Greenspace Design for Airports

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Abstract. This research seeks to substantiate the need for special psychophysical recreation areas (closed greenspaces) at international and regional airports. To that end, the researcher has: studied the medical and psychological impact of flight on human condition; considered the creation and maintenance of greenspaces from the standpoint of botany; analyzed the existing closed greenspaces at airports, their pros and cons; proposed solutions to identified problems; analyzed various layouts for such greenspaces and projected the microclimate they might have; developed a concept and proposed a working model for stand-alone airport greenspace. The paper analyzes a pilot design and proposes the basic principles behind airport-based psychophysical recreation areas: special plants for better microclimate; comfortable visuals, i.e. harmonious and non-aggressive interiors; use of greenspace to mitigate the stress the airport environment subjects human beings to; airport greenspacing on the basis of space classification; layout optimization, i.e. functional zoning of greenspaces, with special areas being arranged for crew members, arriving and departing passengers, and passengers of different age groups. Spatial layouts, engineering, and designs may vary to better fit the purpose. Thus, a single closed greenspace instance may comprise multiple modules to serve different use cases. One mandatory feature is accessibility for persons with reduced mobility combined with special communication means for persons with disabilities.

1. Introduction
Most people have flown at least once. Before boarding, each passenger has to check-in, check their luggage, pass the customs, pass the passport control, and then wait for departure. All of this makes some people uncomfortable and instils a fear of flying, an irrational fear of plane crash (aerophobia). Aerophobic people have less options for travel. To suppress their fear and discomfort, they start drinking hard liquors, hence the ever greater numbers of misbehavior under the influence of alcohol. According to Rosaviation, 15 aircraft had to land before time from 2014 to 2016 due to inadequate passengers.[1] On the other hand, a majority of crashes in civil aviation is caused by the so-called ‘human factor’, which means crew members also have to relieve their stress, to which end they need special recreation facilities. [2]

This research seeks to substantiate the need for special psychophysical recreation areas (closed greenspaces) at international and regional airports. To that end, the researcher has decided to:
1. Analyze the problem from the standpoints of health, biology, psychology, and botany to identify what could substantiate the need for airport greenspaces.
2. Study similar buildings that have specially designed closed greenspaces, analyze their pros and cons, and propose solutions to identified problems.
3. Analyze various layouts for such greenspaces.
4. Project the microclimate they might have.
5. Conceptualize and propose a working model for stand-alone airport greenspace.

According to Aeroflot’s statistics for 2014, 25% of people decide not to fly at all due to their aerophobia, 14% of people are so aerophobic they have never boarded, and every fourth person is uncomfortable onboard [3]. There are special apps such as Fear of Flight and Normal Flight that people with vestibular dysfunction can use to find out the actual position of the aircraft in flight [3]. For pilots and other crew members, these are occupational risks. The idea behind this research effort is to design such airport areas that passengers and crew members could use to relax before and after flight. The author hereof proposes greenspaces as such recreation areas, where people could go to recover physiologically and activate the parasympathetic nervous system to improve the mood.

Assessment of human comfort at an airport requires analysis of the existing recreation areas:

- Playrooms for children, usually small; one or more depending on the airport. Often placed to overlook the taxiway so that children could watch the planes.
- Mother-and-child rooms, usually small, equipped with sinks, swaddling tables, laundry dryers, kitchenettes, children’s furniture, cribs, etc. Entry requires depositing the luggage in a lockup facility, tickets and documents at hand, and a medical check.
- First-aid posts in common areas and at the airside. Usually provide only basic examination services; however, some are equipped to handle critical patients.
- Charging spots, usually at food courts and in common waiting rooms; however, some airports feature special charging spots equipped with a variety of connectors for plethora of devices.
- Wi-Fi areas. Location and access mode depend on the airport’s connections

People tend to concentrate in the common waiting room; it brings together many different streams and thus needs extra greenspace the most.

In 2016, Booking.com surveyed 4.5 thousand business travelers from 8 countries to find out what could make them feel stressed. 34% of the respondents said it was luggage inspections. Skyscanner surveyed 10 thousand travelers and found out that most of them were comfortable at cafes and restaurants, business class lounges, and the airside, while the common waiting room, the check-in area, the luggage inspection site, and the border controls were least comfortable.

2. Methods

To research airport greenspace organization, the author hereof has applied a systematic approach, collected and analyzed the existing research output, examined the existing designs and solutions, systematized the regulatory frameworks and guidelines, and collected statistics. The novelty of this research is that it analyzes and systematizes airport architectures and layouts to propose a solution for creating functionally different, but equally comfortable areas for people to stay, including persons with disabilities; the paper discusses at length how air pollution is harmful to human health and how greenspaces, themed gardens, green walls, etc. could benefit human psyche and emotions, to which end it proposes an experimental design for Ryazan Airport [4].

The first thing a person encounters upon arrival at the airport is the air full of exhausts. The place is always full of cars, buses, trains, aircraft, and maintenance vehicles, all of which pollute the air. A single car emits a kilogram of toxins per day. The exhaust of gasoline and diesel cars contains carbon monoxide, hydrocarbons, aldehydes, sulfur dioxide, soot, benzopyrene, and solid matter, all of which stay in the air for long. These substances are extremely hazardous, especially when combined with other matter found at the airport, which is a lot of soot, lead, and its compounds. Assuming that the parking lot is full, and the public parking lot of a major airline hub is designed for 200 to 400 cars on average, while ever more cars arrive to drop passengers, and there is always over a dozen of maintenance vehicles running on the apron, every human outside the airport is exposed to an unimaginably damaging influence of total exhaust. Aircraft-exhausted gases are barely soluble in the air. As Princeton University’s Junfeng Liu says, every tenth death caused by air pollution is attributable to aircraft [5]. While removing every source of pollution from an airport is not an option, the impact can be mitigated by using filters or planting expansive greenspace.
The exhausts of aircraft and other vehicles at the airport affect not only human beings but also the entire ecosystem. Plants provide a sort of ‘litmus test’: if exposed to polluted environment, their leaves become yellowish or crusty. Thus, a proper layout tailored to the cardinal directions and coupled with the proximity of water will help plants adapt to, and grow in, enclosed space; and then such successfully grown plants will help clean the air [7].

For many people, flight is a stressful experience that combines multiple adverse factors: an unusual situation, fear of height or acrophobia, lack of control, adverse weather, fear of night flight, or fear that pilots might err. Particularly anxious people research plane crash statistics; even those who have never been afraid of flying can be frightened by any abnormal experience, e.g. when the plane hits turbulence [8].

Color therapy is an effective way to influence human psyche and emotions. Phobias and emotional stress can be relieved prior to flight by means of a special color solution; for instance, if the room is mainly decorated with ‘calming’, relaxing, and pacifying colors such as white, green, and little blue, people there will be at peace. Another well-known fact that the dominance of artificial lighting causes tension and discomfort in human beings, which is why natural stone, wood, eco-friendly white paints, and green plants are highly recommended for interior design.

3. Results
This study focused on the existing airport greenspaces [9]. Today, only few airports in the world provide closed greenspaces. The best one is Changi, Singapore, which features a whole complex of botanical gardens: a butterfly garden, an orchid garden, a sunflower garden, a cactus garden, and the brand-new enchanted garden. Butterfly Garden (Terminal 3) Orchid Garden (Terminal 2) Sunflower Garden (Terminal 2) Cactus Garden (Terminal 1) Enchanted Garden (Terminal 2) [10-11].

As can be seen in the airport maps, these greenspaces are found at terminal centers as well as at the airside (the airside greenspaces are open-air locations though). The existing experience can be referred to when designing greenspaces for any location within an airport. April 11, 2019 Changi inaugurated its new terminal, Jewel. This is a huge complex that brings together more than 300 stores, a parking lot, and an enormous garden with a waterfall that the terminal is actually centered around. 5 levels of the 10-storey building are under the ground. The terminal has a toroidal shape with a hole in the center; rainwater enters the building through the hole and mixes with pumped water to create a waterfall in the middle of the garden, which passively cools down the entire inner space.

A small garden is found at Lihue Airport, Kauai Island, Hawaiian Archipelago, USA. This is but a small place with local plants and a gazebo right in the middle of the main building.

In 2011, the Netherlands’ Schiphol Airport inaugurated its greenspace for passengers to have rest before departure. This open-air garden occupies a good 200 square meters. The area is in Terminal D, and it used to be a common waiting room. It features both living and mockup plants. An open-air platform for spotting is also decorated with both living and mockup plants. While waiting there, passengers can enjoy footage of world-famous parks, gardens, and sanctuaries projected onto the walls. Notable is the greenspace of Adler Airport in Sochi. Plantings occupy small square-shaped floor-level platforms; however, this design has its own advantages. The area in the atrium fits harmoniously into the airport space.

Simferopol Airport inaugurated its newest terminal in the village of Ukromnoye in 2018. For this building, the Ficus Bureau had designed and architected a greenspace innovation: a five storeys high green wall in the main lobby above the check-in desks. The designers claim that at 15 meters in height, 110 meters in breadth, and 1,600 square meters in area, this is Europe’s largest green wall. Besides, the airport has over 30 thousand plants in other places. The system itself is modular to facilitate replanting or replacement. The designers also considered the local seismic activity, and the wall design has been certified as earthquake-proof (up to 9 on the magnitude scale).

Still, today’s architecture lacks good examples of closed greenspace. One good instance is the Lowline Project, NYC, an underground and uniquely-lit garden located where once was a trolleybus station. The designers want not to generate electricity under the ground and create artificial lighting;
rather, they want to somehow transport sunlight underground. The design also conceptualizes self-regulated greenspace.

Indoor greenspace is mainly intended to:

- help people working at the place relax and calm down. In that case, it can be situated in any part of the building, whether on the same level as offices, on a separate level, on balconies or on the rooftop, or in a multi-level cluster. (See the public area of Morumbi Corporate. Aflalo Gasperini);
- invigorate. Such greenspace is usually integrated into workspace or is located in the passageways between departments. This enables employees to relax or cheer up without leaving the workplace. (See the Green Corridor of Karolinska Institutet in Stockholm);
- serve as a spacer.

‘Living’ walls made of moss or sundry vegetation are an increasingly popular solution (see Patrick Blank). Interiors decorated with living plants mitigate stress as they provide a nice distraction from the monotonous and boring interiors of offices or other public spaces while also breaking the monotony of straight lines [12].

Plants to be used in an experimental airport design fall into two groups: mandatory (i.e. those that have positive effects while being low-maintenance, e.g. monstera, bamboo, chlorophytum, and sansevieria) and dispensable (those that are not to be touched upon, or otherwise come in contact with, human beings). This paper only proposes the plants whose effects are known to be harmless for humans.

Plants can also help control the indoor temperatures by absorbing heat during the day and emitting it during the night, which keeps the indoor microclimate balanced. Same applies to humidity: plants prevent air from being demoisturized by sunlight in summer or by heating in winter, which is why focus should be made on projecting how greenspace will alter the microclimate around itself. Interstate Standard of Residential and Public Space defines several categories of administrative and public spaces; the greenspace to be designed is a 3b space (intended to sustain crowding, mainly for people in outerwear) [13]. Each room has to comply with the temperature and humidity standards. There must be protections in place to prevent deformation or corrosion of fencing. The most important thing to do is to apply waterproof coating, as higher humidity may compromise frost and moisture resistance. The design can draw upon the existing experience of winter garden construction, i.e. on the solutions that prevent water from condensation inside the structures. For instance, the structures and framework of winter gardens usually make use of aluminum profiles separated by special waterproof pads or EPDM inserts [14].

The next step is to provide ventilation. Winter gardens have no restrictions on ventilation types, which is why they use both natural and induced air draft. Optimal temperature and humidity are crucial to proper closed greenspace.

Moscow State Construction University, Department of Architecture has made an experimental design of closed greenspace for Ryazan Airport. The layouts were based on the previously obtained recommendations on airport zone-specific landscaping.

Analysis of the experimental design helped formulate the following basic principles behind greenspace:

- greenspace containing recommended plants must become an integral part of public airport space to improve its microclimate;
- comfortable visuals, i.e. harmonious and non-aggressive interiors coupled with greening help mitigate the stress associated with staying at the airport;
- greenspace must be tailored to space classifications and optimized spatially;
- greenspace is subject to zoning, as there must be different zones for crew members, departing and arriving passengers, as well as for passengers of different age groups;
- spatial layouts, engineering, and designs may vary to better fit the purpose. A single closed greenspace instance may comprise multiple modules to serve different use cases.

A mandatory feature is accessibility for persons with reduced mobility combined with special communication means for persons with disabilities.
4. Conclusions

It is strongly recommendable that airports feature specialized greenspace that could be integrated in airport interiors and exteriors in one of the ways described herein. Plants have extremely diverse effects on human beings and their habitat: they improve sanitation, mitigate the heat, enhance the microclimate, protect from UV radiation and winds, generate oxygen, ionize the air, and emit phytoncides, which kill harmful bacteria; besides, greenspace protects from noise, absorbs airborne dust and hazardous chemicals, while also having positive influence on human psyche and emotions. This research begins a large-scale effort to analyze airport greenspace and expand the scientific knowledge of how closed greenspace can affect human health and psychological condition, and what kind of technology exists that could help design airport greenspace.

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