Thesis Proporsal

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PART I: Scholarly Framework

Title:

Tracking the move: Experimentation of a computational method for studying environment and pedestrian movement relationships in urban places

Statement:

People create structures in context of places; those structure then condition the making of people. In that recursive process, people and places change, continually. . . . What we lack in these theoretical frameworks is a clear set of methodological protocols. (Johnson et al 1990: 8)

This research thesis attempts to use computer technology in urban studies to understand how culture and society are embedded specific relational patterns that constitute the architecture of urban space. A successful urban space is used space, and most urban space use is movement. Therefore, the main purpose of the thesis is to propose a computational method that is used to study pedestrian movement in small urban spaces, in order to provoke a sense of people-place awareness for architects and urban designers during the designing. The understanding of pedestrian and environment relationships will lead the designers to create a better urban place where social life --contacting between people-- can be stimulated. The thesis, then, presents a sample experimentation of how this proposed method can be implemented.

Theoretical / Conceptual Framework:

Cities are splitting apart. The separation between the old city--traditional downtown--and new--suburbs-- began with the spread of residential development and interstate highways. Shopping centers, office parks, new housing--a large house on small lot, attached townhouses and garden apartments--were built away from downtowns, abandoning the deteriorating older parts of the city. Meanwhile the developing new city has its own problems. Life in suburbia has an alienated quality, hardly sustaining old senses of neighborliness. People are living without street life and amenities. The old and new areas are both a cause and a consequence of the fragmenting of cities. (Barnett, 1996) As the new cities grow, the cutting off from the rest of

society causes more strain on the social and physical fabric of the old one. To restore and create a lively community--an unforced and informal liveliness that once contributed so much to the quality of urban living-- remains a major challenge for urban design until today.

It is important for architects and urban designers to provide an attractive environment in order to stimulate an urbanity. A claim for an absence of social life in urban space, in fact, stems from a lack of understanding of the dialectical nature of social and space relationship.(Hillier, 1989) In the shadow of the Modern movement, this lack has at root to do with the paradigm within which space is conceptualized as being without social content, and society without spatial content. Therefore, many architects and urban designers have remained unaware of the notion of space as the relation between spatial organization and socio-cultural consequence. That could be an obstacle to better design. In the late 1950s, sociologist Herbert Gans showed that the wealth and power of any large city was partly dependent on the series of 'small urban villages' that were hidden from the view. The complexity of different ways of life was obscured by the dominant culture and society. This research thesis is based on the principle that the movement of pedestrian in small urban space is essential to the social success of public space and that it is the design of space which determines the movement and interaction of people in the urban environment.

Although the analysis of people's behavior in relation to their built environments is a major concern in the field of urban design, environment-behavior research is not considered sufficiently during most architects' design process. Among publications that have made an impact on the way of thinking of space in relation to social and cultural systems, Edward T Hall's ***The Hidden Dimension*** (1966) applied the cultural understanding of the relationship between space and behavior patterns to problems of urban form. In 1970, William H. Whyte formed a small research group, The Street Life Project, which looked why some city spaces respond well to needs of people but some do not. This resulted in both the film and book, '***The Social Life of Small Urban Spaces'*** (1980). This first hand observation project studied how people inhabit the most intensively used urban spaces in New York by overlooking the plazas, recording daily patterns, and also talking to people who used the spaces. The result shows what could be the basic elements of successful urban space. Bill Hillier and Julienne Hanson's ***The Social Logic of Space*** (1984) studied historic cities and found that their organic development led to remarkably similar street patterns. These, they argued, were not a function of the economics of market forces but of simple social arrangement related to how people prefer to use cities. All the routes in a city can be represented as an axial line map that can be analyzed in a computer and the interconnectivity of roads can also be calculated. Their 'Space

Syntax' analysis of the interconnectivity in urban context can be used in an explanatory way, explaining why certain places work while others remain underused.

In terms of methodology, fieldwork and first-hand observation, which are central to the study of experimental behavior, are widely accepted as necessary for any architectural and urban design project. However, the ideal of dynamic and discursive patterns of social and physical complexity somehow marks a difficulty on the study. Urban designers lack techniques to describe and properly investigate the relation between spatial organization and its social nature and consequence. As a result, many designers disregard the social influence in design, leading to the creation of urban space that is likely destructive of the pattern of pedestrian interaction. Although results from empirical observations --mostly in forms of tables, charts and graphs-- are basically useful, they fail to fully address dynamic quality of space --pedestrian movement and activity patterns-- in order to support designers' decisions during the design stage while allowing rooms for the designer's imagination. This thesis puts forth the use of a computer simulation technique as a method for studying behavior and environment relationships is an alternative solution to benefit the observation process, improve the results' visualization thus, fulfilling the design.

The advent of computer techniques indicates an important paradigm shift in architecture. Computer technology has the capacity to store, transform, and convey information, organize a complex type of knowledge, and thereby, stimulate and increase designers' creativity. Until recently, however, the typical use of digital technology in architecture has been limited to enhancing efficiency, productivity, and the visual impact of the work. Computers have been deployed primarily to imitate traditional modes of production; to replicate ink drafting, and simulate perspective views or the experience of walking through a space. Moreover, computer modeling, generally, tends to occur after a design is substantially completed and only minor modifications are subsequently made. The CAAD (computer-aided architectural design) modeling has mostly been used for 'design review'--of single design ideas-- rather than for the exploration in the early conceptual phases--of alternative ideas-- and design analysis as part of a decision support system. The original idea behind using computers in architecture, to improve the built environment by providing the best instruments and methods for the creator of architecture, has not yet been fully realized. For many years, the promise of what computers could bring to the field of urban design and planning has remained largely unfulfilled.

The thesis proposes a computational method for simulating pedestrian movement in urban places in order to reveal the implicit dimension of social consequence in built environment. The study will be investigated on the basis of the pedestrian movement influenced by the spatial

configuration of space and the presence of attractions in urban context. Combining with an empirical observation, this simulation method will provide alternative ways for designers to recognize and clearly understand the relationship between space and the way people move through it. The dynamic patterns of pedestrian movement and the possibility of social interaction will be visualized through the use of simulated environment. Once architects and urban designers get to understand the characteristics of people-place relationships in a given context, the design of the urban space will imply a better quality of urban life, thus, a lively community can be created.

The architect Cedric Price once said, in the book ***Cities for a small planet*** (Rogers, 1997), that the main problem with urban space is that the buildings get in the way of pedestrian movement. With a greater understanding of environment and behavior relationships, this will be less inevitable.

Methodology:

This research thesis consists of two parts: a literature review of related work and a proposed method for studying pedestrian behavior and environment relationships.

In the first part --literature review-- focuses on reviewing rigorous experimental and theoretical works concerning the interrelationships between physical environments and human behavior, particularly pedestrian movement in urban spaces. There are 3 categories for the studies:

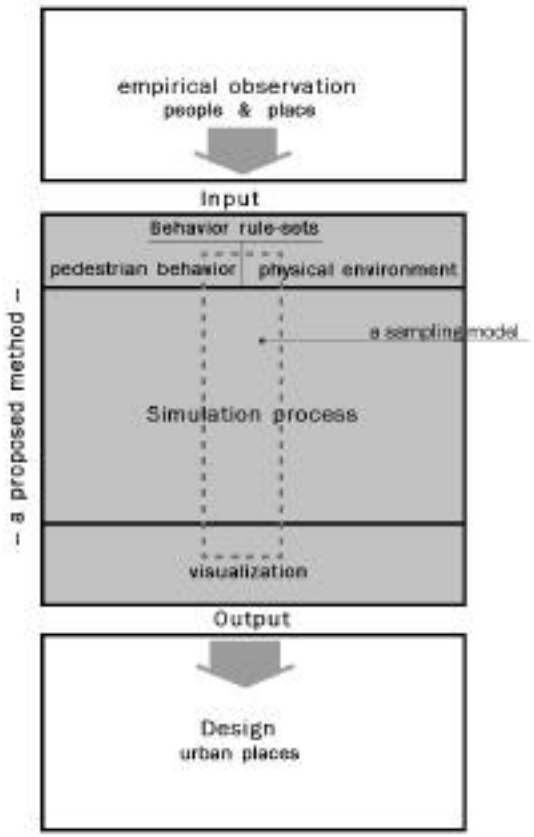
1. Empirical studies:
- To investigate appropriate methods used for observing many aspects of pedestrian behavior.
- To learn about what characteristics of behavior can be observed and would be useful for the field of architecture and urban design.
- To examine efficient ways to represent the results of those observation studies.
2. Theories of pedestrian behavior:
- To examine theories of how people interact with built environments and their implications for the design process.
- To study the methods of analysis, recognizing relationship between a theory and computer technology for describing and presenting an idea.
3. Computational models
- To explore computer technologies that revolutionized the study in urban design.

The related works will be analyzed to identify the implementation approaches, applications, methodologies, and impacts on the framing of architectural and design concepts. This will

provide lessons and examples of the studies --both empirical and theoretical-- that have succeeded and failed to apply in design process.

Then, in the second part the thesis explores a methodology for investigating the influence of environmental factors on people movement The method connects an empirical observation to design process, suggesting alternative design ideas or solutions concerning how people use space. Then, a computational method for simulating pedestrian movement in small urban places will be proposed as a strategy to increase the understanding of people-place relationships with respect to design conceptual framework. There will be two components to this phase, the conceptual model of the proposed system and the sampling model for suggesting the answer of how the system can be implemented.

1. The conceptual model of the proposed method
   In this stage, a computational model called "Mousehaus" will be proposed, developed, and demonstrated as a method to be used as part of design decision support system. There will be three parts of this proposed method: input, simulation process, and outcome, as seen in the following diagram.



The input will be behavior rule-sets derived from the empirical study while the output will be the visualization of the results generated from the simulation process. The simulation will require 2 components to the database as the input. One is a set of behavior rule describing how pedestrians move, such as paths, stops and speed. The other is a fixed rule database calibrated from characteristic of physical environment, such as a layout of space, visual access, and climatic aspects.

In order to simulate pedestrian movement in urban places, I will make a hypothetical model of how people behave in a simulated environment by abstracting the physical environment and proposing a computational model of behavior in Mousehaus. Mousehause will be a computer simulation based on concepts of rule-driven autonomous agents. In these terms, a "mouse" is an active agent, playing the role of pedestrian and associating with the behavior rules; while a "house" or surrounding environment is a passive agent, associating with the fixed rule (although some fixed rules do have behaviors). The Mousehaus simulation is simply an interaction between active and passive agents. As a result, after the mice are programmed, they will move around the simulated environment, according to their behavior rules and the situation they find themselves in. The third part of the system is the outcome, the visualization of the results of the simulation. This part will mainly seek ways to display the results in comprehendible, suggestive and innovative ways. The output will be in alternative forms, varying from texts, tables, charts, two-dimensional diagrams, to interactive three-dimensional diagrams so that designers will increase the understanding of the use pattern in the built environment. Eventually, they will integrate those implicit dimensions with the design of space.

2. A sampling model

This part aims to suggest the possible answer of how the proposed system can be implemented. By taking a small part from the model prototype Mousehaus, I will examine in depth, finding ways to simulate pedestrian behavior and track their movement through the virtual environment. A computable game-like experimentation will be created to accomplish this mission. The behavioral example rules for pedestrian selected from literature survey --chosen from both quantitative and qualitative points of view-- will be set up as the basis for the experimental simulation. These rules will provide the "what if" situation concerning the features of physical environment affecting how pedestrian move through space and/or spend their times within the urban space. In order to identify paths (track pedestrian move) and locations of use, I will introduce grid system, superimposed upon a space layout. This

strategy will allow information to be embedded in each particular cell and this kind of behavioral database will be effectively used as the input for the simulation. The results of the simulation will allow the "what if" questions to be answered.

By continuing to input rules into the mouse (pedestrian), watching the behavior resulting from these rules and comparing it with what we know about actual behavior, we expect to observe a rich and complex set of behaviors emerge. However, the simulation will not necessarily replicate the behavior of any particular person but rather the overall pattern of movement can be seen.

Scope of Investigation:

In the first phase, the study of research projects and related theoretical works are based on published literature as well as information available on the Internet. I took William H Whyte's '***The Social Life of Small Urban Spaces'*** as my starting point. I looked at what other sociologists, urbanists and architects had written about the need for more understanding about people and place relationships, focussing on the study of pedestrian movement behaviors in relation to spatial organization of urban space. Some rigorous works within the framework will be selected to serve as a pilot for further in-depth research. The core issues of investigation are:

- Pedestrian movement
  - environmental influence on pedestrian interaction and social activity
  - the effects of spatial characteristic of a built environment on pedestrian movement
  - methods of observation and empirical works in a field of physical environment and pedestrian behavior
- Implementation of computer technology in urban study
  - computational technique supporting design decision systems
  - AI (Artificial Intelligence) based behavioral modeling, including an autonomous agents technology

Empirical studies have examined how pedestrian movement influenced by spatial organization of space and attractions along the path. Through a reviewing the literature, the method of observation will be general review. The behavior rule-sets will be drawn from the selected empirical work. The information falls into 2 categories:

1. Active behavior rule set for simulating pedestrian behaviors
   - choices of route --path preference and pedestrian flow, typology of the use of paths such as return on the same path, or single loop.
   - inspections and full stops -- speed of movement, location of use, activities
   - numbers of pedestrian -- either aggregation or distinction of age and gender

2. Fixed rule or passive behavior rule set for simulating physical environment
    - path layout and space configuration --plan and sections, specifying entry points
    - perceived path structure--materials, formal aspect of fixtures and displays along the path, trees and paved textures
    - presence of attraction --location of desirable elements in place
    - presence of distraction--location of undesirable elements in place

    Although there are many other of significant factors that affect pedestrian behavior such as the sun path, temperature, crowding and urban street networks, those factors will not be addressed in this study.

Then, a computable model prototype of pedestrian behavior is proposed as a design decision support system. There will be the description of the model Mousehaus, its objective, and the review of computational process models which are the basis of the integrated simulation system. It will be an in-depth investigation of how model operates--input, method of analysis, simulation runs and output, including result analysis, problem and further study.

PART II: Logistical Framework

Outline of Tasks:

Research

1. **Introduction**
    - What is Mousehaus
    - Importance of Understanding Environment - Behavior Relationships in Urban Study
    - Pedestrian Behavior in Small Urban Places
    - Goal of the thesis
    - Assumption and Hypothesis
    - Method of Investigation
    - A Scenario
2. **Literature review of related work**
    - Empirical studies

- Methods in environment - behavior research
    - Methods of observation
    - Methods of analysis
    - Theories of pedestrian behavior

- Identify theories, concepts and methods applied in each precedent based on the reviewed material
- Advantages and difficulty of each work
  - Computational model
- Development in computation in urban design
  - Simulation of urban environment
  - Design decision support system
  - Overview of Artificial Intelligence and Artificial Life in urban study

3. Assumption and Hypothesis

4. Empirical Study

- Setting
- Method of study
- Results

5. The simulation Study

- Mousehaus: computational model description
- Example run

6. Visualization of the Results (both from observation and simulation)

- What needs to be visualized?
- Alternative way to visualize the results

7. Discussion and Conclusion

8. Reference

Presentation

- Documentation
- Preparing for public presentation

Schedule:

Autumn 2000

September - December	Study the use of computer in urban studies
	Demonstration of initial idea of Mousehaus

Winter 2001

Week 1-4	Literature Review
	Develop thesis proposal

Week 5-7	Summarize and analyze collected information Identify theories and relationship among related proposal and works Study methods of observation and survey Propose thesis proposal
Week 8-10	Set up scenario for the demonstration Develop the prototype model

Spring 2001

Week 1	Continue develop the prototype model
Week 2-3	Conduct the observation of pedestrian movement and site survey Gather and organize data from the field work
Week 4-7	Work on final presentation: simulation and prepare the demonstration of how system works
Week 8	Final Review
Week 9-10	Write and submit thesis documents