Walker White Paper 3

TECHNICAL DESIGN OF BIRD FRIENDLY GLASS

EXECUTIVE SUMMARY

Making sheet glass safe for birds is responsible bird-friendly building design practice. The application of markers that are visible to birds and humans or visible to birds not humans (UV) spaced 10 cm (4 inches) vertically or 5 cm (2 inches) horizontally (2 x 4 Rule) on Surface #1 of a window will eliminate bird-window collisions. Bird deterrent markers of any shape and size can be applied effectively on other window surfaces when visible looking at glass from outside. Published bird-safe building guidelines are available from numerous municipalities across North America (most notably the City of Toronto, Canada), several government agencies (e.g., the Canadian Standards Association (CSA Standard 460)), and private organizations to guide bird safe building design and construction. Two testing methods are used to evaluate bird-window collision prevention products, tunnel and field experimental protocols. Both have value, but field experiments are required as a final assessment to validate accuracy and establish confidence in effectiveness. While establishing the best testing methodology is important, standards such as the CSA A460 use the combined wisdom of years of research and in-field tests, and certainly are seen as the best approach in securing a generally accepted assessment method by the technical community.

INTRODUCTION

Billions of birds are killed striking clear and reflective sheet glass worldwide. Prevention of this unintended and unwanted human-associated avian mortality is being driven by both ethical and legal reasons. The scientific study of collisions between birds and windows inform us that all individuals of all bird species behave as if sheet glass is invisible to them. Science also informs us how to transform clear and reflective sheet glass into barriers that birds will see and avoid. Glass that is visible to and avoided by birds is bird safe and therefore bird friendly. The purpose of this paper is to provide guidance in creating bird safe glass, and the appropriate test methods needed to evaluate the design of bird friendly glass.

BIRD SAFE DESIGN FEATURES

As early as the 1970s, I conducted scientific experiments at Southern Illinois University at Carbondale as part of my doctoral research using a flight cage (later called a tunnel) as well as a field site that simulated windows installed in actual human structures. Both methods were designed to determine how to transform sheet glass into a barrier that birds would avoid. Wild-caught Dark-eyed Juncos (*Junco hyemalis*), a frequent sparrow-size collision casualty, were tested in this first tunnel using lines placed on clear windows incrementally spaced to obstruct one side of their escape route to safety. A subject was released from an enclosure at one end of the tunnel where it immediately flew to the opposite end. In its attempt to escape to safety, it was forced to choose either a flight path through an unobstructed half or what was being tested on the obstructed half. These early tests revealed that birds the size of a sparrow will completely avoid the obstructed half if 2.5 cm (1 in) wide lines covering it were separated by 10 cm (4 inches) oriented in vertical columns or by 5 cm (2 inches) oriented in horizontal rows. The results of 27 experiments with each junco subject making 10 to 30 trial tunnel flights were published in the scientific peer-reviewed *Journal of Field Ornithology* in 1990 , and by the early 2000s were called the “2 x 4 Rule.” Other than through their actions, birds cannot tell us why four inches between vertical pattern elements works as effectively as two inches separating horizontal elements. One reasonable interpretation is that birds use wider spacing flying around vertical tree trunks than they do horizontal branches of shrubs and trees. The outcome of this work has defined the design of bird safe windows. Bird safe sheet glass consisted of uniformly applying elements making up a pattern over the entire glass surface such that their spacing followed the 2 x 4 Rule. Additionally, these first tunnel experiments revealed that pattern elements can have any shape or size, as long as the 2 x 4 Rule was followed— dots, larger circles, diamonds, squares, or other shapes were equally effective at deterring bird strikes. Work in Austria by Martin Rossler and his research team, publishing in the peer-reviewed 2015 scientific journal *Biologia*, further validated the 2 x 4 Rule, and further revealed that the size of pattern elements can be remarkably modest . Using lines in their tunnel testing, they found 2 mm (0.08 inch) wide lines having 7% coverage were as effective as 13 mm (0.51 inch) wide lines covering 50% of the entire glass surface. Their work also documented that the greater the contrast between pattern elements the greater their ability to deter bird strikes, interpreting increased contrast making pattern elements more visible to humans and presumably birds.

Field experiments were essential in revealing the importance of applying patterns to protect birds on Surface #1, the outside facing surface of a window. Most windows are installed in buildings where they cover a darker interior. Simple physics of light transmission and reflection teach us that even a perfectly clear piece of conventional sheet glass acts like a mirror when viewing it from outside. When the glass is tinted, the quality of the reflection appears to increase. ***Testing these reflective effects in tunnels is extremely difficult, and not confidently reliable***. The realistic reflections off Surface #1 are what deceive birds, and why they behave as if the glass is invisible to them, most often killing themselves flying into the illusion of facing habitat and sky. To make these reflected windows bird safe, bird safe patterning must be applied to Surface #1 where birds can see them.

Habitat and sky seen through clear panes are just as lethal to flying birds when they try to reach habitat and sky behind these invisible barriers. Such see-through effects occur when sheet glass is installed as an outside railing, as walls around atria, or on both sides of a corridor (linkway) between buildings, or across glass-lined walls of a room with bright interior lighting, and when clear panes meet in the corners of buildings. In these see-through conditions, pattern elements can be applied on any glass surface and still deter bird strikes because they will be seen by birds and humans looking at the glass from outside.

Many birds, perhaps most if not all, have the ability to see ultraviolet (UV) reflected radiant light, in what is a range of visible wavelength between 300-400 nanometers (nm = 10^{-9}). Humans do not see radiant light in the UV range. Consequently, when avian UV perception was first reported in the late 1970s, the use of UV patterning that birds see and humans do not was immediately recognized as an elegant solution to deter bird-window collisions. In 2004, a product offering a UV-reflecting and UV-absorbing pattern was developed for testing. Both tunnel and field-testing experimental protocols have determined that UV signals effectively deter bird strikes. These results appeared in 2009 in the peer-reviewed scientific publication *Wilson Journal of Ornithology* . A follow up scientific publication reported the details of the UV signal that was needed in order to be effective. That follow up research published in 2013 in the *Wilson Journal of Ornithology* found UV-reflections minimally required a strength of 20-40% over the 300-400 nm wavelength range placed adjacent to 100 or near-100% UV absorption elements with the same 2 x 4 Rule spacing as visual pattern elements . The original experiments studying UV signals to deter bird-window collisions were conducted with external films for retrofit applications to existing problem windows. The use of UV signal patterning on novel sheet glass, that is, creating UV patterning on inorganic glass for remodeling and new construction, has been a greater challenge. There have been some successes that continue to guide improvements. There is no current external film to retrofit sheet glass in existing buildings using UV signals to deter bird strikes. There are successful prototypes, but no manufacturer has committed to making and offering it for commercial sale because of return on investment uncertainty. There is currently one manufacturer that offers an effectively proven novel sheet glass using UV signals to deter bird strikes; others are developing and expecting to offer UV bird safe glass in the near future.

BIRD SAFE GLASS STANDARDS

Research on bird-window collision prevention has guided the development of bird friendly building design. Bird friendly building design guidelines have been established and adopted by various cities and municipalities throughout North America. These published guidelines have been used to create mandatory and voluntary legislation to describe bird friendly construction in a growing number of locations at the local, regional, and federal levels in North America and Europe. A comprehensive list of the municipalities that have adopted bird friendly standards along with the guidelines themselves can be found in the CSA (A460) Standard.

Recognized international organizations who develop technical standards, among others, for materials and products have established Technical Committees to describe and evaluate bird safe building design, materials, and methods to assess effectiveness. The Canadian Standards Association (CSA) is currently completing a bird-friendly window design standard based on the results of years of research from my original studies and later validated by the studies of Rossler and his team and others. This collective research results describing specific criteria to prevent bird-window collisions will form the basis of the Bird Friendly Building Design (CSA A460) standard. This work has recently completed a public review comment period. When released CSA A460 is expected to guide bird-safe building industry practices, serving as a model for bird-safe building construction worldwide. The American Society for Testing and Material (ASTM) is studying the means objectively and accurately to assess bird-safe building materials, to include bird-safe sheet glass. The concern over identifying an accurate method to serve as an industry standard to evaluate bird-safe products is still under consideration and awaits resolution due to challenges, limitations, and flaws associated with the current tunnel test design approach.

EVALUATING BIRD SAFE GLASS

From my original tunnel tests in the 1970s, Martin Rossler and his research team in Austria, and Christine Sheppard and her research team at ABC in the United States, who adopted and implemented a modified method from that of Rossler, continue to test bird –safe glass in their respective tunnels. There are detailed differences from the original tunnel, but in general, tunnel testing is fundamentally dichotomous choice tests, forcing birds to fly through an unobstructed pathway to safety or one of equal size but covered in some fashion with whatever is being evaluated to deter strikes.

By comparison, field tests are conducted in actual building location sites where windows are framed and accurately simulate their installation in human structures. Field experiments compare bird strike rates at clear and reflective control windows to clear and reflective prototype windows designed to deter strikes.

Many preventive prototypes can be tested in a relatively short period of time using a tunnel, over a few weeks where they are conducted at bird banding sites. Field experiments test relatively few prevention products (4-7) over 30-90 days, and only during the North American non-breeding season (late October to early April) to prevent the potential loss of parents because some birds die colliding with the experimental windows.

The difference and confidence in the results of tunnel versus field-testing was documented in the earlier cited 2013 scientific article in the *Wilson Journal of Ornithology*. In that report, an alarming discrepancy was recorded for a current sheet glass product purporting to be and still being sold as bird safe. The ABC tunnel test results documented it as bird safe when installed in a clear see-through effect, reducing the risk of a strike by 58-66%. In contrast, this same product in the same setting, a clear see-through installation, resulted in a 28% greater risk of a strike compared to the clear conventional glass control in the field experiment. These two experimental protocols produced opposite and contradictory test data for the very same glass product, and as such suggest caution and strong evidence not to rely on tunnel test results as a final assessment measure of effectiveness of any bird-window collision prevention method. These results further indicate that tunnel testing certainly should not be adopted as an industry standard and final assessment of bird-safe products. To do so runs the risk of evaluating a product as bird-safe when, as in this example, it is not; worse, this particular product installed as a clear see-through pane was a far bigger bird killer than conventional glass; surprisingly, it reduced the risk of a strike by 55% compared to the clear control when covering a darker interior as a reflective window.

Furthermore, tunnel testing is markedly not as accurate as field-testing in simulating hazardous clear and reflective windows installed in human structures. Components of tunnel testing that limit a more accurate simulation of installed windows include: (1) the stress of captured individuals of several different species released to fly within restricted space to alternative decision areas, (2) controlling illumination to simulate clear and reflective panes, (3) netting placed in front of test panes that subjects can potentially see and thereby influence their choice, and (4) not being able to control for variable weather conditions during test periods.

By contrast, field experiments accurately simulate installed clear and reflective windows in commercial and residential buildings. Each preventive treatment and control are monitored under the same conditions that, among other factors, include the same lighting and weather conditions, and the natural behavior and density of birds in the vicinity of all windows. An especially important component in field experiments is the ability to control for location installation bias by randomly moving treatments and control windows daily over the experimental period. The ability to conduct experiments by randomly moving treatments and controls at existing structures is extremely difficult and most often impractical, which makes testing preventive bird-window collision products at actual buildings unrealistic without extraordinary effort, commitment, and financing.

As noted, tunnel testing is most useful in evaluating several potential preventive options to deter bird strikes at see-through sheet glass. To be sure, most tunnel test results are similar to field test results, but the limitations of tunnel experiments to accurately simulate windows in actual buildings precludes this protocol from serving as a definitive tool in evaluating bird-window collision prevention methods. The field experiment protocol provides accurate results to serve as a definitive assessment of evaluating bird-window collision prevention because the effectiveness of treatments are compared in an environment like that of windows installed in actual buildings. Consequently, field experiments must be used to verify tunnel-testing results to qualify a glass as bird safe.

All the above notwithstanding, the overall goal is to significantly reduce bird strikes at commercial and residential glazing. While establishing the best testing methodology is important, standards such as the CSA A460 use the combined wisdom of years of research and in-field tests, and certainly are seen as the best approach in securing a generally accepted assessment method by the technical community. These standards can be adopted and implemented immediately and will serve to save billions of bird lives without delay.

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