REGENERATING THE RIVER OF LIFE OF THE CITY
IMPROVING THE PEDESTRIANS’ EXPERIENCE ON URBAN STREETS IN TORONTO

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ABSTRACT

REGENERATING THE RIVER OF LIFE OF THE CITY – IMPROVING THE
PEDESTRIANS’ EXPERIENCE ON URBAN STREETS IN TORONTO

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Urban streets should be functional as both “path” and “place”, but “street as place” has been overlooked in urban design. The purpose of this thesis is to develop design guidelines for improving pedestrians’ experience on urban streets in Toronto. The study site is Gould Street in downtown Toronto. A preliminary study revealed thermal comfort, safety, social interaction and visual experience as key factors influencing pedestrians’ experience on urban streets. Design guidelines were formulated from literature review to address these key factors on Gould Street. These factors also form the framework for site inventories and analyses. The design concept, “Regenerating the river of life of the city”, is implemented by applying the guidelines to three design solutions. These alternatives were compared to identify their strengths and weaknesses related to the guidelines. Conclusions are drawn regarding the applicability of the guidelines, the limitations of the research and possibilities for future studies.
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# TABLE OF CONTENTS

1. INTRODUCTION ............................................................................................................. 1
   1.1 Background .................................................................................................................. 1
   1.2 Goal and Objectives .................................................................................................... 2
   1.3 Methodology .............................................................................................................. 3

2. PRELIMINARY SITE STUDY ....................................................................................... 5
   2.1 Existing Land Use ....................................................................................................... 6
   2.2 Key Issues of the Site ................................................................................................. 14

3. LITERATURE REVIEW ............................................................................................... 15
   3.1 Literature on Thermal Comfort Design ................................................................. 15
   3.2 Literature on Safety Design for Pedestrians ......................................................... 22
   3.3 Literature on Social Interaction Design for Pedestrians ....................................... 28
   3.4 Literature on Visual Experience Design for Pedestrians ...................................... 30
   3.5 Guideline Summary ................................................................................................. 36

4. SITE INVENTORY AND ANALYSIS ........................................................................ 39
   4.1 Microclimate Inventory and Analysis .................................................................. 39
   4.2 Safety Inventory and Analysis ............................................................................... 48
   4.3 Social Interaction Inventory and Analysis ............................................................. 52
   4.4 Visual Experience Inventory and Analysis ............................................................. 59
   4.5 Summary .................................................................................................................. 63
5. DESIGN DISCUSSION.................................................................64
   5.1 Design Concept..........................................................64
   5.2 Design Solutions.......................................................65
   5.3 Design Comparison....................................................75

6. OBSERVATIONS AND CONCLUSIONS....................................83
   6.1 Applicability of Guidelines and Methodology...................83
   6.2 Detail Design Observation...........................................84
   6.3 Limitations..............................................................87
   6.4 Further Studies.......................................................88
   6.5 Conclusion..............................................................89

7. REFERENCES.................................................................90

APPENDIX A: PEDESTRIAN MOVEMENT DATA..........................93
LIST OF TABLE

Table 3.3-1 Dimensions for plazas .................................................................29
Table 3.4-1 Preference matrix .................................................................31
Table 3.4-2 Perceptual characteristics for motorist and pedestrian ..................32
Table 3.5-1 Guideline summary .................................................................36
Table 4.1-1 Wind speed and pedestrian discomfort ..................................40
Table 4.1-2 Weather data for Toronto .........................................................41
Table 5.3-1 Design comparison for the thermal comfort guidelines .................76
Table 5.3-2 Design comparison of the safety guidelines .................................77
Table 5.3-3 Design comparison of the social interaction guidelines ...............78
Table 5.3-4 Design comparison of the visual experience guidelines ...............79
Table 5.3-5 Design comparison of all the design guidelines .........................81
LIST OF FIGURES

N.B. All photos not credited in text were taken by author.

Figure 2-1 Key map of Gould Street .................................................................5

Figure 2.1-1 Existing land use plan.................................................................6

Figure 2.1-2 Commercial buildings on Gould Street ......................................7

Figure 2.1-3 Old commercial building ..........................................................7

Figure 2.1-4 Sam the Record Man .................................................................7

Figure 2.1-5 Institutional buildings on Gould Street ......................................8

Figure 2.1-6 Ryerson Library ............................................................9

Figure 2.1-7 BKS building and Toronto Life Square.................................10

Figure 2.1-8 Kerr Hall ..........................................................11

Figure 2.1-9 Sculpture of Egerton Ryerson .................................................11

Figure 2.1-10 CED & Lake Devo .............................................................12

Figure 2.1-11 IMA Building ..............................................................12

Figure 2.1-12 OKF, SCC and OAK .........................................................13

Figure 2.1-13 RCC building ..........................................................13

Figure 2.1-14 ENG building ..............................................................14

Figure 3.1-1 Windbreaks and wind reduction zones of varying permeability ....18

Figure 4.1-1 Sun pattern on June 21st ......................................................42

Figure 4.1-2 Sun pattern on Sep. 21st and Mar. 21st ..................................42
Figure 4.4-1 Visual experience analysis.................................................................60
Figure 4.4-2 East side of the “Sam the Record Man” building...............................62
Figure 4.4-3 Blank wall beside Lake Devo...............................................................63
Figure 4.4-4 Center area with a sculpture...............................................................63
Figure 5.1-1 Natural river.......................................................................................65
Figure 5.1-2 Concept diagram................................................................................65
Figure 5.2-1 Site plan of Design Option 1.................................................................72
Figure 5.2-2 Site plan of Design Option 2.................................................................73
Figure 5.2-3 Site plan of Design Option 3.................................................................74
1. INTRODUCTION

“The street is the river of life of the city, the place where we come together, the pathway to the center.” (Whyte 1988, p.7)

1.1 Background

Streets, as a main component of a city, have existed since the first ancient village was founded. However, in today’s modern cities, streets are designed primarily for vehicle traffic. Fewer people choose to use streets as places to walk, to ride, and to socialize, and such changes clearly signify that urban streets are gradually losing their livability. If urban streets are regarded as “the river of life of the city” (Whyte, 1981), regenerating this “river” will then re-energize the life of the whole city. Most of the research about urban streets has studied pedestrian movement patterns in relation to different street settings. For example, William Whyte’s “Street Life Project” studied pedestrian movement patterns on urban streets and public squares in New York (Whyte, 1981). This kind of research can be used as reference to develop urban street design guidelines for Toronto, and thus to help create a more comfortable and vivid street life for its more than 2.5 million Torontonians.

From a designer’s point of view, there are several ways to analyze the form and function of urban streets. No matter which approach is used, two key characteristics of streets will keep constant: “path” and “place” (Moughtin 2003, p.133). Since street design has become vehicle-oriented, “street as place” has increasingly been overlooked
(Moughtin 2003, p.134). This North American trend has been observed by Greenberg, who stated that “postwar city planners in Toronto ignored the street as a public place” (Greenberg 1987, p.189). When a street only functions as a “path” for most of the time, the “path” purpose will become dominant unavoidably while the “place” role will then turn subservient. As a result, streets will lose their charm for people. Thus, urban street design needs to be more focus on pedestrians’ needs to bring life back to urban streets. This is the essential purpose of urban street design.

The impetus for this thesis was an international student design competition which was sponsored by the Ryerson University in 2007. The goal of the competition was to redesign Gould Street in downtown Toronto to be more pedestrian-focused.

1.2 Goal and Objectives

The purpose of this thesis is to develop design guidelines for improving pedestrians’ experience on urban streets in Toronto. To achieve this goal, several objectives are identified and listed below. Each objective also serves as a progress stage in this study.

- Identify key factors that influence pedestrians’ experience on urban streets in Toronto;
- Develop design guidelines for improving pedestrians’ experience on urban streets;
- Through design options, apply the design guidelines to a site in Toronto;
- Evaluate the design options to better understand the usefulness of the guidelines;
1.3 Methodology:

After setting the goal and objectives of the study, an applicable methodology was developed to guide this research process of the study. The following flow chart shows a summary of the involved procedural details of this research. To better comprehend the site, the first step is to conduct a preliminary site study to identify the key issues that influenced the pedestrians’ experience on Gould Street. With the site problems as background, the literature review focuses more on the four identified issues. Based on these main factors, a comprehensive site inventory and analysis are conducted to develop a more thorough understanding of the issues detected. Computer modeling and on-site observations are the core methods used in the site inventory and analysis. In the computer modeling approach, SketchUp is used to generate a three-dimensional computer model with street dimensions and details in order to conduct the sun pattern study for microclimate analysis. Furthermore, data are collected from the on-site observations and are used for the wind pattern study, the safety study, the pedestrian movement study and the visual study. After studying the site, three design options are then developed, and the guidelines are used to compare the design options with the existing street conditions so as to evaluate the strengths and weaknesses of each option. The observations and conclusion are eventually drawn based on the results of the design comparison.
Improving pedestrians’ experiences on urban street

Design Competition

Preliminary site study to identify key issues

Literature review

- Literature review on thermal comfort design
- Literature review on safety design
- Literature review on social interaction design
- Literature review on visual experience design

Generate guidelines on pedestrian-oriented urban street design

Conduct detailed site inventories and analyses of the key issues

Develop three alternative design solutions

Compare the design solutions to the existing site based on the design guidelines

Discuss the strengths and weaknesses of each design option

Discuss the strengths and weaknesses of each design option

Observations and conclusion
Applicability, limitations, future studies and conclusion
2. PRELIMINARY SITE STUDY

Toronto is the largest and the most multicultural city in Canada. The establishment of the earliest urban community in Toronto was dated back to 1793 when the “Town of York” was founded (Benn, 2007). More than 2.5 million residents are now living and working in this highly-urbanized center. The site to be studied – Gould Street (See Figure 2-1) – is located in the heart of downtown Toronto. The street is also adjacent to the Yonge Street commercial corridor, running from east to west between Yonge Street and Mutual Street. In addition, the Dundas Subway Station and a commercial center, the Eaton Shopping Center, are only five-minutes walking distance away.

Figure 2-1: Key map of Gould Street (Adapted map from: http://maps.live.com/)
In general, Gould Street does not have busy vehicle traffic because it is not the main circulation artery in downtown Toronto. Nevertheless, as a street adjacent to a university campus, commercial district, and residential buildings concurrently, Gould Street does have busy pedestrian traffic every day. As a typical urban community street with a large number of pedestrians, Gould Street offers a lively and dynamic urban context that provides a prime opportunity to explore the development of pedestrian-focused urban street design strategies in Toronto.

2.1 Existing Land Use

Gould Street is a city-owned right-of-way which is 27 meters wide and 412 meters long having six streets intersect with it at the same time. As shown in Figure 2.1-1,
there are thirteen existing buildings along Gould Street: one residential building is situated on the east end of Gould Street; two commercial buildings are located adjacent to Yonge Street; the rest of the ten structures are scattered along the street. The Ryerson University owns this group of institutional buildings.

The west end of the street (see Figure 2.1-2) is connected to Yonge Street. Yonge Street is one of the main commercial and entertainment corridors of downtown Toronto. Two buildings located at this intersection are old buildings. One of them is a four-storey building composed of red brick (see Figure 2.1-3), whereas the other one is a two-storey landmark building (see Figure 2.1-4). Located on the north-east corner of the Yonge-Gould intersection, this remarkable structure – used to be called “Sam the Record Man”, is a heritage building that has been a landmark on Yonge Street for many years.
decades. The store was closed on June 30, 2007, and was bought by the Ryerson University in 2008 as part of the future campus expansion plan. This store is still considered as an icon on Yonge Street today.

As shown in Figure 2.1-5, most of the buildings situated on Gould Street are the properties of the Ryerson University, which serve for institutional purposes. The university was founded in 1948 and was initially called the as Ryerson Institute of Technology. The institution was named after Egerton Ryerson, who was the founder of public education in Ontario. As a young university, the Ryerson University currently has a total of 25,000 undergraduate and graduate students, including 1,600 Master's and PhD students registered in the fall of 2007, and the student population is predicted to continue to grow. Because of the limited physical space availability in the highly urbanized downtown area, the future campus expansion of the Ryerson University will be facing
some difficulties. In other words, the capacity of the existing buildings will be stretched to a maximum to accommodate more university students, and thus Gould Street will probably have more users in the future. This clearly reveals that the redesigning of Gould Street is essential to the development of the Ryerson University.

The ten buildings along Gould Street include the Ryerson Library (LIB), the Ryerson Bookstore (BKS) with the Toronto Life Square, the Kerr Hall (KHS), the Heaslip House (CED), the School of Image Arts (IMA), the O’Keefe House (OKF), the Student Campus Center (SCC), the Oakham House (OAK), the Rogers Communications Center (RCC), and the George Vari Engineering and Computing Center (ENG).

The first building located to the east of the “Sam the Record Man” is the 11-storey LIB building (see Figure 2.1-6), which was built in 1974. The library building is also an example of Brutalism architecture. As a high occupancy building in the university campus, the library provides thousands of students’ spaces for studying and learning everyday. The part of Victoria Street between the LIB building and Kerr Hall has been designed as a traffic-free zone that presents as a widened...
pedestrian walking path with vegetation planted along the way pleasantly.

Across Gould Street from the LIB building, locates the BKS (Ryerson Bookstore) which is found at the corner of Gould Street and Victoria Street (see Figure 2.1-7). The original block was a four-storey building with a parking garage and was erected in 1988. The development was recently converted into a new multi-use complex called the “Toronto Life Square” (formerly known as “Metropolis”). Such transformation was built on top of the original building. “Toronto Life Square” is a mid-rise building with ten floors above grade and three levels underground. An opportunity is then created to connect Gould Street to the Dundas Subway Station. This latest development has a loading bay entry to the subway on the south side of Gould Street and the O’Keefe Lane.

A big complex situated on the east side of the LIB building is the “Kerr Hall” (see Figure 2.1-8). It was named after the school’s first principal and was officially opened in 1963. The structure is composed of four buildings that are oriented in the form of a square to enclose the Ryerson Quad (also called “Ryerson Community Park”). Its historic facade is the landmark of the Ryerson University. This facade became the remaining part
of the first institutional building for teacher training in 1852, and now serves as an entrance to the underground athletic center of the university. The well-known monumental sculpture of Egerton Ryerson (see Figure 2.1-9) is placed on the axis of the Kerr Hall and facing Bond Street.

Beside the BKS, the CED building (Heaslip House) is established at the southeast corner of Gould Street and Victoria Street (see Figure 2.1-10). Opened in 2006, the CED was designed by RDH Architects and won an Ontario Association of Architects (OAA) Design Excellence Award the year after. Its design was constructed to incorporate the original facade of the 1930s deco building – the O’Keefe House. The Lake Devo (formerly known as Devonian Square), found in front of the CED building, is a well-used
public square and is considered as another landmark of downtown Toronto. Designed and awarded in 1970’s, this “Lake Devo” acts as a reflecting pool in summer and performs as a skating rink in winter.

The School of Image Arts (IMA) is located next to the CED building on the south side of Gould Street. Facing Lake Devo is a blank wall which is one of the sides of the four-storey IMA building. A banner occupies this wall which shows the name of the Ryerson University (see Figure 2.1-11). Such setting disturbs the harmony created within the environment of the Lake Devo.

![Figure 2.1-10: CED & Lake Devo.](image1)  ![Figure 2.1-11: IMA building](image2)

Between Bond Street and Church Street, three small buildings are situated on the south side of Gould Street. They are the OKF, SCC and OAK (see Figure 2.1-12). At the
southeast corner of Bond Street, the OKF block was built around 1875 and was later renovated in 2004. This yellow three-storey building is a co-ed residence, which houses thirty-three first-year students. The OAK building is located at the southwest corner of Gould Street and Church Street. Built in 1848, this red brick building used to be the home and office of an architect. As one of the earliest example of Gothic architecture, the block was listed as one of the Toronto Historical sites since 1977. Recently, this historic structure was fully integrated with the Student Campus Center. The newly-designed facility was opened in 2005.

The Rogers Communication Center (RCC) is positioned on the northeast corner of Gould and Church
intersection. This four-storey structure (see Figure 2.1-13) was opened in 1992 and was then become the university’s flagship building for education in digital media communications.

Another building located at the southeast corner of Gould Street and Church Street is the George Vari Engineering and Computing Center (see Figure 2.1-14). The building was three-storey high and was designed by Moriyama & Teshima Architects in 2004. This block was later officially renamed in 2005.

2.2 Key Issues of the Site

The preliminary site study gives a big picture of the street and distinguishes the key issues that need to be addressed in the design development. These key issues related to the goal of the study include the following: pedestrian’s thermal comfort, safety, social interaction and visual experience. Such issues are also typical and common subjects for the study of the other urban streets in Toronto. These factors become the main component of this research and will be served as the basis of the following literature review, site inventories and analyses, design discussion chapters, and the final evaluation.
3. LITERATURE REVIEW

The scope of the literature review is based on the four key site factors identified in the previous chapter – Chapter two, which will affect the proposed pedestrian-focused design: thermal comfort design for pedestrians, pedestrian safety design, social interaction design and visual experience design for pedestrians. A synthesis of the general principles and guidelines is identified at the end of each review. A guideline summary is also provided in the final component of every review to serve as a checklist in the process of the analysis and comparison of the design alternations.

3.1 Literature on Thermal Comfort Design

When people are faced with a landscape, they tend to choose a comfortable place to stay: such as to find an adequate shade from hot summer sun and extreme temperatures as well as to walk in sunshine during cold days (Francis, 1987, p.32). Places where people do not feel comfortable will become “dead spaces”. “To create thermally comfortable habitats for people” becomes a major contemplation in considering microclimatic factors in the process of developing urban designs (Brown & Gillespie, 1995, p.63). Creating comfortable microclimates in urban street design can “enhance the quality of thermal comfort” (Pressman, 1995, p.183) and help to improve the walking experience of pedestrians on the streets.

Common microclimatic factors include solar radiation, wind, air temperature, humidity, and precipitation (Brown & Gillespie, 1995). However, not all of these factors
can be easily changed or controlled in a landscape. In an outdoor space, solar radiation, wind, and energy partitioning are more modifiable than air temperature and humidity. This is because “wind is remarkably efficient at mixing air heat and moisture” (Brown & Gillespie, 1995, p.46). Therefore, modifying solar radiation and wind becomes a crucial method used in microclimatic landscape design.

Designing outdoor spaces to be “winter-friendly” (Pressman, 1995, p.213) for a city such as Toronto can be extremely important for such design may determine why some public spaces attract people while others do not (Pressman, 1995, p.213). Understanding the winter conditions in Toronto and searching solutions to deal with them are thus essential in landscape architectural design.

**Modifying solar radiation**

Solar radiation is a significant element in microclimate which affects people’s thermal comfort level, and this factor can be drastically modified by the landscape (Brown & Gillespie, 1995, p.93). In general, solar radiation is the first factor to be considered in summer while wind is the second factor. In contrast, wind becomes the key factor in designing a space for cold days whereas solar radiation turns out to be the subsidiary factor in winter microclimate design. Thus, “the seasonal movement of the sun and existing or proposed structures” must be taken into account in redesigning an existing site (Marcus & Francis, 1997, p.32).

**Modifying wind**

As stated above, in designing landscape for thermal comfort, wind is a major
factor in winter, but this concern should not be counted in summer. Moreover, to design an area for spring and fall use, considering convection is just the same weight as considering solar radiation (Brown & Gillespie, 1995). Protecting people from the prevailing winds in outdoor public spaces is the key to designing in cool or cold seasons (Brown & Gillespie, 1995, p.23). “Wind chill” reflects the equivalent temperature that people feel when air temperature and wind speed are combined together (Brown & Gillespie, 1995, p.65). Consequently, “wind chill” can dramatically increase the human energy loss during the cold season. This explains why people feel colder on a windy day than a sunny one, even though both the air temperatures are the same. Moreover, the larger the difference between the human body temperature and the air temperature, the stronger the wind chill cooling power (Brown & Gillespie, 1995, p.73). This also implies the negative effect of wind will be most noticeable in a climate where the ambient temperature is just high enough to support people to sit outdoors, or where many outdoor areas have no access to direct sunlight (Marcus & Francis, 1997, p.33). Therefore, avoiding cold microclimatic air pockets and protecting people from the wind in winter and during the marginal seasons of early spring and late autumn can unquestionably increase people’s thermal comfort in these seasons (Pihlak, 1983, p.34).

Using proper windbreaks is also a major technique to protect pedestrians from the winter wind. Figure 3.1-1 shows that windbreaks of different permeability provide different level of effectiveness in wind reduction zones. When adjusting the permeability of the material from impermeable to permeable, the change in wind speed becomes
smaller, but the wind reduction zone becomes larger (Brown & Gillespie, 1995, p.130). There are some useful techniques to predict the wind speed pattern and the wind-reducing zone so that windbreaks can be used properly in landscape design. The common principles that can be applied in the design process are listed below:

1) Wind speed is the lowest behind buildings and solid objects, but the wind reduction zone of these wind breaks is very small with the presence of turbulence.

2) Wind speed is low behind trees with approximately 50 percent porosity. When branches are extended to the ground, the wind reduction zone is relatively large.

3) Wind speed is the same as in the open behind lightly leafed and leafless deciduous trees and those of the coniferous trees which branches do not extend to the ground.

4) A windbreak is most effective when it is oriented perpendicular to the prevailing wind.

5) The height of a windbreak directly relates to the distance that protection extends to the opposite direction of the wind.

6) The density of different height levels of windbreaks is important for the purpose of wind reduction.
7) An irregular windbreak configuration is more effective in reducing current eddying than a uniform one.

8) Woody vegetation can have a significant effect on the wind flow on a landscape, affecting both direction and speed of wind.

The advantage of vegetation windbreaks is the fact that the vegetation filters the wind without attempting to deflect or stop it entirely. Air passes over the top of an object will not sweep down to the ground and will resume its normal pattern at some distance downwind. Air passes through the belt emerges on its leeward side at a slower velocity (Pressman, 1995, p.169). Windbreaks are commonly more effective when plants are larger and denser. Therefore, deciduous plants are more useful in summer whereas evergreen plants make better windbreaks in winter as well as other seasons (Brown & Gillespie, 1995, p.131). Furthermore, shrubs are also useful in modifying wind at a smaller scale. Hence, planting shrubs in sitting areas and entrances is more effective (Brown & Gillespie, 1995, p.131).

Modifying snow (Brown & Gillespie 1995; Pressman, 1995)

Another important microclimatic factor that can be modified in landscape design in winter city is snow drifting and deposition since it closely relates to wind patterns. Modification of snow deposition can be achieved through modification of wind patterns. This can be done by reducing wind speed substantially for a short time on the upwind side of the area. Another way is to put permanent windbreaks composed of evergreen shrubs or temporary windbreaks such as snow fences. Windbreaks should be placed
between 15-30 times of their heights upwind from the area to be protected to provide sufficient space for snow accumulation.

**Other factors**

Besides solar radiation, wind and snow, some other elements of urban streets also have an impact on the thermal comfort in landscape design. For example, water features installed in a dry landscape can reduce the amount of energy emits into heating surfaces and air (Brown & Gillespie, 1995, p.142). That is because the evaporation of water helps to cool down the temperature of the hot surface and its surrounding area. However, during spring and fall, people may feel colder near a water body because the evaporation of the water accelerates the energy loss in the surrounding area.

In addition, using different materials for different landscape elements can provide pedestrians with different levels of thermal comfort. For example, at the same temperature, a wood bench makes people feel warmer than a metal bench does. Similarly, the same can be applied to hand rails. Other materials such as concrete, metal, tile and stone are much colder and harder, but they can still be used as secondary seating (Marcus & Francis, 1997, p.44). Keeping flexibility in landscape design and allowing people to modify the landscape as they desire are always considered as a wise approach in microclimatic landscape design as microclimate is still believed to be “an inexact science” (Brown & Gillespie, 1995, p.167).

There is another point that needs to be mentioned. It is impossible to design thermal comfort for all users in all seasons. Therefore, the focus of microclimate design is
“the thermal comfort of the majority of people in the majority of time” (Brown & Gillespie, 1995, p.72). In other words, the microclimatic design should be targeted on major groups in all landscape design projects.

Summary

This chapter introduces the major microclimate factors and the common techniques on modifying these factors in landscape design. Properly using this knowledge in urban street design can improve pedestrians’ thermal comfort on urban streets. Some microclimate design guidelines are therefore generated and listed below.

**General principles:** (Brown & Gillespie, 1995; Brown & LeBlanc, 2007; Caborn, 1965; Pihlak, 1983; Pressman, 1995)

a) **Orientation of street elements** – Adjust and orient street elements toward south and block as little solar radiation as possible.

b) **Sun pockets** – Design south-facing ‘sun pockets’ to function as comfortable outdoor gathering areas during the less comfortable seasons.

c) **Avoidance of overshadowing** – Prevent overshadowing by buildings and natural elements.

d) **South-facing slope** – Slope the surface toward the south and reflect solar radiation onto people to maximize the intensity of solar radiation.

e) **Dry landscape** – Ensure the surface of the landscape elements to be dry. It is because most of the energy will be absorbed by those surfaces and will be emitted by terrestrial radiation. Thus, less energy will go into evaporation.
f) **South-facing seating** – Public benches, chairs, and seating areas should always be facing a southerly direction in regions with winter climates.

g) **Calm spots** – Create outdoor spaces in the landscape so that they are in the “wind reduction zones” to benefit from a lower wind speed.

h) **Covered pedestrian area** – Using canopies, arcades, galleries, and other overhead shelter systems to cover primary pedestrian movement areas can provide weather protection and retard outgoing radiation at night.

i) **Proper windbreaks** – Select the porosity of windbreaks or shelterbelts to provide the desired amount of wind reduction and targeted size of wind reduction zones.

j) **Comfortable material** – Choose natural materials for paving and furniture to provide better thermal comfort to people.

k) **Flexibility** – Keep the environment flexible so that it can be changed over time to adapt to human comfort needs.

l) **Dark and solid surface** – Provide some dark or solid surfaces that can absorb solar radiation during the day and emit terrestrial radiation in the evening in order to enhance the microclimate in the evening.

3.2 Literature on Safety Design for Pedestrians

Safety, as one of the basic needs of people (Maslow, 1954), is an essential element to be considered in pedestrian-oriented urban street designs. If a street is well-used by pedestrians, it is more apt to be safe for people (Jacobs, 1961). From an environmental
design perspective, there are factors that play a significant role in affecting the pedestrians’ safety on urban streets. These issues include lighting, sightlines, entrapment spots, movement predictors, activity generators, sense of ownership, and finding help (Wekerle & Whitzman, 1995). In addition, accessibility also helps to enhance the safety of public spaces and to “makes all of a place usable for everyone” (Whyte, 1981, p.33).

**Lighting**

In designing urban streets, all pedestrian spaces, such as sidewalks, paths, entrances, alleys, laneways, inset spaces, access and egress routes, and signage, need to be well lit. Lighting needs to be consistent and placed properly. Lights should not be applied in places that are not intended for nighttime use to avoid confusion in way finding. The maintenance of lighting fixtures is also important for people’s safety. Security lighting may create blinding glare and/or deep shadows that may hinder the view for potential observers. This step should be carefully reconsidered. Human eyes need to adapt to night lighting and have trouble adjusting to severe lighting disparities. So, using lower intensity lights often requires more fixtures.

**Clear sightline**

Keeping sightlines clear for visibility purpose and being able to be seen by others can enhance safety on urban streets and in urban public spaces. Jacobs’s concept of “eyes upon the street” also explains the importance of seeing and being seen on an urban street (Jacobs, 1961). Elements on streets or buildings may have impacts on the “visual permeability” of the spaces (Wekerle & Whitzman, 1995, p.32), such as sharp corners,
walls, berms, fences, bushes, pillars, large columns, and hidden entrances. These are the areas that need more thoughts to create safer spaces for people. Furthermore, being seen by others is another concern of people in public places and need more consideration in urban design.

**Entrapment spots**

The definition of entrapment spots is “small, confined areas, adjacent or near a well-traveled route, that are shielded on three sides by some barrier” (Wekerle & Whitzman, 1995, p.33). Examples of entrapment spots are dark recessed entrances, gaps in tall shrubbery, and elevated or sunken areas. Useful techniques to change entrapment spots to create safer public areas involve adding activities, limiting access, changing lighting quality and using camera surveillance.

**Movement predictors**

Movement predictors mean that pedestrian’s movement can easily be predicted because there is no other route for pedestrians to choose (Wekerle & Whitzman, 1995, p.37). Some examples are pedestrian tunnels, narrow passageways, and pedestrian bridges in urban areas. Providing clear sightlines and appropriate lighting can improve the safety conditions in these situations.

**Activity generators**

The purpose of activity generators is to add eyes on the street or open spaces to make the place more secure (Wekerle & Whitzman, 1995). People will not use or watch the street if they have no reason to use or watch it (Jacobs, 1961). Social programs,
events and entertainment functions can attract more people into public spaces. Combining activities and developing off-hour activities can populate the place and make it safer for users (Wekerle & Whitzman, 1995). Putting a seating area next to a food stand and adding a telephone beside a playground or washroom are some examples that can be used in urban areas. Special events and outdoor cafes can bring people onto the street, especially at night time (Wekerle & Whitzman, 1995, p.49).

**Sense of ownership**

Increasing a sense of ownership can also increase the safety in urban public spaces (Wekerle & Whitzman, 1995, p.50). Creating a sense of ownership can help to show a clear demarcation between where public space is and where private space is. For example, a street that is open to vehicular traffic would be considered as public spaces. However, a visitor may hesitate when entering a small community garden because of the uncertainty of ownership of the space.

**Finding help**

Finding help is also a key factor in safety design, such as setting useful information systems and improving the legibility of the overall design. For instance, signage with basic information like simple maps, emergency information, telephone locations and washroom locations should be able to be seen at the entrances and activity nodes (Wekerle & Whitzman, 1995). Besides, urban public spaces need not to be only attractive to people, but also be legible to people so that they can make sense of the place.

**Accessibility**
Accessibility helps to make public spaces accessible and safe for everybody. In 2001, people who suffer from physical disabilities were about 12.4% of the entire population in Ontario (Human Resource Development Canada, 2004). Accessibility planning in urban designs is aimed to provide safe and accessible public spaces for everyone. In urban street design, accessibility can be achieved by designing public spaces that have accessible routes, ramps and smooth surfaces for people with physical difficulties to pass through safely (Goltsman & Gilbert, 2007).

**Summary**

Common safety problems are discussed with some recommended solutions in this chapter. With a better understanding of these safety problems, designers will be able to design the landscape properly to improve pedestrians’ safety on urban streets. Some safety design guidelines can then be generated for the design development.

**General guidelines:** (Atlas & Hopper, 2007; Goltsman & Gilbert, 2007; Jacobs, 1961; Marcus & Francis, 1997; Wekerle & Whitzman, 1994)

a) **Proper lighting** – Avoid poorly placed lights and ensure potential problem areas are well-lit: pathways, stairs, entrances/exits, parking areas, automated teller machines, phone kiosks, mailboxes, bus stops, children's play areas, recreation areas, pools, laundry rooms, storage areas, dumpster and recycling areas, etc. Proper lighting should be placed at proper heights.

b) **Camera surveillance** – Provide surveillance, especially in proximity to designated points of entry and opportunistic points of entry.
c) **Clear sightline** – Keep clear sightlines. Potential problem areas include sharp corners, walls, berms, fences, bushes, pillars, large columns, hidden entrances and planting near entrances.

d) **Avoidance of entrapment spots** – Avoid the creation of entrapment spots, such as dark recessed entrances, gaps in tall shrubbery, and areas that are elevated or sunken.

e) **Optional route** – Provide optional routes for pedestrians to choose from.

f) **Activity generators** – Provide different activities in public spaces to attract more people. Locate additional activities along an “active edge” to reinforce activity generators. Initiate off-hour activities on downtown streets.

g) **Sense of ownership** – Create a sense of ownership of a place.

h) **Effective information system** – The name of buildings should be easily seen, and main entrances should be obvious. At the same time, clear directional signs should be installed at public transit stops, taxi stands, and nearby streets. Simple and clear neighborhood maps will give a sense of welcome at entrances and active nodes.

i) **Physical accessibility** – Provide accessible routes, walking surfaces, curb ramps and entrances to enable people to access safely.

j) **Climate-responsive accessibility** – Pay more attention on design details of a project to maintain pedestrians’ safety in different seasons.

k) **Pedestrian flow continuity** – People should be using the sidewalk fairly frequently.
3.3 Literature on Social Interaction Designs for Pedestrians

Social interaction design is one of the important aspects in urban street design because urban streets act as stages for the social life of the city. It is the social interaction function of the street that makes it “the greatest urban space” (Whyte, 1988, p.10). A big portion of social activities and new information are generated when people get together every day on urban streets (Francis, 1987, p.23). Some concepts may give rise to the street redesign movement. The desire for people to walk and experience urban street activity and life is one of the most influential trends in urban street design (Francis, 1987, p.25). Another movement in street design has the broad theme of “street livability or sociability”, which focuses on the importance of the street environment as the social life of cities (Francis, 1987, p.26). These concepts may utilize different methods to address social interaction in street designs.

As describe by Whyte (1981, p.96), the “triangulation effect” is important for social interaction on urban streets. The stimulus can be physical objects or sights, such as a view to a landmark, a street band, sculpture, musicians, and entertainers (Whyte, 1981, p.96). These might not be excellent art works, but they are important to an urban street because these elements help to bond people together (Whyte, 1981).

Street plazas, as “an activity focus” (Lynch, 1981, p.443), function as a place for people and draws people together (Marcus & Francis, 1997, p.14). When designing a street plaza, the size of a street plaza is hard to standardize because every street has its own context. However, some aspects can help to give a sense to the design. Table 3.3-1
shows different distances that can be used in designing street plazas for different purposes.

<table>
<thead>
<tr>
<th>Source</th>
<th>Distance (meter)</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lynch</td>
<td>12</td>
<td>Intimate space</td>
</tr>
<tr>
<td></td>
<td>&gt;24</td>
<td>Pleasant human scale</td>
</tr>
<tr>
<td></td>
<td>&gt;137</td>
<td>Largest enclosed square</td>
</tr>
<tr>
<td>Gehl</td>
<td>Max 70 – 100</td>
<td>Watching events</td>
</tr>
<tr>
<td></td>
<td>Max 20 – 25</td>
<td>Seeing facial expression</td>
</tr>
</tbody>
</table>

Table 3.3-1: Dimensions for plazas (based on: Marcus & Francis, 1997, p.14)

**Summary**

The key points introduced in this chapter can be used in urban street design to promote social interaction on urban streets so that urban streets can become a place where people likes to use and feel comfortable to meet with friends. Some general design guidelines are synthesized from the literature and listed below.

**General Guidelines:** (Francis, 1987; Lynch, 1981; Marcus & Francis, 1997; Pressman, 1995; Whyte, 1981 & 1988)

a) **Commercial components** – Storefront close to sidewalks can improve the social life of urban streets.

b) **Socially comfortable seating** – Sitting should not only be physically comfortable, but also socially comfortable.

c) **Street amenities** – Simple amenities also enhance social interaction on streets, like benches, trash containers, clocks, drinking fountains, or different ledges.

d) **Triangular effect** – Physical objects or sights can be the stimulus to enhance social
activities.

e) **Street plaza in proper size** – The size of plazas for different purposes should be different: 70 to 100 meters are the maximum distance for watching events; and, if the purpose is to let people to see facial expression, 20 to 25 meters will be the maximum distance.

f) **Public art for social interaction** – Installed in public spaces to promote communication among viewers.

g) **Spaces for different programs** – Create series of spaces in different sizes to encourage special events.

h) **Advertisement** – Use bulletin boards, banners, screens or other ways to advertise upcoming events, new features, or the street itself.

### 3.4 Literature on Visual Experience Design for Pedestrians

Visual experience is as well crucial in the process of street design. This helps to improve the attractiveness of streets. Jane Jacobs believes that “if a city’s streets look interesting, the city looks interesting” (Jacobs, 1961, p.39). A city and its streets can be analyzed in terms of path, edge, node, district and landmark (Lynch, 1960). These terms mean not only the forms but also the functions of varies urban forms. The quality of these terms can be described as “imageability”, which is defined as the quality of a physical object “which gives it a higher probability of evoking a strong image in any given observer” (Lynch, 1960, p.9). Defining landmarks on urban streets helps to create
“stronger identities” and tie the city together (Lynch, 1960, 54). This can be done in two ways: “making the element visible from many locations or by setting up a local contrast with nearby elements” (Lynch, 1960, p.80).

Kaplan’s Preference Matrix (see Table 3.4-1) is another important theory that started in 1972 which was used to study people’s visual preference on rural and urban landscape. This theory focuses on finding people’s need of understanding and exploration in a landscape (Kaplan, Kaplan & Ryan, 1988). In the Preference Matrix, coherence and legibility enhance people’s understanding, and “provide information that can help with making sense of environment” (Kaplan, Kaplan & Ryan, 1988, p.13). By contrast, complexity and mystery suggest “the potential for exploration” (Kaplan, Kaplan & Ryan, 1988, p.13). From another point of view, coherence and complexity can be expressed the information in a two dimensional image, while legibility and complexity can be used to communicate a deeper meaning of the actual three dimensional spaces. Using these four factors in urban street design can help to create more enjoyable spaces for people.

<table>
<thead>
<tr>
<th></th>
<th>Understanding</th>
<th>Exploration</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-D</td>
<td>Coherence (order)</td>
<td>Complexity (richness)</td>
</tr>
<tr>
<td>3-D</td>
<td>Legibility (distinctiveness)</td>
<td>Mystery (unknown)</td>
</tr>
</tbody>
</table>

Table 3.4-1: Preference matrix (Kaplan, Kaplan & Ryan, 1998, pp.13)

In urban streets, spatial characteristics for pedestrians are different from those of the motorists (Rapoport, 1987). For example, pedestrians prefer a human-scaled place with interesting views whereas motorists prefer a wider as well as more open and
symmetrical images or objects. Table 3.4-2 shows some typical perceptual characteristics for motorists and pedestrians.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Motorist spaces</th>
<th>Pedestrian spaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradual curves &amp; long views</td>
<td><img src="image" alt="Diagram" /></td>
<td>Sudden changes in direction &amp; short views</td>
</tr>
<tr>
<td>Regular rhythms</td>
<td><img src="image" alt="Diagram" /></td>
<td>Irregular rhythms</td>
</tr>
<tr>
<td>Wide spaces</td>
<td><img src="image" alt="Diagram" /></td>
<td>Narrow spaces</td>
</tr>
<tr>
<td>Symmetrical</td>
<td><img src="image" alt="Diagram" /></td>
<td>Asymmetrical</td>
</tr>
<tr>
<td>Simple buildings</td>
<td><img src="image" alt="Diagram" /></td>
<td>Complex buildings</td>
</tr>
<tr>
<td>Gradual modulation &amp; small complexity range</td>
<td><img src="image" alt="Diagram" /></td>
<td>Sudden changes &amp; large complexity range</td>
</tr>
</tbody>
</table>

Table 3.4-2: Perceptual characteristics for motorist and pedestrian (Rapoport, 1987)

Urban streets design should be attractive in all seasons throughout the year. Keeping a street vivid and interesting all year long can help pedestrians to experience the changes of the street scene in different seasons and weather conditions, such as blooming flowers in spring, a water fountain in summer, leaf colour changing in the fall and snow
falling in winter. In a winter city, additional examples can be utilized to provide spaces for the presentation of ice sculpture installation, the setting of bold paving or furniture colours and special winter illumination and urban furniture.

In addition, designing for traffic-calming purpose not only provides safer urban streets, but also creates a more visually appealing space for pedestrians. The key in designing a traffic-free zone is “not to eliminate the automobile, but to separate vehicular and pedestrian movement” (Brambilla & Longo, 1977, p.17). In urban design history, traffic-free streets are not usually seen in downtown Toronto because “the creation of expensive and permanent auto-restricted zone to protect pedestrians does not seem necessary in Toronto” (Greenberg, 1987, p.194). When urban streets once were designed as vehicle-oriented, the width of the roadway was based on the traffic volume, and the leftover space would become the sidewalk for pedestrians (Heinz, 2006). This approach should be reversed in the design of a pedestrian-oriented street. The spaces for pedestrians will be the first thing to consider whereas the needs of vehicular traffic will come secondary (Heinz, 2006). Sidewalk widening and traffic calming could provide more space for tree planting, street furniture, and pedestrian scale streetlights (Greenberg, 1987, p.196) to create a series of public zones for pedestrian to enjoy.

However, it is impossible to set up a formula to calculate the width of every street’s sidewalk in a city because different streets in different cities have different functions and contexts. Another problem generated in the formula approach is that this gives “the same weight to one foot of walkway width as to another” (Whyte, 1988, p.77).
The context of a sidewalk is important and can change the way it works for “how a walkway works depends very much on what is on either side of it” (Whyte, 1988, p.77). Therefore, there is no “all-purpose optimum sidewalk width” (Whyte, 1988, p.78) for all urban streets.

Street trees and many other street elements, such as lamps, benches and trash receptacles, all have positive effects on pedestrians’ visual experience (Duarte, 2000). Street trees are also a powerful device in “defining and humanizing” the street spaces with a great visible impact (Duarte, 2000; Greenberg, 1987). In downtown Toronto, making the tree pit a walkable space contributes to a pedestrian-friendly design because urban sidewalks are usually very narrow (Greenberg, 1987, p.202).

Because urban streets are all linear spaces lined along with their buildings, the visual experience of pedestrians are gained from a serial vision of urban streets (Cullen, 1961). Different visual images people gathered along a street reveal various spatial characters of the street, which also stimulate people to generate diverse spatial feelings towards the environment (Smardon, 1986). For example, people may feel most comfortable in an outdoor space when its building walls are 1/2 to 1/3 of the height as the width of its opening. However, if the ratio is below 1/4, people will lose the enclosed feeling. When the height of street buildings is greater than the street width, the street spaces will perceive to resemble a “pit” (Smardon, 1986, p.127).

Summary

This chapter launched some theories and research on people’s visual experience.
in an urban area. Some key points and recommendations are generated as design guidelines below.


a) **Imageability** – Reinforce the design as a whole to create a strong image of the space.

b) **Coherence** – Provide order of the space so that people can understand the space.

c) **Complexity** – Provide richness in the urban spaces.

d) **Legibility** – Create spaces that people can make sense of.

e) **Mystery** – Create visual interest that people want to explore.

f) **Perceptual characteristic for pedestrian** – Use pedestrian-friendly forms and elements to create spaces.

g) **Interests between interior and exterior** – Doors and windows on the street increase people’s interest in interior and exterior activities along the street. Second-storey activity also influences the attractiveness of urban streets.

h) **Just-enough sidewalk width** – In order to let the pedestrians to feel good, the proportions within the sidewalk have to be balanced. Sidewalks should be just wide enough to be slightly crowded at peak times.

i) **Landmarks of the street** – Creating landmark by making the element visible from many locations or by setting up a local contrast with nearby elements” (Lynch, 1960, p.80) helps to tie the city together.
j) **Visual accessibility** – Minimize elevation changes in street design because it has some “physically and physiologically negative impact on people” when the elevation change is more than a foot (Whyte, 1981, p.58).

k) **Seasonal interests** – Provide seasonal interest by changing colours, textures of materials, and planting various species of plants.

l) **Natural elements** – Trees, especially big trees, can greatly increase the attractiveness of urban streets, and “channel the walkway and moderate the scale of the right-of-way” (Whyte, 1988, p.94).

m) **Public art for joy** – Use art in public spaces to “create a sense of joy and stimulate creativity” (Marcus & Francis, 1997, p.82).

3.5 Guideline Summary

The previous part has reviewed the literature related to the four key factors on urban street design. Some design guidelines have been generated to reflect the significance and impacts of different factors. In this chapter, design guidelines for each of the four key factors are explained in the literature review and are summarized in Table 3.5-1 along with the relevant literature sources. These guidelines will also be used as a checklist for the design comparison chapter.

<table>
<thead>
<tr>
<th>Category</th>
<th>Sources</th>
<th>Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal</td>
<td>Brown &amp; Gillespie 1995</td>
<td>a) Orientation of street elements</td>
</tr>
<tr>
<td>comfort</td>
<td>Brown &amp; LeBlanc 2007</td>
<td>b) Sun Pockets</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------</td>
<td>----------------</td>
</tr>
<tr>
<td></td>
<td>Caborn 1965</td>
<td>c) Avoidance of overshadowing</td>
</tr>
<tr>
<td></td>
<td>Pihlak 1983</td>
<td>d) South-facing slope</td>
</tr>
<tr>
<td></td>
<td>Pressman 1995</td>
<td>e) Dry landscape</td>
</tr>
<tr>
<td></td>
<td>Verge &amp; Williams, 1981</td>
<td>f) South-facing seating</td>
</tr>
<tr>
<td></td>
<td></td>
<td>g) Calm spots</td>
</tr>
<tr>
<td></td>
<td></td>
<td>h) Covered pedestrian area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>i) Proper windbreaks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>j) Comfortable material</td>
</tr>
<tr>
<td></td>
<td></td>
<td>k) Flexibility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>l) Dark and solid surface</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety</th>
<th>Atlas &amp; Hopper 2007</th>
<th>a) Proper lighting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jacobs 1961</td>
<td>b) Camera surveillance</td>
</tr>
<tr>
<td></td>
<td>Marcus &amp; Francis 1997</td>
<td>c) Clear sightline</td>
</tr>
<tr>
<td></td>
<td>Wekerle &amp; Whitzman 1994</td>
<td>d) Avoidance of entrapment spots</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e) Optional route</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f) Activity generators</td>
</tr>
<tr>
<td></td>
<td></td>
<td>g) Sense of ownership</td>
</tr>
<tr>
<td></td>
<td></td>
<td>h) Effective information system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>i) Physical accessibility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>j) Climate-responsive accessibility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>k) Pedestrian flow continuity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social interaction</th>
<th>Francis 1987</th>
<th>a) Commercial components</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lynch 1960 &amp; 1981</td>
<td>b) Socially comfortable seating</td>
</tr>
<tr>
<td></td>
<td>Marcus &amp; Francis 1997</td>
<td>c) Street amenities</td>
</tr>
<tr>
<td></td>
<td>Pressman 1995</td>
<td>d) Triangular effect</td>
</tr>
<tr>
<td></td>
<td>Whyte 1981 &amp; 1988</td>
<td>e) Street plaza in proper size</td>
</tr>
</tbody>
</table>
Table 3.5-1: Guideline summary

The literature review was structured based on the four key issues identified in the preliminary analysis of the site. The literature review resulted in the identification of indicators that can be measured and assessed to further investigate or enhance each of these key issues. This review also resulted in a synthesized set of design guidelines that support the design phase of the study. In the next chapter, site inventories and analyses will be presented based on the indicators associated with each key issue.
4. SITE INVENTORY AND ANALYSIS

In order to compare the key issues of the site more effectively and more thoroughly, site inventories and analyses were conducted. This chapter describes the inventory and analysis of each of the key issues that are anticipated to influence pedestrians’ experience of Gould Street: thermal comfort, safety, social interaction and visual experience. The site inventory method and its resulting analysis are presented for each issue.

4.1 Microclimate Inventory and Analysis

Microclimate consideration is an indispensable aspect in the landscape design of a winter city such as Toronto. According to the definition of the Livable Winter City Association, a “winter city” is a city “in which the average maximum day-time temperature is equal to or less than zero degree Celsius for a period of at least two months or longer” (Pressman, 1995, p.17). In this study, solar radiation and wind are the focus of study in the microclimate inventory and analysis.

**Method for microclimate inventory**

Two different methods were used to conduct the inventories for wind and solar radiation. First, the solar radiation inventory was done by analyzing a three dimensional computer model to generate sun pattern images on the critical days of the year. This *SketchUp* three-dimensional (3-D) model contained all the detail information of the existing street, such as building heights, street width and existing planting areas. The critical days included the Summer Solstice (the day with the longest period of sunshine
in the summer – June 21st), the Fall Equinox (September 21st), the Winter Solstice (the
day with the shortest period of sunshine – December 21st), and the Spring Equinox
(March 21st). On each day, the sun pattern images were produced for three periods
during the pedestrian rush hours of the street that were identified in the preliminary site
study, that is, 9:00am-10:00am, 11:30am-12:30pm, as well as 4:00pm-5:00pm. The
purpose of these images was to show the areas where the solar radiation could be the
most effective for people at the busiest time of the street. Twelve sun pattern images of
different periods and days were eventually produced for further sun analysis.

Subsequently, the site observation was employed to study the wind inventory.
The key information collected in the wind study was to identify the windy and calm
spots on the site since these results were directly related to the thermal comfort of
pedestrians. The wind patterns in urban built environments are usually complex and hard
to predict. Table 4.1-1 revealed the relationship between the wind speed and the level of

<table>
<thead>
<tr>
<th>Wind Speed</th>
<th>Pedestrian Discomfort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 4 m/h (6km/h)</td>
<td>No noticeable effect is felt.</td>
</tr>
<tr>
<td>4 - 8 m/h (6 - 13km/h)</td>
<td>Wind is felt on the face.</td>
</tr>
<tr>
<td>8 -13 m/h (13-21km/h)</td>
<td>Wind disturbs hair, flaps clothing, and extends a light flag mounted on a pole.</td>
</tr>
<tr>
<td>13 -19 m/h (21- 30km/h)</td>
<td>Wind raises dust, dry soil, and loose paper and disarranges hair.</td>
</tr>
<tr>
<td>19 to 26 m/h (30-42km/h)</td>
<td>The force of the wind is felt on the body.</td>
</tr>
<tr>
<td>26 to 34 m/h (42-55km/h)</td>
<td>Umbrellas are used with difficulty; hair is blown straight; and pedestrians have difficulty in walking steadily.</td>
</tr>
</tbody>
</table>

Table 4.1-1 Wind speed and pedestrian discomfort (Marcus & Francis, 1997, p.33)
pedestrian discomfort (Marcus & Francis, 1997, p.33), which was used in the site observation of the wind inventory. If the “felt” wind speed at one spot was higher or lower than the reported wind speed (indicated in the weather data) at the same time of the day, this spot would be considered as a windy or calm spot. According to the weather data of Toronto from 1971 to 2002 (see Table 4.1-2), the most frequent wind direction in winter was the west wind while that of summer was the east wind. The table also showed that the maximum wind gust came from west. Therefore, in the wind inventory, the west wind and the east wind are observed for the wind analysis and are used to indicate the typical summer and winter wind patterns.

<table>
<thead>
<tr>
<th>Daily average temp (°C)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-4.5</td>
<td>-3.9</td>
<td>0.4</td>
<td>6.4</td>
<td>12.3</td>
<td>17.3</td>
<td>20.7</td>
<td>20.4</td>
<td>16.2</td>
<td>9.7</td>
<td>4.6</td>
<td>-1.3</td>
<td>8.2</td>
</tr>
</tbody>
</table>

| Most frequent wind direction | W | W | E | E | E | E | E | E | W | W | E |
|------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|-----|

<table>
<thead>
<tr>
<th>Maximum gust direction</th>
<th>SW</th>
<th>SW</th>
<th>W</th>
<th>W</th>
<th>SW</th>
<th>W</th>
<th>W</th>
<th>W</th>
<th>NW</th>
<th>SW</th>
<th>W</th>
<th>SW</th>
</tr>
</thead>
</table>

Table 4.1-2: Weather data of Toronto
(Adapted from: Canadian Climate Normal 1971-2000)

Solar radiation analysis

Figure 4.1-1 shows the summer sun pattern. The area that is coloured in orange indicates where sunlight can be reached on June 21st. Figure 4.1-2 shows the sunshine area on Sep. 21st and Mar. 21st because the sun patterns of these two days are the same. Figure 4.1-3 shows the sunshine condition on Gould Street on Dec. 21st.

In accordance with the climate data of Toronto (Environment Canada, 2004), the daily average temperature in Toronto downtown was -1.3°C in December and 0.4°C in
March. Most pedestrians have preference to sunshine and calm zones in winter and spring respectively for they still feel the coldness outdoor. On the other hand, the daily average temperature in June and September was 17.3 °C and 16.2°C. In such conditions, most
people tend to have affinity to the shade and to enjoy the breeze when staying outside because of the increase in temperature. Therefore, in the sun analysis, the overlap area between the sun patterns of summer and fall will form a new pattern for the warm seasons (see Figure 4.1-4), and similarly, those of winter and spring will combine to create a new pattern for the cold seasons (see Figure 4.1-5). Consequently, the sun pattern during the cold season suggests the places where pedestrians can get comfortable sunshine on the street whereas the warm season sun pattern shows which parts of the street need more shady area. With reference to these two illustrations, the intensity of colour identifies the intensity of the solar radiation on the street, and the areas with red outline highlights where people can get sunshine from morning to afternoon.

Figure 4.1-4 shows the highest number of areas on the street that have access to sunshine during the warm seasons. However, the south-facing side of Gould Street in
front of the Kerr Hall will need to be shaded to improve pedestrians’ thermal comfort level during summer and early fall. As shown in Figure 4.1-5, the north side of the street and Lake Devo has sunshine in cold seasons, which can be served as comfortable places for people during late fall, winter and spring.

Figure 4.1-4: the warm season sun pattern on Gould Street

Figure 4.1-5: the cold season sun pattern on Gould Street
Wind Analysis

Figure 4.1-6 shows the wind pattern of a northwest wind, which is the most frequent wind in the cold seasons. These windy spots make pedestrians feel uncomfortable when the weather is cold. The calm areas in the cold seasons will be cozier for people. As shown in the wind pattern diagram in Figure 4.1-7, the windy area
will form a more pleasurable environment for pedestrians because of the cooling effect of the wind in the warm seasons. The calm areas, on the contrary, may be too warm or too hot for people during summer and early fall.

The overlap areas created from the northwest wind pattern and that of the cold-season sun pattern produces a new illustration which contains both the sun and wind patterns for the cold seasons (see Figure 4.1-8). Different areas in this figure represent different meanings – sunny-calm places (orange and pink), sunny-windy places (orange and blue), shady-calm areas (pink without orange), and shady-windy areas (blue without orange). However, based on these four images, there is no indication of a sunny-windy place or shady-calm area on the site. The sunny-calm places include the Lake Devo, the space in front of the Kerr Hall, the area between the LIB and the Kerr Hall, plus the southwest corner of the RCC building. These areas will be suitable places for people

Figure 4.1-8: Sun and wind pattern for the cold season
when the weather is cold. Shady-windy areas include the area between the LIB and the BKS, the northwest corners of the IMA, and the north side of the high-rise residential building. These open spaces are not satisfactory for pedestrians because of such environment make people feel uncomfortable in the cold seasons.

When the southeast wind pattern is overlapped with that of the sun pattern in the warm seasons, a new shape of both sun and wind patterns for the warm season is then formed (see Figure 4.1-9). The meaning of the colours in this figure is the same as that in Figure 4.1-7. The sunny-calm places (orange and pink) in the warm seasons include the Lake Devo and the space in front of the OKF and the SCC building. When these zones are existed as open spaces in the warm seasons, more shade areas should be considered in the plan. Nevertheless, the presence of the water pool (Lake Devo) can help to ease the over-heated condition of the site. The sunny-windy places (orange and blue) can be found...
on the south side of the Kerr Hall, the south side of the RCC building and the southeast corner of the LIB building. These areas will become thermally comfortable for pedestrians if more shades are placed along the street. With no shady-calm area (pink without orange) and a few shady-windy areas (blue without orange) identified in the warm season figure, solar radiation is expected to be strong along the whole street during the warm seasons.

4.2 Safety Inventory and Analysis

Method

To comprehend the pedestrian movement on Gould Street, site observation was used to identify the places that have safety concerns. Various aspects of the street are observed, including lighting, sightline, entrapment spots, optional routes and signage of the street. Some of the “unsafe” spots were marked on the site map to reveal the safety level of different zones of the street.

Analysis

In the safety analysis, three safety levels were identified by the site observation as noted in Figure 4.2-1, including level A (pale: safe spots), level B (pink: semi-safe spots) and level C (red: unsafe spots). In other words, the safety issues involved in areas in level C area are more serious than those in the level B areas. On the other hand, the level A areas are the safest area on Gould Street.
The zones in level A are open street spaces that usually make pedestrians feel safe to travel along Gould Street. These areas include the sidewalks on both sides of the street (see Figure 4.2-2). The different areas of level A, in fact, share some common characteristics which make those places a safe space for people. Firstly, these areas are commonly open and welcoming not only to pedestrians but also to vehicles. Secondly, the lighting quality of the level A sidewalks of street is better than those of the alleys and some other entrances.
The areas in level B are less safe than those in level A. For example, a level B, which is located beside the Lake Devo, has vegetations like shrubs and coniferous trees. A big natural stone is also placed in that area, which leads to a problem – the sightline of the pedestrians is then blocked by the stone as well as by the shrubs and the coniferous trees. Another level B area in question is the walking paths with one-meter in width found outside the SCC building (see Figure 4.2-3). Since the building on both sides have no window facing the path, this area becomes a dead space on Gould Street. A secondary entrance of the RCC building on Church Street intersection becomes the third example of the level B area with respect to the safety analysis. The entrance is indented making both the sightlines blocked from the street the building interior. The last example of level B areas is Dalhousie Street, between the high rise residential building and the ENG building. This quiet zone has pretty light pedestrian and vehicle usage because there is no entrance to any of the surrounding buildings from the pathway. However, this area can be seen by people in the grocery store and people in vehicles.
Level C areas need to pay the most attention because of their least safety level. The O’Keefe Lane, which is situated between the Ryerson Library and the “Sam the Record Man” store, is one of the examples that require effort on improving their safety condition (see Figure 4.2-4). The lane is a long narrow alley that is not well-lit at night. It functions as a service access for several businesses on the west side Yonge Street. The businesses include an adult cinema, a massage parlour, the Evergreen Street Mission and two strip bars. Many paths on the Ryerson campus have installed camera surveillance systems to ensure pedestrians’ safety, but the O’Keefe Lane has no such arrangement. Its safety problem has caused some negative impacts on the pedestrian safety on
Gould Street. The other unsafe level C area is the big arch-shaped entrances of the Kerr Hall, which connect Gould Street to the Ryerson Community Park. As shown in Figure 4.2-5, these two deep arches have big columns which block the sightline of pedestrian. As Wekerle and Whitzman’s “Safe Cities” stated that this spot was regarded as an example of an “entrapment” spot in urban design (Wekerle & Whitzman, 1995, p.36).

4.3 Social Interaction Inventory and Analysis

Methods

The analysis of social interaction is focused on the users of the street. A pedestrian movement pattern was employed to find out where and how people use Gould Street in this study. Several methods were utilized to ensure the most typical pedestrian movements on the street are recorded effectively and convincingly enough to reflect the reality. This is achieved through data collection, including the record of various pedestrian activities in different seasons, weather conditions, time of a day, and at a variety of zones on the street.

The site observation data reflecting the pedestrian movement was selectively collected in two seasons of the year: fall and winter. The fact that the data in spring and summer is not considered becomes a limited criterion of this study. However, since the site is adjacent to a university, Gould Street usually has more pedestrians in fall and winter than in spring and summer. The highest level of pedestrian traffic usually occurs on weekdays. Two weekdays were then selected in fall, which included a sunny day (Nov.
13th, 2007) and a rainy day (Nov. 21st, 2007). Similarly, two weekdays were chosen in winter, including a sunny day (Jan. 22nd, 2008) and a snowy day (Jan. 25th, 2008).

To understand the pedestrian movements at different times of the day, three rush hour periods of the street on weekdays were identified, which include the morning rush hour from 9:00am to 10:00am, the noon rush hour from 11:30am to 12:30pm, and the afternoon rush hour from 4:00pm to 5:00pm.

Moreover, three key observation spots were distinguished as the most active nodes during the three different rush hour periods on Gould Street. The first spot is located at the intersection of Yonge Street and Gould Street. As the starting point of Gould Street from the west, this intersection connects Gould Street to the busy Yonge Street corridor and the Dundas Subway Station. The second observation point is situated between Victoria Street and Bond Street. This part of the street is served as the center of connection from the Ryerson University to the matrix of the city. The third observation spot is the intersection of Church Street and Gould Street. This main conjunction has a large number of pedestrians crossing the roads because this crossroad connects four important university buildings to one another.

Last but not least, the pedestrian movement study is also targeted on pedestrian activities. Several questions were set by the observer to determine what types of data are necessary: 1) how many people are walking on which side of the sidewalk; 2) where and how many people are crossing the street; and 3) where and why are people stopping?

**Walking Analysis**
As Gould Street is right beside the Ryerson University in downtown Toronto, there are a large number of pedestrians using the street everyday, especially during the daily rush hours. The peak pedestrian flow can be more than 1200 people per hour. Most population of the street users is university students. The results of comparing the pedestrian walking patterns among these four days are not very distinguishable, yet it is obvious enough to show people’s preferable route on the street in different conditions.

As shown in Figure 4.3-1, pedestrians tend to use the south-facing sidewalks more than the north-facing ones on a sunny day in fall. The open spaces and sunny pockets on the street, such as the Lake Devo, also have many users even in late fall. People prefer to walk under the sun rather than on the indoor paths inside the Kerr Hall or the covered sidewalks located beside the Toronto Life Square. The sidewalks beside the high-rise buildings are also not well-used because of their windiness and shadiness. It is interesting to note that the sidewalk that leads people to the Ryerson Library is far more populated than many other parts of the street, but its width is obvious shorter than that of the other...
sidewalks of the street. Figure 4.3-2 shows the pedestrian pattern on a sunny day in winter. The south-facing sidewalks are a little more populated than the north-facing ones on a sunny winter day. However, the total pedestrian numbers in winter is less than that in fall even on a sunny day.

Figure 4.3-2: Pedestrian pattern on a sunny winter day

Using the data collected on a rainy day and a snowy day, the common pedestrian patterns are then obtained. Firstly, fewer pedestrians are using the street on a wet day than on a sunny day because people prefer to use indoor paths or covered sidewalks instead of the uncovered ones (see Figure 4.3-3 and Figure 4.3-4). Secondly, on a typical wet day, the south-facing and north-facing sidewalks have almost the same amount of pedestrian

Figure 4.3-3: Pedestrian waking pattern on a rainy fall day
flow because the solar radiation on both sides of the street is the same.

Figure 4.3-4: Pedestrian walking pattern on a snowy winter day

**Staying Analysis**

In the staying analysis, four different purposes of staying were identified, including eating, smoking, waiting for friends, and relaxing. Figure 4.3-5 shows that pedestrians with different purposes have different preferable areas for their stopping. For instance, people choose the places near a landmark to wait for their friends because these spots are easy to be identified by most people. Moreover, the “staying-for-relaxing”

Figure 4.3-5: Staying pattern of all four days
people like to choose those places with seating walls in the sunny pockets of the street. Food vendors typically choose the sunny and calm places that are closed to the major pedestrian flow.

Figure 4.3-6 shows the staying pattern on a sunny day in fall, whereas Figure 4.3-7 shows the same situation but in winter. The result reflects that there are more people staying on the street in fall than in winter, and people prefer to reside on the south-facing

Figure 4.3-6: Staying pattern on a sunny day in fall

Figure 4.3-7: Staying pattern on a sunny day in winter
sidewalks to enjoy the sunshine in the fall before the temperature gets too low. Moreover, the identified staying spots are concentrated in front of the Kerr Hall and near the intersection of Bond and Gould on a sunny day in the fall. In contrast, more staying zones in winter are located near the entrances of where people have convenient access to buildings.

Figure 4.3-8 shows the staying patterns on a rainy day in the fall, and Figure 4.3-9 shows the staying pattern on a snowy day in winter. It is understandable that only a few
people are staying on the street on rainy or snowy days; and, if they have to go outside to
get food or smoke, most of them will perform the action as quickly as possible.

The areas where pedestrians like to walk or stay on the street are considered to be
socially comfortable places. There are a number of zones that are recognized to be
thermally comfortable places and the socially comfortable places along Gould Street.
These places will be the highly desirable spaces to improve thermal comfort and social
interaction for people.

4.4 Visual Experience Inventory and Analysis

Method

To study the visual experience of the pedestrians on the street, Cullen’s serial
vision and the method used to analyze the spatial enclosure (Smardon, 1986) were chosen
to investigate the targeted spaces. Several sections of some of key areas of the street were
prepared to measure the degrees of street enclosure. Some photographs of the street
landmarks were selected for further analyses using Kaplan’s preference theory.

Analysis

The street sections in Figure 3.4-1 show the changes of conditions of the spaces
along Gould Street. The scale beside each section points out the ratio of the building
height to the street width to show the level of enclosure at certain zones of the street. As
shown in Figure 3.4-1, Section A-A shows the space at the west end of Gould Street has a
comfortable degree of enclosure. However, people may not have an impressive visual
Figure 4.4-1: Visual Experience Analysis
image of this part of the street because the space looks like a boring urban street with no street trees or any other type of plantings on both sides. Section B-B shows the street space between the Ryerson Library and the Book Store. The space may let pedestrians feel too enclosed since several high-rise buildings are situated on both sides of the street. The visual feeling make people sense like being in a pit, which is a common experience for people visiting downtown areas. After experiencing a very enclosed space, Section C-C illustrates an open space on Gould Street in which the previous enclosed feeling still some what persists. The street trees planted along the street divide and define the space into two parts – a street and a plaza. Section D-D shows that the space between the Kerr Hall and the IMA building has a comfortable degree of enclosure. The pedestrian walking spaces are right beside a vehicle path and the street trees are placed in planters along the buildings. The street section shown in Section E-E reveals a comfortable enclosed space between the Kerr Hall and the OAK house. The mature street trees along the street together with the three historical buildings on the south side of the street enhance the richness of this part of the street. Section F-F shows that a comfortable level of enclosure is offered in the street space between the RCC and the ENG buildings. However, street trees are only planted on one side of the street, and the street furniture are not set in an order which spoils the overall coherence of the space. Section G-G shows the space between the RCC building and the high-rise residential building. When walking on the south-facing sidewalk of this part of the street, pedestrians may experience a strong feeling of enclosure.
In Figure 4.4-1, three focal points along Gould Street are indicated, including the “Sam the Record Man” building (Focal Point 1), Lake Devo (Focal Point 2) and the sculpture of Ryerson Egerton (Focal point 3).

As the first focal point on Gould Street from the west, the “Sam the Record Man” building is a landmark located at the intersection of Yonge Street and Gould Street. Since this building is an old historical building with some graffiti drawn on the side wall (see Figure 4.4-2), the views of this intersection look untidy and mysterious. Moreover, because the street changes its orientation and sidewalk width without any hints to users, this ruins the coherence of the perception. People may feel awkward on their first visit to that part of the street. Therefore, this area is not visually preferable for pedestrians.

The second focal point – the Lake Devo, recognized as a well-designed plaza, is the most visually pleasant spaces on Gould Street and gains most of the users’ praises. The shape of the reflecting pond and the position of the rocks signify the order of the space. The big rocks further enhance the richness of the space which increases people’s affection towards the space. At the same time, as a distinctive place of the street, the plaza provides a common zone for short-time stay for large groups of people. However, as shown in Figure 4-4-3, the scenery of the Lake Devo is disturbed by the blank wall of the
IMG building situated on the east side of the plaza. This issue should be further addressed in the streetscape design.

The statue of Egerton Ryerson in front of Kerr Hall is the third focal point of Gould Street. The icon marks as an extension of the centerline of the Ryerson quad, and it is also function as a “visual centerline” of the street (see Figure 4.4-1). However, the statue is situated in a planter beside a trivial sidewalk only (see Figure 4.4-4). The existing street setting does not provide any reinforcement to the center of the street.

4.5 Summary

In this chapter, the four key issues of the site are analyzed revealing the strengths and weaknesses of the site. The results obtained from various analyses strongly influence the design development presented in the next chapter.
5. **DESIGN DISCUSSION**

This chapter presents a synthesis of all the potential designs. A discussion of the design concept marks the beginning of the study, in which the concept is derived out of the philosophical idea explored in Chapter One and the site issues identified in Chapter Two respectively. Following this concept development stage, three alternative design solutions are presented. These designs are influenced by the guidelines developed in Chapter Three and the site analysis presented in Chapter Four. Such design solutions are then compared to the existing site and evaluated in relation to the guidelines generated in Chapter Three.

5.1 Design Concept – Regenerating the River of Life of the City

Over the past decades, urban streets – “the river of life of the city”, have been slowly losing their vitality. The design concept of this project is to regenerate these urban streets. This concept is inspired from William Whyte’s idea of his famous Street Life Project (1980). According to his thought, urban streets were symbolized as rivers flowing and connecting different parts of the city. As long as this stream is flowing smoothly, the city will be vivid and vital.

In Figure 5.1-1, the typical form of a natural river is shown. The different patches on both sides of the river represent spaces that rely on the river to live. Figure 5.1-2 is the concept diagram applied to the study site. In this diagram, the paths represent the river, the places along the street represent the islands, and buildings on the street represent the
land adjacent to the river. The land on both sides of the river has different functions.

Similarly, the buildings situated along the streets will have various roles in a city. Walking on the street is like fish swimming in the river, and the islands become places to stay and rest. The river, islands, and fish will then be symbolized as a vivid conceptual image of an urban street.

Figure 5.1-1: Natural river (Source: http://maps.google.ca/maps?hl=en&tab=wl)

Figure 5.1-2: Concept diagram
5.2 Design Solutions

Three design options were developed to solve the same design problem – “improve pedestrians’ experience on Gould Street”. These three solutions include a traffic-free street design (Option 1), a partially-traffic-free street design (Option 2) and a traffic-normal street design (Option 3).

Option 1 – Traffic-free design

Designing traffic-free streets in the downtown of a city, especially for commercial streets, has been a common design strategy to solve the conflict of vehicle traffic and pedestrian flow. This design approach has many advantages as well as disadvantages. Figure 5.2-1 presents the site plan for Design Option 1, along with some street sections showing different pedestrian spaces along the street.

To design for pedestrians’ thermal comfort, the sunny and calm areas on Gould Street are developed to be seating areas and street plazas with deciduous trees or umbrellas so that pedestrians can enjoy themselves in the shade of trees in the warm seasons and sunshine in the cold seasons. Some of these warm and inviting places may also have food vendors to further attract people to come and stay in the area. For example, umbrella-covered seating, pergolas and a place for a food vendor are provided in the seating plaza between the Ryerson Library and the Kerr Hall, as well as the plaza between the RCC building and the ENG building. In addition, the south-facing side of the street is designed to have more benches than the north-facing side of the street because the north-facing side is usually more shady and windy.
To allow for pedestrians’ safety, the street is designed to be a traffic-free zone. It was discovered in the pedestrian movement analysis in this study that a large number of pedestrians were found to cross Gould Street at several key points, such as at the intersection of Victoria Street and Gould Street and the crossing between the RCC building and the ENG building. This became the major reason for designing a traffic-free street. In this proposal, the original vehicle path is raised to the same elevation as the sidewalk to improve pedestrian accessibility. Along the pedestrian-only part of the street, a seven-meter-wide corridor is reserved to be accessible and cleared for service and emergency vehicles only.

To improve pedestrians’ social interaction, Option 1 provides a variety of sizes of open spaces and flexible seating for different groups of people to participate in different social activities on the south-facing side of the street. Without the vehicle traffic, the street spaces will be quieter and safer for people to use and enjoy. A central plaza in front of the sculpture of Egerton Ryerson is designed to be the heart of the street at this location for major events.

To improve pedestrians’ visual experience, Option 1 promotes a street park in downtown Toronto. All street furniture is set beside planters on both sides of the street to create a more intimate feeling on the street environment. The arrangements of the benches, which are complementary to the planters, are not only comfortable to use, but also represent the land patterns adjacent to a natural river. A yellow-brown colour theme is used to match the colour theme of the buildings along Gould Street and represent the
colour of earth tone. The paving pattern is designed to be curvilinear to symbolize the river. The seating walls and movable benches are designed to be at different heights between 30 cm to 120 cm so that they look like the backdrop of the city, and can also serve the different needs of people.

Option 2 – Partially-traffic-free design

The distance between two intersections in a downtown area is usually very short, but the vehicle traffic is not always busy on every street. For this reason, some of the roads between intersections are unnecessary. Closing road segments affords the opportunity to create more open spaces and enhance pedestrian safety. The quality of such spaces can also be improved. In Option 2, most parts of the street are opened to vehicle traffic, and only a small portion of the street between Church Street and Dalhousie Street is traffic-free. This is because there are a large number of pedestrians crossing Gould Street at this location, and closing the street will enhance pedestrians’ safety on Gould Street. Figure 5.2-2 shows the site plan for Option 2 and detailed sections of the street.

To improve pedestrians’ thermal comfort, the vehicle path in Option 2 is kept to a minimum width and is moved further south to leave more space on the north side of the street where it is sunny and calm. A two-meter wide sidewalk is designed for the north-facing side along with a one-meter planting strip between the street and the buildings. The south-facing side of the street is used for seating and street plazas with public art integrated into the design.

To enhance pedestrians’ safety on Gould Street, the speed limit is lowered, and the
road is elevated at every intersection to work as a speed bump and a crossing for pedestrians. Street lamps and trash receptacles are placed along the curb on both sides of the street. In addition, the part of Gould Street between Church Street and Dalhousie Street is closed and designed to be a street plaza between the RCC and ENG buildings because a large number of pedestrian crossings occur there.

To improve social interaction of pedestrians, three street plazas are designed in Option 2. These plazas include a seating plaza between the library building and the Kerr Hall, a gathering plaza in front of the historical sculpture, and a pedestrian plaza on the closed part of the street. These plazas with seating will also have planting beds, food services or water features nearby to provide nice views and amenities for pedestrians as well as a place to talk with friends or enjoy hotdogs from the local vendors. Benches at different heights are simple and removable to improve the flexibility of the street so that different programs can be offered on the sidewalk without blocking the street.

To improve pedestrians’ visual experience in Option 2, a flowing pattern is used in the street paving to represent a natural river. To keep the continuation of this pattern, the material colour of the roadway may also need to be changed to reinforce the pattern. Street trees are planted in straight rows whereas the trees in the planting areas are placed to create a natural canopy on the street. A jagged form is used for the planting edges and benches on the south-facing side of the street, with a symmetrical central plaza designed to be the main gathering space for people. This physical combination of street furniture and walls represent the skyline of the city while also serving the needs of people.
Roadside parking is not allowed in this design to avoid vehicles blocking pedestrians’ views of the street.

**Option 3 – Traffic-normal design**

To enhance street life, Option 3 keeps all parts of the street open to vehicular traffic and pedestrian flow. Figure 5.2-3 shows the site plan of Option 3 and its related street sections.

To improve pedestrians’ thermal comfort on Gould Street, the north-facing sidewalk and the vehicular path of the street are designed to be at a minimum width, and the south-facing side of the street is made wider for sidewalks, seating and plantings. Sunny and calm areas are created to be gathering plazas with seating and food services.

To design for pedestrians’ safety, the street is opened to vehicular traffic so the street can accommodate different users all day long. The speed limit of the street is lowered, and speed bumps also work as pedestrian crossings at every intersection. To avoid roadside parking, the width of the road is kept to a minimum. The part of Gould Street between Church Street and Dalhousie Street is closed to avoid busy pedestrian crossings occurring at this location. A pedestrian plaza is created at the same location.

To improve the social interaction of pedestrians, some open spaces are created with seating, benches and art pieces on the south-facing sidewalk. These open spaces have different sizes and amenities for different programs and activities, such as large gatherings, small group gatherings and short conversational exchanges.

To improve people’s visual experience on Gould Street, some offset planting areas
with benches and flowing paving patterns are also used in Option 3. The street between Yonge Street and O‘Keefe Lane has been straightened to enhance the coherence of the street. A gentler curve is positioned between Bond Street and Church Street to line up with the other end of Gould Street on the east side of the intersection of Church Street. By doing this, the street spaces are more naturally presented and make more sense to the users.
Figure 5.2-2: Site Plan of Design Option 2
Figure 5.2-3: Site Plan of Design Option 3
5.3 Design Comparison

The existing street and the design options were evaluated with respect to the design guidelines to identify the strengths and weaknesses of each design solution in order to improve the pedestrians’ experience on Gould Street. As an exploratory study, the general guidelines of key factors are used as a checklist in the comparisons among the three design options and the existing site.

Thermal comfort comparison

The purpose of the first comparison is to understand to which extent the different design solutions address pedestrians’ thermal comfort. There are twelve guidelines in this category, and ten are applicable in this project. Table 5.3-1 shows that the existing street does not work very well in addressing this factor, but the three alternative design solutions meet most of the guidelines. In other words, these design guidelines help to improve the thermal comfort of pedestrians in these urban street designs.

Options 2 and 3 match eight out of ten applicable guidelines, and Option 1 matches nine out of ten guidelines. Flexibility is the guideline that Options 2 and 3 do not achieve. Option 1 (traffic-free street design) is more flexible by providing more places with different microclimatic conditions for people to choose. For instance, people can choose the place where they feel more comfortable, especially in the marginal seasons when some people feel warm and others feel cold. In contrast, Options 2 and 3 have fewer choices for pedestrians in different seasons or weather conditions. Therefore, the traffic-free design becomes the best choice to improve pedestrians’ thermal comfort.
Table 5.3-1: Design comparison of the thermal comfort guidelines

<table>
<thead>
<tr>
<th>Category</th>
<th>Guidelines</th>
<th>Existing street</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
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<td>a) Orientation of street elements</td>
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<td>✓</td>
<td>✓</td>
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<tr>
<td></td>
<td>b) Sun Pockets</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>c) Avoidance of overshadowing</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>d) South-facing slope</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>e) Dry landscape</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>f) South-facing seating</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>g) Calm spots</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>h) Covered pedestrian area</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>i) Proper windbreaks</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>j) Comfortable material</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>k) Flexibility</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
</tr>
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<td></td>
<td>l) Dark and solid surface</td>
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<td>✓</td>
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<td>3/10✓</td>
<td>9/10✓</td>
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</tbody>
</table>

Table 5.3-2 shows the results of the comparison of the safety guidelines. There are eleven guidelines in this category, and all of them are applicable to the study site. The results of the comparison show that all the design options can improve the safety of the existing site, and the existing street setting is not very responsive to pedestrians’ safety needs. Referring to Table 5.3-2, Options 2 and 3 meet all of the safety guidelines, whereas Option 1 only meets nine out of eleven guidelines.

In creating a sense of ownership, Option 1 may cause users to have confusion about the ownership of the spaces. For example, pedestrians may not use the street if the street does not look like a public street. In contrast, Options 2 and 3 have a normal public street setting, and the street is open to vehicular traffic. This setting will not confuse people.
even on their first visit.

<table>
<thead>
<tr>
<th>Category</th>
<th>Guidelines</th>
<th>Existing street</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>a) Proper lighting</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>b) Camera surveillance</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>c) Clear sightline</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>d) Avoidance of entrapment spots</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>e) Optional route</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>f) Activity generators</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>g) Sense of ownership</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>h) Effective information system</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>i) Physical accessibility</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>j) Climate-responsive accessibility</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>k) Pedestrian flow continuity</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Table 5.3-2: Design comparison of the safety guidelines

Another guideline which Option 1 does not achieve is continuity of pedestrian flow which requires keeping the street in use at most of the time. Traffic-free design enhances some street safety on one hand, but creates certain issues on the other end. Usually, pedestrian-only streets can avoid the conflict between vehicle traffic and pedestrian flow by establishing a vehicle-restricted zone. This design method is more popularly used in designing commercial streets (Brambilla, 1977). Gould Street is not a commercial street, and keeping the street continually in use by people is hard to achieve on a traffic-free street because the amount of pedestrian flow on Gould Street can vary widely at different times. In Option 1, it is hard to keep “eyes on the street” (Jacobs, 1961) at all times. Without vehicular traffic, the street might become a dead space at some times of the day because there are no people on the street. In Options 2 and 3, vehicular traffic, as one
kind of activity on the street, helps to keep the street active most times of the day. In other words, having vehicles on the street maintains life on the street and thus, in turn, helps to improve the safety of pedestrians.

Social interaction comparison

Table 5.3-3 shows the results of comparing the three designs with the social interaction guidelines. Of a total of eight guidelines, seven are applicable to the site. The results clearly show that the existing street is not working well in promoting social interaction. Design Option 1 is the best solution for improving social interaction, and meets all the design guidelines in this category. Option 2 achieves six out of seven guidelines, and Option 3 only meets five of them.

<table>
<thead>
<tr>
<th>Category</th>
<th>Guidelines</th>
<th>Existing street</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social interaction</td>
<td>a) Commercial components</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>b) Socially comfortable seating</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>c) Street amenities</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>d) Triangular effect</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>e) Street plaza in proper size</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>f) Public art for social interaction</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>g) Spaces for different programs</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>h) Advertisement</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>SI Total</td>
<td>7/8 applicable guidelines</td>
<td>0/7✓</td>
<td>7/7✓</td>
<td>6/7✓</td>
<td>5/7✓</td>
</tr>
</tbody>
</table>

Table 5.3-3: Design comparison of the social interaction guidelines

In Option 1, there are more spaces to accommodate street-related activities and programs. In this design, Gould Street looks more like a linear park than a street. In Options 2 and 3, the vehicular path occupies some street space, and this may lower the
street’s capacity and flexibility in accommodating events on the street.

Option 2 has more pedestrian spaces than Option 3 which may provide even more opportunities to enhance the triangular effect on the street by creating a link between people in different street spaces.

**Visual experience comparison**

Table 5.3-4 shows the comparison of the design options to the visual experience guidelines. There are thirteen guidelines in the visual experience design, and all of them are applicable in this project. The existing street design is not as good as the other designs since it only achieves six out of thirteen guidelines in this category. Option 1 satisfies twelve out of thirteen design guidelines while the other two design options achieve all the guidelines.

<table>
<thead>
<tr>
<th>Category</th>
<th>Guidelines</th>
<th>Existing street</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual experience</td>
<td>a) Imageability</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>b) Coherence</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>c) Complexity</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>d) Legibility</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>e) Mystery</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>f) Perceptual characteristic for pedestrian</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>g) Interests between interior and exterior</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>h) Just-enough sidewalk width</td>
<td>✓</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>i) Landmarks of the street</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>j) Visual accessibility</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>k) Seasonal interests</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>l) Natural elements</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>m) Public art for joy</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>VE Total</strong></td>
<td>13 applicable guidelines</td>
<td>6/13✓</td>
<td>12/13✓</td>
<td>13/13✓</td>
<td>13/13✓</td>
</tr>
</tbody>
</table>

Table 5.3-4: Design comparison of the visual experience guidelines
Option 1 does not meet the sidewalk width guideline as it provides walking spaces that are too wide for average pedestrian flows. This can have a negative impact on the pedestrians because of the vacuum effect on the street. In this case, people may feel the spaces between each other are too wide. In Options 2 and 3, the width of the south-facing sidewalk can be adjusted to accommodate different events or abnormal pedestrian flows by rearranging or removing the movable seating.

**Overall comparison**

Table 5.3-5 shows the comparison results of all the categories. In all forty-four guidelines, forty-one of them are applicable to this project. The results show that all of the design options address the key issues of the site much better than the existing street design. The existing site only meets twelve out of forty-one guidelines. Option 2 achieves thirty-nine out of forty-one guidelines, and becomes the best solution in improving pedestrians’ experience on Gould Street. Option 1 is the worst choice of these three design solutions, yet thirty-six guidelines are still achieved. In other words, the pedestrians’ experiences on Gould Street will be greatly improved by following the general guidelines.

In general, when addressing the pedestrians’ thermal comfort on an urban street, Option 1 is the best choice. If safety concern is the most important objective in an urban street design, Options 2 and 3 are better choices than Option 1 because they keep vehicular traffic on the street. In promoting the social interaction of pedestrians, Option 2 is slightly better than Option 3. Option 1 works best in solving the social interaction
issues, but is the least successful in addressing the other three design factors. If the visual experience of pedestrians is the first priority in designing an urban street, Options 2 and 3 will be better than Option 1. On the other hand, Option 1 will be the best choice if the street is a commercial street. All in all, Option 2 is the best solution in addressing these four issues that affect the success of urban street design in Toronto because this option provides pedestrians a safe and attractive streetscape with public open spaces along the street for social interaction.

<table>
<thead>
<tr>
<th>Category</th>
<th>Guidelines</th>
<th>Existing street</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC Total</td>
<td>10/12 applicable guidelines</td>
<td>3/10 ✔</td>
<td>9/10 ✔</td>
<td>8/10 ✔</td>
<td>8/10 ✔</td>
</tr>
<tr>
<td>SI Total</td>
<td>7/8 applicable guidelines</td>
<td>0/7 ✔</td>
<td>7/7 ✔</td>
<td>6/7 ✔</td>
<td>5/7 ✔</td>
</tr>
<tr>
<td>VE Total</td>
<td>13 applicable guidelines</td>
<td>6/13 ✔</td>
<td>12/13 ✔</td>
<td>13/13 ✔</td>
<td>13/13 ✔</td>
</tr>
<tr>
<td>Total</td>
<td>41/44 applicable guidelines</td>
<td>12/41 ✔</td>
<td>36/41 ✔</td>
<td>39/41 ✔</td>
<td>38/41 ✔</td>
</tr>
</tbody>
</table>

Table 5.3-5: Design comparison of all the design guidelines

**Summary**

Using the design guidelines as a checklist, this design comparison shows the strengths and weaknesses of different design solutions in addressing the four key issues. There is no perfect solution for every aspect of urban street design because different design solutions always help solving some problems while giving rise to other issues. Therefore, in a project, the key to choosing the best design approach is to first understand the problem of the site and then set appropriate design objectives to solve the issues.

Because the guidelines are generated from the literature review which has guided
many landscape designs to a great success, an assumption was made at the beginning of this study – the design option with the highest amount of design guidelines met would be the best design. However, these comparisons show that different design approaches may better address different factors in urban street design. In the design process, the “best” design approach depends on which objectives are the most important to meet in the project.
6. OBSERVATIONS AND CONCLUSIONS

The purpose of this chapter is to summarize the research and to place the results in the context of professional practice. Observations are made with respect to the assumptions and limitations of the study and suggestions on future studies are then derived. Finally, the chapter concludes with the discussion and analysis of various design approaches and the evaluation of pedestrians’ urban experience.

6.1 Applicability of Guidelines and Methodology

This study shows that in urban street design, different design factors that improve pedestrians’ experience on urban streets can be addressed through different design solutions. The study site, Gould Street, represents one kind of typical urban street with a large number of pedestrians in a downtown area. Similar urban streets in Toronto may have those common key issues as found in Gould Street. The methodology used in this study and the conclusions may be applicable to other urban street designs. Correspondingly, the general street design guidelines in this thesis may also be applied to similar urban street designs in Toronto or in other big cities.

Moreover, site investigation is the key in urban street design that helps a designer to understand the relevant character of a site and the needs of its pedestrians. The key issues of urban streets with different contexts could be totally different, but the site study method may still be useful in other situations.
6.2 Detail Design Observations

From the synthesis of literature review, site analysis and development of design options, the following observations are offered as means to enhance pedestrians’ experience on urban streets in Toronto through design.

**Thermal comfort design**

Pedestrians’ thermal comfort on urban streets in a winter city such as Toronto is the most basic objective that needs to be addressed in urban street design. Gould Street, studied in this research, is a secondary east-west street in downtown Toronto. Some results of the study can be applied to other similar street designs to improve people’s thermal comfort. For example:

- Narrowing the north-facing sidewalk and the vehicular path to widen the south-facing side of the street is an approach used in all three solutions. By doing this, more plantings and small open spaces can be created on the south-facing side of the street in a downtown urban area.
- Sunny pockets with deciduous trees are the best areas for creating open spaces on an urban street so that people can enjoy sunshine in the cold seasons and tree shade in the warm seasons.
- Seating on urban streets should be south-facing with some deciduous trees to enhance people’s thermal comfort. In addition, it is also better to choose wooden benches instead of any other materials.
- Windy areas should not be used as public open spaces on urban streets not only
because they are not comfortable for people, but also more seriously because the wind channeling effect may hurt pedestrians in a dense urban area.

- Covered pedestrian areas are usually used for bus-waiting areas, but these are not very appropriate and practical for normal sidewalks in Toronto.

**Safety design**

Safety is another basic requirement of a pedestrian that needs to be met on an urban street. The safety recommendations are applicable to all the urban streets in Toronto. Paying more attention to urban street details can greatly enhance the visual and physical accessibility of urban streets. Some examples are:

- Street lighting should satisfy all the street users and create consistent lighting quality on urban streets. In historical neighborhoods, the street lighting is usually insufficient and inconsistent because different parts of the street may have been undergone some reconstruction in the past. For example, there are more than four types of lighting fixtures that do not line up with each other on Gould Street. In the future, the street layout, furniture and its lighting design should be kept consistent after all construction work is completed.

- Medium and large shrubs are not very appropriate to use in street design as they may block people’s sightlines on the street. However, small shrubs, perennials and trees are recommended for street plantings.

- To create a sense of a public street space, urban streets should be kept open to their users, including pedestrians, bicycle cyclists and drivers.
It is also important to be “climate responsible” in urban street design. Examples include reserving a snow accumulation strip beside sidewalks, keeping pedestrian spaces accessible for snow plows, and using anti-slip material for paving.

**Social interaction design**

The importance of social interaction consideration in urban street designs should be recognized. Recommendations drawn from this study can improve people’s social interaction on the streets, and can be applied to the other similar situations. For instance:

- To improve social interaction, more flexible street seating should be designed so that the seating space can be changed to suit various purposes. The arrangement of seating shall be able to offer people with more choices and provide people with different scenes to enjoy.

- Introducing public art into street spaces also makes the street environment more inviting and helps to promote more social activities for pedestrians.

**Visual experience design**

The image of the city is composed of the representation of its streets; whereas the impression of streets is abstracted from the visual experience of people. Recommendations for improving people’s visual experience may also be applicable to other street design in similar urban settings. For example:

- Design concepts can improve the imageability of the streets by reinforcing the street design as a whole. In the city of Toronto, special design concepts should be developed for different kinds of streets. For example, community streets in a neighbourhood can follow
the same concept but different design solutions can be used. With this approach, the image of the whole neighbourhood can be reinforced, and every street can still have a unique design to show its own strengths. In this way, the city would then deliver a stronger image to people.

- It is also important to consider that spaces for people should have some perceptual characteristics for pedestrians. This is usually overlooked when designing pedestrian-oriented streets in a vehicle-oriented city. The spatial feeling of a pedestrian on a street is different from that of a person in a vehicle, or a person in a building.

- In a pedestrian-oriented urban street design, the visual weight of the vehicular path should be as light as possible. In other words, the roadway should be designed as narrowly as possible to minimize its visual impact on pedestrians while plantings and small open spaces should be created to make the street visually more welcome and delightful.

- At the same time, sidewalk width should be just enough to fit normal pedestrian flow. Having wider sidewalks does not imply the offering of a better visual experience to pedestrians.

6.3 Limitations

As an exploratory research, the methodology of this study has some limitations which may have an impact on the results of the study.

First, in the design comparison process, the researcher’s personal bias may have an impact on the validity of the comparison results. If other professionals and street users in
Toronto could also participate in the design and evaluation process, the results of this study may be more objective.

A second limitation of this study is that the results of the design options cannot be actually measured on the site because they will not be built. If the designs could be built, site inventories and analyses could be conducted which would provide more valid data to support the design evaluation.

In the design comparison, the counting of the total number of achieved guidelines for each design solution is not a valid way to determine the success of the design solution. These numbers only show one way to measure the outcome of the design in addressing one of the key factors. In a design project, the optimum suitability of a design comes from the synthesis of a good balance between its strengths and weaknesses.

6.4 Further studies

There are four possible further studies on several related topics that can be useful for developing a comprehensive guideline on urban street design for Toronto.

The first topic is to re-evaluate the design options by surveying the preferences of street users in Toronto. By using this kind of evaluation study, it would be possible to get a better understanding of pedestrians’ preferences with respect to different design approaches to urban street design.

The second one is to re-evaluate the design guidelines of this thesis by applying them to the design of a similar urban street. This study would help to improve and revise
the guidelines when they are applied to similar sites.

The third is to re-examine the design guidelines of this thesis by comparing these guidelines to another street of similar urban situation that is successfully designed and is well-used by pedestrians. The results of the comparison in this study could be used to test and finalize the design guidelines.

The fourth is to develop a similar study on different kinds of urban streets, such as south-north urban streets, major streets, commercial streets and residential streets. Combining the results from all these studies and this thesis, a comprehensive set of design guidelines for urban street design in Toronto could be developed, and would add greater validity for application to urban street redevelopment in Toronto.

6.5 Conclusion

Nowadays, as an indispensable element in the city, urban streets have become only a path for people, and the other important characteristics of streets, the street as place, has not received adequate attention in urban design. As demonstrated in this thesis, the design based on the suggested factors, which improve pedestrians’ experience on urban streets, can offer opportunities to bring people back to urban streets, to create interesting spaces for pedestrians, and thus to reinforce the image of the city. If the urban street is “the river of life of the city” (Whyte, 1981), regenerating this “river” will contribute greatly to creating lively and vivid street image in the album of the city.
7. REFERENCES


APPENDIX A: PEDESTRIAN MOVEMENT DATA

DATE: NOV. 13, 2007
TIME: 9:00AM-10:00AM
TEMP.: 7.1 °C (SUNNY)
WIND: WN 7km/h

PEDESTRIAN MOVEMENT INVENTORY

Legend:
- 0-20% 1-250 p/h
- 20-40% 250-500 p/h
- 40-60% 500-750 p/h
- 60-80% 750-1000 p/h
- 80-100% 1000-1300 p/h

STAYING POINT
MAIN ENTRANCE

NOTE: 1. MAXIMUM OBSERVED PEDESTRIAN FLOW TO BE 100%.
2. p/h -- person per hour.
3. WEATHER DATA SOURCE: ENVIRONMENT CANADA (http://www.climate.weatheroffice.ec.gc.ca)
NOTE: 1. MAXIMUM OBSERVED PEDESTRIAN FLOW TO BE 100%. 2. p/h -- person per hour. 3. WEATHER DATA SOURCE: ENVIRONMENT CANADA (http://www.climate.weatheroffice.ec.gc.ca)
PEDESTRIAN MOVEMENT INVENTORY  
DATE: NOV. 13, 2007  
TIME: 16:00PM - 17:00PM  
TEMP.: 7.6 °C (SUNNY)  
WIND: W11 km/h

LEGEND:
- 0-20% 1-250 p/h
- 20-40% 250-500 p/h
- 40-60% 500-750 p/h
- 60-80% 750-1000 p/h
- 80-100% 1000-1300 p/h
- STAYING POINT
- MAIN ENTRANCE

NOTE: 1. MAXIMUM OBSERVED PEDESTRIAN FLOW TO BE 100%.  
2. p/h -- person per hour.  
3. WEATHER DATA SOURCE: ENVIRONMENT CANADA (http://www.climate.weatheroffice.ec.gc.ca)
PEDESTRIAN MOVEMENT INVENTORY

DATE: NOV. 21, 2007
TIME: 9:00AM-10:00AM
TEMP: 4.7 °C (MODERATE RAIN)
WIND: N 19km/h

NOTE: 1. MAXIMUM OBSERVED PEDESTRIAN FLOW TO BE 100%.  2. p/h -- person per hour.  3. WEATHER DATA SOURCE: ENVIROMENT CANADA (http://www.climate.weatheroffice.ec.gc.ca)
PEDESTRIAN MOVEMENT INVENTORY

DATE: NOV. 21, 2007
TIME: 11:30AM-12:30PM
TEMP: 5.3 °C (RAIN)
WIND: NE 6km/h

LEGEND:

- 0-20% 1-250 p/h
- 20-40% 250-500 p/h
- 40-60% 500-750 p/h
- 60-80% 750-1000 p/h
- 80-100% 1000-1300 p/h
- STAYING POINT
- MAIN ENTRANCE

NOTE: 1. MAXIMUM OBSERVED PEDESTRIAN FLOW TO BE 100%.
   2. p/h -- person per hour.
   3. WEATHER DATA SOURCE: ENVIRONMENT CANADA (http://www.climate.weatheroffice.ec.gc.ca)
PEDESTRIAN MOVEMENT INVENTORY

DATE: NOV. 21, 2007
TIME: 4:00PM-5:00PM
TEMP: 4.4 °C (MODERATE RAIN)
WIND: N 17km/h

LEGEND:

- 0-20% 1-250 p/h
- 20-40% 250-500 p/h
- 40-60% 500-750 p/h
- 60-80% 750-1000 p/h
- 80-100% 1000-1300 p/h

STAYING POINT
MAIN ENTRANCE

NOTE: 1. MAXIMUM OBSERVED PEDESTRIAN FLOW TO BE 100%.  2. p/h -- person per hour.
3. WEATHER DATA SOURCE: ENVIROMENT CANADA (http://www.climate.weatheroffice.ec.gc.ca)
PEDESTRIAN MOVEMENT INVENTORY

DATE: JAN. 22, 2008
TIME: 9:00AM-10:00AM
TEMP.: -2.4 °C (SNOW)
WIND: NW 32km/h. WINDCHILL: -10 °C

NOTE: 1. MAXIMUM OBSERVED PEDESTRIAN FLOW TO BE 100%. 2. p/h -- person per hour. 3. WEATHER DATA SOURCE: ENVIRONMENT CANADA (http://www.climate.weatheroffice.ec.gc.ca)
PEDESTRIAN MOVEMENT INVENTORY  DATE: JAN. 22, 2008
TIME: 11:30AM-12:30PM  TEMP: -0.9 °C (SNOW)
WIND: NW32km/h. WINDCHILL: -8°C

LEGEND:
← 0-20% 1-250 p/h  ← 20-40% 250-500 p/h  ← 40-60% 500-750 p/h  ← 60-80% 750-1000 p/h  ← 80-100% 1000-1300 p/h

NOTE: 1. MAXIMUM OBSERVED PEDESTRIAN FLOW TO BE 100%.  2. p/h -- person per hour.
   3. WEATHER DATA SOURCE: ENVIROMENT CANADA (http://www.climate.weatheroffice.ec.gc.ca)
PEDESTRIAN MOVEMENT INVENTORY

DATE: JAN. 22, 2008
TIME: 16:00PM - 17:00PM
TEMP.: -1.3 °C (SNOW)
WIND: S35km/h. WINDCHILL: -9°C

LEGEND:

0-20% 1-250 p/h  20-40% 250-500 p/h  40-60% 500-750 p/h  60-80% 750-1000 p/h  80-100% 1000-1300 p/h

STAYING POINT MAIN ENTRANCE

NOTE: 1. MAXIMUM OBSERVED PEDESTRIAN FLOW TO BE 100%.  2. p/h -- person per hour.
3. WEATHER DATA SOURCE: ENVIROMENT CANADA (http://www.climate.weatheroffice.ec.gc.ca)
PEDESTRIAN MOVEMENT INVENTORY

DATE: JAN. 25, 2008
TIME: 9:00AM-10:00AM
TEMP: -7.1 °C (SUNNY)
WIND: SE 11km/h. WINDCHILL: 12°C

LEGEND:

0-20% 1-250 p/h 20-40% 250-500 p/h 40-60% 500-750 p/h 60-80% 750-1000 p/h 80-100% 1000-1300 p/h

NOTE: 1. MAXIMUM OBSERVED PEDESTRIAN FLOW TO BE 100%. 2. p/h -- person per hour. 3. WEATHER DATA SOURCE: ENVIRONMENT CANADA (http://www.climate.weatheroffice.ec.gc.ca)
PEDESTRIAN MOVEMENT INVENTORY

DATE: JAN. 25, 2008
TIME: 11:30AM-12:30PM
TEMP.: -6.1 °C (SUNNY)
WIND: SE 13km/h. WINDCHILL: -11°C

LEGEND:

- 0-20% 1-250 p/h
- 20-40% 250-500 p/h
- 40-60% 500-750 p/h
- 60-80% 750-1000 p/h
- 80-100% 1000-1300 p/h

STAYING POINT
MAIN ENTRANCE

NOTE: 1. MAXIMUM OBSERVED PEDESTRIAN FLOW TO BE 100%.  2. p/h -- person per hour.
3. WEATHER DATA SOURCE: ENVIRONMENT CANADA (http://www.climate.weatheroffice.ec.gc.ca)
PEDESTRIAN MOVEMENT INVENTORY

DATE: JAN. 25, 2008
TIME: 4:00PM-5:00PM
TEMP: -5.4 °C (SUNNY)
WIND: SE 15km/h. WINDCHILL: -11°C

LEGEND:

0-20% 1-250 p/h
20-40% 250-500 p/h
40-60% 500-750 p/h
60-80% 750-1000 p/h
80-100% 1000-1300 p/h

STAYING POINT
MAIN ENTRANCE

NOTE: 1. MAXIMUM OBSERVED PEDESTRIAN FLOW TO BE 100%. 2. p/h -- person per hour.
3. WEATHER DATA SOURCE: ENVIRONMENT CANADA (http://www.climate.weatheroffice.ec.gc.ca)