Feature

The Invisible THREAT

Photo © Matti Keltanen

Creating bird-friendly buildings

By Christine Sheppard, PhD, Anne Lewis, FAIA, Bruce Fowle, FAIA, and Guy Maxwell, AIA

Ask most facility managers about birds and they probably think about pigeons nesting on air-conditioning units or Canada geese fouling walkways. However, most species also contribute to insect control, habitat-regenerating seed dispersal, as well as spring song and bright colours.

Unfortunately, the increasing use of glass in the built environment has been reflected in an enormous, but little-recognized toll—annually, about 25 million birds are killed by collisions with glass in Canada, and up to one billion in the U.S. As interest grows in this, and other sustainability issues, the building industry is in a unique position to respond.[1]

Why do birds collide with glass?

Some wonder why they can see glass and birds cannot. In reality, people cannot see glass either and injuries can occur. However, people come to recognize mullions and window frames mean glass—context that is meaningless to birds. Birds try to fly toward reflected vegetation or sky, or to habitat seen through glass, and because they often fly into small spaces, even minimal glass can pose a hazard. This is why virtually everyone has seen or heard a bird hit a window.

Most collision victims are small songbirds, such as thrushes, warblers, sparrows, and tanagers—some of the most beloved and colourful species. These birds are neotropical migrants, meaning twice a year they travel between wintering grounds in South and Central America in the fall and breeding grounds in Canada in the spring. Most songbirds migrate at night, often travelling up to 124 km (200 mi) daily at speeds of approximately 48 km/h (30 mph). In the early morning hours, they come down to rest and feed, often attracted to urban areas by the glow of city lights. Many collisions occur during these spring and fall migratory seasons because the birds are in unfamiliar territory and do not recognize the glass-clad structures.

Further, bird vision is different than that of humans. The former has four retinal cones, while the latter has only three, and they also perceive more colours and can see ultraviolet (UV) light. Their response time is quicker, and they have excellent peripheral vision because their eyes are on the sides of their head. However, for the same reason, their binocular vision is limited and depth perception is poor. Birds are also less sensitive to contrasts—meaning they need to be closer to resolve two adjacent objects. So, at 48 km/h, they have little time to avoid colliding with glass, even if they see it.

A commonly asked question is, if so many birds are killed by glass, why are more dead birds not seen on the ground? While some are disposed of by maintenance workers, most are taken by scavengers like rats, raccoons, cats, crows, and gulls. Some scavengers actually patrol areas where collision victims are frequently found. It is important to note residential homes likely kill more birds than other types of buildings due to the typical bucolic settings.

Figure 1

Photos courtesy Chris Sheppard, American Bird Conservancy

Glass transparency is demonstrated here in an atrium with plants.

Causes of bird/glass collisions

Glass appears differently to birds depending on numerous factors, including how it is fabricated,

Figure 2

The deadly mirage presented through glass reflectivity is shown here, with a mirrored wall reflecting trees.

the angle at which it is viewed, and the difference between exterior and interior light levels. Combinations of these factors can cause glass to look like a mirror or dark passageway, or to be completely transparent.

Glass transparency

Birds strike transparent windows, attempting to reach potential perches, plants, food, water sources, or other lures seen through the glass (Figure 1, page 27). Common architectural features that are especially dangerous include:

- glazed skywalks joining buildings overhead;
- glass walls in front of lobbies with interior plants;
- corner windows with glass installed perpendicularly on both sides; and
- exterior glass handrails.

Glass reflectivity

Viewed from the outside, transparent glass can be highly reflective. Under the right conditions, almost every type of architectural glass, reflects the sky, clouds, or nearby habitat familiar and attractive to birds. When birds try to fly to the reflection, they hit the glass. Reflected vegetation is the most dangerous, but birds also attempt to fly past reflected buildings or through passageways that are not there. Mirrored glass is particularly hazardous because it is reflective at all times of day and presents undistorted images of sky, trees, and other habitat features birds mistake for reality (Figure 2).

Fatal light attraction

The problem of bird collisions with glass is greatly exacerbated by artificial light. Light escaping from building interiors or from exterior fixtures can attract birds, particularly during migration on foggy nights or when the cloud base is low. Strong beams of light can cause birds to circle in confusion and collide with structures, each other, or even the ground (Figure 3, page 30). Others may simply land in lighted areas and must then navigate an urban environment rife with dangers, including glass.

Trends toward bird-friendly construction

In the last several years, the problem of bird/glass collisions has received considerable public attention. Scientists began researching the problem intensively around 1979, and their estimates spurred birding groups to get involved. The Toronto non-profit group, Fatal Light Awareness Program Canada (FLAP Canada), led the way.[2] In 1993, its volunteers began documenting thousands of 'kills' in downtown Toronto by walking the streets in the early morning hours and picking up dead and injured birds at the base of glass buildings. The powerful photographs of hundreds of dead songbirds have motivated groups in other cities to mount similar efforts (Figure 4, page 32). Today, there are volunteer monitoring programs in many major Canadian and U.S. cities, and their findings are an important basis of scientists' estimates of bird mortality.

Figure 3

Photo © Kelly Rypkema

The Municipal Art Society of New York's Manhattan 9/11 memorial, "Tribute in Light," demonstrates fatal light attraction, with birds trapped in the light.

LEED

It quickly became apparent the building industry could play a lead role in reducing these deaths by designing and constructing buildings that would not kill birds. The U.S. Green Building Council (USGBC) now offers a pilot credit for reducing bird collisions in the Leadership in Energy and Environmental Design (LEED) program. Pilot Credit 55 has been the most popular LEED pilot credit ever offered.

Currently, there are no mandatory prerequisites or optional credits for preventing bird collisions for buildings targeting LEED certification in Canada. However, the issue is mentioned in the Canada Green Building Council (CaGBC) 2009 LEED Canada New Construction (NC) reference guides, under the Sustainable Sites (SS) category. Specifically, the guide suggests birds' migratory patterns be considered in building designs.

Lawsuits

In 2013, amid growing awareness of the bird/glass problem, a ground-breaking Canadian lawsuit created an important precedent for building owners. The environmental group Ecojustice brought suit against Cadillac Fairview, a firm whose reflective-glass buildings near downtown Toronto had killed hundreds of birds. The suit alleged that the killing of birds was caused by a failure of the company to take measures that would reduce bird deaths—an alleged violation of the *Environmental Protection Act* (*EPA*) and the *Species at Risk Act* (*SARA*).

Cadillac Fairview was held not liable because it had recently taken steps to retrofit the building with an exterior film visible to birds. However, the court did conclude light discharged from windows is a prohibited 'contaminant' in circumstances where birds are deluded by the reflection of safe places, such as the sky or trees.

Also, as a result of the court's interpretation of the law, Ontario can now require building owners to obtain an environmental compliance approval if they are discharging light that is killing or injuring birds. Under *SARA*, the court found the inadvertent killing of threatened species in window strikes was covered by the provision prohibiting harm to listed species.

Legislation

State and local jurisdictions have also taken action by passing legislation mandating bird-friendly buildings in certain cases, and more is pending. Toronto requires most development four storeys or greater to adhere to the *Toronto Green Standard* (*TGS*), which includes a number of bird-friendly measures.[3] These include either treating glass with a density pattern or muting reflections for the first 10 to 12 m (33 to 39 ft) above-grade, and installing shielded light fixtures.

San Francisco's 2011 *Bird Safe Building Act* requires bird-friendly treatment of façades for new buildings within a clear flight path of less than 91 m (300 ft) from any natural bird habitat of 0.8 ha (2 acres) or more. The treatment must extend for the first 18.2 m (60 ft) in height of the building and is also required for hazardous features in all new buildings—such as skywalks, glass rails, and transparent corners. Other similar laws are passing in jurisdictions throughout North America.

Solutions

As concern for bird deaths intensifies, the building community is increasingly demanding new products, information, and design solutions to reduce fatal collisions.

Several published guidelines are now available, including *Bird-friendly Development Guidelines*, published by the City of Toronto and referenced in the TGS, and *Bird-friendly Building Design* published by the American Bird Conservancy.

Figure 4

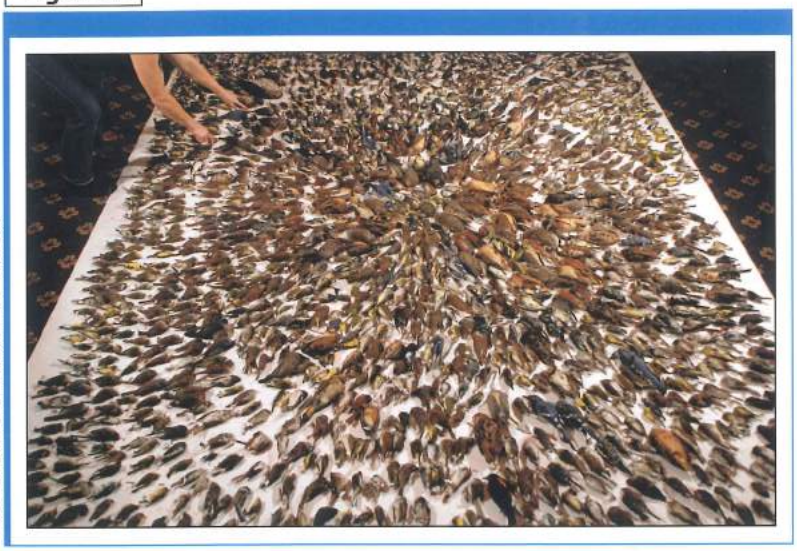

Photo © Kenneth Herdy, FLAP Canada

This photo shows some of the many birds collected by Fatal Light Awareness Program (FLAP) in Toronto.

Figure 5

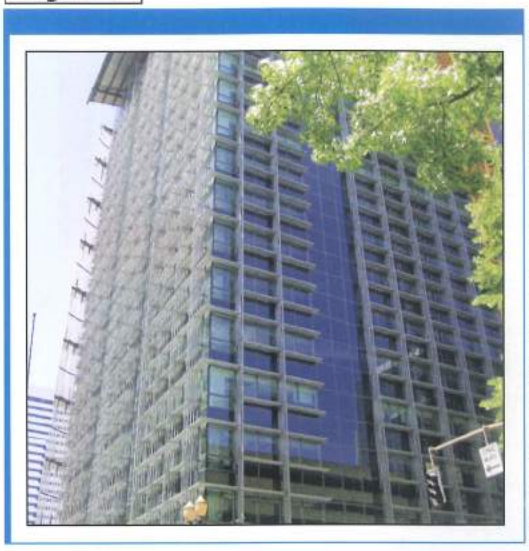

Photo courtesy Christine Sheppard, American Bird Conservancy

These architectural elements help break up the solid glass façade by creating 'visual noise.'

Although the science is constantly evolving, certain principles of bird-friendly construction are now generally accepted.

Visual noise

'Visual noise' refers to any glass treatment that alerts birds to its presence (Figure 5). Since birds cannot see glass, any texture, pattern, or architectural element making the surface more visible to birds will reduce collisions.

Common treatments include:

- non-reflective or patterned films on glass;
- screens or netting positioned in front of glass;
- retractable shutters;
- exterior roller shades;
- changes of glass plane to distort reflections;
- projecting sun-control elements (*i.e.* brises soleil);
- integrally patterned or fritted glass; and
- tape stripes or patterns on glass.

The 2x4 rule

Tunnel testing has consistently shown birds will not attempt to fly through horizontal spaces less than 51 mm (2 in.) high or through vertical spaces 102 mm (4 in.) wide or less. This is referred to as the '2x4 rule' and is applicable regardless of the type of visual noise being proposed. Whether lines, dots, or squiggles, elements creating the spaces must be big enough to be visible to birds—about 12.7 mm (1/2 in.) in diameter for dots, and 3.17 mm (1/8 in.) wide for lines (Figure 6, page 34).

More is more for patterns

Even if a pattern meeting the 2x4 rule cannot be achieved, more pattern is better than less. The goal is to reduce the intervals of clear glass as much as possible so birds are aware of a barrier. The pattern need not obstruct building occupants' view—tests have identified patterns that deter most bird collisions while only covering five to seven per cent of the glass.

Less is more if it is glass

Bird mortality is directly related to the percentage of transparent glass on a façade. All-glass buildings are becoming more prevalent due to marketing perceptions, life-style changes, and more energy-efficient glass products. Thus, more buildings are now hazardous to birds. Given this trend is not likely to be reversed in the foreseeable future, the glass industry needs to step up and seriously address the bird-kill issue.

Eliminating the mirror effect

Highly reflective glass is particularly hazardous and should be avoided, especially where it reflects sky or vegetation. While high reflectivity used to be synonymous with high performance, this is no longer the case as the glass industry continues to develop more energy-efficient coatings allowing greater transparency with lower reflectivity. Reflective glass is now specified more for uniformity of appearance between vision glass and opaque glass than it is to meet energy

codes and such. Tests have shown glass reflectivity of less than 15 per cent reduces bird collisions.

Apply treatments to the exterior glass
The most effective solutions are installed on the outside surface of glass or in front of glass, because reflections can be strong enough to make internal treatments invisible from the outside. Some treatments that reduce transparency, such as interior shades, can even increase reflectivity in certain situations, so it is important to analyze each building to determine the nature of the problem before choosing material.

Reduce unnecessary lighting
The key to all bird-friendly design is the importance of reduced night lighting as illumination attracts birds to a building in the first place. Special efforts should be made to reduce landscape, parking lot, tower, and 'vanity' lighting, such as for façades and signage. Instead, motion detectors or computerized systems that respond to actual building use should be employed, so lights are not on when there are no occupants in the space.

Shield interior landscape
Various interior plants—especially trees—attract migratory birds looking for food and refuge after a long flight. Unfortunately, many of these interior landscapes are lit at night for the enjoyment of people using the building. If they are visible from the outside through glass, they pose a particular hazard to birds. Screening these landscapes, or even just turning off the accent lights, can reduce the threat.

Bird-friendly glass products

Some members of the glass industry are actively developing glass products that will reduce bird collisions, with several already available in North America. These products fall into three general categories: fritted, UV-reflective, and etched.

Figure 6

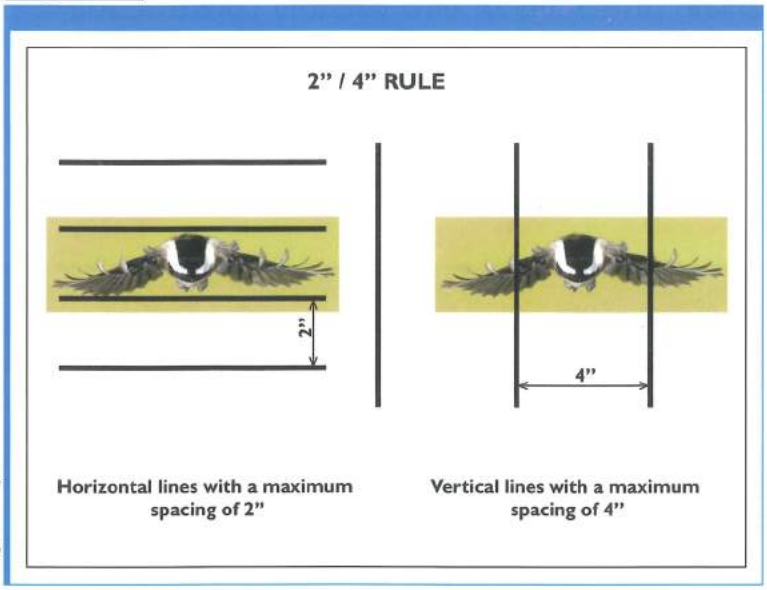

Image © Roy Hancliff

This diagram demonstrates the '2x4' rule.

Figure 7

Photo courtesy FLAP Canada

Film applied to the outside of the glass on 33 Yonge Street in Toronto.

Fritted glass

Fritted glass (*i.e.* conventional glass with baked-on ceramic patterns) effectively reduces bird collisions. These patterns can take the form of dots, stripes, or any other shape. Striped patterns can be more effective than dotted patterns, with less coverage. However, in most conventional fritted glass, the frit is applied to what is called the #2 surface—the inside face of the outer pane. This is not as visible as if the frit were applied to the #1 surface—outside face of the outer pane—where it is exposed to weather. Several European manufacturers are now willing to warrant fritted glass with the frit on the #1 surface where there have been problems in the past related to wear ability. North American manufacturers need to do the research and development necessary to create this, and make it available to help reduce bird collisions.

UV-reflective glass

As noted, birds can see ultraviolet light, but humans cannot. This is the principle behind UV-reflective glass. One product offers glass with a UV-reflective twig pattern applied as a coating on the #2 surface. The pattern is nearly invisible to humans, but can be seen by birds. This product has been used for several years in Europe, but only recently in a few North American locations. This too needs to develop the technology to allow it to be placed on the #1 surface to overcome reflections and allow for high-performance coatings to be placed on the #2 surface in order to meet energy requirements.

Etched glass

A newly developed Canadian glass places acid etched patterns on the #1 surface, thereby ensuring the treatment is visible to birds, whether in a reflective or transparent mode. It is currently available in regular or random spaced stripes of several designs conforming to the 2x4 rule.

Retrofit solutions

In existing situations where replacement of glass is cost-prohibitive, several products are available as a surface treatment. UV films, decals, die-cast patterns, and tapes are readily available and can be applied to the outside of glass. Some are designed to last up to 10 years and are highly effective in reducing collisions. Often, they need to only be applied to areas of the glass where bird impacts are common. If applied with an eye to esthetics, these treatments can be architecturally pleasing with little loss of visibility.

Measuring effectiveness

Many of these glass and film products have been tested in experiments using live birds. Typically, the

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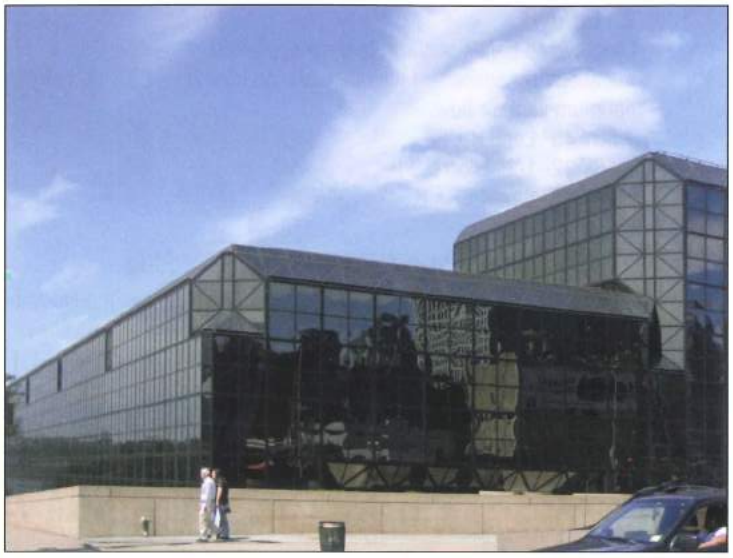
Figure 8

Case Study: Javits Pre-Existing Facade Condition

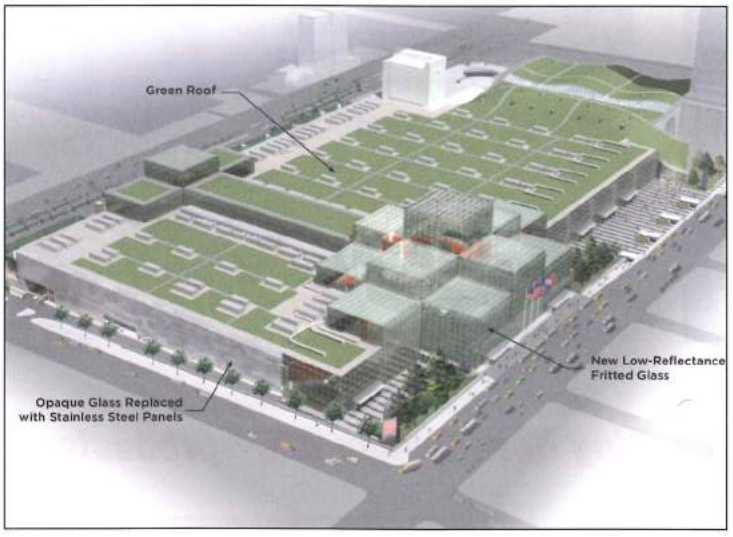


Images courtesy FXFOWLE

The Jacob K. Javits Center in New York before renovations.

Figure 9

Case Study: Javits Proposed Design



This image shows the renovations for the Jacob K. Javits Center.

birds are released in a 7.3-m (24-ft) long tunnel with two types of glass at the end: a control panel (clear), and the panel to be tested. The test glass is rated by the percentage of birds who avoid it and fly toward the clear glass. (Most protocols include a protective net preventing the bird from actually hitting the glass, and each bird is used only once.)

Ratings based on these tests are summarized in *Bird Collisions Deterrence: Summary of Material Threat Factors*, which was developed in 2011 by the American Bird Conservancy and used as the basis for LEED pilot credit evaluations. In this system, opaque material is rated '0' (*i.e.* minimum threat); clear glass, on the other hand, is rated '100' (*i.e.* maximum threat). Tested products receive a rating depending on their effectiveness.[4]

Case studies

There is growing consensus among architects, especially those interested in sustainability, that green buildings should not kill birds. An increasing number of architects are promoting bird-friendly construction and incorporate such elements in their designs. Each of these projects will yield valuable field data over time, critical at this stage of research.

33 Yonge Street

Film was applied to the outside of the reflective glass in high-collision portions of this downtown Toronto building. Horizontal white lines 20.6 mm ($^3/_{16}$ in.) wide and 25 mm (1 in.) apart, give the appearance of open blinds—conventional look the eye only minimally perceives (Figure 7, page 34). Solutions such as this could become the standard for retrofitting problem buildings.

Jacob K. Javits Center

Since its completion in 1986, the Jacob K. Javits Center in New York City has been the site of many bird/glass collisions. Fortunately, the centre has nearly completed a renovation that will make the building both more energy efficient and bird-friendly.

The original building was designed by Pei Cobb Freed & Partners as a modern crystal palace with a vast system of skylights and walls composed of dark, highly reflective glass (Figure 8). The architectural firms FXFOWLE and Epstein, who are responsible for the renovation, re-designed the façade, which includes replacement of nearly one-third of the glass panes with stainless steel, eliminating bird collisions in those areas altogether. The remaining glass panes have been replaced with fritted glass less than half as reflective as the original glass (*i.e.* 15 versus 35 per cent) and more transparent while having a much higher energy performance (Figure 9).

The results have been dramatic. NYC Audubon, an organization working for the protection of wild birds, has been monitoring the building for years, and has reported there were only four bird collisions in the spring of 2013—the first year without construction going on. This is an 80 to 90 per cent reduction from previous years.

Vassar Science Project

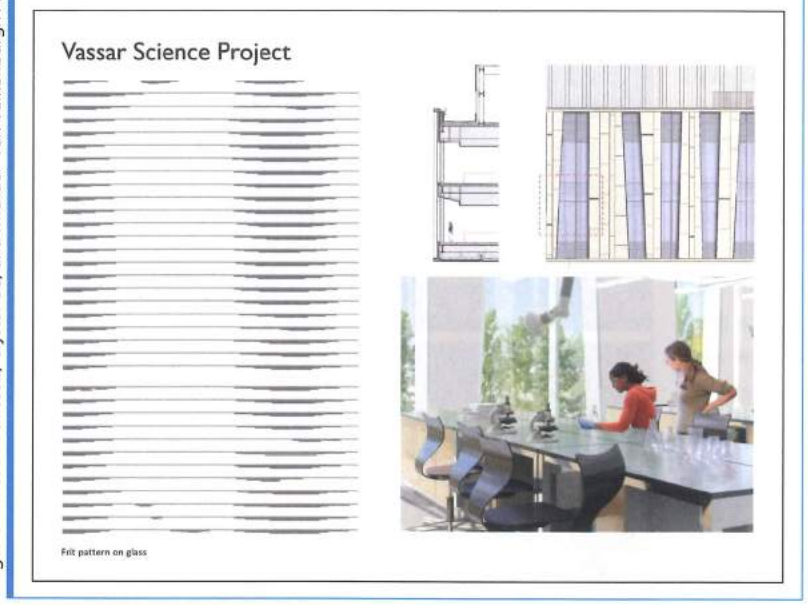
Ennead Architects' new Vassar Science Project, currently under construction in Poughkeepsie, New York, is located in a rich natural area next to a stream in the woods, home to many birds (Figure 10, page 38). The building's design incorporates several innovative elements to reduce potential bird collisions. For example, on one façade where views to the landscape were desired, glass with a UV-reflective pattern will be used to deter collisions. External sunshade louvres on a portion of this façade further serve as a deterrent.

On another façade, the glazing has been designed with a double-layer frit pattern, with horizontal lines of varying dimensions on both #2 and #3 surfaces of the insulating glass. Thus, the effect to a person walking inside—as well as to birds flying outside—will be a dynamic moire pattern that changes with every move of the viewer. Additionally, the outer layer of the frit is light grey and the inner layer is dark grey in order to improve the pattern visibility under differing light conditions (Figure 11, page 38).

Conclusion

All these developments indicate an increasing mandate for bird-friendly construction. Though the science is continually evolving, it is clear bird-friendly design can be compatible with other goals of green construction. Often, architectural features such as sun screens or louvres designed primarily to conserve energy, can also serve to reduce bird/glass collisions—and therefore be cost neutral. As new information, products, and design solutions become available, bird-friendly architecture will be even more achievable, and one billion beloved songbirds will not be lost annually to tragic collisions.

Figure 10



The frit pattern, louvres, and an interior view of the Vassar Science Project.

Figure 11

A rendering of Vassar Science Project.

Notes

[1] With special thanks to Marcia Fowle, AnMarie Rodgers, and NYC Audubon, from whose newsletter portions of this article were excerpted.

[2] For more information visit www.flap.org.

[3] See www.toronto.ca/planning/environment/greendevelopment.htm, in effect since 2010.

[4] Data charts can be found at www.abcbirds.org.

Christine Sheppard, PhD, is the American Bird Conservancy's bird collisions campaign manager and author of 2011 Bird-friendly Building Design. *She is a former department head of the Ornithology Department at the Wildlife Conservation Center, Bronx Zoo and helped formulate the U.S. Green Building Council's (USGBC's) LEED Pilot Credit 55. Sheppard can be contacted by e-mail at csheppard@abcbirds.org.*

Anne Lewis, FAIA, is a retired architect in Washington, D.C. and president of City Wildlife. She has lectured extensively on bird/glass collisions and the need for architects to embrace the principles of bird-friendly design. Lewis can be reached at anne.lewis@citywildlife.org.

Bruce Fowle, FAIA, founded FXFOWLE Architects in New York. He assisted in writing Bird-safe Building Design Guidelines *published by the New York City Audubon and has spoke about the cause at various public forums. Fowle has designed several buildings that directly address the issue, including the New York Times Headquarters Building, the Center for Global Conservation at the Bronx Zoo, and the renovation and expansion of the Jacob K. Javits Center. He can be contacted at bfowle@fxfowle.com.*

Guy Maxwell, AIA, is a partner at Ennead Architects LLP in New York and a leader in developing standards for bird-safe design. He helped formulate the USGBC's LEED Pilot Credit 55 and is a board member of the New Jersey Audubon Society and the Bird-safe Glass Foundation. Maxwell can be reached at gmaxwell@ennead.com.