The DFW Airport Study

Natural light and views increased passenger comfort and dwell time near the windows, driving concession sales.

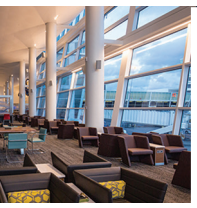
Key Findings

Optimized daylight and views at the DFW airport gate resulted in:

83% longer dwell times

15°F cooler surface temperatures

102% increase in concession revenue



Cornell University

Executive Summary

Relieving stress in a stressful environment.

Today's airports are hectic environments. Beyond the travel-related stressors of security screening and wayfinding, discomfort due to poor acoustics, glare, or lack of thermal control can increase travelers' stress and hurt the overall passenger experience. Improving the physical environment therefore presents an opportunity to provide passengers with a more comfortable and less stressful travel experience.

Key Findings

Optimized daylight and views at an airport gate resulted a more comfortable physical environment for passengers and an improved commercial performance of the airport:

- **83%** longer dwell times near the windows
- **15°F** cooler surface temperatures
- **102%** increase in concession revenue

The Physical Environment

With major airports greeting millions of passengers a year, the question arises – what design features or amenities in the airport most influence their experience? Studies have shown that physical environmental factors such as lighting and temperature play a crucial role in how passengers perceive comfort in an airport setting.

Research Methods

To better understand the importance of daylight and views in the airport setting on passenger comfort, Dr. Alan Hedge of Cornell University conducted a comparative study of 503 passengers in DFW Airport, half of whom were seated at a gate with conventional windows and half of whom were seated at an adjacent gate with electrochromic glass (View Smart Glass) which intelligently optimizes daylight and views to the outdoors.

Studies have also shown that the benefits of airport design features can extend beyond the passenger and improve the airport's commercial performance.

To quantify this benefit, Dr. Hedge performed an analysis of concession revenue at a restaurant before and after installation of View Smart Glass.

Results

Passenger comfort. Passengers at the gate with electrochromic glass had an 83% longer dwell time near the windows compared to passengers at the gate with low-E glass. This supported behavioral and environmental observations of improved visual and thermal comfort: more frequent screen device usage near the windows, less frequent behaviors of glare avoidance, and 15° F cooler surface temperatures at the gate with electrochromic glass. Passengers also rated daylight and views as the 2nd most important seat priority in the gate, ranking it above popular amenities such as electrical outlets.

Concession revenue. The study revealed that concession revenue of a restaurant saw an average 102% year-over-year increase over a six-month period after installation of the electrochromic glass.

Conclusions

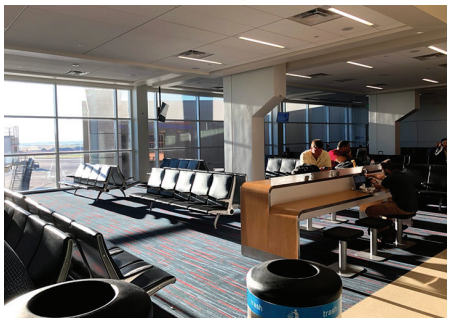
By improving the physical environment, airports have the potential to significantly enhance passenger comfort. The present study demonstrated that daylighting and views are particularly important features of an airport that impact passenger comfort that, when optimized, can help relieve the stress associated with travel.

Cornell University. Hedge A, Nou D, and Horton R. (2018). Electrochromic Glass Enhances the Passenger Experience in Airports. Ergonomics International Journal. 2(6):000162. DOI: 10.23880/eoij-16000162

Research Methods

The DFW Airport Study was conducted at Dallas Fort Worth International Airport in fall of 2017. At the time, two locations in Terminal A – Gate A28 and The Twisted Root restaurant – had its existing Low-E glass replaced with View Smart Glass.

The study on passenger comfort was performed by comparing experiences at two adjacent gates in Terminal A: Gate A28, which was fitted with View Smart Glass, and Gate A25, which retained its existing Low-E glass. 503 passengers, approximately 250 from each gate, were interviewed over the course of 5 weeks during the morning hours of 7:00 to 11:00 AM on clear days when sun penetration was the greatest. Over the 5-week period, over 30 hours of gate area videos were recorded and assessed for common behaviors, such as device use and dwell time. Infrared (thermal) imaging was also taken to assess temperature differences.



Gate A25 – Low-E glass

The Twisted Root Restaurant, pre-installation of electrochromic glass

Gate A28 – Electrochromic glass

The Twisted Root Restaurant, post-installation of electrochromic glass

The study on concession revenue was performed at The Twisted Root restaurant, which was also fitted with electrochromic glass in fall of 2017. At this restaurant, over 80% of the seats had a view of the bar, which is directly positioned along the exterior windows through which 100% of the available natural light enters. The revenue performance of the restaurant was evaluated before and after installation, over the course of six months.

All locations are oriented in the East-Southeast direction, and therefore experience full sun penetration in the morning hours throughout the year.

Dr. Alan Hedge
Professor Emeritus of the Department of Design and Environmental Analysis
Cornell University

The Expert

Dr. Alan Hedge is a Professor Emeritus of the Department of Design and Environmental Analysis at Cornell University. He directed the Human Factors and Ergonomics teaching and research programs at Cornell University and his expertise lies in the impact of design and workplace ergonomics, including office lighting conditions, on the health, comfort, and productivity of workers.

Dr. Hedge has authored over 50 book chapters and 250 articles on the subject of human factors.

The Results

Passenger Comfort

Gate areas in airports are often designed with large floor-to-ceiling windows to provide passengers with ample natural lighting and views of the outdoors. However, excessive daylight penetration can lead to substantial visual and thermal discomfort – direct glare from the sun's rays and indirect glare from reflective surfaces such as laptop and phone screens can cause harsh lighting conditions, and seats nearest the windows can reach uncomfortably warm temperatures.

The video footage collected at both gates demonstrated far fewer behaviors of discomfort at the gate where the electrochromic glass technology tinted the windows the reduce harsh sun penetration. At the gate with Low-E glass (A25), passengers frequently used their body to shield their electronic devices from glare and wore sunglasses while at the gate. At the gate with electrochromic glass (A28), passengers comfortably used their personal electronic devices such as tablets, laptops, and phones, even in the seats nearest the windows. As travelers become increasingly connected to their devices, particularly in airport settings to retrieve flight information, access entertainment, or engage in work, providing passengers with an environment that fosters comfort as well as productivity is key.

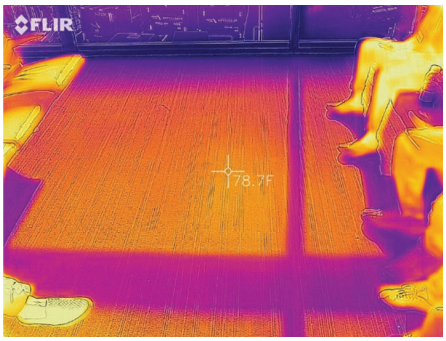
This significant improvement in passenger comfort was quantified by an **83% longer dwell time** in the zone near the windows in the gate with electrochromic glass compared to the gate with Low-E glass.

Observations of discomfort with lighting conditions at Gate A25 – Low-E glass. On the left, a passenger shielding a device from glare, and on the right, a passenger wearing sunglasses while facing the windows

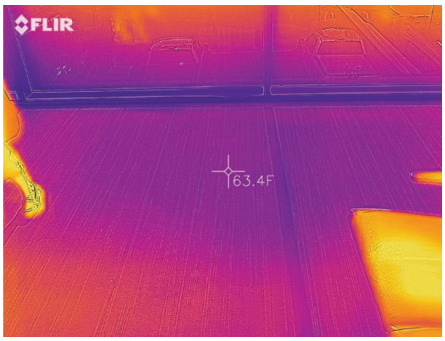
Passengers appear to use their screen devices comfortably in Gate A28 – Electrochromic glass.

Cooler Temperatures

In addition to reducing glare from harsh sun penetration, the electrochromic glass technology also reduces uncomfortably warm temperatures, particularly in the seats nearest the windows. The study found that surface temperatures in the gate with Low-E glass were up to 90°F, whereas surface temperatures (seats, carpet, passenger clothing and skin) in the gate with electrochromic glass were **10 to 15°F cooler**.



Floor temperature measured at Gate A25 – Low-E glass



Floor temperature measured at Gate A28 – Electrochromic glass

A separate study of passenger comfort in an airport setting revealed a dominant preference for cooler temperature conditions, suggesting that the lower temperatures experienced in the gate with electrochromic glass enhances the passenger experience[1].

1 Kotopouleas, A and Nikolopoulou, M. Evaluation of comfort conditions in airport terminal buildings. Building and Environment. 2018. 130: 162-178.

Daylight and Views are a Gate Amenity

The study also found that passengers prioritize access to light and views as their second highest seating priority, outweighing electrical outlets and bathrooms in importance. This places daylight and views in direct comparison to other amenities that are often installed to enhance the passenger experience.

Ranking	Seat Choice Factors
1	Having an empty seat next to me
2	**Access to views or daylight**
3	Near an outlet
4	Near a bathroom
5	Near restaurants or stores
6	Near the TV

Impact on Revenue

The concession revenue study at The Twisted Root Restaurant revealed an average **102% year-over-year increase** in revenue over the six months after installation of View Smart Glass. This observed boost in revenue supports other studies that have demonstrated that design features in the airport that target the passenger experience can improve the airport's commercial performance. Environments that reduce passenger stress and that have longer dwell times have been shown to encourage concession engagement[2-3-4].

Year-over-Year	Sales
Oct 2017 – Oct 2016	+ 89%
Nov 2017 – Nov 2016	+ 108%
Dec 2017 – Dec 2016	+ 101%
Jan 2018 – Jan 2017	+ 107%
Feb 2018 – Feb 2017	+ 83%
Mar 2018 – Mar 2017	+ 128%
Average over six months	**+ 102%**

Conclusions

By improving the physical environment, airports have the potential to significantly enhance passenger comfort. The present study demonstrated that not only are daylight and views features that passengers prioritize when looking for a seat at the gate, these environmental conditions are key factors that affect passenger comfort, which in turn gate and concession expenditures.

2 Wu, C. and Chen, Y. Effects of passenger characteristics and terminal layout on airport retail revenue: an agent-based simulation approach. 2019. Transportation Planning and Technology. 42(2): 167-186.
3 Volkova, N. Determinants of retail revenue for today's airports. GAP: German Airport Performance, Federal Ministry of Research and Technology.
4 Adey, P. Airports, mobility and the calculative architecture of affective control. Geoforum, 2008, 39, 438e451.