddah, Saudi Arabia. Aviation museums vary in size from housing just one or two aircraft to hundreds. They may be owned by national, regional or local governments or be privately owned. A lot of aviation galleries focus on military or civil flight, or on aircraft history of a particular period, for example, pioneers flight or the succeeding golden age among the World War I and II, or a specific sort of aircraft.

**Keywords** Aviation Hub and Expo, Aircraft Engineering, Transport Industry, Aviation Galleries, Aviation Museums

## **1. Introduction**

The aircraft is an air vehicle heavier than the air and is an

air transport. Flying either by sail, by motor or by several engines, it can fly in the air depending on the force generated on their wings, or by the force of air drag. Also, the aircraft require regular maintenance to ensure airworthiness, maintain aircraft reliability and provide flight safety [1]. Aircraft is one of the most important inventions in these days which have contributed significantly to the development of society at the present time, and it has transferred the whole world a quantum leap as it has shortened the distances between people in different places around the world [2, 3]. The major importance of aircraft is to shorten the time and shorten the distance between people, as it is unlike the previous methods of transportation such as cars and ships, which needed months to get from the Middle East to the United States of America.

Aviation was able to enter all areas of life and from the widest doors, because of the great ease, and the high efficiency unmatched in linking the different cities of the world [4]. Some may suggest that the term aviation is linked only to travel, but the term is actually larger and more general. The most important areas related to aviation and aircraft are travel field, business field, military field, and other using.

Aviation and aircraft are commonly used in travel and business field. Many people today rely on flying in their travels from one area to another around the world. Aviation takes a great deal of time and is easy, convenient and comfortable for travelers. Airlines are competing around the world to provide the best services to passengers on their airlines. Besides that, aviation and aircraft entered the commercial space from the widest possible range. Aircraft have the capacity to carry goods, parcels, and letters [5]. Transport and shipping companies have specialized in this

and have gained international fame for the amount of service they have provided to people.

The aircraft entered the military field shortly after the invention of the aircraft, and expanded its use in this area, and the development of private aircraft known as warplanes, which included several types of aircraft: fighter aircraft, bombers, cargo planes and aircraft that carry out attacks ground, spy planes, and others [6]. Aircraft have made significant contributions to turning the course of wars in general.

Recently, aircraft, especially helicopters, have been used to provide assistance to the needy as quickly as possible, and then transfer them to the nearest medical center or hospital for full treatment. The aircraft have helped in this area unmatched, especially at unusual times, places where regular ambulances are difficult to reach.

Aircraft also have many other roles in different operations such as firefighting. Aircraft are used very heavily for the rapid transfer of water to the place of fire and extinguishing it as quickly as possible and without endangering people's lives during this process. Forests rely mainly on aircraft to carry out this operation, in addition to the search and rescue operations, which are carried out largely by the use of aircraft and this provides quick and accurate search for missing and at risk.

In addition, safety is one of the strategic objectives of the International Civil Aviation Organization (ICAO) to promote the global civil aviation system. According to statistics, nearly 40% of aviation accidents occur at airports, and the most common type is runway deviation [7]. This can be viewed as a Constraint Satisfaction Problem (CSP) based on several mathematical principles [8]. Thakur, Baksh, Kumar, and Singh have proposed implementing a Constraint Satisfaction Problem (CSP)-based solution for sequencing aircraft departures on a runway, which aids in developing optimal departure schedules and planning the initial climb phase for departing aircraft [9].

In addition to human-beneficial transportation, awareness of the unprecedented impact of aviation emissions on the global environment and climate change scenarios is also important [10]. Hence, the impact of aviation on the environment cannot be ignored and should be included in the education stage

Therefore, the goal of the project is to propose a development of Aviation Hub and Expo to preserve the rich history and artifacts of creating a knowledgeable destination from the Saudi dwellers. With the group of old and new aviation including special exhibitions, photographs, films, interactive, maps, artwork, engines, uniforms, medals and research and education facilities, the museum will take an innovative approach while keeping with tradition.

## 2. Literature Reviews

### 2.1. Transform the Old Airport into an Aviation Hub and Expo

Renovating or rebuilding old military airports or old local commercial service airports into aviation hubs is one way to achieve sustainable architectural design development. The combination of aviation history museums and shopping centers will become rich cultural and historical landmarks. Furthermore, it is also an excellent educational venue.

The airport is not only a transportation hub, but is also regarded as an important city connection and communication place, and it has full potential in an increasingly networked world [11]. In terms of the culture, geography and economy of its location, the airport can be integrated with advanced transportation technology [11]. Similarly, aviation hubs and expos can also be equipped with public transportation such as commuters to attract more tourists, which is more convenient because aviation hubs and expos are usually far away from residential areas.

In addition, it is possible to establish an aviation hub in cooperation with architecture and design partners to provide architectural products essential for structure, maintenance and modern design, enhance the terminal experience, and the possible result will increase the visitor experience.

### 2.2. The Importance and Role of Aviation Hubs and Expositions

Educators are aware of the importance of the informal education community in telling aviation stories. Through educational partnerships with many informal community institutions, some aircraft companies have provided artifacts and professional development opportunities for their members.



Figure 1. The common educational programs in museum [13]

The collection should include airplanes, aviation artifacts, technical documents, historical photos, and an airplane in its original state from the last century. Besides that, the building allows visitors to experience the history and wonders of the aircraft cabin and cockpit in the museum's collection. An educational wing equipped with a large number of 3D movies, this is the latest and fascinating visual learning tool [12]. Museums often carry out education and special programs to highlight galleries or museums [13]. The examples of educational programs in the museum are shown in Figure 1.

Moreover, the flight museum not only needs to store, protect and display the aircraft, but also needs to reconfigure the aircraft as the needs of collections and exhibitions change [14]. Furthermore, the aviation hubs should design concrete floors to be non-slip, easy to clean and promote drainage, while also supporting the museum's desire for enclosed spaces [14].

### 3. Case Studies

This section introduces some examples that have the same building type as this project. The case studies considered different Aviation Hub and Expo from various parts of the world to have an overall idea to help in the design of this project. The case studies essentially provide a better understanding of an example of an executed solution similar to the project to be created. The chosen case studies are:

- (1) Dornier Museum, Germany
- (2) National Air and Space Museum, Washington, DC.
- (3) Steven F Udvar-Hazy Center, Chantilly, VA

#### 3.1. Dornier Museum

Dornier Museum located at Germany with area of 7000.0 sqm is designed by Allmann Sattler Wappner Architekten, completed in year 2009 (Figure 2 and Figure 3) [15]. The concept is sited in connection to the Friedrichshafen Airport. The point of the historical center is to show the innovation of air ship development and the historical backdrop of the Dornier plant, which was established in 1922, and to introduce connections to contemporary history. Museum and airplane terminal are over a significant time span, in one area. This concurrence shows itself inside a bow formed runway.

Among the displays are veteran flying machines some of which can in any case fly today. The exhibition hall's area in Friedrichshafen, the origination of the Dornier organization, and its physical vicinity to Friedrichshafen Airport commute home the immediate connection between the beginning of avionics and present-day air activity. Also, the landscape lines guide the way to the runway [15].

The architecture satisfies two different requirements of the exhibition. First, the hangar provides sufficient space for the large number of original aircraft on display.

Secondly, the "museum box" which appears to float above the foyer forms the centerpiece of the exhibition.

The designer needs to give the guests a substantial feeling of how innovative advance influences individuals' lives in The Museum Box, the core of the presentation, follows a time of improvements in flight and aviation innovation and as the guest walk around it, he will find how these improvements fit into the more extensive setting of the circumstances.



Figure 2. Dornier Museum (exterior) [15]



Figure 3. Dornier Museum (interior) [15]

#### 3.2. National Air and Space Museum

The National Air and Space Museum located at Washington, DC is designed by Hellmuth, Obata and Kassabaum (HOK) (Figure 4 and Figure 5). The project style is 20th-century Modern and the project year is 1972-1976 [16, 17].

The floor is kept clear for wandering visitors by hanging many of the historic airplanes from the roof trusses where they can be seen against the changing sky. The enormous glass walls and ceilings bring plentiful light to the seemingly boundless interior. Around evening time, the museum center inside enlightenment makes these points of reference of aeronautics noticeable from outside, an impact that turns the exhibition hall back to front, if just for some time.

The west glass divider works as a monster entryway for

the establishment of planes. On the off chance that the Hirshhorn turns internal, the National Air and Space Museum that rose adjacent to it in 1976 opens itself to the outside world. Working with a comparative size and shape and of an indistinguishable pinkish Tennessee marble from the generally styled National Gallery of Art over the Mall, the Air and Space building was intended to express contemporary feel [16, 17].



Figure 4. National Air and Space Museum (exterior) [16]



Figure 5. National Air and Space Museum (interior) [17]

### 3.3. Steven F Udvar-Hazy Center

The Steven F Udvar-Hazy Center is designed by Hellmuth, Obata and Kassabaum (HOK) with site of 71,000 m<sup>2</sup> located at Chantilly, VA (Figure 6 and Figure 7). The function of the project is to display and preserve Smithsonian's collection of historic aviation and space artifacts. The project style is considered as high tech, where the year of the project is 2000-2003 [18].

The outline of the extensive focal overhang (a half cylinder of steel trusses) was affected by the massive structures utilized as a part of the twentieth century to house zeppelins. The spaces were intended to guarantee protection of the ancient rarities utilizing at least direct common light, with lifted walkways to guarantee ideal review. The glass perception tower is reminiscent of an airplane terminal control tower, allowing all-encompassing perspectives of the encompassing zone.

The fact of the project is between the eighteenth century Sully Plantation and the twentieth century Dulles Airport lingers the 21st century Steven F. Udvar-Hazy Center. The project is outlined by an indistinguishable structural firm from its parent exhibition hall on the Mall, the mammoth Udvar-Hazy Center houses; the biggest flight and space antiquities in the Air and Space accumulation. The space distribution of the project consists of 4 parts namely main exhibition hangar, public amenities IMAX, observation tower, and space hangar [18].



Figure 6. Steven F Udvar-Hazy Center (exterior) [18]



Figure 7. Steven F Udvar-Hazy Center (interior) [18]

## 4. Space Program

In this study, the space program is required. The area and spaces in the program are calculated in detail to figure out the building area. Finally the program of an important part of the museum has been studied and looked for. The project was dedicated to have six main zones, which is main lobby, admission office, education and library, galleries and expo, watch tower, in addition of services. The zones are demonstrated in bubble diagram shown in Figure 8.

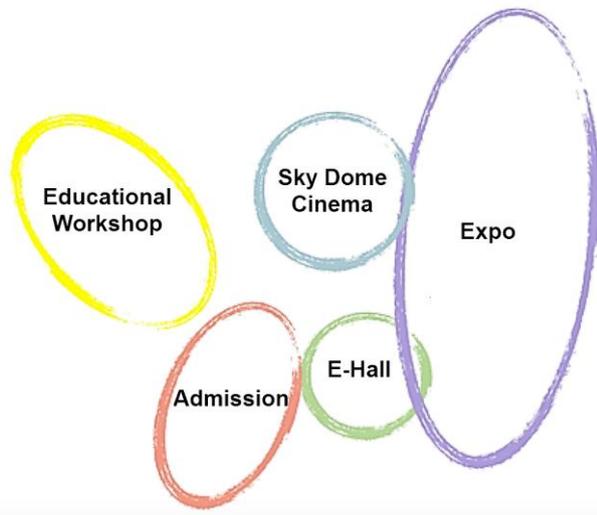


Figure 8. Bubble Diagram

The function requirements of the museum and galleries are discussed on military or civil flight, or on aircraft history of a particular period. It can include special exhibitions, photographs, films, interactive, maps, artwork, engines, uniforms, and models. Besides that, this building will have an education category. It has classes and workshops and a full range of tools and resources used to forge a relationship between the student and learning of aviation engineering. The space program of each zone is tabulated in Table 1 where museum and galleries area occupied the largest area about 69.4%.

Table 1. Program assumption and detailed area

Area Distribution	Percentage (%)	GFA (m <sup>2</sup> )	NET (m <sup>2</sup> )
Main Lobby (Welcome Center)	5.8	930	900
Admin Area	6.2	992	962
Education Area	9.1	1458	1428
Museum and Galleries Area	69.4	11130	11100
Sky Dome Cinema	4.2	670	640
Services	5.3	859	829
<b>Total</b>	<b>100</b>	<b>16039</b>	<b>15859</b>

The main lobby of the project is also known as Welcome Center which consists of gathering space, ticket counter, books and gifts shop, restaurant and café, visitor's service, toilet, storage, security and waiting area. The admin area consists of several sub-zones namely director's room, secretary room, general office, educator's office, conference room, kitchen, security and supervision, toilet, and reception lobby. In the education area, there are several

sub-zones namely lobby and information, auditorium, workshop, cinema, library, books collection, archive, library storage, general office and toilet. The main component in the project is Museum and Galleries Area which is equipped with hall, aviation history, hanger 1: war collection, hanger 2: Saudi aviation, hanger 3: international aviation, theater, temporary gallery, as well as outdoor gallery. Also, the Sky Dome Cinema is composed of cinema and washroom. Lastly, the services zone has staff room M/F, lockers M/F, washroom M/F, clinic, lounge M/F, shops, security area, prayer hall, toilet, storages and mechanical room.

## 5. Site Selection and Analysis

This study chooses the site according to the needs of the project. The site was selected according to the needs of the site criteria and then compares the three different options. This study takes into consideration the size of the project for the site and the site analysis and building orientation of the chosen site.

### 5.1. Site Selection

Two sites are chosen that are the most suitable for the project and site area. They are then evaluated and the best is chosen. Figure 9 illustrates Site 1 is located in Taif, Saudi Arabia. The site is accessible through terminal road, Al Huwaya and Makkah Mukkarama road. It is near Taif international Airport. Figure 10 illustrates Site 2 is located in Jeddah, Saudi Arabia, in Obhur Al-Shamaliyah Area.



Figure 9. Site 1 [19]



Figure 10. Site 2 [20]

### 5.2. Site Criteria

In the site criteria, a scale of weighting factors is used to determine the site from the most important to the least important in the comparison. The (WF = 1, 2, and 3) is used, number one indicates the least important and three indicates the most important. The considered site evaluation criteria are accessibility, shape, topography, surroundings, view, visibility, future development and weather.

Table 2. Site evaluation result

Site Criteria	Site 1	Site 2
Access/ Traffic=3	15	12
Shape/ Proportional=3	15	15
Topography=3	6	15
Surrounding=2	10	8
Views=2	10	6
Visibility=3	8	6
Future development=3	12	15
Weather=3	6	15
Total	82	92

In general, the chosen site should be easy to access and has a high weight factor because it needs to be easily accessible to accommodate the people's needs by traveling and giving them better and faster ways of transport. It is preferable that the site has a rectangular shape rather than a square shaped. The rectangular shape makes it easier to plan. Regarding the topography, the site is slightly bent to help in drainage and in the movement of water away from the site if rainfall occurred in the area. Furthermore, the surroundings of the site should not be a residential area. In addition, the site to the outside is preferred to have a nice view. The site should have a good visibility for the project.

The site should have the capability for future expansion and development. Lastly, the weather of the site should be free from hurricanes, tornadoes, thunderstorms, lightning, hail, winds, and winter weather. The site evaluation result is tabulated in Table 2.

Based on the site evaluation result in Table 2, the highest score from the site evaluation table was the second proposal which is the site located in Jeddah, at Obhur Al-Shamaliyah Area. The site size boundary is about 2,305.105 m<sup>2</sup>.

### 5.3. Site Analysis

Figure 11 and Figure 12 illustrate the site accessibility and noise analysis respectively. The site can be accessed through North Obhur Road, South Obhur Road, Al-Madinah Road as well as Al-Malik Road. The noise level is considered to be very high from the east of the site that comes from bridge. Also there is also high noise that is coming from the main street North Obhur Road. Low noise to the site comes from one direction that is empty sites.



Figure 11. Site accessibility



Figure 12. Noise analysis

Figure 13 and Figure 14 depict the site surrounding and site view respectively. The views from inside to the site from the south and north side are considered to have the best view because it consisted of the beautiful places, in the north which will be Al-Waleed tower and from the south will be the sea. The good views from the site looks over the

bridge, it is considered as a good view because it is changeable and gives the public something to see. The natural view of the site comes from the west side of the site. It is a good weather and has many resident buildings in the region that creates a pleasant view for the private. The visibility from the outside of the site to the inside is better from the south and southwest side because it has the sea, and good weather.



Figure 13. Site surrounding

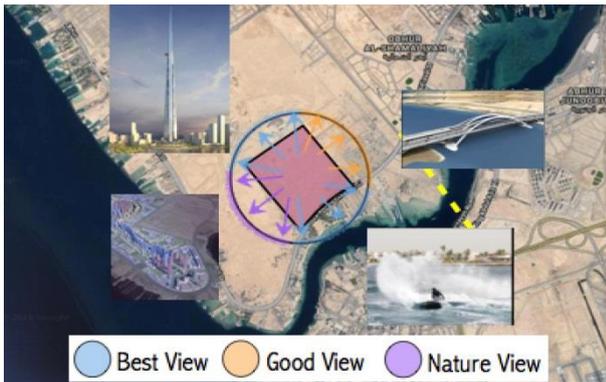


Figure 14. Site view

For the climate analysis in Jeddah, the summers are long, sweltering, muggy, arid, and partly cloudy, whereas the winters are short, warm, dry, windy, and mostly clear. Over the course of the year, the temperature typically varies from 65 °F to 102 °F and is rarely below 59 °F or above 107 °F. Also, Jeddah experiences extreme seasonal variations in the perceived humidity. Besides that, the average hourly wind speed in Jeddah experiences mild seasonal variation over the course of the year. The sliding 31-day quantity of rainfall in Jeddah does not vary significantly over the course of the year, staying within 0.1 inches of 0.1 inches throughout. Figure 15 demonstrates the site climate analysis where the site experiences cool wind from northwest direction and hot wind from southeast

direction.



Figure 15. Climate analysis

After conducting the detailed site analysis, the best way to put the building will be to have an open space towards the northwest to get the better wind and avoid the bad wind and the highest amount of noise. Having the building towards the southeast will have better and easier accesses for the travelers and public coming from the roads direction because it will be open to the main streets.

## 6. Zoning and Project Design

Figure 16 and Figure 17 demonstrate the site zoning and site plan respectively. The main concept of Aviation hub and expo is to centers of education in its historical development. The full range of tools and resources are used to forge a relationship between the visitor and a work of art: exhibitions, catalogs, and the work of curators are the most important facets of the museum's cultural mediation. It should reflect the past and future of Saudi Arabia city and people.

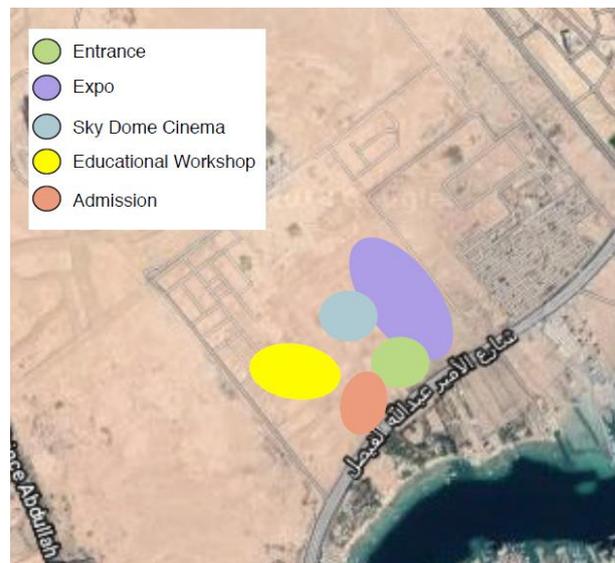


Figure 16. Site zoning

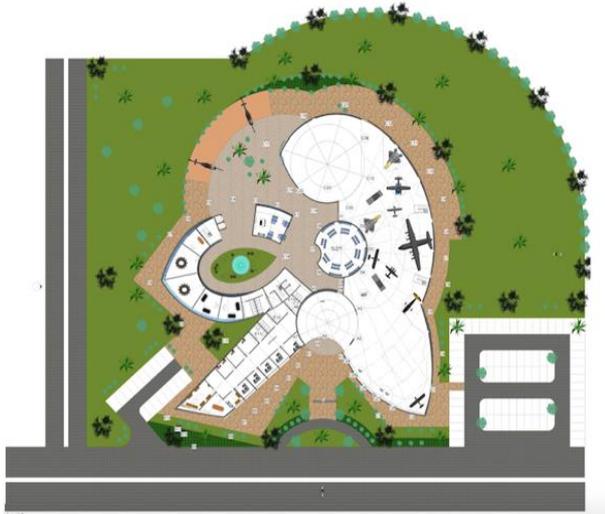


Figure 17. Site plan

The concept of the aviation that flying away inspired people to freedom and aviation associated with this idea. Thus, there is freedom in movement within the exhibition and when looking at its contents.

Regarding the shading element of the project, a large overhang is added at the entrance not only to emphasize on the entrance but also acts as an effective shading device for customers entering. Another shading element already exists on site, which are the trees. It provides natural shading to areas nearby it, including the exhibition itself.

Besides that, the building orientation is considered for ventilation and lighting during evening. The sun is at west which faces a major portion of the educational workshop, providing natural lighting to it. The wall of the indoor area is of full height double-glazed glass to receive maximum lighting. Double-glazed is used to reflect and prevent much of the solar radiation to enter into the indoor building

Water is an important element in the design not only for the aesthetic purpose but also as a passive design feature as a cooling agent. The presence of water features like falling water, pond, water wall, water-roof, and water stream in all phases in the building helps to cool down the environment. Besides that, the building is also near to existing surrounding water that helps for the same purpose too.

Landscaping on the site including vegetation like plants or shrubs can be added around the site or even in the building itself to cool down the surrounding area, complementing it with the existing site.

## 7. Conclusion

Aviation hubs and expo play a role in preserving incredible aircraft, spacecraft, artifacts, galleries, explaining the history of aviation and its impact on our world. This project builds up the air transport industry as per the most recent universal guidelines, fortify the position of the Kingdom as an all-inclusive persuasive

player in flying, accomplish money related development and manageability, and implement the important tenets, directions and strategies to guarantee air transport wellbeing and security. The chosen site for this project is located in Jeddah, Saudi Arabia, at Obhur Al-Shamaliyah Area. The project consists of several components such as main lobby, admission office, education and library, galleries and expo, watch tower, and services. Overall, this project develops a dynamic stage that draws in the general population with the stories of the city, the nation, and the world all in all. By motivating the general population to go more distant and more profound into culture and history and to intend to fortify crowds to look past the history and to better welcomes the encounters of others and the value to create for KSA.

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