A Simulation-Assisted Workflow for Outdoor Thermal Comfort Design in Downtown Syracuse

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A SIMULATION-ASSISTED WORKFLOW FOR OUTDOOR THERMAL COMFORT DESIGN IN DOWNTOWN SYRACUSE

Pouya Zhand
Advisor: Prof. Tarek Rakha

Clinton Square, Syracuse. Photo by Pouya Zhand

Pouya Zhand
Advisor: Prof. Tarek Rakha
Cities are not just about the buildings and skylines. Cities are also about the space between buildings. (the ground in figure-ground). More importantly and fundamentally cities are about people and the life that happens between buildings.
For the first time in the history, shortly after the millennium, the majority of the global population became urban rather than rural. Cities have grown rapidly, and urban growth will continue to accelerate in the years ahead. World’s urban population is expected to increase by 80% by 2050, from 3.3 billion in 2007 to 6.4 billion in 2050. In this rapid growth, cities and city spaces play a huge role on our life. Studies have proven that live, safe and healthy cities and public places can spark economic growth, as well as build communities and affect individuals’ mental and physical health.
Numerous studies in fields ranging from social psychology to magazine cover design have proved that nothing grabs people’s attention more than other people, especially other people’s faces. We are hard-wired with a desire for congenial places to gather. That’s why it’s particularly surprising how much we overlook the importance of public places today.

1) **Economical growth** (GDP, standard of living)
2) **Community Engagement** (Sense of belonging, Population growth (Density), Level of activity)
3) **Mental and physical health** (QOL, Life expectancy, Healthcare costs)
The average American spends 87% of their life indoors, then another 6% of their life in automobiles. That’s only 7% of your entire life outdoors. So the role of the designer is how by a series of successful public interventions can increase the percentage of the Life between buildings.
Simulation tools can inform the design of attractive public spaces by providing insight about the environmental conditions.
Thesis Chapters

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1. Public Places (Research)
“It is difficult to design a space that will not attract people; What is remarkable is how often this has been accomplished.”

- William H. Whyte
Modernists rejected the city and city space, shifting their focus to individual buildings.

Source: Jan Gehl, *Cities for people*
Car Invasion:
Factors to design successful public places:

**Safety**
- Protection from crime
- Protection from traffic
- Protection from the elements
- Public watch
  (View in and from)

**Accessibility**
- Conveniently located public transit stops
- Alternate modes of transportation
- Proximity
- Walkable
- Visual accessibility

**Visual/Design**
- Desired path
- No blank walls or dead zones around the edges
- Aesthetic quality
- Human-scale
- Elements of Nature (Green)
- Welcoming & Inviting

**Activity & Use**
- Opportunities for conversations
- Opportunities for play
- Place to stop and stand
- Place to walk
- Gathering points
- Flexible
- Sittable
- Customizable

**Thermal Comfort**
- Protection from harsh climate
- Relatively more comfortable
- Opportunities to enjoy good weather
Focus of this thesis:

Accessibility
- conveniently located public transit stops
- Alternate modes of transportation
- Proximity
- Walkable
- Visual accessibility

Visual/Design
- Desired path
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Place
Without thermal comfort the best designed public places tend to fail.

Why thermal comfort matters?
|   | Outdoor thermal comfort |
What is thermal comfort?

“That condition of mind which expresses satisfaction with the thermal environment and is assessed by subjective evaluation” (ANSI/ASHRAE Standard 55-2010)
The mean radiant temperature (Tmrt) is among the most important variables affecting human thermal comfort in an outdoor urban space (Lindberg, 2008).

Tmrt is the uniform temperature of an imaginary enclosure in which radiant heat transfer from the human body is equal to those in the actual non-uniform enclosure (ISO, 1998).

It is the composite mean temperature of the body’s radiant environment. Compared with convection or evaporation, radiative energy exchange accounts for a large share of human heat transfer (Folk, 1974) and it is closely correlated with outdoor thermal comfort as well as pedestrian activities (Nikolopoulou et al, 2006).

Mean Radiant Temperature (Tmrt):
Contributing Factors

- Air Temperature
- Air Movement
- Clothing
- Metabolic Rate
- Food and Drink
- Body Shape
1. Solar Radiation
2. Atmospheric long-wave radiation
3. Long-wave radiation from urban surfaces
3. Development of the tool
3D Model

Urban Analysis

XML
Wall

XML
Window

XML
Ground

Solver

Surface Temperatures

MRT
| 4. | Case study design |
The image of the city - Kevin Lynch: 5 elements
The image of the city: 1) Landmark
The image of the city: 2) Node
The image of the city: 3) Path
The image of the city: 4) District
The image of the city: 5) Edge
The image of the city: Site
Solar hour study of downtown Syracuse and site

March 21  June 20  September 22  December 21
Site and Intersection
Galleries Lot
17,000 sqft
80 Parking Space

Current situation
1 - Material and footprint showed the most impact on the outdoor thermal comfort of surroundings.

2 - Passive strategies are effective but only during warmer months in Syracuse.

3 - Relying on only passive strategies can not be enough in providing outdoor thermal comfort specifically in the colder months of the year in Syracuse.
Adaptable architecture

Indoor

- Cafe/Bar
- Bike Share Store

Outdoor (Multi-Purpose)

- Sport venue
- Public classes
- Farmer’s Market
- Plaza
- Dance stage
- Ice skating rink
- Concert

Indoor

- Indoor flower garden
- Urban Living Room (Public lounge)
- Convenience store

Programs: 24/7, attracts different group of people
Indoor flower garden
Urban Living Room (Public lounge)
Convenience store
Cafe/Bar
Bike Share Store

Programs: distribution
Diagrid exoskeleton

Heating/Cooling Radiant System

Ramp System

Reinforced concrete
Radiation study
Long section
View from Warren street Southbound

View from Maddison street Westbound
View from Cafe/bar

View from indoor garden
Highlights of the simulation results
Ability to directly plug in Rhino Model

Ability to analyze complex geometries

Needs expertise

Glazing

Material

Vegetation and Water
Simulation tools can inform the design of attractive public spaces by providing insight about the environmental conditions. However, there are limitations and considerations.
The simulation tools are aids in design. Designers and city planners rely on intuition to design public spaces. Thus, many public spaces fail all around the world. Most of them have a general knowledge about the climate and sun paths. But if designers have access to tools that simulate the actual real situation it can inform the design more effectively therefore, there is a greater chance to create a successful public space. This aid can be more needed specially in where harsh climate and a precise analysis can be crucial.