ENHANCING THE AIR TRAVEL EXPERIENCE
HOW DYNAMIC GLASS CREATES MORE COMFORTABLE SPACES IN AIRPORTS

By: Ahoo Malekafzali, PhD, Technical Solutions Analyst
Today’s architects are specifically focused on developing indoor spaces that improve the occupant experience by contributing to the comfort and well-being of the people inside. This is especially true when it comes to improving the travel experience in airports, especially since airport renovations in North America alone are projected to reach more than $100 billion over the next few years, according to the Wall Street Journal.¹ This expenditure is driven by more than just a desire to modernize – it is driven by an urgent need to create a more pleasant travel experience which is critical to airports and airlines’ bottom lines.

**THERMAL AND VISUAL COMFORT CONSIDERATIONS FOR TRAVELERS**

Studies have shown that thermal and visual comfort, both for travelers and airport staff, are key influencers of a positive airport experience. Research studies on comfort conditions in airports revealed that thermal comfort underperformance has a negative effect on overall satisfaction. Additionally, travelers reported a strong preference for more natural light, even under conditions when it is estimated to be sufficient, particularly in morning hours.² However, often times, letting in natural light can result in glare and excessive heat, which can aggravate already tense and rushed travelers, creating a frustrating experience for travelers, staff and airport businesses hoping to gain travelers’ attention.

It’s important for airports to account for the three factors contributing to travelers’ visual and thermal comfort:
1. An unobstructed connection to the outdoors
2. Glare
3. Excessive heat

### 1. UNOBSTRUCTED OUTDOOR VIEWS

Almost all modern airports utilize glass-centric designs since travelers expect an unobstructed connection to the outdoors. As a result of this expectation, blinds and shades are typically not viable options, making dynamic glass a particularly attractive solution due to its ability to prevent heat gain and glare and offer unobstructed views without the need for any sort of window covering. Even when fully tinted, dynamic glass still allows travelers a clear view to the outdoors.

**WHAT IS DYNAMIC GLASS?**

Dynamic glass, or electrochromic glass, is an electronically tintable glass used for windows, skylights, facades and curtain walls. Electrochromic glass, which tints automatically in response to the sun, is popular for its ability to improve occupant comfort, maximize access to daylight and outdoor views, reduce energy costs and provide architects with more design freedom without blinds.
2. GLARE

Glare is another important consideration because throughout the day, excessive glare can force travelers away from windows, leaving what is already sparse seating unoccupied. Additionally, in our connected, digital world, travelers expect to be able to utilize devices like smartphones, tablets and laptops while waiting at airports, and glare on these screens compromises use. While fritted glass has been utilized at airports to help control glare, the research below suggests that dynamic glass is a better glare control solution due to its ability to sufficiently control glare during times of the day identified as high glare periods.

ASSESSING GLARE RISK

Daylight simulation tools allow us to better understand the location, duration and severity of the glare discomfort risk travelers may face. In the example below, a specific airport building is evaluated for glare risk at a location on the south façade, considering seated passengers.

This study analyzed the presence of glare throughout the year, as well as which portion of the window or “zone” was the cause of the glare. The modeling data depicted below shows that the middle zone of the glazed façade accounts for more glare hours for all daylight travelers. Considering both upper and middle zones, as glare would be present for every daylight hour of the day for five months out of the year.

![Glare Problem for Every Daylight Hour for 5 Months*](image)

*For the purpose of this simulation, clear sky conditions were assumed. Contact SageGlass for additional details on this simulation.
GLARE CONTROL COMPARISON

After assessing the location and duration of glare, it’s necessary to assess the severity of the glare and how well different solutions manage it. This simulation compared electrochromic glass with in-pane zoning (tinting specific sections within a pane of dynamic glass) with fritted static glass. The assumption is that frit would cover only about the top third, zone 1, of the glass to block some high angle glare while still providing visibility.³

The Figure B below shows that at 1 PM on December 21 the use of fritted glass resulted in a daylight glare probability (DGP) of 0.51, creating intolerable glare because the sun was still capable of penetrating through the top zone of the glass where frit was present. Under the same circumstances, when utilizing dynamic glass with in-pane tinting capabilities (Figure A), the daylight glare probability was 0.25, or imperceptible, since dynamic glass was able to control glare from the sun through the top zone while allowing sufficient daylight to be admitted through the other two zones in the glass. Looking now at Figure D 8 AM on January 21 the fritted glass allows a DGP of 0.8, again in the “intolerable” range whereas the multi-zone dynamic glass (Figure C) provides a DGP of 0.29, again in the imperceptible range. While the glare outcome is the same, the reason is different. The middle zone has no frit, thus no glare control impact at this time. At this date and time, the glare was primarily in the middle zone, so the dynamic glass tinted this area to 1% VLT, blocking glare while keeping the remaining zones clear for daylight admission.

<table>
<thead>
<tr>
<th>DECEMBER 21 - 1:00 PM</th>
<th>JANUARY 21 - 8:00 AM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DYNAMIC GLASS</strong></td>
<td><strong>DYNAMIC GLASS</strong></td>
</tr>
<tr>
<td><strong>DAYLIGHT GLARE PROBABILITY = 0.25</strong></td>
<td><strong>DAYLIGHT GLARE PROBABILITY = 0.29</strong></td>
</tr>
<tr>
<td>1% VLT</td>
<td>60% VLT</td>
</tr>
<tr>
<td>18% VLT</td>
<td>1% VLT</td>
</tr>
<tr>
<td>60% VLT</td>
<td>60% VLT</td>
</tr>
</tbody>
</table>

Dynamic glass is able to control glare through full tinting of the top zone and intermediate tinting of the middle zone while keeping the bottom zone clear to maximize daylight admission.

<table>
<thead>
<tr>
<th><strong>DAYLIGHT GLARE PROBABILITY SCALE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.35 IMPERCEPTIBLE GLARE</td>
</tr>
<tr>
<td>0.35-0.40 PERCEPTIBLE GLARE</td>
</tr>
<tr>
<td>0.40-0.45 DISTURBING GLARE</td>
</tr>
<tr>
<td>&gt;0.45 INTOLERABLE GLARE</td>
</tr>
</tbody>
</table>

Here only the middle zone needs to be tinted to control glare, which dynamic glass with in-pane zoning allows, while keeping the upper and lower zones clear for maximum daylight.

<table>
<thead>
<tr>
<th><strong>FRIT GLASS</strong></th>
<th><strong>FRIT GLASS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DAYLIGHT GLARE PROBABILITY = 0.51</strong></td>
<td><strong>DAYLIGHT GLARE PROBABILITY = 0.8</strong></td>
</tr>
<tr>
<td>Sun penetrates through the top zone where the frit is present. Even at 70% the frit is still not sufficient to control glare.</td>
<td>Sun penetrates through the middle zone where frit is not present, so during this time period the frit is not correctly placed to control glare.</td>
</tr>
</tbody>
</table>

Sun penetrates through the top zone where the frit is present. Even at 70% the frit is still not sufficient to control glare.
THE RESULTS OF THIS MODELING DEMONSTRATE FOUR KEY FINDINGS:

1. Modeling glare potential in airport applications is an important step as it can reveal significant risk, far greater than what might be expected without any actual data.
2. During high glare periods, fritted glass, even with frit placement matching the glare source, is frequently insufficient to control glare.
3. There are many frit placements that do not align with the glare source, preventing it from alleviating glare.
4. Multi-zone dynamic glass can effectively control glare regardless of source location at any point in time.

3. EXCESSIVE HEAT

The third consideration in the overall travel experience is excessive heat. Dynamic glass can block up to 95 percent of solar heat—a solar factor of 0.05—exceeding the performance of almost any conventional glass product.

In a recent study at Dallas/Fort Worth (DFW) Airport, dynamic glass was used to reduce solar heat gain and improve comfort at an airport bar. Evaluating one month of data, the bar’s sales of alcohol increased by 80 percent year over year. This increase can be attributed to passengers feeling more thermally comfortable and as a result spending more time, and thus money, at the airport bar. Since airport food and beverage locations, on average, spend 18 percent of their gross sales on rent, as compared to the industry standard of 6-10 percent, they need to ensure sufficient traffic and encourage diners to linger to increase the bill of sale to offset this rent premium.

“Passengers benefit from SageGlass’ access to daylight and views, but direct solar penetration can be controlled. This means better working conditions for security personnel, which in turn leads to a better travel experience. SageGlass is an innovative technology that is helping us transform the 50-year-old terminal building to better serve the next generation of travelers.”

Greg Maxam, Director of Sustainable Design at Alliance, Architect of the Minneapolis-St. Paul International Airport’s Terminal 1.

ENERGY SAVINGS

Because airports need to provide a comfortable and convenient travel experience, they are also frequently high-energy consumers due to their 24-7 hours of operation, size and extensive use of glazing. Conventional low-e glazing rarely goes lower than a g value of 0.25 whereas dynamic glass can achieve a g value of 0.12 in its first intermediate tint state and even 0.05 in its fully tinted state. That means in its fully tinted state dynamic glass is allowing in 5 time less solar radiation than a conventional low-e glazing with a g value of 0.25. This significant reduction in solar heat gain lowers peak energy demand, allowing for HVAC downsizing, as well as ongoing energy savings due to decreased overall consumption.
VISUAL AND THERMAL COMFORT CONSIDERATIONS FOR AIRPORT STAFF

While it’s important to improve the experience for travelers, it’s also mission critical to provide a comfortable environment for all airport staff, especially those who are responsible for the safety and security of all travelers. For agents working at security checkpoints, discomfort can lead to distraction and compromise performance. To alleviate these concerns, dynamic glass was installed at one of the security checkpoints at the Minneapolis-Saint Paul (MSP) International Airport to create a glare-free, thermally comfortable work environment. Due to the positive reaction of TSA agents, the airport has now purchased dynamic glass for all security checkpoints to enhance the thermal comfort of both agents and travelers moving through them.

Research has also echoed airport workers’ desire for a more visually and thermally comfortable work environment. In a study conducted by the U.S. General Services Administration (GSA), traditional glass windows were compared with dynamic glass at the Land Port of Entry in Donna, Texas. GSA surveyed Customs and Border Protection agents working at the facility, both in the command center and inspection booth, about the impact of electrochromic glass on visual comfort. Agents were unanimous in their preference for dynamic glass over the previous static glass windows, rating it with a score of 8.77 out of 9 for the following category: “Overall, the new switchable windows meet the outdoor visibility needs of my mission better than conventional windows”.

CONCLUSION

As airports look to improve the experience for travelers and staff alike, dynamic glass is a proven technology that can help do this by delivering enhanced visual and thermal comfort year round.

REFERENCES
3. Upper third, Zone 1, had 70% Frit coverage.

WHY SAGEGLASS?

SageGlass® is the pioneer of the world’s smartest dynamic glass and is transforming the indoor experience for people by connecting the built and natural environments. Electronically tintable SageGlass tints or clears on demand to control sunlight and prevent heat and glare without the need for blinds or shades. SageGlass dramatically reduces energy demand and the need for HVAC by blocking up to 95 percent of solar heat. As part of Saint-Gobain, SageGlass is backed by more than 350 years of building science expertise that only the world leader in sustainable environments can provide.

If you want to learn more about dynamic glass you can visit www.sageglass.com or contact us by email at sales.emea@sageglass.com.

sageglass.com / sales.emea@sageglass.com