REFLECTION SUPERSONIC WORLDPORT

COMPLEX PROJECTS
ENERGY

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1. Introduction

The modern aviation industry is experiencing rapid growth, evident in the alarming increase in passenger volumes. This demand of increasing air passengers can be met by implementing new technologies, however this not only necessitates a meticulous reorganization of the operational processes within airports but also demands a conscientious approach toward climate-conscious practices. Climate-conscious practices are one of the most important aspects of innovations since the world is facing an environmental crisis that poses a threat not only to Europe but the whole world. That is why the European Commission is enforcing different proposals like the European Green Deal in which making Europe the first climate-neutral continent in the world is a binding commitment. Considering that the aviation industry is at the forefront of technological innovation and aerospace engineering breakthroughs airports will play a big role in reaching European Union climate goals. That is why there is a need for a new type of airport which starting in Berlin, eventually can be placed at multiple locations in the world.

2. Problem and Methods

Taking into account the environmental challenges posed by a growing number of passengers and technological innovations, the following main question was asked regarding the future architecture of airports:

'How to design an airport to accommodate the reconfigured European aviation industry?'

To be able to answer the question it was necessary to conduct different methods of research, namely: field, literature, mapping and research by design. Field and interview methodologies were used to verify, support, and complement the literature and mapping methodology. To be able to research by design all the mentioned research methods were used as a base.

Literature research

In order to create a program for a new type of airport, the already existing airport programs needed to be analysed. The case study approach was applied. Additionally, online resources, and interviews supported the research of the possible client.

Mapping and field research

The fitting site for a big structure as an airport is crucial. To establish if the site is suitable for an airport, research based on mapping and field visit was necessary. Finding out the connectivity and identifying surrounding areas was needed. Additionally, analysing possible future scenarios regarding expansions were important.

Research by design

By using research by design new scenarios/designs can be explored or invented and compared to each other.

3. Research and Design

The conceptual framework is based on two scientific articles describing the main aspects of future airports, followed by innovations regarding airplanes, hydrogen fuel, checkin and baggage handling systems in the commercial aviation industry. The research is divided into three main aspects: program, client and site.

Research of the program was conducted based on available literature and mapping of already existing airports. Based on mapping of existing airports and a possible yearly passenger flow at the Supersonic airport an estimation of the area needed for the airport was made. It is of course not enough to understand how traditional airports work to create a new typology. All the innovations that can be implemented in the new airport design need to be understood as well. That is why the implemented technological innovations inside the building as well as outside of the building were researched. Based on that the program was adjusted to fit the new typology.

The second part of research was focused on the site. Site requirements were divided into three categories, namely energy, area, and building. Different requirements in these three categories were analysed on scales from L to S. This resulted in a site location that was further analysed to position the terminal building, innovation centre and the energy and fuel providing structures in the most fitting places on the site.

Literature, online resources, and interviews supported the research of the possible client. Finding out what parties own the airports around the world was the first step to getting an understanding of the possible client. Additionally, since this research was not about a general airport, companies investing and creating applicable technological innovations in the field of aviation were researched. This way it was established what other companies will be a part of this project.

Al the research was then used to support the first phase of the design which was more focused on research by design. The program was a base for the size and functioning of the terminal building, while the client research supported how the building functions and the site how the building had to

be positioned and what kind of flows were happening to reach the building. Based on this various possibilities and scenarios were created and the ones related the most to the research were chosen. By researching by design new possibilities for the flows were invented. For example, how the airplanes can park on the site in a different way than a traditional way, saving time, energy and resources. This way of research also resulted in a new type of the flows inside the terminal building, which is decentralized instead of centralized. Eventually by experimenting with different possibilities resulted in a design of a Supersonic airport that answers the main question of this project.

'How to design an airport to accommodate the reconfigured European aviation industry?'

The design of the Supersonic airports needs to focus on the implementation of European future goals regarding the aviation industry in a way that can be applied not only in Berlin but also at other locations. The goals are focused on making the future better for everyone by improving the scientific impact, innovation growth and sustainable development. All these aspects need to be the main focus and work together in a balanced way. To be more specific in the Supersonic project all these aspects were realized by focusing on them before designing the airport, it was important to figure out how these will not impact the design, but create the design. For example the scientific impact and innovation growth are implemented not only by applying the newest innovations but also by creating spaces were these can be researched and new innovations can be made. Experts can work together and test their theories at the airport grounds in a safe way. At the same time all the innovations applied are helping with the sustainable development. At the site there is not only an innovation center but also a green hydrogen production facility. This approach can also be seen in the shape, functionality and materialization of the architecture of the terminal building. The building is long and narrow to make the airplane and passengers flows more efficient and continuous. The shape of the roof helps with producing hydrogen that is needed to fly the supersonic airplanes by catching the rainwater, the facades are sloped inwards to save energy that is needed to

heat, cool and ventilate the big spaces, while creating enough floor space area. The materials applied in the building can be reused or recycled, have a long lifespan and do not require much upkeep. By applying this approach an airport that not only accommodates the reconfigured European aviation industry but represents it was designed and in the future more airports can be designed this way.

4. Reflection

Challenges during research and design process

During the research and the design process there were some challenges. When different companies whose innovations were implemented in the project were reached out to, they were not able to answer any questions because of the confidentiality reasons. Also when professors from TU Delft aerospace engineering were reached out to, they did not reply. This made the aviation industry technological innovation research mostly literature based, which was very successful. However it is impossible to establish for sure without experts if all the innovations implemented in the project are the latest and the most fitted choices. Another challenge presented itself during analysing the exiting airports. Due to safety reasons only the public parts of the airports are shown in the literature. When airports in the Netherlands were reached out to, and asked if a tour in the back of the house was possible, the request was refused due to safety concerns. That is why the plans of the Supersonic project were developed based on available literature information, mapping, consultations with a tutor with airport design experience and by research by design method. This combination of methods worked well for the Supersonic Worldport, however it would have been interesting to be able to compare the traditional processes happening in the back of the house to the ones at the Supersonic airport.

An ethical issue that needs to be mentioned is when designing a project like this a question rises if using a lot of energy to in the end save a lot of energy is responsible and reasonable. For example green hydrogen will ensure that the airplanes will fly CO2 neutral and have no negative effect on the environment, however a lot of energy is needed to build the structure for hydrogen production and even the terminal building. Looking at how the number of air passengers is growing rapidly and how it would be unethical to make air transport exclusive it seems like a right choice to seek a solution that in the long term is beneficial to everyone. Thus making the construction of this whole project not even a choice but a necessity.

Feedback and learning process

During the process of this project weekly feedback session were scheduled where a lot of input from the mentors was given. The input was related to

the project as well as to the way of working and it was very useful, because it had impacted the project and the design process in a positive way. During the course of the project a lot of new knowledge about design and design processes in aviation industry was gained. One important example is what are the flows and how to design these in an airport.

Relation between the studio topic, master track, and master program

The Supersonic Worldport project relates to the topic of energy in the studio. This is one of the main topics included in the complex projects studio. Energy is researched on the Berlin as well as on the site scale and it is divided into three categories namely: construction of buildings, energy usage of buildings and transportation to buildings. The project connects to the master track as it is based on extensive research on relevant topics such as innovations and climate change. The project also relates to the master programme of MSc AUBS as in the end, it results in a technical design, which is worked out on an urban scale as in the building science scale.

Relevance in the larger social, professional and scientific framework

The Supersonic project has a relevance in the larger social, professional and scientific framework, because it tackles various problems that are occurring in the world at the moment. Airports stand as crucial nodes in global connectivity, functioning as gateways to the world. With a growing air travel demand, reaching 16 billion passengers by 2050, the aviation industry faces the challenge of efficiently accommodating this growth while trying to minimize its effects on the environment. ‘Technological innovation is a “double-edged sword” and is considered a significant contributor to issues, such as climate change, ecological imbalances, and worsening pollution, and an effective means to solve environmental and sustainable development problems’ (Fan & Shahbaz, 2023). Therefore it is important to rethink airport design to facilitate new efficient, effective, and environment-conscious technologies and collaborative spaces for airport staff, airlines, and technology partners encouraging innovation. Implementing these can serve in collaborative efforts in advancing airport technologies, improving operational processes, and minimizing the contribution to climate change.

References

The following main references were used to conduct research and support the project.

Abbas, A. T., De Vicente, J., & Valero, E. (2013). *Aerodynamic technologies to improve aircraft performance*. Aerospace Science and Technology, 28(1), pp. 100–132. https://doi.org/10.1016/j.ast.2012.10.008

Airport Cooperative Research Program. (2010). *Airport passenger terminal planning and design. Volume 1: Guidebook.* (Report no. 25) Transportation Research Board of the National Academies. https://nap.nationalacademies.org/read/22964/chapter/1

Automated baggage loading. (n.d.). Unitechnik Group. https://www.en.unitechnik.com/production-automation-robotics/robotics/automated-baggage-loading.html

Bogaisky, J. (2023, September, 13). Through airport security in 30 seconds? That's the goal of this new technology. Forbes. https://www.forbes.com/sites/jeremybogaisky/2023/09/13/through-airport-security-in-30-seconds-thats-the-goal-of-this-new-technology/

Boom - Supersonic Passenger Airplanes. (2023, October, 17). Boom - overture. Boom. https://boomsupersonic.com/overture

Destinus. (2023, March, 6). Hypersonic Travel - Destinus. Destinus - A New Class of Fast. https://www.destinus.ch/hypersonic/

European Court of Auditors.(2018) *Special Report: A European high-speed rail network*. https://op.europa.eu/webpub/eca/special-reports/high-speed-rail-19-2018/en/

Fan, S., & Shahbaz, M. (2023). Carbon neutrality and green finance. In Elsevier eBooks (pp. 217–238). https://doi.org/10.1016/b978-0-443-15936-7.00010-4

Federal Aviation Administration Advisory Circular. (1989). *Airport Design.* U.S. Department of Transportation. https://www.faa.gov/documentLibrary/media/Advisory_Circular/draft_150_5300_13a.pdf

Gibson, A., Horrax, S. (2022). Airports as Catalysts for Decarbonisation. Jacobs. https://www.jacobs.com/sites/default/files/2022-06/Aviation-Hydrogen-Report_v3a_Final_14-6-22.pdf

International Air Transport Association (IATA). 2011. Vision 2050 report. Singapore, 12 February 2011. https://www.iata.org/contentassets/bccae1c5a24e43759607a5fd8f44770b/vision-2050.pdf

Medvedev, A. H., Alomar, I., & Augustyn, S. (2017). Innovation in airport design. Aviation, 21(1), pp. 23–28. https://doi.org/10.3846/16487788.2017.1303542

Postma-Kurlanc, A., Leadbetter, H., Pickard, C. (2022). *Hydrogen Infrastructure and Operations. Airports, Airlines and Airspace.* Aerospace Technology Institute. https://www.ati.org.uk/wp-content/uploads/2022/03/FZO-CST-POS-0035-Airports-Airlines-Airspace-Operations-and-Hydrogen-Infrastructure.pdf

Proponent. (2018, March, 6). Technological collaboration in aerospace. Proponent. https://www.proponent.com/news/technological-collaboration-aerospace/#:~:text=Aerospace%20is%20not%20necessarily%20an,of%20good%20old%2Dfashioned%20cooperation.

Puddy, R. (2022, July, 8). Next-gen baggage scanner presented to Global Airport Security Community. Micro X. https://micro-x.com/next-gen-baggage-scanner-presented-to-global-airport-security-community/

Rajapaksha, A., & Jayasuriya, N. (2020). Smart Airport: A review on future of the airport operation. Global Journal of Management and Business Research, pp. 25–34. https://doi.org/10.34257/gjmbravol20is3pg25

Research and Innovation. (2021). *Horizon Europe.* European Commission. https://research-and-innovation.ec.europa.eu/system/files/2022-06/ec_rtd_he-investing-to-shape-our-future_0.pdf

Schönwetter, C. (2005). Airport design. Cologne, Germany: Daab Pub.

Sreenath, S., Sudhakar, K., & Yusop, A. F. (2021). Sustainability at airports: technologies and best practices from ASEAN countries. Journal of Environmental Management, 299, 113639. https://doi.org/10.1016/j.jenvman.2021.113639