Visualizing Bird Migration:
Highlighting the Relationship Between Migratory Birds and the Toronto Region through Graphic Design Practice

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ABSTRACT

Bird migration phenomenon takes place many thousands of meters above the ground and between distant locales and therefore remains largely invisible to human observers. The goal of this thesis project is to bring migration into focus by using environmental graphic design installations that highlight Toronto's role as a stopover site for migratory birds and activating a site on the city's waterfront. The final design artifact is composed of three site-specific elements. The first is a wall-mounted graphic work that functions like a sundial to reveal the cyclical nature of seasonal migration. The second is a boardwalk installation that measures the distances travelled by birds migrating from Central and South America to Toronto. The final component is a map of the primary avian stopover sites in Toronto (hot spots), which encourages visitors to explore the city's natural habitats.

This thesis offers examples of how graphic design can go beyond traditional awareness campaign tactics to call attention to natural processes in the environment in order to create meaningful connections between citizens and the natural world. Therefore the role of design in facilitating human connection to natural cycles is of paramount importance.

ACKNOWLEDGEMENTS

Members of my committee have been generous supporters of this study. Angela Norwood, my thesis supervisor, has been supportive and encouraging. I was fortunate to find a thoughtful individual whose interests are closely aligned to my own, and who inspired me to pursue projects that encourage environmental advocacy. I am grateful to her for her continued support and mentorship throughout the process. I would also like to express my sincere thanks to my thesis advisor, Angela Iarocci who has offered many suggestions and inspiration for my project. With a passion for environmental graphic design, her guidance has been extremely helpful in shaping my design artifacts and my approaches to research methodology.

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The goal of this graphic design thesis is to educate the public and to encourage active interest in environmental causes by highlighting the relationship between the Toronto region and the migratory birds that have traveled through it for millennia. This project will contribute to the field of graphic design by exploring how projects can go beyond traditional environmental awareness campaigns, which often employ shock tactics to produce targeted results such as financial donations to a specific cause. Such campaigns often fail to inspire people to consider bigger questions behind the surface problem. This project explores the potential within environmental graphic design and spatial installation to call attention to natural processes in the environment to create meaningful connections between people and processes in the natural world.

Bird migration is a complex phenomenon that can be perplexing until it is understood as part of a larger system, one that also includes human activity. The immense distances traveled by birds, and the different levels of space they occupy in the sky, means that migration primarily occurs out of sight at any given time. Revealing this invisible phenomenon is an important part of this thesis and the final design artifact. By bringing migration into focus, empathy is possible; the first step in creating a connection between people and other species. The goal of this thesis is to remind viewers of their place within the ecosystem by inspiring curiosity through an outdoor installation that visualizes information related to bird migration. The research questions are therefore: 1) How can design reveal and mediate empathy for natural systems and non-human species? 2) How can graphic design activate people to engage in the issue of bird conservation? 3) What type of design artifact encourages learning through interaction?

The speculative design artifact for this thesis will engage people on multiple levels using a variety of scales and formats, including three-dimensional forms, large format graphics, ground and wall-based elements. Not currently installed, the site-

sensitive project has three main components titled *Clockwork, One-Way Flight,* and *Hot Spots. Clockwork* is made up of a wall-mounted, two-dimensional graphic and a three-dimensional element that casts a shadow interacting with imagery on the graphic. It takes advantage of the sun as a moving light source to highlight seasonal information. The second component, *One-Way Flight,* is a ground-based graphic installation that uses the Waterfront Trail boardwalk to plot distances traveled by migratory birds that visit Toronto. The final component, *Hot Spots* is a map of three Toronto sites, displayed on a panel at the site.

CONTEXT

The Toronto region is an important stopover site for roughly 270 migratory bird species.[1] Traveling thousands of kilometers across the ocean without rest, birds must have enough energy stored to make the journey. While not well understood, the most common theory to explain why birds make these costly trips every year is that they are opportunists, taking advantage of the benefits each climate has to offer. In the warmer climes of Central and South America, birds enjoy abundant food but shorter days, which affects foraging opportunities. Conversely, North America's springtime offers millions of migrant birds longer days, plenty of plants and insects, and a safe place to attract mates and raise their young.[2] Birds are instrumental in facilitating ecological processes such as pollination of plants and dispersal of seeds and their presence ensures effective pest and disease control.

Migratory birds travel from South and Central America to North America along four main flyways that follow geographic features including mountain ranges and coastlines.[3] Migration paths included in this study are the Atlantic, Mississippi, Pacific, and Central Flyways. (Fig.1) Toronto's location at the convergence of the Atlantic and Mississippi flyways, and its proximity to Lake Ontario, make it a critical resting site for birds traveling over the lake from the south and those about to make the trip from the north. During spring migration, birds are en route to the Arctic and Boreal forests in Northern Canada. In the fall, birds migrate to the Gulf of Mexico, the Atlantic Coast, and Central and South America.

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[1] The usage of the term 'migratory' refers to species that use Toronto as a stopover site on their way North, but do not breed in the city.

[2] A. Forsyth & K. Miyata. *Tropical Nature: Life and Death in the Rain Forests of Central and South America.* (New York, New York: Touchstone, 1995),142.

[3] Ibid,. 6.

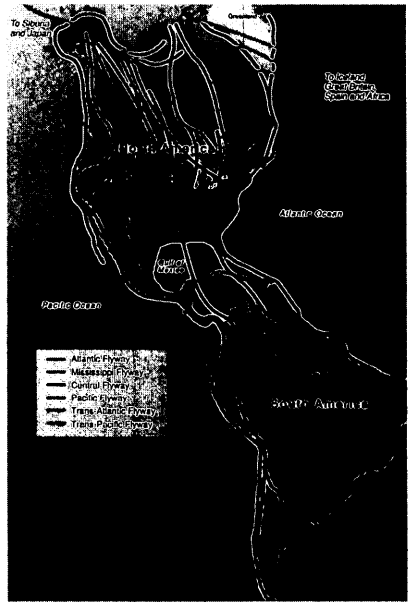

Figure 1. Migratory Flyways

The green space in the city is also of critical importance to migratory birds that rely on different habitat types for food and breeding opportunities. Five main types of habitat exist in the city: lakeshore areas, river valleys, upland woods, old fields, and meadows.[4] Areas that are especially hospitable to migratory birds include High Park, the Toronto Islands, Leslie Street Spit, Sunnybrook Park, and the Humber, Don Valley, and Rouge River ravines.[5] For the purposes of this thesis, the areas under consideration are High Park, Leslie Street Spit, and Toronto Island, all of which see the highest number of migrants.

[4] Ibid., 21.

[5] Particular bird species prefer specific habitats and for the purposes of this thesis, these will be referred to as Forest, Meadow, and Wetland.

THEORETICAL FRAMEWORK

In the last two hundred years, urban development has altered the landscape of Toronto significantly. Extensive wetlands and valleys that once provided habitat for a variety of bird species have since been filled in or otherwise destroyed to make room for agricultural and industrial lands.[6] Fortunately, 13.5% of the Toronto region remains natural (or semi-natural) providing enough habitats to sustain numerous migratory bird species.[7]

Although attractive natural areas can be found in the Greater Toronto Area, there are also myriad dangers. Both migratory and resident bird species (those that remain in Toronto year-round) face habitat destruction, the most significant factor in bird conservation.[8] From year to year, migratory birds find new obstacles in their path, either along their routes or at their destination. Skyscrapers, wind turbines, airplanes, and glass windows cause millions of annual collisions worldwide, with the largest numbers in metropolitan areas.[9] For reasons unknown to science, light pollution lures birds to urban environments and seems to trap them there. Compounding the problem further, birds cannot see clear or reflective glass, resulting in flocks of birds becoming disoriented and striking buildings.

Although there are important initiatives in place that raise awareness of the problem of light pollution (Lights Out Toronto) and help rehabilitate injured birds (Fatal Lights Awareness Program or FLAP), what is lacking are design projects created as outdoor installations that connect citizens to this problem in a more tangible way. It is important to create positive and hopeful messages that inspire people to learn about natural systems and to think of themselves as part of the system at work. Methods used to engage people through effective ecological communications are discussed in more detail later in this paper.

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[6] "Birds of Toronto: A Guide to Their Remarkable World" (The Working Group, Ontario, 2009), 4.
[7] "Migratory Birds in the City of Toronto: A Literature Review and Data Assessment." *Toronto.ca.* 2009. Web. 29, Oct. 2012.
[8] David S. Wilcove. *No Way Home: The Decline of the World's Great Animal Migrations* (Washington, DC: Island Press, 2008), 5.
[9] "Birds of Toronto: A Guide to Their Remarkable World" (The Working Group, Ontario, 2009), 12.

Regardless of the dangers posed by urban environments, birds will continue to migrate as they have been doing for thousands of years. Birds have excellent homing abilities that allow them to travel vast distances without getting lost. With heightened visual, tactile, geomagnetic, olfactory and auditory senses, birds use information from their environment to orient themselves. The sun acts as both a compass and a clock, providing temporal information and direction. For example, at 10am local time, the sun is 30 degrees east of south, and birds use this information to calibrate their circadian (daily) and circannual (yearly) biological clocks. The circannual rhythms of birds are determined by the number of daylight hours. Also known as the photoperiod, the amount of daylight effects birds' hormone levels, and causes them to migrate, thus linking their physiology to the light/dark cycle and directly to Earth's own cycles.[10]

Compared to humans, birds maintain a powerful connection to the earth, using innate abilities to read cues from their surroundings. Humans were not always so out of touch with the environment. Pre-modern civilizations used the stars to navigate great distances, and created time-tracking devices dependent on celestial information. The oldest timepiece, the sundial, is based on ancient Egyptian and Babylonian astronomical findings that the earth rotates on an axis, revolving around the sun. Furthermore, Roman cities were traditionally organized around north-south and east-west axes.[11]
However the design of contemporary cities are no longer as in touch with natural systems, directly affecting their citizens' ability to parse out basic temporal and navigational information provided by the sun, moon, and stars. Many cities are designed to keep ecological processes out of view, and hide the fact that the earth functions as one ecosystem.[12] Sim van der Ryn defines design as "the intentional shaping of matter, energy and process to meet a perceived need or desire... that inevitably connects culture and nature through exchanges of materials, flows of energy, and choices of land use."[13]

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[10] John Elphick. *Atlas of Bird Migration.* (New York, NY: Firefly Books, 2007), 26.
[11] Sergio Correa de Jesus. "Environmental Communication: Design Planning for Wayfinding." Design Issues, 10.3 (1994): 33.
[12] With the Industrial Revolution came urban areas that were unfamiliar and communicated less effectively than cities that were organized based on the cardinal directions, impacting human orientation/navigation.
[13] Sim van der Ryn. *Ecological Design.* (Connecticut: Island Press, 2007), 24.

In this way urban design that does not consider natural systems produces landscapes that separate people from nature, which is detrimental to human well-being since we are highly dependent on experiencing natural environments directly, in ways ranging from physical reliance to emotional and intellectual enlightenment. In 1984, the biologist Edward O. Wilson introduced a hypothesis called *Biophilia*, which described the human affinity for natural over built environments. [14] Wilson proposed that the human need to be in natural settings might have been hardwired through evolution, ensuring a connection to the environment that sustains human life.[15] Our preference for sunlight, trees, and flowers rather than biologically sterile environments, demonstrates "an innate urge to affiliate with other forms of life" and is now a widely accepted theory across many disciplines.[16]

The conservation of natural areas such as parks and ravines are therefore of paramount importance for fostering a connection to nature. The natural areas in and around the Toronto ravines were preserved after Hurricane Hazel, a catastrophic weather event in 1954. Due to massive damage and many casualties, city planning was forced to restrict development in ravines (which are prone to flooding and mudslides) and introduced a conservation department to protect large areas of land from being overtaken for urbanization.[17] Protection of these areas is enforced through by-laws that control the number of developments approved by the city and the Toronto Region Conservation Authority (TRCA).[18] Furthermore, along with preserving existing areas, the TRCA also rehabilitates degraded habitats at a community level. If it were not for these interventions in urban planning that influenced governmental policy, Toronto would not contain the natural areas it does today.

Also contributing to existing green spaces has been a growing awareness at a policy-level of the importance of natural areas for bird conservation. Sustainable

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[14] David Stairs, "Biophilia and Technophilia: Examining the Nature/Culture Split in Design Theory," *Design Issues*, 13.3 (1997): 37.
[15] Ibid.
[16] E.O. Wilson, *Biophilia.* (Cambridge: Harvard University Press, 1984): 85.
[17] Coady, G. and R.B.H. Smith. "Greater Toronto Area Bird Checklist and Reporting Guidelines." (Toronto Ornithological Club, Toronto, Ontario, 2000), 4.
[18] "Ravines and Natural Features," *Toronto.ca,* Web, 2, Mar. 2013.

development methodologies have been adopted with the potential for positive impact on biodiversity and bird migration. Through the involvement of community partners and stakeholders, a migratory bird protection policy has been developed for Toronto in the form of three initiatives. First, a series of *Bird-Friendly Development Guidelines* published in 2007 were produced to aid urban designers and architects, building owners and managers, as well as residents by providing tools to make buildings less hazardous to birds. Second, the public awareness campaign Lights Out Toronto was also created with the aim of informing citizens of the dangers faced by migratory birds in the city. The ultimate goal is to reduce light pollution during migration season as much as possible. The third initiative is the rehabilitation and release of injured birds, overseen by the Fatal Lights Awareness Program (FLAP). This policy joins municipal agencies and not-for-profit organizations with private citizens to conserve bird diversity in the city.

One of the priorities of conservation programs is creating opportunities for interaction between citizens and wildlife that encourage people to learn more about birds. Many programs exist to facilitate learning, including nature centers, national wildlife refuges, school programs, festivals, newsletters, and *citizen science* (the partnership between public and professional scientists to conduct research that will preserve biological diversity), among others.[19] Often overlooked is the potential for art and design projects to create experiences that inspire and activate citizens to care about environmental issues. The design artifact for this thesis fulfills many of the goals of traditional campaigns through a dynamic outdoor installation that educates as well as creates a lasting impression through curiosity and discovery.

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[19] "Urban Conservation Treaty for Migratory Birds." (Program Handbook, U.S. Fish and Wildlife Service, 2009), 26.

LITERATURE REVIEW

In urban settings, people rely on visual communications to interpret their surroundings and respond to the effective combination of text and image to capture their attention. In order to create a project that captures viewer's interest and encourages them to engage with the material, designers may look to psychology for insight into human behavior and motivation. The field of psychology also investigates perception, the process of organizing and interpreting sensory information. The human senses are restricted to sight, smell, taste, hearing, and touch, while many other animals have advanced senses that involve different sensory organs. Birds, for example, can detect the earth's magnetic field and have vision that extends into the ultraviolet spectrum. Due to limited perceptual abilities, humans cannot sense large-scale changes in the environment that develop cumulatively, such as global warming and air pollution.[20] The same is true for phenomena like bird migration, which is difficult for people to comprehend due to the vast distances covered by birds and the fact that they travel many thousands of meters above the ground, and thus almost completely out of view.

The relatively new field of Conservation Psychology addresses how humans make decisions about their environments and form relationships to other species. In addition to these psychological studies, art and design projects are also important to examine as many artists and designers are concerned with revealing animal perspectives to discover new worlds, an approach that can be useful in creating a lasting connection to animals. Furthermore, there are designers working with the sun as a medium have created fascinating works linked to the sun's movements and this reminds us of our dependence on sunlight by using the enchanting qualities of light and shadow.

Traditional Awareness Campaigns

A common error in traditional awareness campaigns is the use of shock tactics to capture viewers' attention but failing to follow up with a positive or hopeful message. Although there are examples of effective social and environmental awareness campaigns, most

[20] Christie Manning. "The Psychology of Sustainable Behavior" (Minnesota Pollution Control Agency, St. Paul, Minnesota, 2009), 16.

projects that deal with bird migration focus on negative aspects such as collisions with buildings. For example, many campaigns use photographs of dead birds, which can have an immediate impact on the viewer but often create feelings of apathy in the long term (Fig. 2).

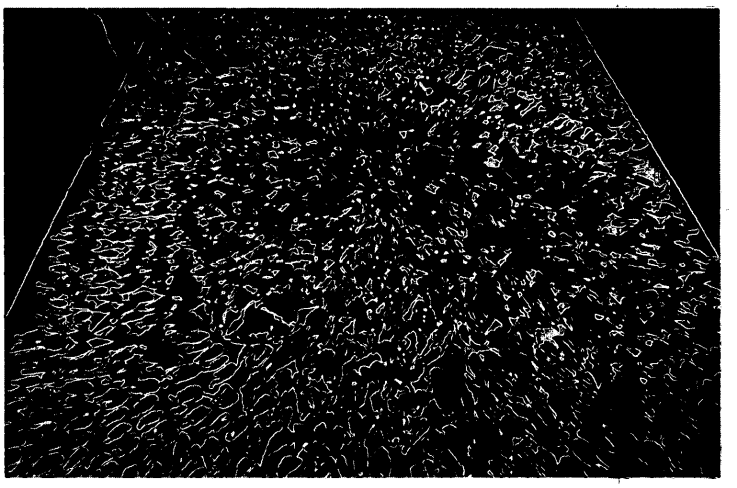

Figure 2. Building collision victims

Furthermore, many advocacy groups use patronizing messages that ultimately create feelings of guilt in the viewer[21] (Fig. 3). As explained by Klaus Töpfer, Executive Director of the United Nations Environment Programme (UNEP):

> Messages from governments, exhorting people to drive their cars less or admonishing them for buying products that cause environmental damage, appear not to be working. People are simply not listening. Making people feel guilty about their lifestyles and purchasing habits is achieving only limited success.[22]

As this statement shows, rather than encouraging people to consider other possibilities or to ask bigger questions, strategies that rely on feelings of guilt simply do not produce lasting results. Many campaigns provide a large amount of information on a poster, website or pamphlet, with the expectation that it will be sufficient in raising awareness. However, simply providing textual information to viewers can improve general

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[21] "Communicating Sustainability: How to produce effective public campaigns" (United Nations Environment Programme, Paris, France, 2005), 6.
[22] Ibid.,13.

knowledge about an issue, but does not necessarily affect attitudes or beliefs or result in changes and increased public engagement.[23]

Figure 3. Government Campaign for safe driving

Concerned with what motivates people by examining their thoughts, emotions, and behaviors, psychology provides helpful insight into factors that influence human behavior. For the purposes of reaching an audience, it is important to understand that people respond negatively to being confused, but enjoy learning and discovering at their own pace. A balance of providing enough information to interest, but not enough to overwhelm, allows viewers to begin to answer their own questions. Psychology also shows that thoughtful processing occurs when the mind receives information it did not anticipate. Awareness campaigns employ this proven tactic of surprise to capture an audience's attention, but often make the error of using imagery or text that generates feelings of apathy. As Christie Manning has explained in *The Psychology of Sustainable Behavior*, designers can use this knowledge to "attract and keep people's attention and to encourage them to engage in deeper, deliberate processing" by ensuring a positive overarching message is used to create a lasting impression.[24]

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[23] Doug McKenzie-Mohr. "Promoting Sustainable Behavior: An Introduction to Community-Based Social Marketing." *Journal of Social Issues,* 56.3 (2000): 546.

[24] Christie Manning. "The Psychology of Sustainable Behavior" (Minnesota Pollution Control Agency, St. Paul, Minnesota, 2009), 20.

In order to communicate messages of sustainability and conservation, it is important to first understand how relationships to the environment motivate people. The emerging field of Conservation Psychology is concerned with the conservation of resources and ecosystems as well as improving the quality of life for human and non-human species.[25] Carol D. Saunders defines this field as a "scientific study of the reciprocal relationships between humans and the rest of nature, with a particular focus on how to encourage conservation of the natural world."[26] Of utmost concern in this thesis are the connection of humans to natural cycles, and the role of design in facilitating that bond. Developing respect and love for animals is often addressed in educational programs including zoos, however innovative approaches by designers are beginning to gain popularity.

Alternate Design Projects

Projects that explore the lives of animals create opportunities for empathy and remind people of their responsibility as stewards for the environment. Two artists whose projects reveal a desire to break free of the limits imposed by human language by exploring the natural world are Sam Easterson and Natalie Jeremijenko. As the science writer Lynn Love has commented, their works "point to difficulties in conventional natural history studies of noting where 'natural' habitats and behaviors end and the human world begins, if in fact they can be separated."[27] Easterson creates artworks that strive to capture animal perspectives by placing small cameras on birds and other animals. His work provides a view of what the animal might see, but ultimately through a human (anthropocentric) point of view (Fig. 4). While it is true that, "[a]t best we're experiencing . . . a technological parasite – an artificial point of view in terms of animal subjectivity," Easterson's work nonetheless offers a glimpse into environments and views we would not

[25] Similar to the field of Environmental Psychology, Conservation Psychology emphasizes the relationship to the natural world, while Environmental Psychology focuses on built and natural environments to begin to solve environmental problems.
[26] Carol D. Saunders. "The Emerging Field of Conservation Psychology." *Human Ecology Review*, 10.2 (2003): 138.
[27] Lynn Love, "Sam Easterson," *The Brooklyn Rail Online*, 2006, Web. 19, Nov. 2012.

otherwise be privy to, such as foraging areas and aerial views of the earth by birds in flight.[28]

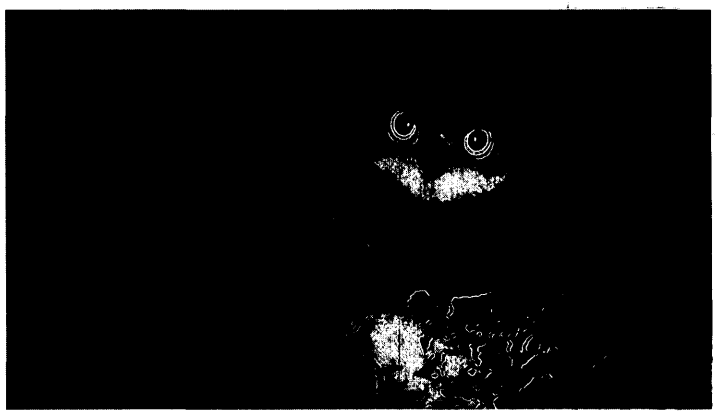

Figure 4. Burrowing Owl, Sam Easterson

Bat Billboard (2008), a speculative design by Chris Woebken in collaboration with Natalie Jeremijenko, encourages the public to learn more about the habitat and behavior of bats. The proposed billboard would act both as a real, climate-controlled habitat for bats as well as an interactive display of messages for the public.[29] The habitat created within the billboard is meant to prevent bats from contracting White Nosed Syndrome, a fatal fungal infection that kills bats in large numbers. The infection is a public health risk because bats control mosquito populations, and by extension mosquito-born diseases, very effectively. The billboard graphics would provide "translations" of bat calls (technology currently under production) for the public: "Look at her, she has beautiful ears" and "taking off for another insect snack" are examples of some of the messages that could be produced through translation. Although dependent on anthropocentric messages to communicate with an audience, this project is interesting because it encourages a kind of social interaction with the bats, rather than simply listing facts and showing graphic imagery urging people to care about bat conservation (Fig. 5).

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[28] Ibid.
[29] Chris Woebken, "Bat Billboard," *woebken.net,* 2010, Web, 10 Nov. 2012.

Figure 5. Bat Billboard, Natalie Jeremijenko and Chris Woebken

> What birds and animals offer us is not confirmation of our sense of having an exalted place in some sort of cosmic hierarchy, it's admission into a larger scheme of things, where our minds are no longer turned in on themselves . . . By giving us the freedom to see the world afresh, birds and animals renew our humanity.[30]

Along with animal-centered projects that encourage viewers to shift their perspective to see their place within the ecosystem, a growing number of designs are tapping into natural systems to achieve the same goal. *One-Day Poem Pavilion* (2008) by Jiyeon Song is a site-sensitive sculptural installation whose function depends on sunlight. The arched sculpture produces shadow forms that change with the movements of the sun during the day and year to spell out stanzas of a poem. Song developed a modular system of perforations through extensive research into light and shadow, which allows sunlight to pass through, spelling out different combinations of words. Fascinated by the solar calendar, Song focused on themes of rebirth, renewal, and the passing of time to spell out different stanzas during the summer and winter solstice. Visitors to the site experience poems depending on the time of day and year they visit, making the overall effect quite intimate, with a different experience for each viewer (Fig. 6).

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[30] "A Point of View: Behaving like Animals," *BBC News Magazine*, September 10, 2011, Web. 19, Nov. 2012.

Figure 6. One-Day Poem Pavillion, Jiyeon Song

Another example of a design that works with the movement of the sun and therefore highlights a larger system is *Urban Tales* (2010) by Katie Bevin, which uses shadow to playfully spell out a phrase from a Dr. Seuss Poem in a public park. Working with existing structures (bollards), Bevin created a modular typeface that interacts with cast shadows and ground elements to form a typographic narrative in Wellington's urban Waitangi Park in New Zealand. Viewers are able to read the words as they form on the ground, changing hourly throughout the day. Another aspect of the project includes a discovery walk, further engaging people to learn about the park (Fig. 7).

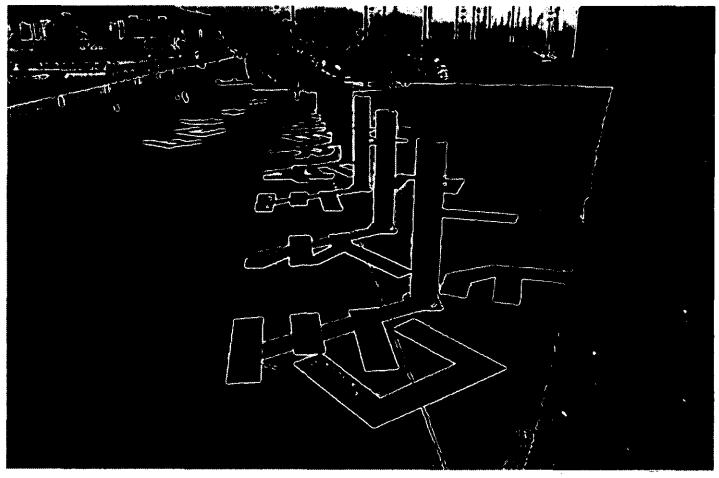


Figure 7. Urban Tales, Katie Bevin

METHODOLOGY

The methodologies in this thesis comprise two main parts: visual research (experimental studies), and ethnographic research (participatory study). This thesis was sparked by a fascination with the cyclic and seasonal nature of migration. With the intention of creating an artifact that revealed migration's underlying system, my process was initially concerned with studying how birds use environmental factors for navigation and orientation. Textual research into the subject revealed that birds use three compasses to relate to their surroundings: a magnetic, stellar and solar compass. The principles behind each compass were explored visually using collage. This way of working revealed the seemingly disconnected threads in my research while at the same time allowing the freedom to rearrange images and text to discover new meanings. Having worked on the collages concurrently, they share a visual language with imagery derived from a collection of sources as well as similar colors and materials, the use of masking tape and vellum for example. The juxtapositions created in the collages gave rise to new ways of looking at avian navigation and helped me to narrow my focus to the solar compass.

Visual Research

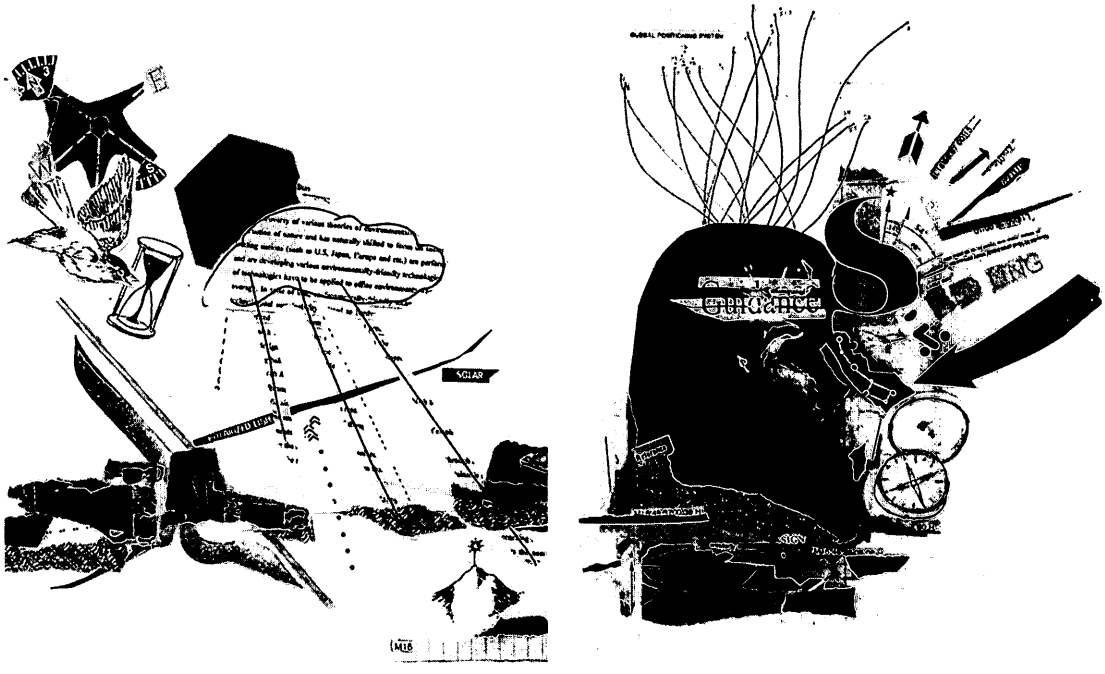
The magnetic compass is the mysterious as it relies on the earth's magnetic field, something we know to exist but cannot see or feel as humans. Experiments with homing pigeons suggest that birds may be able to create a map of their position, including latitudinal information based on the magnetic field. Based on this theory, flying toward the equator would feel different to a bird than travelling toward the north or south pole due to the intensity of the magnetic field.[31] I speculated that birds perceive the magnetic field through sight and touch and created a collage that combined imagery to express these abilities. I created an visual analogy of a tactile experience that humans can relate to, the dipping of one's toes into water (shown with hand drawn waves) to represent the way a bird experience the magnetic field as an entity that has mass. Map elements were

[31] Wolfgang Wiltschko and Roswitha Wiltschko, "Magnetic Orientation in Birds," *The Journal of Experimental Biology.* 199, (1996), 30.

included to remind the viewer of the way birds see the earth, from their perspective high above ground level. A cluster of typographic characters appear to be drawn to a magnet near the top of the composition to signify the literal quality of magnetism, with concentric circles representing the field itself (Fig. 8).

Figure 8. Magnetic Compass, Jillian Ditner

During the day birds use the position and movement of the sun to orient, and at night they rely on the position of the stars to find their way. Although humans can learn to interpret temporal information from the sun and directional information from the stars, birds have an innate ability to read these celestial objects. The collages created for the stellar and solar compasses both employed imagery that related to sight as these compasses depend on vision more than any other sense (Fig. 9 & 10).



Figures 9 & 10. Solar Compass, Stellar Compass, Jillian Ditner

With the stellar compass I wanted to express the ethereal quality a starry night sky and used photographs of constellations to aid the reading of the piece. Fragments of found type were combined to spell the words "illuminated guidance" and placed over an image of a hawk, partially covering the eyes to emphasize that birds see the stars as a kind of map. Above the hawk's head are lines that connect to dots to represent how birds actually plot the position of the stars with the words "global positioning system" placed to emphasize the accuracy with which birds use the star compass to navigate and orient. Other graphic elements include hand drawings of a compass and fragments of found imagery layered to produce a textural impression of the earth as seen from a bird's-eye-view.

Upon completion of the collages, I came across an experiment that suggested instead of a genetically coded map of the stars, birds most likely use the center rotation of stars to navigate.[32] Due to the earth's daily rotation, the stars appear to move during the

[32] Stephen T. Emlen, "Migratory Orientation in the Indigo Bunting," *The Auk,* 84.3 (1967), 309.

course of a night, rotating around the North Star, Polaris. Birds may be able to detect the center rotation, a marvel we are only able to capture through the use of time-lapse photography. My visual response to this information took form as a poster based on the North Star itself. The poster is viewable during the day, but is activated in the dark with glow-in-the-dark inks to capture the ethereal quality of the stars at night. Largely typographic in nature, the poster utilizes contrasting typefaces and combines many different glyphs that require a closer look to discover the word Polaris. Other words that stand out include massive, luminous, plasma and gravity as well as "a distance of about 434 light years from Earth." The placement of the text, which overlaps in some areas, is meant to guide the reading of the piece. For example, three lines of text that explain Polaris' etymology as a Greek word meaning "the Dog's Tail" are placed below an upside-down image of a dog, requiring the viewer to make the connection between image and text. By asking the viewer to participate in the reading of the work, they have the chance to discover the piece for themselves (Fig. 11).

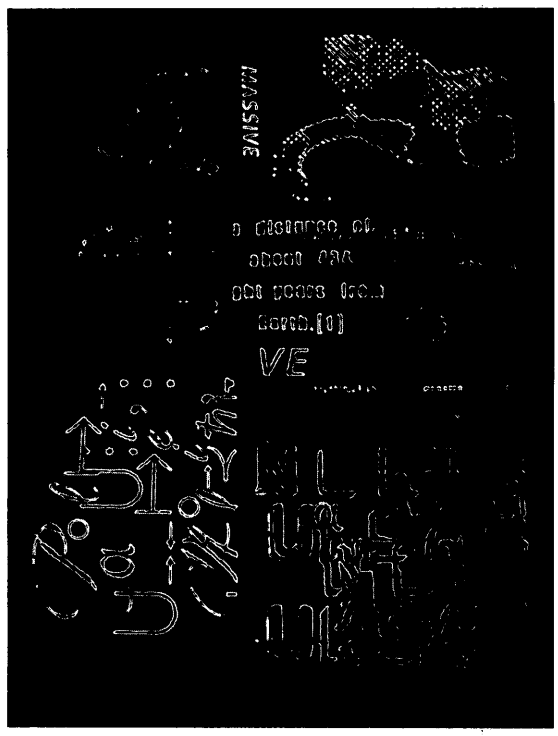


Figure 11. Polaris, Jillian Ditner

Although humans lack the ability to detect the magnetic field and cannot perceive of the center rotation of the stars without the aid of advanced technology, we can derive temporal and directional information from the sun. Considering sunlight as a medium to communicate the phenomenon of bird migration, I decided to conduct a participatory study to test the effectiveness of the human solar compass. The study employed qualitative research in the form of interviews, participatory tests, and observations. These methods allowed insight into participants' behaviors and decision-making processes. The objective was to determine whether people could decipher temporal and navigational clues to determine time of day and cardinal direction based on photographs of cast shadows. Knowing that people would not have comparable abilities to birds, I hypothesized that participants would have difficulty determining time of day by using shadow position and length when provided with directional information.

Participant Study

I had the opportunity to interact with ten participants ranging in age from 22 to 59 years old, three males and seven females. For two of the participants English was not a first language. All participants signed consent forms and each was tested separately, in thirty-minute interviews. The interviews took place in a quiet room. Beginning with a short interview, I asked questions about participant's navigational preferences in order to understand if they used the sun for navigation in ways they did not realize. For example, they were asked if they knew which direction the sun rises and sets, and if they considered themselves in possession of a good sense of direction.[33] Upon completion of the interview, participants were then asked to arrange four photographs of a house taken at different times of day. The photographs were presented in random order, and the participants were asked to imagine themselves in the photographer's position facing south, and to arrange the images according to when they were taken: 9am, 12pm, 3pm, and 6pm (Fig. 12).

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[33] See Appendix E for sample interview questions.

Figure 12. Task 1, Ordering Photographs according to 9am, 12pm, 3pm and 6pm.

The final part of the study challenged participants to guess time of day based on the appearance of cast shadows in thirteen photographs. I explained that the photographs were taken from either north, south, east or west, and asked participants what time of day the photo was taken, telling them to take their clues from the cast shadows available (Figure 13). Most participants articulated that it was difficult for them to orient themselves to the direction of the photographer. After the task was completed, I asked participants to explain what factors they used in determining time of day other than shadows, which led to comments about color temperature and lighting present in the photographs.

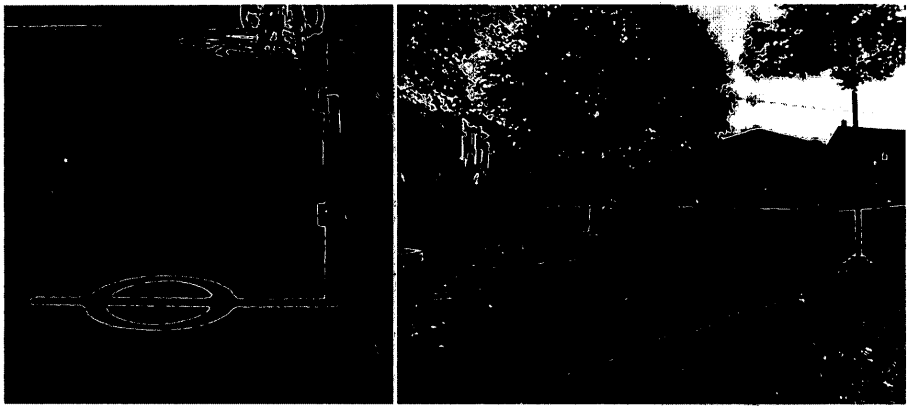

Figure 13. Task 2, Photograph test providing directional information

From the study it was clear the majority of participants had difficulty using shadow position to determine time of day, although most considered themselves as having a good sense of direction. Only three participants reported that they were aware of the position of the sun during the day as a way of helping them tell time or direction while three others admitted that they were not aware that the sun rises in the east and sets in the west. Generally, participants who reported they were not aware of the position of the sun during the day also did poorly on Test 1 (arranging photographs in order according to time of day), suggesting that a basic awareness of the sun's movements improves the ability to tell time based on shadow length and may improve one's sense of direction although it is difficult to fully determine whether an awareness of the sun's position in the sky aids people in telling time or direction for navigational purposes. It is, however, safe to conclude that most people lack the ability to use shadow length as an indicator of time of day.

This study confirmed my hypothesis that people do not have an inherent solar compass that allows them to determine time of day and direction, reinforcing my choice to use sunlight as a medium to convey the phenomenon of bird migration. Having determined the medium, I then returned to a more playful formal approach to figure out the best way to manipulate sunlight for the purposes of communicating the seasonal factors influencing migration. I began by experimenting with cast shadows in the design studio, documenting changes in response to a shifting light source. I was interested in creating symbols and imagery with shadow, and conducted typographic explorations using video recordings, silhouettes, projections, and laser-cut type to determine the possibility of a written message that would change depending on the direction of a light source (Fig. 14).

Figure 14. Typographic explorations, Jillian Ditner

While exploring the formal qualities of light and shadow in a controlled studio setting, I began research into the ancient time-telling devices, the sundial. Sundials indicate time with a three dimensional element called a gnomon, which casts a shadow onto a plane marked with hour lines. The changing position of the sun during the day effects where the shadow lands, correctly indicating time. Realizing the potential for a design based on the principles of a sundial to indicate peak seasons of bird migration, I felt it was necessary to investigate sunlight outside of the controlled studio setting. I moved my experiments outdoors to trace the shadows of objects in chalk and paint, documenting the results with photography (Fig. 15).

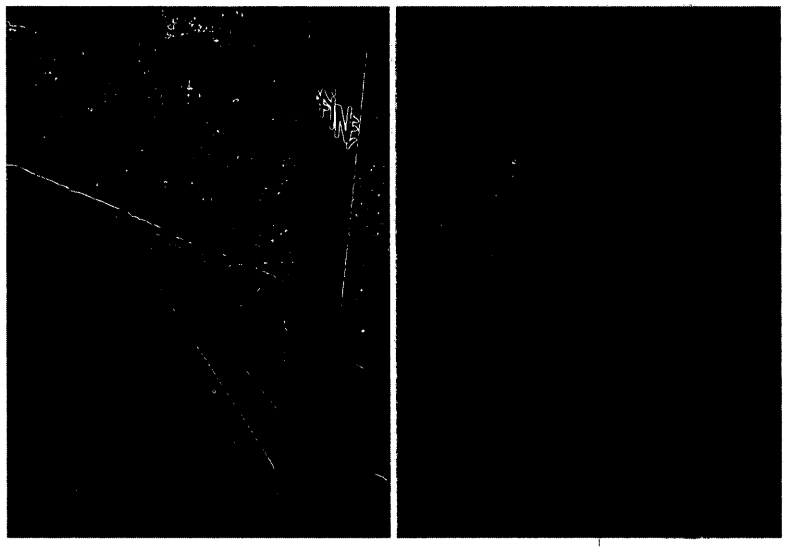

Figure 15. Outdoor Shadow Experiments

A hands-on approach allowed me to visualize how shadows behave and led to understanding cyclic daily rhythms. However, lacking the time to document changes over the course of a year, I knew I had to find another way to track shadows throughout the seasons. This is when I turned to technology for help and began using the program 3D modeling software to develop a template for a vertical sundial.[34] The 3D software allows designers to add longitudinal and latitudinal information and time zone specifics (geolocation) to their models.[35] This site specific data also calculates the sun's position and has a feature that enables the user to turn shadows on, revealing how they relate to the model during the day and year. For my model, I chose to work with the wall of the Power Plant Contemporary Art Gallery, due to its location on Toronto's Waterfront (which acts as a boundary to the city) and its south-facing orientation. After positioning the gnomon near the top of the wall, I plotted where the corresponding shadows landed on an hourly basis for each month of the year, and discovered that it created a series of arced forms with winter months at the top and summer months at the bottom. This pattern

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[34] Similar to a sundial that casts shadows onto a horizontal surface, vertical sundials have a gnomon installed on a wall.

[35] Geolocation is the identification of the real-world geographic location of an object, such as a radar, mobile phone or an Internet-connected computer terminal. Geolocation may refer to the practice of assessing the location, or to the actual assessed location.

emerged due to the fact that the sun is lowest in the sky in the winter and highest in the summer. Spring and fall were represented in the middle of the piece (Fig. 16).

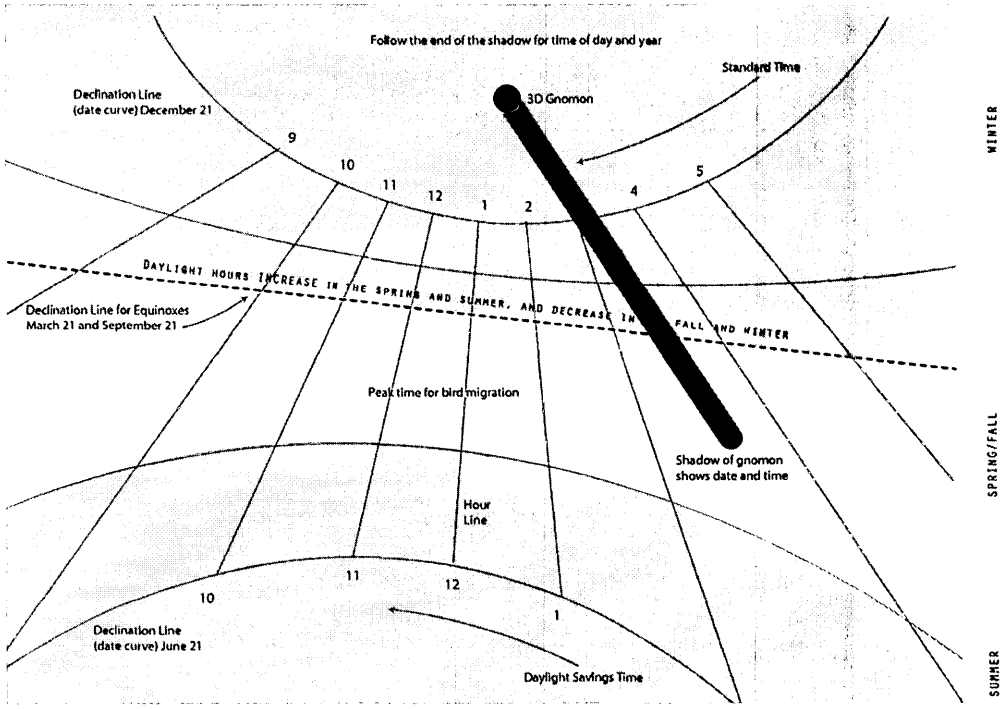
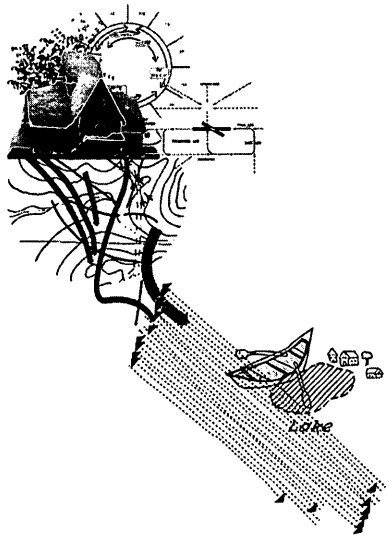
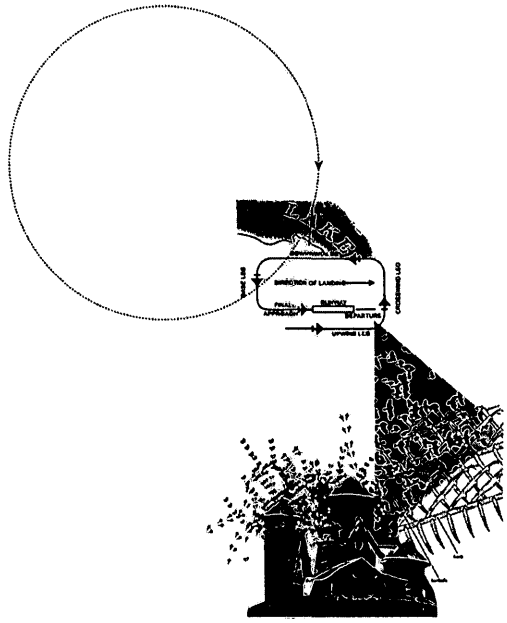


Figure 16. Sundial template

While creating the vertical sundial, I concurrently worked on developing visual responses to convey the importance of Toronto as a stopover site for migratory birds. As migration can be difficult to visualize due to the distances travelled by birds, I designed two posters to illustrate how migratory birds' travel between wintering grounds in the south to breeding grounds in the north (Fig. 17 & 18). By combining diagrams with photography and hand drawn elements, I illustrated how birds pass through Toronto for both of these journeys, using bird houses to represent the wintering and breeding grounds at opposite ends of each poster. Lake Ontario appears in the middle of each poster and helps to locate Toronto in the cycle of migration.





Figures 17 and 18. Southbound and Northbound, Jillian Ditner

In order to convey the importance of Lake Ontario to migratory birds' lasting relationship to the city, I created a poster that focused on the mysterious nature of this large body of water and the invisible migratory routes taken by birds to safely cross it (Fig. 19). Dotted lines stand out against a dark blue background bringing the imagined migratory pathways into focus. Also included is a diagram based on research into factors influencing migration. Birds know when to migrate based on the seasonal increase and decrease of daylight hours, referred to in biology as the photoperiod. When days begin to get longer after the spring equinox (March 21) and shorter following the autumnal equinox (September 22), birds become restless and begin to migrate. I included a small graphic on the upper right of the poster that explains the photoperiod by representing the year as a circle, with the names of the months arranged around it. The pale yellow shape within the circle represents daylight hours and has the appearance of a sun. The sun-like shape extends closest to the outer circle during the summer months indicating that days are longer at this time, and conversely shorter during winter months. Small bird footprints corresponding to spring and fall equinoxes are used to illustrate when birds begin to migrate in relation to daylight length.

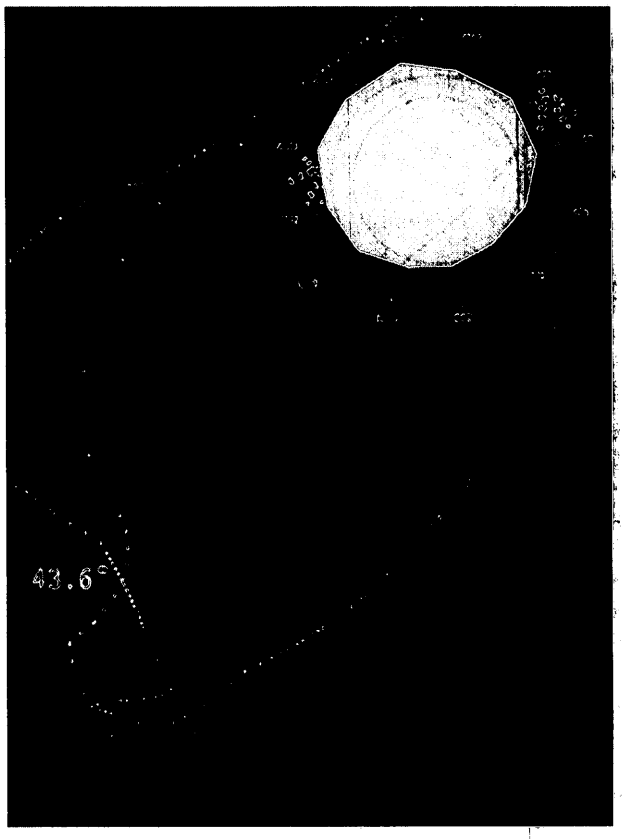


Figure 19. Lake Ontario, Jillian Ditner

These methodologies allowed me to visualize bird migration research in poster form as well as through less structured formal experiments, which furthered my personal understanding of the topic. Always at the forefront was a desire to engage a larger audience with the intangible elements of bird migration. Primary research in the form of a participant study influenced my decision to use the sun as a time-based medium for expressing how seasonal changes influence migration.

DESIGN ARTIFACTS

The final artifacts are a culmination of the academic research and experimental visual research resulting in a speculative environmental graphic design installation made up of three site-sensitive components: a wall-mounted piece titled *Clockwork,* a graphic integrated into the ground called *One-Way Flight,* and a panel with a map of three *Hot Spots* (Fig. 20). It is planned for installation at Toronto's Harbourfront, a location that attracts many visitors (both Torontonians and tourists) with features such as an outdoor skating rink, concert arena, markets, art galleries, and restaurants. The site is also relevant to bird migration as it acts as the boundary to the city and therefore the first point of contact for many birds flying over Lake Ontario.

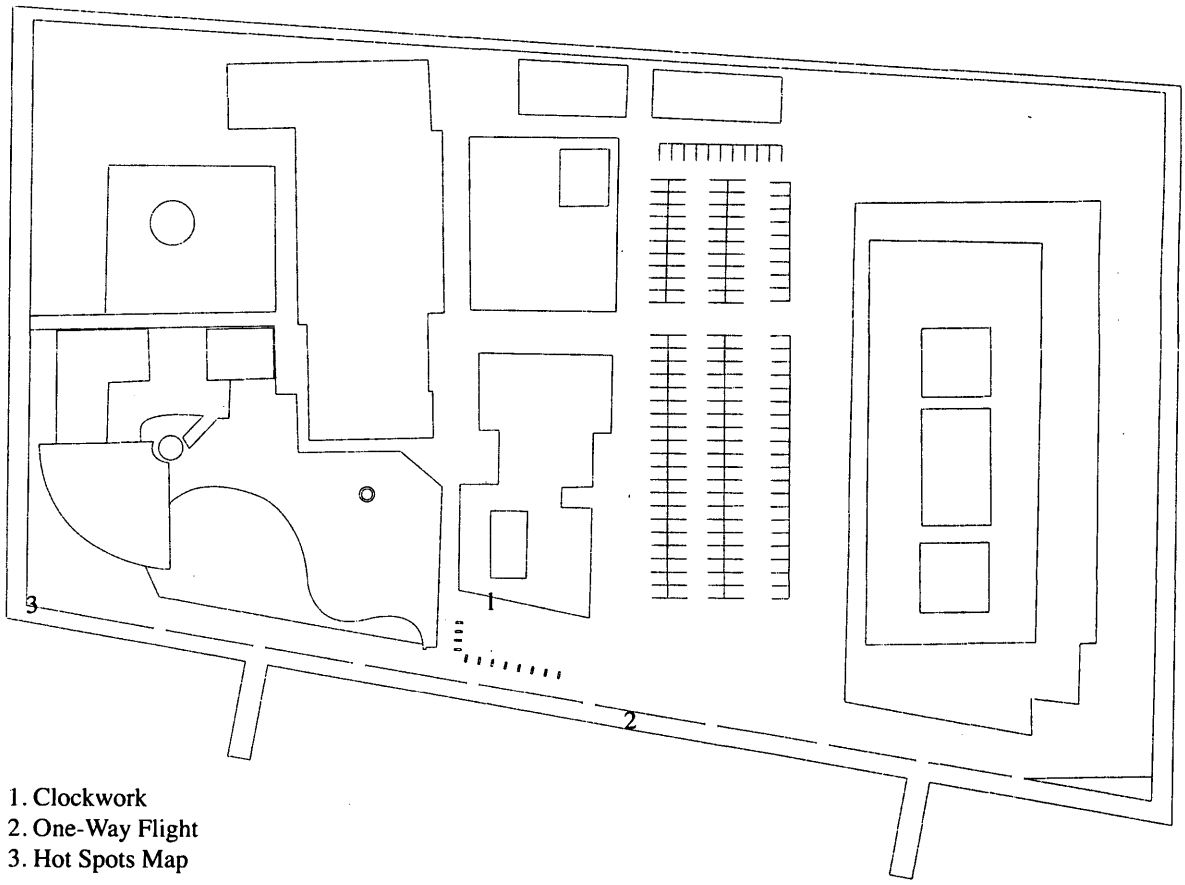


Figure 20. Site map of installations

Clockwork

Clockwork is a large wall-mounted graphic that combines two and three-dimensional elements to function like a sundial, revealing temporal information in relation to bird migration. Planned specifically for the south-facing wall of the Power Plant Contemporary Art Gallery at Harbourfront Centre, *Clockwork* would replace a plywood billboard intended for changing displays that is viewable by the public. The billboard measures twenty-four feet wide by eighteen feet tall (Fig. 21). The materials for *Clockwork* were chosen for their durability and include etched stainless steel panels for the graphic and a steel pipe for the gnomon.

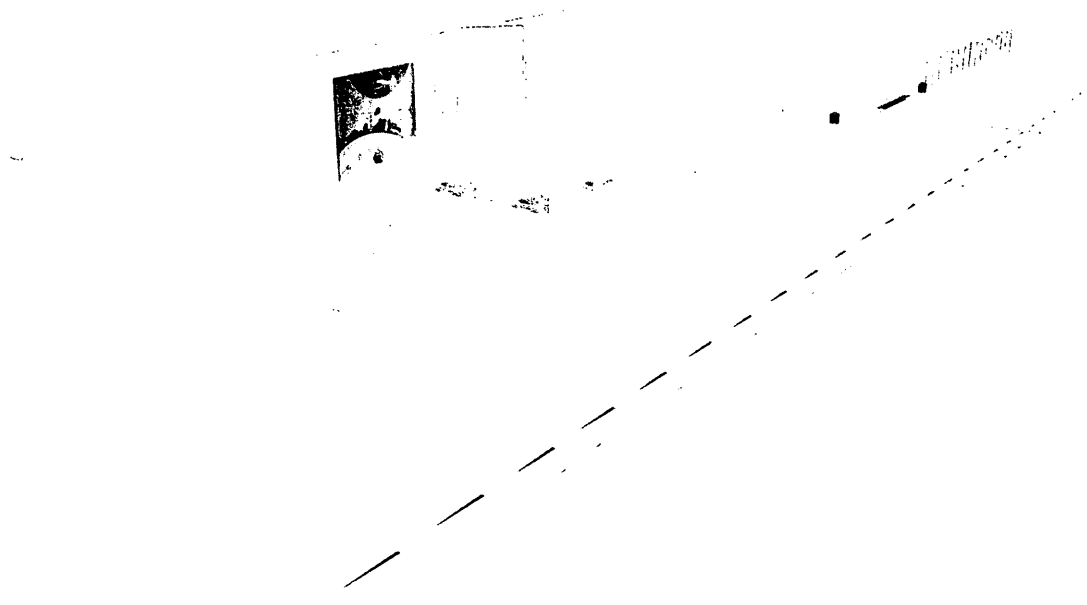


Figure 21. South-facing billboard at Power Plant Contemporary Art Gallery

The two-dimensional surface of *Clockwork* combines the layout of a horizontal sundial (lines that indicate month and hour), with elements to form a narrative about seasonal bird migration. Layered onto the sundial template is a graphic that employs an illustrative style to inject whimsical qualities to the narrative elements. For instance, much of the imagery consists of simple line drawings and silhouettes to create a bold appearance,

meant to attract the attention of passersby and engage them in a conversation about migration. Combined with practical information, this visual language helps communicate the aspects of migration that can be difficult to understand. Other imagery includes a large central dotted circle to represent the cyclic nature of the seasons, shifting the focus from season to season. Winter is symbolized in a pictogram that resembles a tropical forest to represent Central and South America where migratory birds spend the winter months. Conversely, a pictogram of a coniferous forest is used to signify summer near the bottom of the piece, representing the boreal forest of Northern Canada where migrants breed during the summer months (Fig. 22).

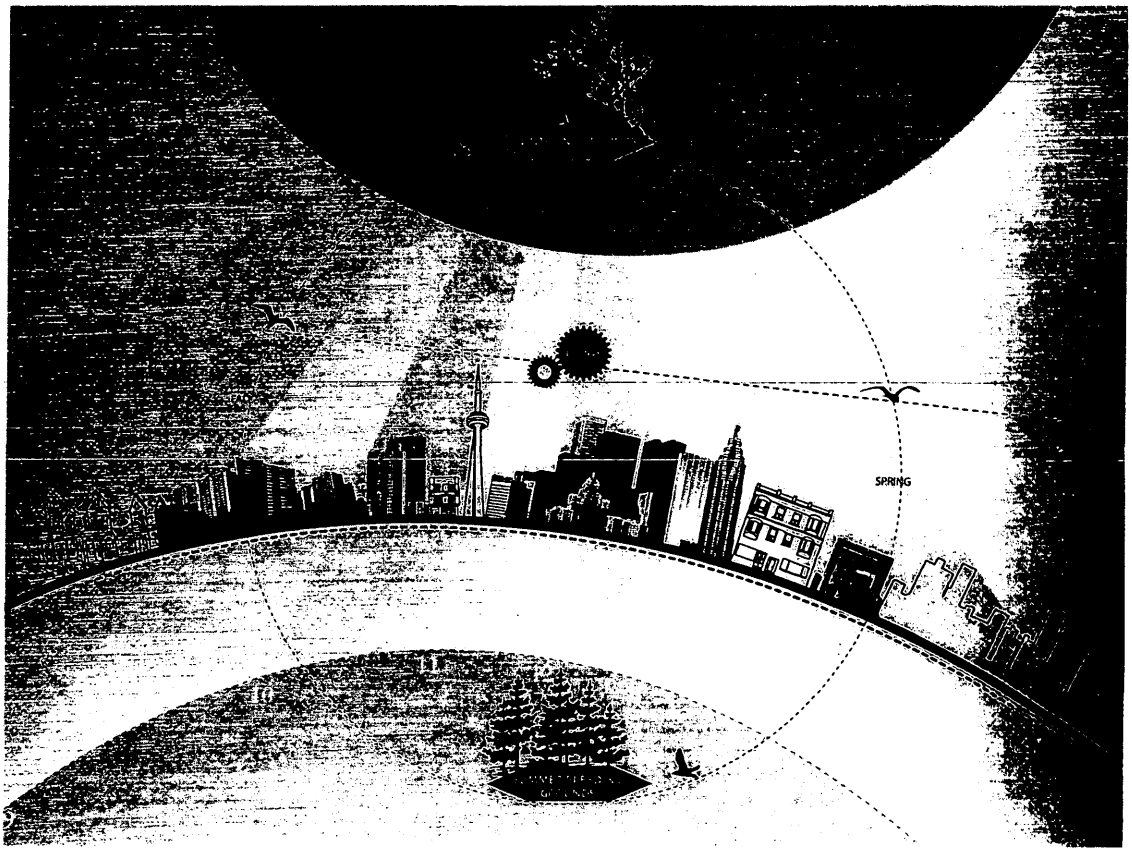


Figure 22. Clockwork, Jillian Ditner

The position of these forests is based on the layout of the sundial with shadows landing near the top in the winter and bottom in the summer, due to the position of the sun in the sky (lower in the winter, higher in the summer). These visual references seem counter

intuitive but act to disrupt the assumptions in the viewer, causing them to pause and think, strengthening engagement with the piece. Spring and fall are represented in the middle of the composition, differentiated from the other seasons by a lighter background tone. During spring and fall, migratory birds use Toronto as a resting site, which is why an urban area is depicted for those months. Recognizable buildings include the CN Tower and other well-known Toronto skyscrapers, signaling to the viewer that the piece is Toronto-specific (Fig. 23).

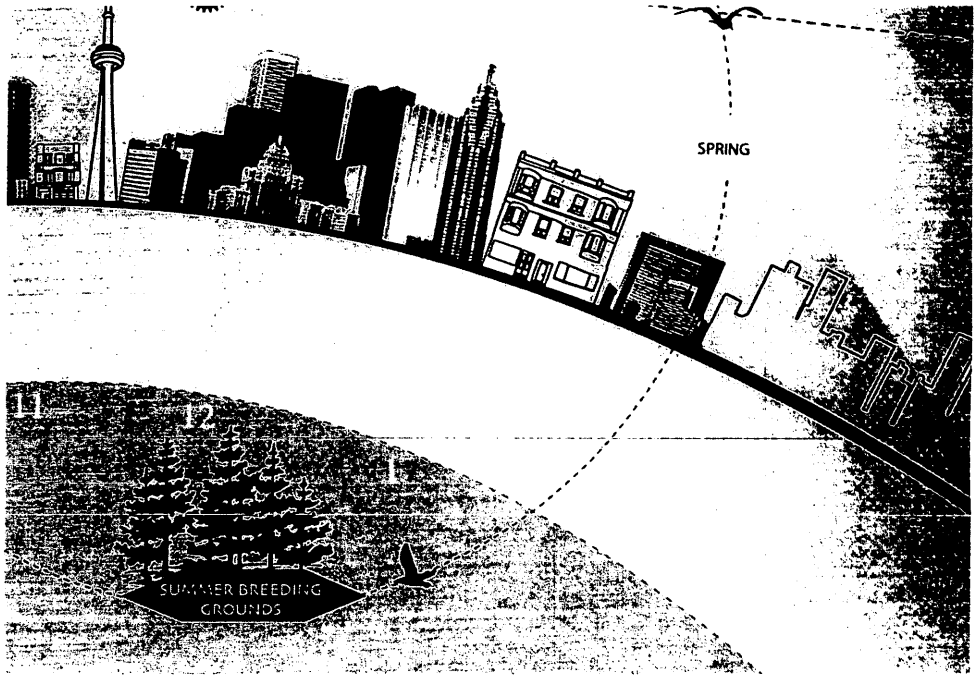


Figure 23. Clockwork Detail, Jillian Ditner

Located near in the middle near the top of the piece is a three-dimensional gnomon that casts a shadow onto the graphic, indicating the time of day and year. A cast aluminum sculpture of a bird seemingly perched at the end of the gnomon helps viewers understand that the context of the piece is centered on migration (Fig 24). This way of looking at the environment through the sun's movements inspires viewers to pay attention the natural world, which moves at a pace that we take for granted.

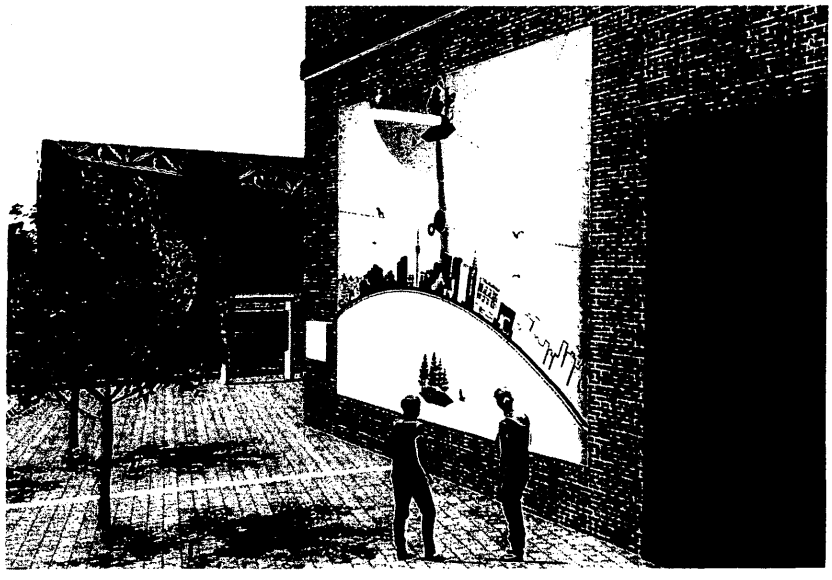


Figure 24. Clockwork installation view, Jillian Ditner

Accompanying the wall graphic is an interpretive didactic panel explaining how the sundial works, helping viewer's gain knowledge of the earth-sun relationship, which is critical for understanding the nature of seasons (Fig. 25). It indicates peak migration period with a dark grey color in the center and uses text to explain how the sun acts like a clock to bring birds to the city the same time every year.

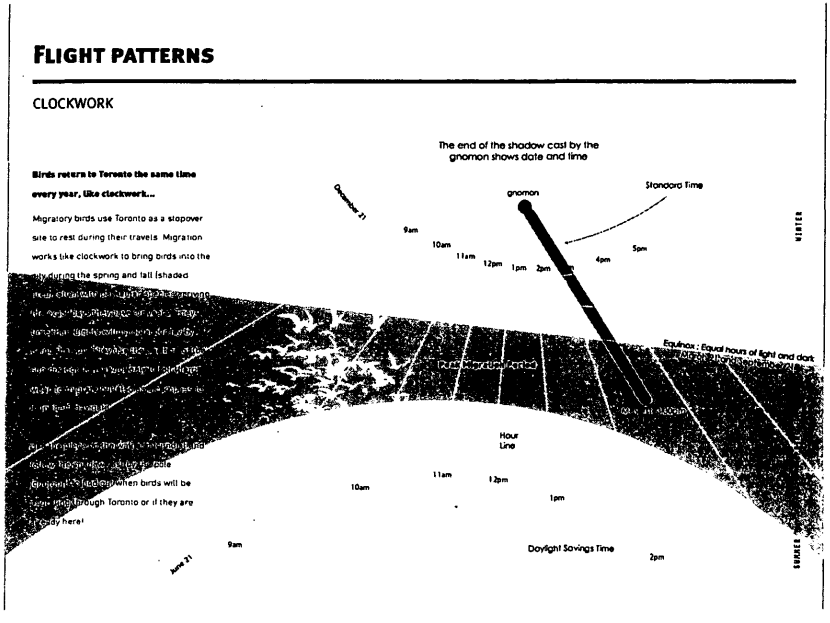


Figure 25. Interpretive Panel for Clockwork, Jillian Ditner

One-Way Flight

The second design component, *One-Way Flight*, is an installation incorporated into the Waterfront Trail boardwalk, accompanied by an interpretive panel. The panel appears at both ends of the boardwalk and employs a map of North and South America to introduce viewers to the distances travelled by birds and also serves to connect dispersed geographic locations into a single system (Fig. 26). Concentric rings were used to plot distances in kilometers from the city, and a "you are here" indictor grounds the viewer in Toronto.

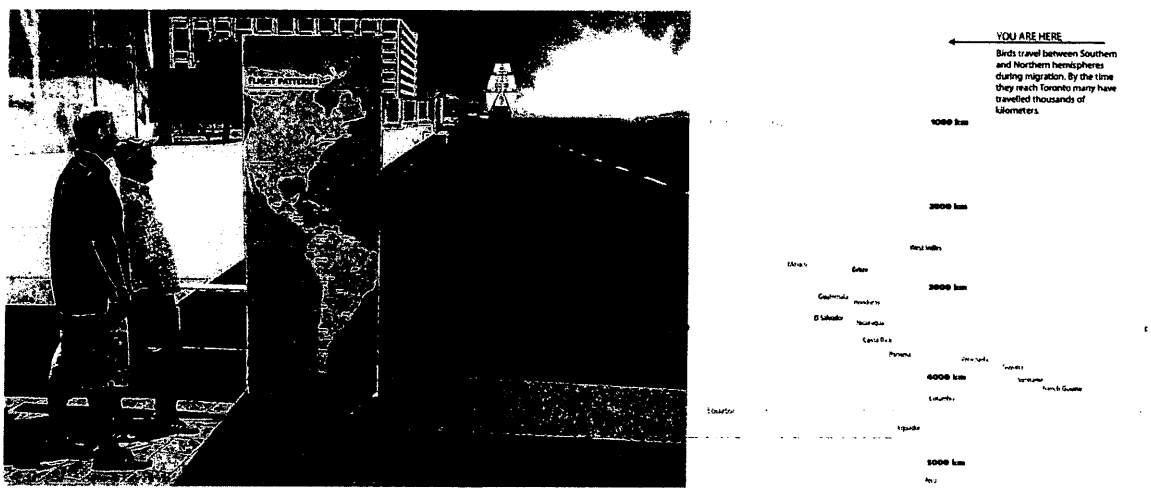


Figure 26. One-Way Flight, installation view and panel detail, Jillian Ditner

Acting as a legend for the installation, the panel lists distances in kilometers that appear as stainless steel planks installed along the 330-meter long boardwalk. In order to make the distances relatable to people, it was necessary to create an installation through a scaled down version that people could walk along. The linear format of the boardwalk lends itself well to indicating distances traveled by birds migrating thousands of kilometers from Central and South America to Toronto and beyond.[36] The west end of the boardwalk represents Toronto, and the east end represents the farthest country that birds migrate from, Argentina. The other Central and South American countries are plotted in between. For example, The West Indies (represented by Havana, Cuba) are

[36] The longest migration is undertaken by a shorebird called the Red Knot, traveling 10,000 km from Argentina to Toronto. Its final destination is in the Arctic.

2500 km from Toronto and are therefore plotted 75 meters from the starting point at the west end of the boardwalk. Distances (at intervals of one thousand kilometers) and country names are highlighted on the boardwalk. Distance is marked with a stainless steel panel (thirty-two inches wide by 118 inches long) laying flush with the rest of the boardwalk and close to the waters edge. Country names are engraved on planks that extend to the granite benches that run parallel to the boardwalk (Fig. 27).

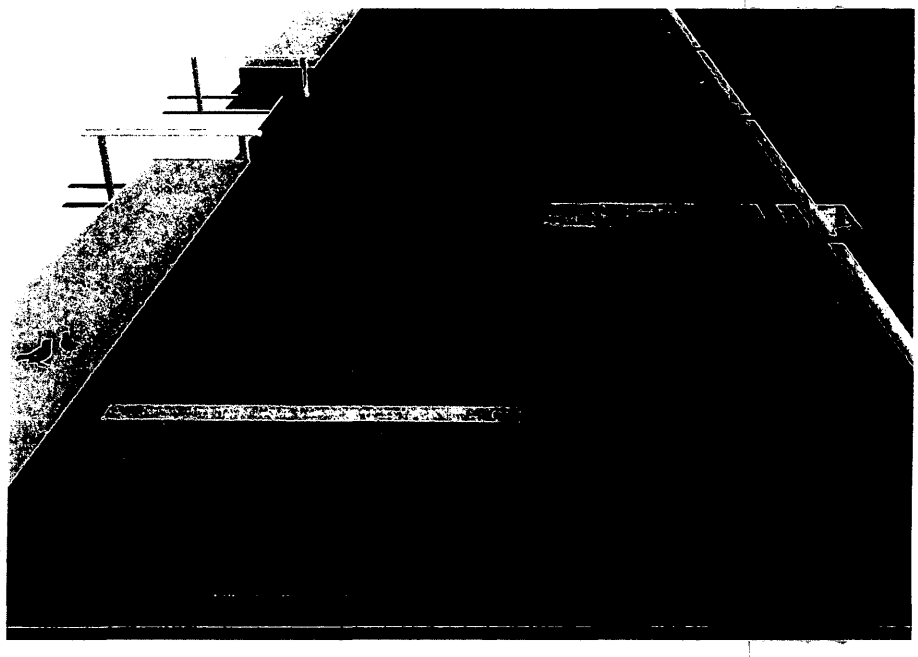


Figure 27. One-Way Flight, steel planks with distance and country names, Jillian Ditner

To increase engagement with the public, a life-sized bird sculpture is installed on the granite benches next to each country plank, representing a species that migrates from that country (Fig. 28). Bird species were chosen based on the Greater Toronto Bird Checklist data (2009) with the aim of representing a wide variety of bird types including songbirds, shorebirds, and raptors, among others. On the bench near the sculpture, inlaid steel type reveals the species common name. Names were included not solely for labeling purposes but because being able to name things gives them importance that is not otherwise perceived, creating an understanding of what makes a particular species unique.

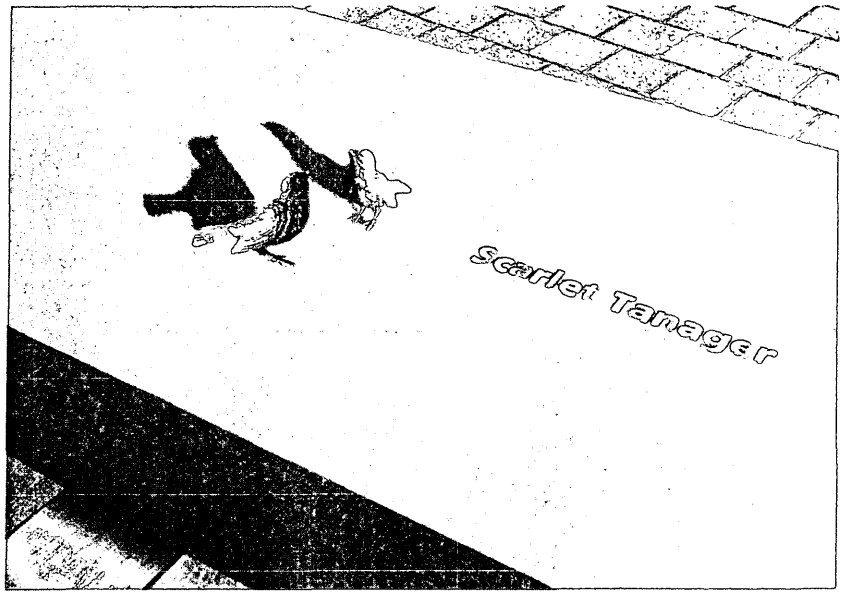


Figure 28. One-Way Flight sculptures, Jillian Ditner

Clockwork connects to One-Way Flight through the extension of the country plank for Venezuela. Extending ten meters past the boardwalk, the plank leads viewers to the wall of the Power Plant Contemporary Art Gallery, which hosts *Clockwork* (Fig. 29). The bird representing Venezuela (the Osprey) can be found perched at the end of the *Clockwork's* gnomon.

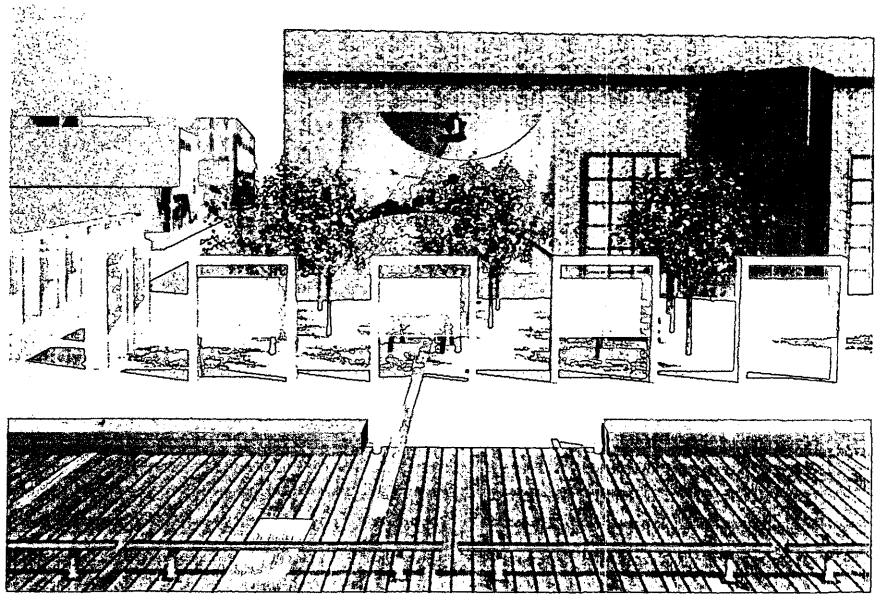


Figure 29. One-Way Flight's connection to Clockwork, Jillian Ditner

Hot Spots

The final component of the artifact is a map of three Toronto sites, referred to as *Hot Spots*, where the majority of Toronto's avian migrants stop to rest in the spring and fall; High Park, Leslie Street Spit, and Toronto Island. The map appears on the back of the One-Way Flight panel, at both ends of the boardwalk. The three hot spots are isolated and magnified to allow for precise indicators of where to look for particular bird species. The images of birds on the map match the sculptural forms in One-Way Flight to aid viewers in transferring recently acquired knowledge onto a new format. Wintering sites are also listed under common names on the map, allowing people to create further connections with information in One-Way Flight (Fig. 30).

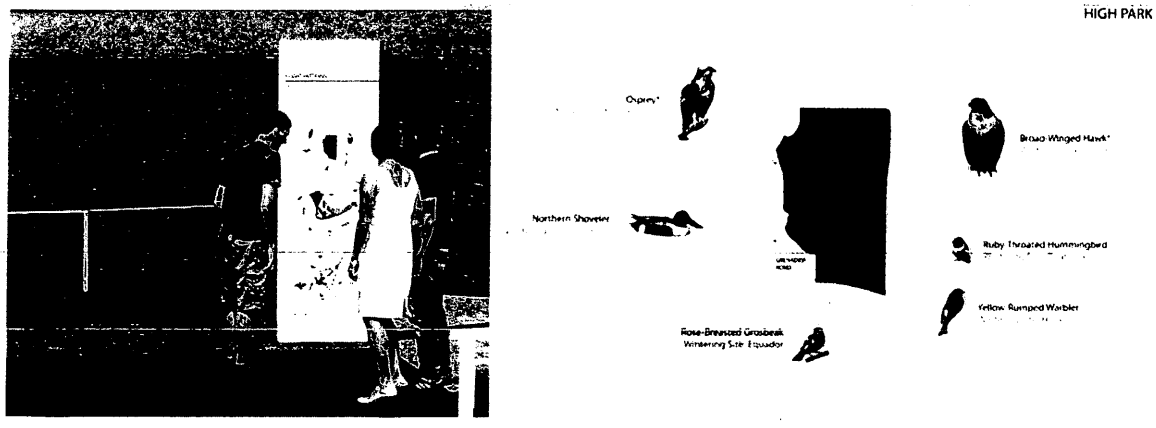


Figure 30. Hot Spots, Installation view and detail, Jillian Ditner

The map will encourage people to explore these natural areas and give them a sense of what to look forward to upon reaching them. Intended to direct people to areas of the city to explore for themselves, there no designed interpretive signs at the actual hot spot sites.

The three components of the artifact work in conjunction to activate the site in a way that allows people to visualize the vast distances travelled by birds and the cycles that regulate migration, creating a sense of wonder and empathy. Instead of overwhelming viewers with information about conservation efforts and habitat protection, the installation provides the opportunity for people to be guided by curiosity through three dimensional bird sculptures, learning the names of birds and migratory distances. Key to active learning is the chance to discover things at one's own pace, and this design allows viewers to begin to answer their own questions, thereby facilitating thoughtful processing and long-term memory. For example, depending on the time of year people experience Clockwork they will see the gnomon's shadow indicating different information. In the winter, the gnomon will indicate that birds are in South and Central America at that time, and when people discover that the message is time-based they can experience important learning that they are likely to remember since it happened through insight and discovery.

CONCLUSION

This thesis was designed to engage people with the natural environment through an interactive design artifact. In contrast to traditional awareness campaigns, this project incorporates environmental graphics, installation and three-dimensional elements to activate a site and engage people in a dialogue about bird migration and influence their values towards the environment. By illustrating the cyclic nature of the seasons with *Clockwork*, making tangible the vast distances traveled by various bird species through *One-Way Flight*, and encouraging exploration of natural parks in Toronto through *Hot Spots*, the artifact works as a system to activate citizens to learn about the fascinating nature of migration.

This type of approach can be applied to a variety of environmental initiatives as outdoor installations have the potential to activate citizens to engage with their surroundings and participate in active learning. This project uses installation to create empathy in viewers by asking them to relate to the distances travelled by birds while also providing realistic sculptures of birds to interact in with. It also promotes learning through didactic features such as interpretive panels, which explain the nature of the seasons, as well as species names and habitats. Interest in bird conservation is sparked through the presence of the *Hot Spots* map, which encourages people to further explore natural areas in Toronto to find birds they learnt about through the installation.

Creating a dialogue with the public is especially important at this time, as biodiversity is in decline worldwide. Many cities isolate people from nature and other species, resulting in citizens' lack of awareness of the importance of other species and natural habitats. Birds add not only to the aesthetic value of our surroundings, they also ensure ecological processes such as pollination of plants, dispersal of seeds, and pest and disease control, making them invaluable to us. For this reason, it is critical to remind people of the rich variety of existing forms of life that exist even in urban environments.

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APPENDIX A

User Scenario

In developing the design artifacts it was necessary to consider how an actual person would experience the interrelated components of the design. The experience is described in the following user scenario. Jane is a 34 year-old woman who lives and works in Toronto. Currently, Jane does not know that Toronto is visited by different birds in the spring and fall, but is confident with recognizing familiar species such as Canada Geese and Blue Jays.

Although Jane lives downtown, she only visits the Harbourfront centre a few times a year to check out concerts and flea markets. After visiting a market on a Saturday afternoon in early May, she walks towards the waterfront at the west end of the boardwalk and notices a large panel with a map. Curious, she examines it closer and discovers that it is about the distances covered by birds during migration. She walks around the other side of the panel and discovers it is double-sided. This panel explains that the green spaces in Toronto accommodate a large number of migratory birds in the spring and fall, and act as stepping-stones for birds to complete their journeys. She recognizes the three areas on the panel as Toronto Island, Leslie Street Spit and High Park and realizes that those are the places to visit if she wants to see a variety of birds. She makes a mental note that she should visit in the spring and fall since migration, as she has learned, is a season-specific spectacle.

From here, Jane notices stainless steel planks on the boardwalk and walks towards them to get a closer look. To her left on the granite benches that run parallel to the boardwalk, she sees a passage of large inlaid steel text that reads "Migratory birds travel thousands of kilometers twice a year" and realizes that it connects to the panel about migration length. She is close enough to read the text on the first stainless steel plank on the boardwalk that has "1000 km" engraved into it. Soon after Jane comes across the first country plank for the West Indies, and sees a sculpture of a small bird on the granite bench to her left with the words "Black-Throated Blue Warbler." She makes the connection that the bird must be from the West Indies and also spots the other sculptures on the benches ahead and continues on to find out which countries these birds are coming from.

About halfway along, Jane notices that one of the country panels extends past the edge of the boardwalk onto the concrete pathway, leading towards a wall 10 meters away. Making a point to come back to where she left off, she follows the line through a small courtyard of trees where it connects to a large artwork on the wall of the Power Plant Contemporary Art Gallery. The artwork has a large shadow cast on it from a sculpture of a bird on a branch placed near the top. She realizes that the bird on the branch must be the bird from the country indicated on the boardwalk. An interpretive panel near the piece explains how the graphic and branch operate like a sundial, and now she stands back from the wall to take in the larger piece again. She sees that spring and fall are labeled in the middle, and understands that the buildings that also land in that area represent Toronto (the CN Tower is the main clue). Jane understands that birds travel through

Toronto in those seasons, and travel north in the spring and south in the fall. She spends a bit more time interpreting the imagery and then returns to the boardwalk to finish her stroll. When she is near the end of the boardwalk, she sits down on the granite bench to rest and look out at the water. She purposely sits next to a sculpture of a small bird to inspect it more closely. It is labeled Eastern Kingbird, which surprises her since she believed it was a swallow. She sees another large panel with the migration distance map and hot spot map and inspects it again. She is curious to see the Eastern Kingbird in its natural habitat and consults the hot spot map to determine where she can find it in Toronto. She plans to make a trip to Leslie Street Spit in the first few weeks on May.

APPENDIX B

Participatory Study Test 2 Results

Direction	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
1. North. 9am	9	9	9	9	9	9	3	9	3	9
2. North. 3pm	3	6	3	3	6	12	9	6	12	3
3. North. 6pm	6	6	6	6	6	6	12	6	9	6
4. East. 9am	6	9	9	9	12	6	3	9	9	9
5. East. 12pm	-	12	12	12	12	6	12	3	12	12
6. East. 3pm	3	6	3	3	3	6	3	6	6	12
7. East. 6pm	9	12	6	6	9	9	12	6	12	6
8. South. 9am	9	6	6	9	9	6	6	9	9	9
9. South. 12pm	12	12	12	12	12	3	3	12	6	12
10. West. 9am	-	9	3	9	12	9	12	9	3	3
11. West. 12pm	-	12	12	12	12	12	3	12	9	12
12. West. 3pm	6	6	3	3	3	3	9	6	12	6
13. West. 6pm	6	6	6	6	6	9	6	6	3	6
SCORE /13	**7**	**8**	**11**	**13**	**9**	**5**	**3**	**9**	**3**	**10**

APPENDIX C

Approvals from the Ethics Board at York University.

YORK
UNIVERSITÉ
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OFFICE OF
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www.research.yorku.ca

Certificate #:	**STU 2013 - 034**
Approval Period:	**03/21/13-03/21/14**

Memo

To: Jillian Ditner, Design, Faculty of Fine Arts
jilldltner@gmail.com

From: Alison M. Collins-Mrakas, Sr. Manager and Policy Advisor, Research Ethics
(on behalf of Duff Waring, Chair, Human Participants Review Committee)

Date: **Thursday March 21st, 2013**

Re: **Ethics Approval**

Graphic Design and our Connection to the Natural Environment

I am writing to inform you that the Human Participants Review Sub-Committee has reviewed and approved the above project.

Should you have any questions, please feel free to contact me at: 416-736-5914 or via email at: acollins@yorku.ca.

Yours sincerely,

Alison M. Collins-Mrakas M.Sc., LLM
Sr. Manager and Policy Advisor,
Office of Research Ethics

APPENDIX D

Sample Consent Form for participatory study.

Informed Consent Form

Date: August 29, 2012

Study Name: Human Orientation based on the Solar Compass.

Researcher: *Jillian Ditner, 4008 TEL Building, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3*

Purpose of the Research: To evaluate participant's abilities to detect time based on the movement of the sun throughout the day.

What You Will Be Asked to Do in the Research: Answer questions about your navigation preferences. Then you will be asked to look at photographs taken during different times of the day and based on the direction they were taken in, guess what time they were taken.

Risks and Discomforts: I do not foresee any risks or discomfort from your participation in the research.

Benefits of the Research and Benefits to You: Your participation will benefit the research by giving insight into human orientation systems. You will be given the answers at the end so that you have a reference for how you did on the test.

Voluntary Participation: Your participation in the study is completely voluntary and you may choose to stop participating at any time. Your decision not to volunteer will not influence the nature of your relationship with York University either now, or in the future.

Withdrawal from the Study: You can stop participating in the study at any time, for any reason, if you so decide. Your decision to stop participating, or to refuse to answer particular questions, will not affect your relationship with the researchers, York University, or any other group associated with this project. In the event you withdraw from the study, all associated data collected will be immediately destroyed wherever possible.

Confidentiality: All information you supply during the research will be held in confidence and unless you specifically indicate your consent, your name will not appear in any report or publication of the research. The data will be collected by handwritten notes and sketches, video and audio recording devices. Your data will be safely stored in a locked facility and only the researcher will have access to this information. Data will be stored for two years and then destroyed. Confidentiality will be provided to the fullest extent possible by law.

Questions About the Research? If you have questions about the research in general or about your role in the study, please feel free to contact Jillian Ditner (jditner@yorku.ca) or the Master of Design graduate program office (telephone 416 736-5885). This research has been reviewed and approved by the Human Participants Review Sub-Committee, York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, please contact the Sr. Manager & Policy Advisor for the Office of Research Ethics, 309 York Lanes, York University (telephone 416-736-5914 or e-mail ore@yorku.ca).

Legal Rights and Signatures:
I_____, consent to participate in *Human Orientation based on the Solar Compass* conducted by *Jillian Ditner*. I have understood the nature of this project and wish to participate. I am not waiving any of my legal rights by signing this form. My signature below indicates my consent.

_____ _____
Participant Date

_____ _____
Principal Investigator Date

APPENDIX E

Participant Interview Questions

1. Do you possess a good sense of direction?
2. Are you good at discriminating between left and right?
3. Do you use any mnemonic devices to remember left and right?
4. Do you think in terms of cardinal directions, or more on landmark recognition?
5. Do you use mnemonic devices to remember cardinal directions?
6. Do you remember routes well if traveled multiple times?
7. Can you remember a route after only traveling it once?
8. Are you good at giving directions?
9. Do you ever experience difficulty with directions?
10. Are you good at judging distances?
11. Do you consider yourself good at reading maps?
12. Do you use GPS devices?
13. Are you aware of the position of the sun when navigating or telling time of day?
14. Do you know which direction the sun rises and sets?
15. Did you grow up in a city or a rural environment?
16. If so, do you think that affects the way you think of space?
17. Do you drive?
18. Do you use maps in your work or study?

APPENDIX F

PANEL ON RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE

Certificate of Completion

This document certifies that

Jillian Ditner

has completed the Tri-Council Policy Statement:
Ethical Conduct for Research Involving Humans
Course on Research Ethics (TCPS 2: CORE)

Date of Issue: **15 February, 2012**