The Sun Will Shine More Brightly Everywhere

Play / Interplay: Architectural responses to ozone depletion and increased UV levels, implementing Toronto's *Shade Policy*

George Thomas Kapelos
Ryerson University

Climate change will influence the way we build. Architects, taking a pro-active stance, are expanding their reach to propose strategies to address global warming. New technologies are being utilized and new alliances formed. Renewed interest in the social program of architecture, aided by technology, is being pursued, especially regarding public safety, health and population wellbeing. Designers are collaborating with environmentalists, scientists and public health practitioners to explore how design can mitigate effects of climate change and nurture healthy environments.

A direct outcome of the rise in carbons in the atmosphere is the thinning of the earth's ozone layer.[1] Humans are culpable, with consumption and unrestrained growth accelerating change. Decrease in ozone coverage has led to increases in the amount of solar ultra-violet radiation (UV) entering the atmosphere, with impacts on human health. Skin cancer is a direct consequence.[2] While UV may benefit Vitamin D production, overexposure to UV causes skin cancer.[3,4,5,6] Even with ozone-reduction protocols, many decades remain before stratospheric ozone concentrations return to 1970s levels.[7]

Our love affair with tanning is well known, even in the face of known risks.[8] Excessive UV exposure, often manifested by sunburn, is recognized as the major cause of the approximately 1.3 million cases of skin cancer in the USA annually.[9] One in seven Canadians will develop a non-malignant skin cancer in their lifetime and 1 in 90 will develop a malignant melanoma which can cause death.[10] The situation is acute in Australia which has the highest rate of skin cancer in the world. Queensland's health authorities state "of all new cancers diagnosed in Australia every year, 80 percent are skin cancers."[11]

HEALTH AND DESIGN: SHADE FOR SKIN CANCER PREVENTION

Skin cancer is one chronic disease that is almost totally preventable.[12] Architecture's role in its prevention is insinuated into a complex web interconnecting climate change, design, health and the built environment. As an architect, my focus is on shade, an environmental intervention which can reduce skin cancer risk.

The cumulative effects of UV exposure and incidence of skin cancer are well documented; children are among the most vulnerable.[13] Two key messages for skin cancer prevention are universal: take precautions (e.g. wear protective clothing or sun block) and seek shade.[14] While behaviour modification reduces risk, it is not easily effected.[15] Shade, be it natural or purpose-built, provides an effective means to reduce UV exposure and thereby curtail long-term skin cancer incidence.[16]

SHADE AND EFFECTIVE SHADE DESIGN

Knowledge exists on designing for shade for all climates (and in this context, shading is any means by which solar UV is either blocked or absent). Emanating mostly from Australia, shade research has focused on defining effective shade, establishing settings-based criteria for shade, measuring protection offered by shade and shade design.

UV is present in most settings, even in the absence of direct sunlight; UV bounces off reflective surfaces or is diffused by atmospheric particles. The amount of UV present is a function of time of day, season, specific location under study, amount of cloud cover and reflectivity of ground and adjacent materials.[17] Measuring effective shade is complex and is subject to site-specific determination.[18] Tree cover and built structures, often in combination, are the most common means of achieving shade. Shade effectiveness is measured by its UV protection factor (UPF). The higher the rating, the greater the protection: a UPF of 15 will reduce UV by approximately 93%.[19] Even purpose-built shade may not prove effective. Queensland researchers measured variables for shade effectiveness in shading structures.[20] They concluded that these public, purpose-built shade structures designed for specific locations in Queensland did not provide sufficient protection.[21] Another study concluded that reflective surfaces can increase UV in a shaded area so that you can even get sunburn while sitting in the shade! [22] In a study of New Zealand school grounds, researchers found that only one-fifth of the shade structures offered a UPF higher than 15.[23]

The results are not much better for natural shade; just being under a tree may not protect you. In both US and Australian studies, shade conditions have been tested against variables such as percent tree cover, tree species, as well as location, UV readings, season and time of day.[24] Researchers in Baltimore MD found that in certain conditions the UPF provided by trees was not much better than under an open sky with 50% cloud cover.[25] As a rule-of-thumb, the amount of bright sky visible under a shaded area can indicate how effective the shade may be. As this area decreases, the protection factor of the shade increases.[26]

To facilitate shade planning, the New South Wales Cancer Council produced a resource kit which promoted the shade audit as a tool to develop site-specific shade solutions.[27] Recently, architects have created a digital tool to assess UV risk at specific sites.[28] These tools and protocols have been tested in Toronto where a pilot study identified high risk to UV exposure in city playgrounds.[29]

Design competitions have drawn attention to skin cancer prevention and shading. The Royal Institute of British Architects emphasized the value of including shade in the design brief for a 1997 competition.[30] In 1998, the Canadian Dermatological Association sponsored a nation-wide competition on shade design.[31] These competitions yielded ideas and approaches, but little critical assessment was undertaken as to their impact or the effectiveness, appropriateness or suitability of designs.

In Australia, Queensland Health collaborated with a school of architecture to produce settings-based design resource materials on shade.[32] More recently, specific research has brought architect and scientist together. In New Zealand swimming pool settings, architects tested design interventions against UV data and applied knowledge to improve design proposals.[33] In Europe, German architects categorized shade structures and developed new shading designs.[34] This work alludes to the importance of shade to address climate change, but solutions presented remain untested. More work remains to be done.

ECOLOGICAL MODELS AND HEALTH-PROMOTIVE ENVIRONMENTS

So, how do architects position their work in relation to climate change and chronic disease prevention? The *ecological model* offers a conceptual approach. Utilized both by social scientists and environmentalists, this model examines the human/context interface and suggests a framework for predicting change and taking action. From the ecologist's perspective, the model examines how living organisms relate to their physical environment. From the social scientist's perspective, the model explores human behaviour, but in the context of social, cultural and institutional structures. Both models, centred on the individual, emanate outwards to understand human action in broader fields of engagement, be they physical or socio-cultural. Both models find common ground when physical and social well-being intersect. Social scientists often seek to modify behaviour in order to improve well-being. Similarly, architects propose design interventions to ameliorate the human condition. While the means may be different, the objective remains the same.

Health-promotive environments describes the intersection of these belief systems. This concept reflects the interaction of social, regulatory and physical interventions that support conditions for healthy living.[35] The World Health Organization strongly endorses this approach, advocating that health promotion be coupled with facilities and public infrastructure to complement health goals, through the creation of spaces and places for healthy living.[36,37,38]

Creating shady places for skin cancer prevention, therefore, becomes one important item on a menu of design strategies. Shade, layered onto environmental, sustainable and green interventions is incorporated into a larger strategy. Together, these benefits become mutually supportive, creating *health-promotive environments* while mitigating climate change impacts.

TORONTO AND CLIMATE CHANGE

I live and work in Toronto, a boreal city with a temperate climate. Located at 43°N, 79°W, it is far removed from places conventionally understood as sub-tropical. However, as elsewhere, our city is experiencing extreme weather and, in the case of addressing harmful UV, Toronto may provide approaches applicable elsewhere.

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This summer, a storm dumped over 100 mm of rain on the region within a few hours and led to catastrophic flooding, power outages, transit chaos and major damage. A few days later, during a severe heat wave, Environment Canada posted a UV alert of 10, or *extremely high*. While it may be summertime in Toronto, drenching rains, sub-tropical heat and a high risk of harm from unprotected sun exposure, appear as harbingers of things to come.

Toronto is working to address climate change, promote sustainability and create health-promotive environments, with measures such as the 2010 *Toronto Green Standard* and the 2009 *Green Roof Bylaw*.[39,40] Joint work of municipal departments – Health, Transportation, Planning, and Parks and Recreation – whose members otherwise would have remained in their silos, are proactively addressing population well-being through design. One initiative includes limiting environmental carcinogens, particularly UV exposure.

"Increasing shade in Toronto contributes to a healthier and more sustainable City," cites the preamble to the City's 2007 *Shade Policy.* Toronto became the first jurisdiction in North America to adopt a comprehensive approach, advocating that shade be "an essential element" for civic facilities.[41] This policy resulted from a concerted effort by the Toronto Cancer Prevention Coalition (TCPC), a voluntary advocacy group, bridging health, design and policy. Since 1998 the TCPC has achieved results through a cluster of activities focused on shade and were the impetus for a 2010 design studio.[42,43,44]

PLAY / INTERPLAY

There are over 1,000 city-owned parks in Toronto where people enjoy outdoor recreation and where shade policies will be implemented. One of these locales, Leaside Park, became the site of *Play / Interplay,* an undergraduate design studio for fourth-year students in a pre-professional architecture program. The studio explored interactive architecture to provide shade, to create engaging environments and to foster sun-safe behaviour in a park, all in a time of climate change.

Students researched interactivity in design and how it could support outdoor recreation, ensure sun safety and address climate change. A large Toronto park in a densely-settled immigrant neighbourhood became the site for design proposals to demonstrate how interactivity could support place-making and sun safety for a diverse population. Leaside Park had been the focus of a 2009 research project I led to calibrate the UV levels and concomitant risks in the park's playground. That study determined that there was a high UV risk in summer in the Park's play areas. Currently the site is bald. There are few trees and no overhead sun shade protection (Figure 1).

In addition to the *Shade Policy,* municipal design objectives included equitable access, place making and community engagement. In light of changing neighbourhood demographics, pressing issues required resolution, including

Figure 1: View of the children's play area, Leaside Park, Toronto

No sun protection is offered in this setting. (George Kapelos)

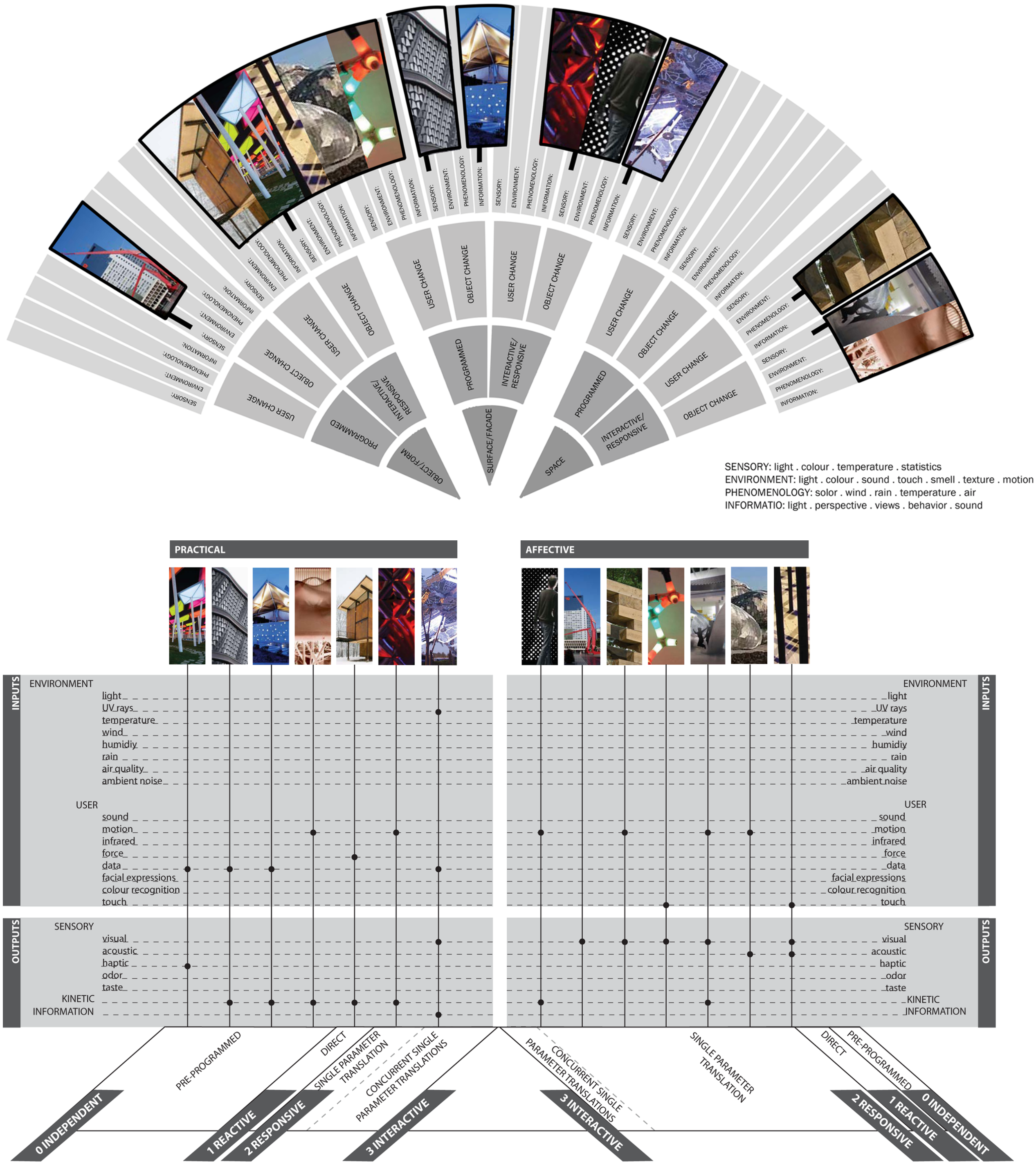

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Figure 2: Matrices of interactive / reactive architecture

Students researched interactive architecture, selected case studies and analyzed projects in detail. Matrices were developed to categorize, describe and situate projects by approach and labelled: *Type* (top) and *System* (bottom). (George Kapelos)

reconfiguring the playing field and introducing a cricket pitch and new program elements which would address the community's diverse needs, especially through changes to facilities and operations to permit a gender-separated bathing area for residents.[45,46] These became key programmatic considerations.

STUDIO OUTCOMES

Students initially researched case studies and explored concepts of architectural interactivity, then developed a park plan, designed shade elements

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Figure 3: Blooming Canopies

The pedestrian system is supported by a network of shading superstructures that respond to the volume of circulation, programme and UV levels. The canopy is composed of modular cells with operable diaphragms that swell and constrict with the ebb and flow of pedestrian circulation, programmed activities beneath and UV levels. (Designer: Dorian Resener, Student, Ryerson University, B. Arch. Sci. 2011)

and executed prototypes. Students visited the site, met with planners and had discussions with members of the TCPC and community. Students made extensive use of digital fabrication equipment to produce working models of design prototypes. In the final review, organized as an informal pinup and walkabout, invited guests met one-on-one with students, and a conversation ensued with park planners regarding studio outcomes. The following summarizes research and design outcomes.

INTERACTIVE ARCHITECTURE

Students researched interactive architecture, selected case studies and analyzed projects in detail. Teams developed matrices which described, categorized and situated projects within a matrix.[47] Taxonomies was labelled by approach.

In the matrix labelled *Type*, interactive / reactive architecture is categorized using a hierarchical system, with the preliminary division (object / form, surface / façade, space) being subsequently divided into two categories (programmed or interactive / responsive) and subsequently sub-divided into source of change (user or object) and finally by type of outcome (sensory, environmental, phenomenological, informational). In the matrix labelled *System,* a field was established whereby elements were classified along a series of axes, which calibrated the level of interface with users (independent, reactive, responsive, interactive), the inputs (environmental, user) and outputs (sensory, kinetic, informational) and the outcomes (practical, affective). Projects were then situated within the taxonomies to provide interpretive information aiding students in the subsequent element design (Figure 2).

This analysis provided students with insights into the range of ways in which interactivity may be explored and helped to clarify the sometimes confusing terminology associated with this emerging field of praxis. It provoked students to consider ways in which interactive design could be utilized in an outdoor environment for play and recreation, while promoting sun safety.

INTERACTIVE ARCHITECTURE FOR SHADE IN LEASIDE PARK

The remainder of the studio addressed the question: how can design address community needs, environmental, health and safety considerations, as well as providing opportunities for new technologies in order to create a vision for the park's future? Each student developed a site plan, which allocated all-season programming activities, facility locations and the specific placement of interactive / reactive elements. Students subsequently designed one element and constructed models to show function, tectonics and materials as well as demonstrate response to park design principles. The following are representative student outcomes. Descriptions are presented in the students' own words.

BLOOMING CANOPIES

"The proposed park plan seeks to mitigate the roles of a park as an area for urban respite, an area for recreation and play, an area for social interaction and a touchstone for a strong community. Large programmed areas encourage families to play together, compete and grow together and, most importantly, help their community grow; by creating stronger intra-community corridors a social fabric can be encouraged to grow in a traditionally transient neighbourhood. In a district where low-income housing dominates the built landscape, one of the designer's considerations was to maximize the use of public space.

"By extending a network through the dense community small pockets of nature, community and leisure can be combined and compounded. Although the proposed pedestrian bridge system benefits the immediate site, its effects are most prevalent in the surrounding areas. By integrating nodes of activity, pedestrian corridors and interest-driven circulation, a meagre parcel of land can be transformed into an event space, creating a destination with a strong sense of place and identity (Figure 3).

"The pedestrian system is supported by a network of shading superstructures that respond to the volume of circulation, programme and UV levels. The canopy is composed of modular cells with operable diaphragms that swell and constrict with the ebb and flow of pedestrian circulation, programmed activities beneath and UV levels. The structure's large scale is conceived to offer direct sunlight mitigation while not imposing on the park's activities. The design is intentionally iconic, providing a strong identity and sense of place to a park that is lacking both.

"The canopy mechanism works by raising or lowering a centrally supported geared column that is attached to the middle of the diaphragm material. The extents of the diaphragm material are restrained along rails that also structure the mechanism. A small electric motor in each cell is linked to a central control along with a sensor array to transcribe movement along the ground. Aside from reacting to movement on the ground, the canopy would be programmed to close when critical UV levels are reached or when precipitation has been detected.

"The network is concentrated to the southern edge of the site both to have the greatest impact on sun mitigation and to provide a relationship to the

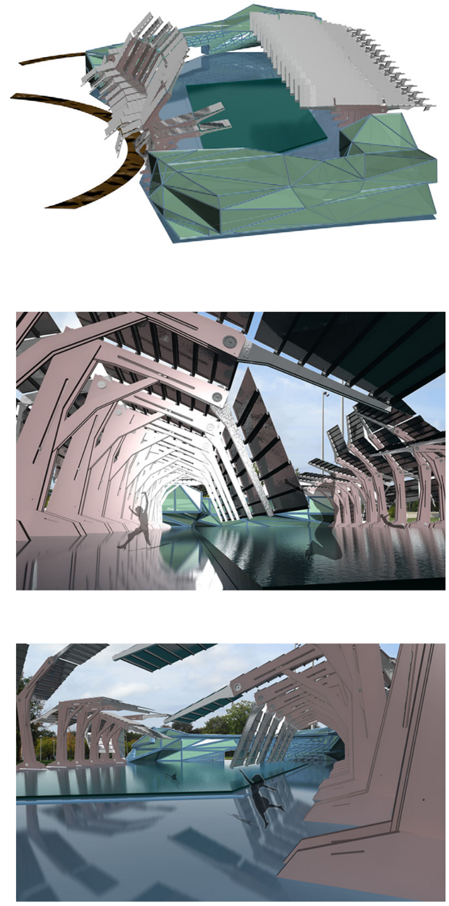

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Figure 4: Dancing Pool

The canopy unfolds in two stages. In the open position, the panels can provide UV protection over the pool and adjacent walkway. In the closed position, the panels provide a visual separation between the walkway and the pool area, addressing cultural sensitivities and allowing female swimmers privacy. (Designer: Behzad Sabbaghi-Banadkooki, Student, Ryerson University, B. Arch. Sci. 2012)

Figure 5: Coral

The design of the interactive element employs a mass produced modular form. At times of the day when UV levels are high, each module will respond and light will be diffused and UV blocked. (Designer: Lai Man Raymond Fan, Student, Ryerson University, B. Arch. Sci. 2011)

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wooded ravine. The wooden frames and tall masts replicate a forest with reactive foliage."[48]

DANCING POOL

"For the design, I found inspiration in the structure and movement of the human body. The built form – a canopy expressed by triangular geometry – provides enclosure over the outdoor swimming pool and at its perimeter, affording UV protection and addressing cultural conventions and customs of pool users.

"As a neighbourhood, Thorncliffe Park has traditionally received new immigrants to Toronto. In recent years, the majority of newcomers are Muslims, where public swimming for female bathers is constrained by cultural and religious circumscriptions. Therefore, and to accommodate the diverse population who may utilize the pool, an overhead canopy and pool enclosure is designed to provide both UV protection and privacy allowing female-only swimming to take place (Figure 4).

"The canopy unfolds in two stages. Side panels powered by an electric motor and connected to the main body by two hinges, move in a circular motion. In the open position, the panels can provide UV protection over the walkway adjacent to the pool. In the closed position, the panels provide a visual separation between the walkway and the pool area, addressing cultural sensitivities and allowing female swimmers privacy.

"The angle of members comprising the canopy roof can change in response to the sun's position and primary source of UV. Roof members have two sections: the main body and an extending arm that provides more coverage when needed. The extendable arms are moved by motor-driven hydraulic jacks and are connected to the main body by rotating fabric; waterproof fabric connects the main bodies to each side. This solution provides for a greater flexibility when the members are in motion."[49]

ENDNOTES

1. This is dramatically tracked by a number of ozone watchers. In particular, see the website *The Ozone Hole* at www.theozonehole.com.
2. Armstrong, B. K. "Stratospheric ozone and health." *International Journal of Epidemiology* 23 (1994): 873-885.
3. There are three types of skin cancer: Basal Cell Carcinoma (BCC), Squamous Cell Carcinoma (SCC) and Malignant Melanoma (MM). BCC and SCC are non-malignant and relatively common and treatable, MM is less common, but can spread to vital organs and be fatal.
4. International Agency for Research on Cancer. *Solar and Ultraviolet Radiation. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans.* 55 (1992), updated 100D (2012).
5. El Ghissassi, F., et al. *Lancet Oncology* 10 (2009): 751-752.
6. Armstrong, B. K., A. Kricker, et al. "Sun exposure and skin cancer." *Australian Journal of Dermatology* 388 (Supp) (1997): S1-S6.
7. Armstrong, B. K. *op. cit*.
8. Albert, M. R. and Ostheimer, K. G. "The evolution of current medical and popular attitudes toward ultraviolet light exposure: Part 3." *Journal of the American Academy of Dermatology* 49 (2003): 1096-1106.

CORAL

"In the proposed park design, the central space is an important node and destination for park users and the community-at-large. The space is envisaged as a gathering place for community activities, such as a market or special event. The interactive element is conceived as an element of infrastructure which will extend the use of this space in all seasons. It acts as a shelter for the space, providing UV and weather protection, while addressing the quality of natural light in the space and establishing a distinct character for the resulting environment (Figure 5).

"The design of the interactive element employs a mass produced modular form. Each module is in the shape of a triangular prism at its default setting; the modules are organized into a triangular grid system and hung above the space at a height of approximately 7 metres creating an overhead covering. Within each element, two triangular frames, situated respectively at element top and bottom, allow the passage of sunlight, to let in light while the three sides of the prism are wrapped with a two-way stretchable fabric. At this setting, light may penetrate into the space, while providing shading. At times of the day when UV levels are high, each module will respond: the bottom triangle will shrink into a smaller opening, and extend towards the ground, elongating the triangular prism. As all modules respond to the sunlight in a similar manner, light will be diffused and spread evenly within the space, the wall on the sides of prisms will block off UV and excessive light.

"The entire system controls the quality of light in the space. The overall impact provides softer light and a dynamic roof system, and pedestrians within the space may experience the sensation that they are underwater, as the light from above is modulated, diffused and directed.

"The shelter canopy may be pre-programmed to respond to specific events. When the space is busy, with movement or activity below, modules may respond dynamically and frequently, changing in height and size, creating an undulating, curvilinear form. When the space is less active, all modules will return to their original default position, creating a simple identical pattern in the plane above. This variability allows the users who interact with the shelter to enjoy a different experience on each visit."[50]

COMMENTARY / CONCLUSIONS

Play / Interplay allowed participants to consider the potential and value of health-promotive environments. The following summarizes comments and presents provisional conclusions.

First, regarding UV and climate change, students gained knowledge of design for sun safety and how this forms part of a larger strategy for a changing climate. The projects described above approached UV protection interactively through covering, folding and dilating, facilitating human engagement and responding to human needs. For UV protection, interactivity provides flexibility and increased adaptability for sun protection. The studio demonstrated how this new area of design praxis could reduce UV risk in outdoor settings. Students saw interactivity as a fundamental prerequisite of effective shade design, drawing on technology to do what humans are reluctant to do: seek cover!

Typically, architecture students will focus on making. Studio participants threw themselves into prototype design, taking full advantage of digital

9. *Ibid.*
10. Canadian Cancer Society / National Cancer Institute of Canada. *Canadian Cancer Statistics 2008*. Toronto, Canada, 2008.
11. Cancer Council Queensland, http://www.cancerqld.org.au/page/prevention/skin_cancer/, accessed 24 July 2013.
12. Anand, P. et al. "Cancer is a preventable disease that requires major lifestyle change." *Pharmaceutical Research*. V 25 (9) (2005): 2097 – 2116.
13. Autier, P. and Dore, J. F. "Influence of sun exposures during childhood and during adulthood on melanoma risk."*International Journal of Cancer* 77(4) (1998): 533-537.
14. Health Canada. *Communicating the health risks of extreme heat events*. Ottawa: Health Canada, 2007. http://www.hc-sc.gc.ca/hl-vs/pubs/sun-sol/safety-prudence-eng.php, accessed 24 July 2013.
15. Livingston, P. M., White, V., Hayman, J. and Dobbinson, S. "Sun exposure and sun protection behaviours among Australian adolescents: trends over time." *Preventive Medicine* 37(6 Pt. 1) (2003): 577-584.
16. Balk, S. "American Academy of Pediatrics, Policy Statement – Ultraviolet Radiation: A Hazard to Children and Adolescents." *Pediatrics* 127(3) (2011): 588 – 597.
17. World Health Organization. *Global Solar UV Index: A practical guide: A joint recommendation of the World Health Organization, World Meteorological Organization, United Nations Environment Programme and the International Commission on Non-Ionizing Radiation Protection*. Geneva: World Health Organization, 2002, 28.
18. Fioletov, V., Kerr, J. B., Fergusson, A. "The UV Index: Definition, Distribution and Factors Affecting It." *Canadian Journal of Public Health*. 101(4) (July/August 2010): I-5 – I-9.
19. Turnbull D. J., Parisi A. V. "Increasing the ultraviolet protection provided by public shade structures." *Journal of Photochemistry and Photobiology B* 78 (2005): 61-67.
20. *Ibid*.
21. *Ibid*.
22. Parsons, P. G., Neale, R. et al. "The shady side of solar protection." *Medical Journal of Australia* 168 (7) (1998): 327-330.
23. Gies, P., and Mackay, C A. Measurements of solar UVR protection provided by shade structures in New Zealand primary schools. *Photochemistry and Photobiology,* 80 (2004): 334-339.
24. Gies, P., Elix, R., Lawry, D., Gardner, J., Hancock, T., Cockerell, S., et al. "Assessment of the UVR protection provided by different tree species." *Photochemistry and Photobiology*, 83(6) (2007): 1465-1470.
25. Grant, R. H. and Heisler, G. M. "Effect of cloud cover on UVB exposure under tree canopies: Will climate change affect UVB exposure?" *Photochemistry and Photobiology* 82(2) (2006): 487-494.
26. Broadhurst, D. "Solar UV in Ontario: Characteristics and Trends." *Shade for Good Health*, Toronto Public Health, July 2007. http://www.toronto.ca/health/tcpc/pdf/shade_conreport0707_2.pdf.
27. See, Greenwood, J. S., Soulos, G. P. and Thomas, N. D. *Under Cover: guidelines for shade planning and design*. Sydney NSW: New South Wales Cancer Council, 1998.

fabrication while also relying upon traditional methods including sketches and hand-built study models. The studio did not allow time to model the proposed schemes with software that calculates UV risk and sunburn time, nor to explore the impact of proposed designs on overall UV reduction in the Park. This would be the logical next step.

Second, student engagement with Toronto's ongoing work with climate change provided real-world insights. Through the combined work of parks planners, health promoters and architects, Toronto's multi-pronged response anticipating climate change provides a model for future practice. Results are not instantaneous. Persistence and close cooperation of a number of groups within and outside government and from a range of disciplines have led to a city-wide strategy on climate change impacts. UV reduction is one small but essential component of this strategy; a glimpse into this was an eye-opener for many students. Architectural design is as much about process as product. The presence in the design process of environmentalists, health promoters and epidemiologists, exposed architectural students to an array of competing interests, and led to a fuller comprehension of the challenges of chronic disease prevention through environmental design. In a complex world, aligning the interests of the architect with other disciplines becomes a necessity to optimize problem solving.

Annually, Toronto spends over $110 million on capital projects in public parks and urban forestry.[51] Parks support a wide range of activities and, metaphorically, are the lungs of a city.[52] In the face of global warming, Toronto and other urbanized areas, whether sub-tropical or not, will rely increasingly on outdoor spaces to provide respite and refuge. Toronto's comprehensive approach in creating health-promotive environments becomes a model. Understanding this approach and applying it in a studio setting supported student success and learning. In addition, the studio gave participants the opportunity to fuse current design preoccupations into interactive architecture with a proven contributor to skin cancer reduction. Such reminders of architecture's social potential are invaluable.

Third, basic theoretical questions need to be addressed in order to come to terms with the complex issues of human / nature interaction. In light of changing environmental conditions, behaviour modification remains a key to individual health, while environmental interventions guided by enlightened policies are also required. Design interventions add interest to the public realm while providing equitable opportunities for recreation, leisure and public enjoyment. The studio drew upon research in design, technology, science, human behaviour and epidemiology to guide the work. Complex problems, idealized through theoretical models, call for equally complex, holistic solutions.

Fourth, exposing students to the complexities of climate change is a pedagogical necessity. Sustainability is now embedded in architectural curricula. Likewise, the use of advanced technology provides architects with an increasingly greater array of tools to conceive, develop and implement design ideas. At the same time, architects are renewing their commitment to social purpose and reaffirming this as a fundamental doctrine of their discipline. Architecture, skin cancer prevention and climate change, which lay at the heart of this studio, provided insights into the interconnected web of issues which will confront these students as they become practitioners.

28. See *Webshade: now changing the way we think about shade.* http://www.webshade.com.au/.

29. See Kapelos, G. T. *City of Toronto Public Playgrounds and Waterplay Facilities Shade Audit Pilot Study.* Toronto ON: Toronto Parks, Forestry and Recreation, 2010.

30. Blyth, A. "Briefing." *The Architecture of Shade*. London UK: [UK] Health Education Authority / Bartlett School of Architecture. 1995. 15 – 17.

31. See Kapelos, G. T. "Taking Cover – *Made for Shade* Competition." *Competitions* 8(3) (1998): 42 – 51.

32. See Department of Architecture, University of Queensland. *Shade for Sports Fields*. Queensland Health, Brisbane, 1995. Department of Architecture, University of Queensland. *Shade for Public Pools*. Queensland Health, Brisbane, 1996. Department of Architecture, University of Queensland. *Shade for Young Children*. Queensland Health, Brisbane, 1997.

33. Mackay, C. "Towards a safe sun-bathing canopy." *Proceedings of the 23rd Conference on Passive and Low Energy Architecture, 6-8 September 2006*. Geneva, Switzerland, 2006, 581-586.

34. Petschek, P. and Gass, S., Eds. *Constructing Shadows, Pergolas, Pavilions, Tents, Cables and Plants*. Basel: Birkhaeuser, 2011.

35. Stokols, D. "Establishing and maintaining healthy environments." *American Psychologist* 47(1) (1992), as discussed in Lawrence, D. F. and Engelke, P. O. "Human activity patterns: exploring the impacts of urban form on public health." *Journal of Planning Literature* 16 (2001): 202 – 218.

36. Barton H., Grant, M., Mitcham, C, Tsourou, C. "Healthy Urban Planning in European Cities." *Health Promotion International*. 24 (S1) (2009): i91-i99.

37. World Health Organization (WHO), Government of South Australia. *The Adelaide Statement on Health in All Policies: moving toward a shared governance for health and well-being*. Geneva: WHO, 2010.

38. Knox, S. "Planning as a Public Health Issue." *Urban Policy and Research*. 21(4) (2003): 317-319.

39. See Toronto http://www.toronto.ca/planning/environment/greendevelopment.htm.

40. See *Sustaining and Expanding the Urban Forest: Toronto's Strategic Forest Management plan, Parks Forestry and Recreation, 2012 – 2022*. http://www.toronto.ca/legdocs/mmis/2013/pe/bgrd/backgroundfile-55258.pdf.

41. The full policy is found at http://www.toronto.ca/legdocs/mmis/2007/hl/bgrd/backgroundfile-6600.pdf.

42. For an account of the activities of the Toronto Cancer Prevention Coalition, see Hepburn, V. *Ten Years Later: The history and development of the Toronto Cancer Prevention Coalition, A retrospective and prospective analysis*. Toronto: Toronto Cancer Prevention Coalition, 2008.

43. See Kapelos, G. T. *City of Toronto Public Playgrounds and Waterplay Facilities Shade Audit Pilot Study.* Toronto: Toronto Parks, Forestry and Recreation, 2010. http://www.arch.ryerson.ca/designforshade/wp-content/uploads/2011/11/Pilot-Report-Volume-1.pdf.

44. See http://www.toronto.ca/children/operators/pdf/shade_guidelines.pdf for information on Toronto's *Shade Policy.*

All told, issues of this studio, albeit sited in a boreal city, could equally be applied to the sub-tropics, where demands for outdoor living and recreation will certainly collide with environmental risks of UV exposure. Creating inviting, outdoor, responsive spaces is a challenge faced by designers everywhere. Global warming and ozone depletion in particular raise UV levels and call into question the safety of being out-of-doors. Propositions from *Play / Interplay* provide a glimpse of life in a world of changed climate, where architecture could also continue to provide places of solidity, utility and delight.[53]

45. Leaside Park is located in Toronto's Thorncliffe Park neighbourhood, a high density, high-rise community and constructed in the 1950s and 1960s. Planned for an initial population of 12,500, the community's population is now over 30,000. The community serves as a welcoming point for new immigrants to Toronto; 87% of the population is recently arrived. Over 66% of the community's members do not consider English as their mother tongue, with Urdu being the most common language (25.3%), followed by Gujarati, Farsi, Tagalog, Pashto and Panjabi (totalling over 20%). There is a disproportionately high number of children under 14 years of age in the community (26%), compared with the Toronto average of 16%. See http://www.toronto.ca/demographics/cns_profiles/cns55.htm.

46. See City of Toronto, Parks Forestry and Recreation, *Parks Plan 2013 – 2017*, http://www.toronto.ca/parks/pdf/engagement/parksplan.pdf.

47. A bibliography of research sources on Interactive / Reactive Architecture, Children's Play Spaces, Structural Systems and Design, UV and Shade Design was provided to students at the start of the Studio. This bibliography is available on request from the author. Two texts were required for student reading: Bullivant, Lucy. *Responsive Environments: Architecture, Art and Design*. London: V & A, 2006 and Fox, Michael. *Interactive Architecture*. Ed. Miles Kemp. New York: Princeton Architectural Press, 2009.

48. Dorian Resener, Student, Ryerson University, B. Arch. Sci. 2011.

49. Behzad Sabbaghi-Banadkooki, Student, Ryerson University, B. Arch. Sci. 2012.

50. Lai Man Raymond Fan, Student, Ryerson University, B. Arch. Sci. 2011.

51. Details of the City of Toronto Parks, Forestry and Recreation (TPFR) budget are found at http://www.toronto.ca/budget2013/pdf/cap13_an_pfr.pdf. Approximately 28% of this budget is allocated to growth and 41% to repairs of existing facilities, both of which categories include design and development of new facilities under TPFR management and ownership. With the City's *Shade Policy*, a portion of capital works will be directed toward shade-related planning and infrastructure.

52. See Olmsted, F. L. "Public parks and the enlargement of towns." New York: American Social Science Association / Riverside Press, 1870.

53. Studio participants included the following fourth-year students in the B. Arch. Sci. Program at Ryerson University, Toronto: Zohra Akbari, Mahsa Ali Marandi Ghodoosi, Sara Damyar, Lai Man Raymond Fan, Navid Feizarbabi, Sam Ghantous, Madiha Hafeez, Babak Haji Ghasemi, Michael Jo, Alissa Laporte, Adryanne Quenneville, Dorian Resener, Behzad Sabbaghi-Banadkooki and Jordan So. Additional personnel who provided input to the studio included staff from Toronto Parks Forestry and Recreation and Toronto Public Health, and members of the Toronto Cancer Prevention Coalition, UV Working Group. Support for the preparation of this paper was received from Ryerson University Department of Architectural Science and the Faculty of Engineering and Architectural Science. Safoura Moazami, Toronto Public Health, provided specific information on the City of Toronto *Shade Policy.* The author is grateful for the assistance and participation of these individuals and organizations.