

WOJCIECH DULIŃSKI*

SUSTAINABLE AIRPORT PASSENGER TERMINAL DESIGN – THE REVIEW OF SELECTED EXAMPLES

ZRÓWNOWAŻONY ROZWÓJ W PROJEKTOWANIU PASAŻERSKICH TERMINALI LOTNICZYCH – PRZEGLĄD WYBRANYCH PRZYKŁADÓW

Abstract

This paper points out recent tendencies in airport passenger terminal architecture. Taking sustainability of the building as a major concern, examples of the current architectural approaches are presented. Norman Foster's Stansted Airport design is identified as a model solution and three cases of its implementation are pictured and analyzed. Moreover, the rising interest in multi-criteria certification in the aviation infrastructure is depicted on the example of *LEED* certification.

Keywords: airport design, sustainable airport, multi-criteria certification

Streszczenie

W artykule przedstawiono aktualne tendencje w projektowaniu pasażerskich terminali lotniczych. W ujęciu uwzględniającym ideę zrównoważonego rozwoju, zaprezentowane zostały przykładowe cechy architektury lotnisk. Port lotniczy Stansted, zaprojektowany przez Normana Fostera, został zidentyfikowany jako modelowe rozwiązanie, którego powielenie pokazano na trzech kolejnych projektach. Dodatkowo wskazano, na przykładzie amerykańskiego systemu *LEED*, rosnące zainteresowanie certyfikacją wielokryterialną budynków w sektorze infrastruktury cywilnych lotnisk pasażerskich.

Słowa kluczowe: zrównoważone projektowanie lotnisk, certyfikacja wielokryterialna

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* MSc. Arch. Wojciech Duliński, Institute of Architectural Design, Faculty of Architecture, Cracow University of Technology.

1. Introduction

A passenger airport terminal is one of the most complex building typology. Different in sizes and architectural expressions, all airports serve travelers providing a certain standard of mandatory procedures (immigration, customs, security check, etc.) based on high-tech electronic equipment, and additional facilities like duty free stores or restaurants. They operate for the most time of day and night, allowing unobstructed flow of passengers throughout halls, corridors, gates, etc.

The abovementioned factors result in relatively high energy consumption in comparison to other types of buildings [1]. Hence, responsible architectural and engineering designs are inevitable in today's highly developed, sustainability-oriented societies. In this paper recent tendencies in passenger terminals design are presented.

2. Transformation towards sustainability

A certain model of optimal 'traditional' airport passenger terminal was developed throughout 20th century. Due to large number of people and big volumes with no daylight, followed by continuous increase of rigorous regulations, huge amounts of ductwork, piping, electric installations, etc. were suspended to structural elements under floor slabs to allow maintaining adequate micro-climatic conditions inside the building. This led to overgrown foundations, columns, beams, slabs and, as a consequence, less efficient economic performance of the building in a long-term run. Airports started to generate a huge ecological footprint along with increased operational costs.

A revolutionary idea was invented and first incorporated into the design by a British architect and technocrat – Norman Foster [2, 3]. His design for Stansted Airport (opened for passengers in 1991) represented a new approach to terminal architecture. This concept is now constantly being multiplied and developed by various architects worldwide (including Foster himself).

The model incorporates low-tech solutions and spatial decisions in order to provide better functional operation of the airport not only in terms of investment costs, but also in terms of operational savings. At the same time, it proposes means of reduction of energy consumption and ecological footprint. In terms of design sustainability, the approach is to create a lightweight, 'Big shed'¹ [4] modular canopy structure that offers sunlight and ventilation openings for less energy-consuming interior conditions upkeep (see Fig. 1).

So far, Foster's model is considered to contain the vast majority of desirable solutions, both in terms of operational functionality and life cycle economical and ecological analysis [3]. Even though the diversity amongst airport terminal buildings is very significant, due to external conditions like: desired capacity, climate conditions, economical issues, etc., principles for the design implemented into Stansted's terminal can be described as an emerging trend in passenger terminal architecture.

As sustainability of a building requires a holistic approach to designing process from the very beginning (conceptual design) to the end of construction, it is much easier to incorporate

¹ 'Big shed' is a term used to describe trends in the contemporary architecture of public use buildings

sustainable solutions into newly built terminals, rather than building extensions, where the design opportunities are often limited by existing conditions. It does not mean that building extensions should not meet current building standards, but for the purpose of this paper, examples of new designs will be presented as model solutions.



Fig. 1. London-Stansted Airport terminal, designed by Norman Foster. Terminal is roofed by a lightweight canopy structure, allowing natural insulation, daylight penetration and natural ventilation of the building. Source: <http://www.si.wsj.net/>

3. Stansted's model implementation

The continuous growth of aviation industry (dictated by enlarging number of passengers), constant struggles of governments in terms of defining geopolitical nodes on the globe, as well as new emerging cities cause numerous opportunities for architects and engineers to design new airports [5]. As mentioned above, regardless size and range, the majority of recent developments follows Foster's idea [2, 3].

3.1. Queen Alia International Airport, Amman, Jordan

One of the clearest examples of the idea is Queen Alia International Airport, (completion in 2012). Located in Amman, the airport serves around 8 million passengers per year, which places it in the group of mid-size regional transit airport.

Due to climatic conditions at the airport's location, implementation of the idea was targeted mainly at the efficient use of Sun energy and maximum reduction of heat gains (overheating) from sun rays at the same time. This is why the architect decided to design a canopy roof as a system of modular concrete shells, covered with PV cells and equipped

with small skylights that allow light penetration into the building. Sunrays accessing interior of the terminal reach bright floors that reflect rays towards ceiling in order to spread the natural light throughout the interior (see Fig. 2).

The use of natural light limits the necessity of additional artificial light support to minimum. A concrete sun barrier (canopy roof) limits heat gains, stabilizes humidity on the right level and allows air-conditioning units to work as an additional installation, occasionally and locally lowering interior temperature. The building is also equipped with integrated system of collection and usage of rainwater. Those noticeably decrease ecological footprint of the terminal, causing substantial operational savings at the same time.

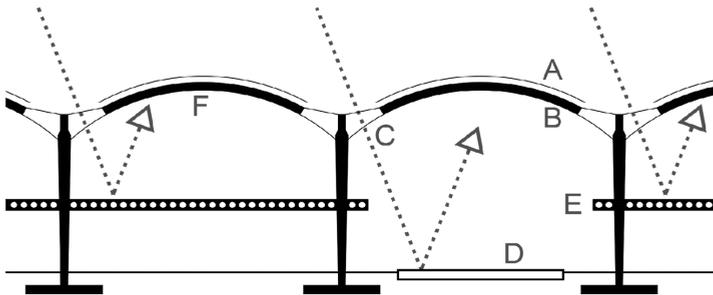


Fig. 2. Cross section of Queen Alia International Airport (Amman, Jordan): (A) photovoltaic panels collecting solar energy, (B) lightweight concrete shell roof structure capturing sunrays and preventing from building overheating, (C) skylights allowing sunlight penetration into the building, (D) interior bright floors reflecting sunlight for better micro-climate, (E) patios for better natural light distribution on all building levels, (F) bright ceilings for better natural light dispersion

3.2. Wrocław Airport, Strachowice near Wrocław, Poland

Wrocław’s Airport, (completion in 2012), also follows the ‘Big shed’ [4] pattern for airport construction. Although smaller in size (about 2 million passengers per annum) than Queen Alia airport, it incorporates some of the ideas into design. Lightweight, wavy structure



Fig. 3. Wrocław Airport, as an example of Stansted’s typology multiplication

of the roof, with vertically situated windows, cleverly brings in sufficient amount of daylight, protecting main hall from direct sun insulation at the same time (see Fig. 3). Adequate volume of the interior prevents from overheating.

4. Multi-criteria certification in airport terminal designs

As today's architecture and building systems become extremely sophisticated, an increasing percentage of investors decide to validate their building's performance by obtaining a certain type of multi-criteria certification². Airports, as a prominent investments in scale of the city, region or even country, are also very often subjected to certification.

Airports' certification is currently mostly developed in United States and, consequently, conducted in LEED Certification system. Many existing airport terminals in U.S. are undergoing renovations and improvement works. Hence, certification of them is based on the *Building Operation + Maintenance*³ system. The most common enhancements for airports are: renewable energy generation (solar panels), water management (low-flow fixtures, water reuse, draught-tolerant landscaping), natural ventilation and sun access, as well as usage of low volatile and natural finishing materials. Undertaking other actions and renovations is subject to external conditions and preceded by necessary SWOT analysis.

Among the examples of new airport designs, certain number of certified buildings can be distinguished. Recently revealed conceptual design of Mexico City Airport shows the complex and far-reaching development of Stansted's idea, aiming to meet *LEED Platinum* certification standards. Although the project is in very early phase, first descriptive visualizations (see Fig. 4) of the idea, together with other published materials (videos, articles) clearly show that sustainability and high energetic efficiency are the main goals that are to be achieved in the design (materials, building performance, building energy consumption, etc.) and later – during construction (high standard of construction site development, protection of the environment and surroundings during construction).

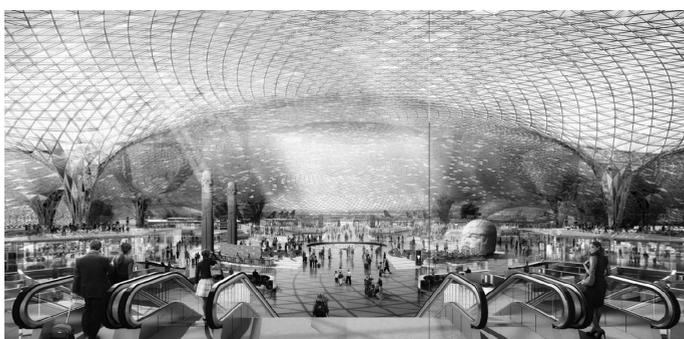


Fig. 4. Mexico City Airport (conceptual design) terminal aims to meet *LEED Platinum* certification standards. Source: <http://www.fosterandpartners.com/>

² The widest known certification systems for the building is *LEED*, *BREEAM* and *DGNB*. By evaluating elements of the investment process, they systematize advantages and disadvantages, illustrating building's general performance in terms of sustainability and Life Cycle analysis.

³ A subgroup of *LEED* certification.

5. Conclusions

The progress in technology and building techniques is clearly visible, and so is the society demand for sustainable development. The following conclusions regarding airport design tendencies can be formulated on the basis of presented research:

- Stansted sustainable airport terminal design can clearly be called a model solution for the past 30 years and recent developments;
- Multi-criteria certification becomes popular among airport terminal buildings due to rising ecological society awareness;
- Stansted model further development, combined with conscious sustainable design process subjected to certification seems to set path for the future strategic planning decisions.

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