Capturing and Integrating Perception of Change into Planning Decision Making Processes

BY

James David Platt

A Thesis submitted to
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in Partial Fulfillment of the Requirements for the Degree of

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Of

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Abstract

Cognitive mapping research of the 1960s and 1970s sought to include perception of the environment into Rational Comprehensive Planning decision making processes of the time. However, the technologies of the day limited the ability of cognitive mapping researchers to compile, analyze and represent their qualitative data in a manner that would facilitate analysis with quantitative data used by planners. Many limitations to cognitive mapping could have been overcome with the use of modern day GIS technology.

In the 1990s, Planners began adopting GIS technology in support of public participation, governance and decision making. During this same time Communicative Action Planning advocates began promoting ideals of inclusion of a differentiated public and alternative ways of knowing into planning decision making processes. While GIS technology has the ability to support Communicative Action ideals, as well as the capture, synthesis and analysis of perception for inclusion into planning decision making processes, examples remain sparse.

This thesis introduces a methodology for capturing, aggregating and analyzing differentiated public perception of neighbourhood change, in a format conducive to incorporation into planning decision making processes.

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Next, I would like to express my gratitude to those people at the 2004 Canadian Association of Geographers Annual General Meeting, who encouraged me to pursue this thesis topic. Most notable among these: Renee Sieber, Tom Carter and Natalie Gravel.

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Finally, I owe a good deal of gratitude to both Ian Shaw and Jean Trottier. As members of my committee they provided necessary and invaluable critical feedback. Their time, effort and opinions are greatly appreciated. A more capable and valuable committee could not have been assembled with respect to the topics covered.

Dedication

To my friend and wife, Julie

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Chapter 1: Introduction

1.1 Introduction

Rational planning processes used in North America sought to make decisions based on what planners believed to be in the best interest of an undifferentiated public. Typically, decisions made as a result of these planning processes were informed by scientific and quantitative information. Advocates of these processes claimed that they were holistic and attempted to consider all relevant parameters in the decision. However, it was the planning expert who would decide which parameters were relevant. This often meant that qualitative information from local sources, which could not be modelled or evaluated by the same scientific methods used to evaluate quantitative information, was viewed as inferior and of little use. Criticisms of this method for being top-down and elitist led to efforts to formalize public participation exercises during the process.

Cognitive mapping researchers of the 1960s and 1970s espoused the importance of including qualitative information, such as public perception of an environment, into rational planning decision making processes. Not only was perception seen as a being a benefit to planners in the decision making process, but it was also viewed as a method of obtaining public participation. The popularity of cognitive mapping is reflected by the abundance of articles found in the literature of the 1960s and 1970s.

Problems integrating the results of such work into the planning processes of the day limited the success of these early pioneers. Technology of the day made the task of compiling, spatially representing and analyzing perception related data cumbersome and tedious. In addition, integrating qualitative perception with other quantitative data sets for analysis was difficult and rarely demonstrated in the literature. An ideal technology for overcoming many cognitive mapping limitations, Geographic Information Systems (GIS), did not appear in the Planning field for sometime later. Cognitive mapping articles declined dramatically in the literature by the end of the 1970s.

In the early 1990s, German social philosopher Jurgen Habermas's *Theory of Communicative Action* (1984) attracted the attention of North American planning theorists (Healey, 1996; Innes, 1995). Proponents of Communicative Action advocated the need for diverse sources and types of knowledge to be included in planning decision making processes. As noted by Sandercock (1998), "without discarding these scientific and technical ways of knowing, we need to acknowledge, as well, the many other ways of knowing that exist; to understand their importance to culturally diverse populations; and to discern which ways of knowing are most useful in what circumstances" (p 76). Knowledge gained from both local and expert sources were considered equally valuable and legitimate.

While in practice, Communicative Action did not replace existing planning decision making processes it did provide planners with a new ideal to strive for (Healey, 1996, p 231). Some even went so far as to suggest that this new ideal constituted a new paradigm for planners (Innes, 1995). The importance of including local knowledge, diverse populations and alternative ways of knowing in the planning process was now an ideal to be attained. And unlike previous attempts to capture and include public perception of the environment in the planning process, this willingness was now supported by GIS technology that could make this happen.

Despite the promise of Public Participation GIS (PPGIS) to provide the ability to include widespread public participation in the planning decision making process, it has met with limited success. Critics contend that PPGIS is an expensive and elitist technology that marginalizes participation from certain groups. Those without access to or have limited knowledge in the use of computer and internet technology are unable to participate to the same level as those with computer and internet skills. In order to support present day Communicative Action ideals, this limitation must be addressed and overcome.

The ability of GIS technology to overcome many of the limitations of cognitive mapping exercises related to the capture, synthesis and analysis of perception has not been met with a desire to do so. Creating a collective image of public perception is rarely an objective of PPGIS. While PPGIS is a promising technology for supporting the capture and inclusion of differentiated public perception of an environment in the planning decision making process, examples in the literature remain few.

The purpose of this thesis is to identify and demonstrate a methodology for capturing, aggregating and analyzing differentiated public perception of neighbourhood change which uses GIS to overcome the technological limitations of cognitive mapping exercises. At the same time, the methodology must be sensitive to the needs of Communicative Active ideals, and therefore, must overcome marginalization issues related to PPGIS initiatives.

Practical application of the methodology will be demonstrated using the *West Broadway: Housing Intervention and Neighbourhood Development* study (HIND) conducted by Skelton, et al (2004) during the summer of 2003. The HIND investigation focused on a slice of time, between 1999 and 2003, during which revitalization interventions were gaining momentum in the stressed neighbourhood of West Broadway.

The HIND study was funded by a Winnipeg Inner City Research Alliance grant delivered through the Institute of Urban Studies at the University of Winnipeg.

This chapter will begin with an introduction to the Winnipeg inner-city neighbourhood of West Broadway. This will be followed by an introduction to rational planning processes and the models they use in decision making. Next, the importance of perception will be addressed. The use of cognitive mapping in public participation will then be introduced. This discussion will conclude with the suggestion that cognitive mapping methodologies of the 1960s and 1970s are still relevant today and can be supported with the use of GIS. From here the research objectives will be introduced followed by a short discussion of the potential significance of this thesis. An overview of the scope and limitations of this work will then be provided. This chapter will conclude with summary comments and an introduction to the chapter topics.

1.2 Research Context & Field Site

The Winnipeg inner city neighbourhood of West Broadway has been the subject of a tremendous amount of attention in recent years. Prior to the mid-1990s the neighbourhood was in decline and in need of rescue. Characterized by a large marginalized population, a deteriorating housing stock, and a turf for gangs and violent crime, the media tagged the neighbourhood with the title *Murder's Half Acre*. Recognizing that this title signalled further deterioration of their neighbourhood, long time residents decided to take action.

The community revitalization efforts that followed focused on community development, employment programs and upgrades to the housing stock. Five years later, there was evidence the neighbourhood had been rescued from continuing deterioration.

Neighbourhood interventions of the past and present, in combination with market forces, have led to various improvements. However, it remains unclear which interventions have had impacted the neighbourhood in a positive or negative way, and which areas of the neighbourhood should be the focus of future interventions.

Many interventions have a spatial component that can be captured, represented and analyzed against other empirical data using a GIS (See Appendix A for an example of distribution of housing interventions by year). Understanding the collective outcome of these interventions can be achieved by capturing and representing perception of where positive and negative changes have occurred within the neighbourhood. Perceptions held by various groups can be modelled separately to gain an understanding of the impacts interventions have had on the multiple publics within the neighbourhood. Such an understanding will allow for planners to better recognize opportunities for future interventions and revitalization efforts.

Incorporating qualitative data, related to perception of change, into the planning process presents a significant challenge. First, many of the long term residents of West Broadway could be classified as 'marginalized'. Obtaining their participation requires a methodology that overcomes cultural, technological and sometimes even language barriers. Second, the method must allow for perceptions to be aggregated into a spatial layer for inclusion in a GIS used for analysis of neighbourhood issues. Third, the method should allow for the perceptions of multiple publics existing within the neighbourhood to be modelled separately to allow for comparisons to be made between them. Finally, the method should not rely solely on planners to collect information. Ideally, the method will allow for community researchers to be included in the process. This will help promote effective communication between respondents and researchers.

1.3 Planning Decision Making Process

Canadian author Gerald Hodge (1998) claims that the rational-comprehensive planning approach "still remains the general basis for community-planning practice today" (p 191). The rational comprehensive approach "is simply a logical decision-making process suited to the diverse needs of communities in their plan-making efforts" (p 190). The process has evolved over the years, to include public participation, as well as feedback loops which "serve… to inform and adjust the initial phases of problem identification and goal articulation" (p 192). While this approach is essentially linear in nature, it should be understood that there is potential for "reiteration of all or part of the process" (p 192). This process is presented in Figure 1.1

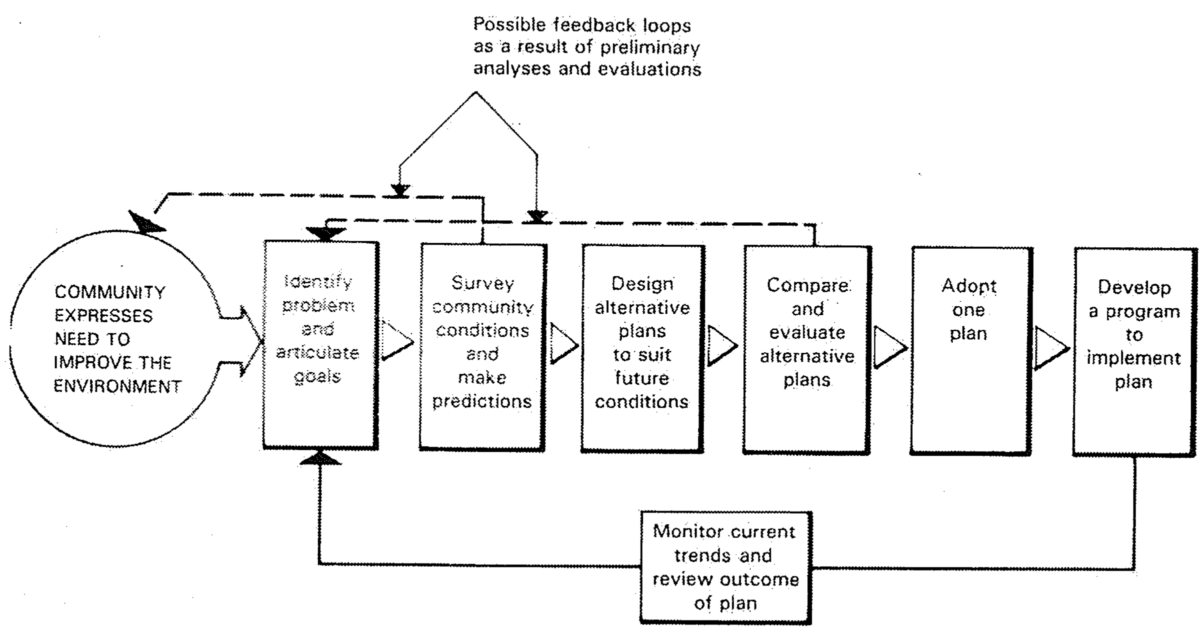


Figure 1.1 - General Model of the Community Planning Process
(Hodge, 1998, p 192)

Models are used throughout the community planning process to assist in identifying problems, representing and analyzing information and trends as well as evaluating outcomes. In neighbourhood planning, models are often spatial in nature. Spatial data used in constructing models may be acquired from secondary sources, such as Statistics Canada Census, and can include data related to housing, income, mobility, education, property values, and crime locations. Other spatial data may be available from a local neighbourhood organization, such as location of housing interventions, recipients of various grant programs or the locations of building permits. These spatial data sets can then be manipulated, organized and analyzed with the aid of Geographic Information System (GIS).

The modern use of GIS in decision making traces its roots to Ian McHarg's seminal work *Design With Nature* (1969). McHarg championed a Gestalt approach to landscape evaluation by overlaying spatial representations of all available measurable parameters and assigning preference to areas based on the collective corresponding values from each of the component layers. McHarg claimed that the biophysical world was disregarded due to an institutionalized myopic prejudice toward strict cost-benefit analysis measured in terms of dollars. In *Design With Nature*, he was able to provide an argument for the inclusion of physiographic and social parameters in land use decision making, along with a rational method of evaluation.

Much like the rational planning process popular at the time, McHarg's overlay technique was limited to phenomena that could be quantified and represented spatially. The effect was to limit the social variables included in analysis to data obtained from experts and secondary data from existing data sources. Data related to social variables was not collected from sources of local knowledge, but rather from experts or census data sources. The institutionalized myopic prejudice McHarg originally sought to overcome now favoured variables which could be easily collected, quantified and represented spatially. Many non-visual human elements, such as value, preference and behaviour, were excluded mostly because they were difficult to capture and model. This was not lost on Porteous (1971) who stated: "To design with nature is mandatory for survival; to design with people is a goal far more difficult to accomplish, but perhaps even more essential" (p 176). Including public perception of an environment into McHarg's overlay technique required the use of 'cognitive mapping' exercises. However, these techniques produced data that were at the time difficult and cumbersome to produce in a format that would allow for inclusion into a spatial overlay operation.

1.4 Importance of Perception

Housing interventions and other neighbourhood revitalization measures are implemented for the purposes of improving the living conditions for the neighbourhood residents. The success of any given initiative will be measured according to the original mandate of that particular initiative. Measuring the collective success of many initiatives in a particular neighbourhood is more difficult. Normally, researchers will use neighbourhood indicators to measure neighbourhood improvement over time. The indicators used will be a reflection of the objectives of the interventions.

As an example, if the primary objective was to improve the safety of residents in a crime-ridden neighbourhood, a collection of interventions aimed at curbing crime and promoting safety would be implemented. One of the interventions in this collection may be aimed at decreasing break-ins by setting up a "Neighbourhood Watch" program. The success of this program could be measured by comparing the number of break-ins before and after the program was initiated. The collective success of all safety programs may be measured using crime statistics for the neighbourhood in general. While the success of some programs can be easily measured using information related to archived statistics such as property values or income, for example, others are more difficult to gauge.

Measuring the collective success of interventions with the general objective of improving the neighbourhood is more difficult to do with statistical indicators. Identifying quantitative indicators, based on factual reality, can be difficult. As noted by Boulding (1956): "there are no such things as *facts*. There are only messages filtered though a changeable value system" (p 6). In order for neighbourhood change to be valued as an improvement over previous conditions, an individual must perceive the change as an improvement. If it is true that "human behaviour depends not on 'reality' but on what people think reality is" (Haynes, 1981, p 2), then it is not reality that should be measured, but rather perception of reality. For instance, quantitative data may indicate that crime decreased in the neighbourhood; however local residents will not consider this an improvement unless they perceive the change in conditions. Therefore, the collective impact of interventions geared toward neighbourhood improvement may be better understood through understanding perception of improvement.

Public perception of an environment represents local knowledge. Capturing public perception requires direct participation from the many diverse groups, or multiple publics, associated with a neighbourhood. During the 1960s and 1970s, public perception, regardless of the form it was captured in, was often viewed as a means of public participation.

1.5 Participation

According to Arnstein (1969), "participation of the governed in their government is, in theory, the cornerstone of democracy—a revered idea that is vigorously applauded by virtually everyone" (p 216). Since the time of Arnstein's seminal work, *A Ladder of Citizen Participation*, in the late 1960s, planners have sought to include citizens in planning and decision-making processes. However, in many instances "public participation has been limited to the rights to know, information campaigns and the right to object through the system of local political representatives and public inquiries" (Carver et al., 2000, p 161). The rational planning process offered very public participation in decisions.

During the 1960s and 1970s, planners were beginning to seek new and innovative ways to include public participation in the decision making process. Many authors felt that planners perceived the environment much differently than the general public which meant that planners were making decisions for the public based on misinformation (Pahl, 1970; Broady, 1968; Porteus, 1971). It was thought that if planners gave some consideration into what the public *see*, "it may enable the design professions to partially fulfill a commonly stated aim of *planning for the people*" (Spencer, 1973, p 4: emphasis original). It was further recognized that "if planning is to be sympathetic and responsive to the real needs it must recognize the importance of the mental images of ordinary people on the ground" (Haynes, 1981, p 23). As noted by Golledge and Stimson (1997), "knowing something about people's perceptions, preferences, and images provides information that complements the designers' and planners' intuition, guidelines and legal restrictions" (p 239). It was thought that public participation in the planning decision making process could be achieved through analysis of public perception of the environment. During the 1960s and 1970s planners looked to the emerging field of 'cognitive mapping' for methods of capturing public perception of the environment.

By the 1990s rational planning processes was being criticized for considering the public as a single group. The problem was that groups within the public body were not recognized. As noted by Sandercock (1998), in rational planning processes "the planner is indisputably 'the knower', relying strictly on 'his' professional expertise and objectivity to do what is best for an undifferentiated public" (p 88: quotation marks provided from source). The ability to capture and distinguish perception of multiple publics was now desired by planners.

The inclusion of local knowledge, such as personal value and preference, into McHarg-style overlay analysis requires for data to be captured, spatially modelled and synthesized into collective images. The collective images will have to be of the same spatial scale and referenced on the same locations as data collected for physiographic parameters. Spatial models of public perception of an environment can be useful to planners in neighbourhood revitalization efforts in three ways. Second, they can be used as a source of local knowledge to aid in the planning of future interventions. And third, they can be useful for understanding the impacts various initiatives have had on multiple publics.

1.6 Cognitive mapping

At the time of McHarg's *Design With Nature*, capturing and modelling public perception, or 'Cognitive Mapping', was becoming a major preoccupation of behavioural researchers. Although originally conceived by Trowbridge (1913) and then given the name 'cognitive mapping' by Tolman (1948), it was Lynch (1960) who would ultimately legitimize it for mainstream behavioural research. Even today, Lynch's *Image of the City* (1960) remains standard reading in any urban design related university curriculum.

Typically, cognitive mapping studies involved surveys in which respondents would be asked to draw or identify locations or routes on a map. Oftentimes, respondents were given a blank page upon which to draw their map. The completed individual maps were then synthesized into a group image. According to Lynch (1960), "It is these group images, exhibiting consensus among significant numbers, that interest city planners who aspire to model an environment that will be used by many people" (p 7). Despite his claim, it was never clearly demonstrated how or why city planners would be interested in such images; or more importantly, how they could be incorporated effectively into the rational planning process.

This criticism was highlighted by Bunting and Guelky (1979) when they chastised cognitive mapping studies for being irrelevant and disconnected with anything tangible. In their words: "At the present time the conventional studies by behavioural and perception geographers remain of little value to geographers" (p 462). In support of their argument they cite Miller, Gallanter and Pribham (1960): "Unless you can use your image to do something, you are like a man [sic] who collects maps but never makes a trip" (p 2). By the late 1970s it was evident that without a clear means of integrating behavioural mapping studies into planning decisions, the entire discipline was at risk of having little relevance beyond creating interesting maps.

Ironically, a clue to the relevance of the very studies Bunting and Guelky chastised can be found in the conclusion of the very same article: "But man's [sic] environmental behaviour is not one-dimensional; it is multifaceted. It involves economic, social and political considerations as well as environmental ones" (p 461). Bunting and Guelky's words hint at the fact that cognitive mapping exercises provide the missing non-visible social/perceptual dimension missing from Gestalt-style McHargian overlay analysis. With GIS still in its infancy, there was no notion of incorporating behavioural mapping products into overlay analysis. The rise of GIS technology was to occur too late for the floundering behavioural mapping movement.

Not only would GIS have leant relevance to the cognitive mapping movement, it would have also given researchers a powerful tool for collecting and synthesizing individual responses, as well as analyzing the results. Unfortunately, without such a tool cognitive mapping research significantly declined in popularity throughout the literature. As noted by Hyunh (2004) "Since the cognitive mapping research declined in the early 1980s, there have been few methodologies developed and even fewer involving technology" (p 29). The few examples that do exist in the literature can be found in the emerging field of 'Public Participation GIS' (PPGIS).

Ad-Kodmany (1998) suggests the failure of generating meaningful public input in planning processes is largely due to a lack of effective tools. The widespread adoption of technology, including the Internet and GIS technology, in the past decade has made GIS a popular tool for enabling communication between planners and citizens. As Barndt (1998) states, "advocates of GIS tend to talk as though this tool will revolutionize the community decision making process" (p 111). However, GIS tools have yet to experience widespread acceptance for obtaining public input into planning decision making processes. Failure in generating meaningful public input into planning processes is no longer due to a lack of effective tools, but rather, a lack of an effective method.

1.7 Research Objectives

This study will seek to describe and demonstrate a methodology for capturing and analyzing local knowledge for use in the neighbourhood planning decision making process that will allow for:

1) Individual perceptions of neighbourhood change to be captured, aggregated and integrated within a neighbourhood based GIS
2) the collective perception of residents to be compared with that of key informants
3) participation from as broad of range of participants as possible
4) non-technical community researchers to be included in the data capture process

1.8 Significance of Research

This thesis contributes to planning practice and scholarship by advocating a methodology that has the potential to:

- widen public participation by reducing barriers;
- involve community researchers in the data collection process;
- successfully collect, aggregate and represent local perception of changing conditions in a spatial format; and
- allow for spatial patterns of perception to be successfully integrated into a GIS for analysis with other more commonly available data layers

From a local perspective, the spatial data products created in this study, and HIND, have the ability to be incorporated into future GIS projects in the West Broadway neighbourhood. These data products serve as a benchmark for comparison with similar data products produced in future studies in the West Broadway neighbourhood.

The introduction of a new methodology for capturing, aggregating and spatially representing local perception of neighbourhood change could serve to encourage the inclusion of such data sets into systems used for neighbourhood evaluation throughout the City of Winnipeg.

1.9 Scope and Limitations

This study focuses on issues related to the capture and spatial representation of public perception of neighbourhood change related to interventions that occurred over a five year period. It is not the intention to demonstrate a correlation between the resulting spatial model of public perception and other spatial datasets, although the potential to do will be implied.

While issues related to public participation will form a significant portion of the discussion, these issues will only be discussed as they relate to capturing the perception of members of the public. PPGIS and cognitive mapping issues found in the literature, not related to the capture or analysis of public perception of an environment will not be included.

This study is based on GIS work done during the HIND study. The GIS and related data capture and analysis techniques developed for the HIND study were used solely for the purposes of analyzing change and perceptions of change within the neighbourhood. Any map products produced during the course of the HIND study, were not integrated into a larger Planning Support System (PSS). The neighbourhood of West Broadway does not maintain any existing GIS capacity at this point in time, nor is it the intention of this study, or the HIND study, to implement one.

Analysis and Planning decisions made as a result the findings of the HIND study will not be discussed.

1.10 Conclusion and Chapter Topics

This study is an investigation of a GIS methodology used for capturing, aggregating and analyzing spatial perception of neighbourhood change. The GIS methodology used in the "Housing Intervention and Neighbourhood Development in West Broadway" study conducted by Skelton et al (2004), will serve as a basis for analysis of the research objectives.

Chapter 2 will discuss methods used for the capture, aggregation and analysis of public perception found in the 'Cognitive Mapping' literature. Critical discussion will reveal strengths and weaknesses of each methodology. This chapter will conclude that technological limitations of the time led to the criticism that cognitive mapping had a lack of practical application in planning decision making processes and contributed to the decline in cognitive mapping research in the early 1980s. It will be suggested that common GIS tools would have sustained the longevity of the cognitive mapping research field, and allowed for incorporation into the planning decision making process.

Chapter 3 will provide a discussion of the use of GIS for public participation in planning and decision making. Major advantages and limitations in the use of GIS technology in planning are documented. The issue of marginalization of segments of the population will be paramount in this discussion. From the discussion it will be evident that public participation GIS researchers have failed to incorporate cognitive mapping methodologies into their research designs, despite the advantages of doing so. It will be concluded that a new methodology, building on cognitive mapping methodologies, is required to incorporate local knowledge into the planning decision making process in a manner sensitive to Communicative Action ideals.

Informed by the literature, Chapter 4 will discuss issues related to the research objectives, and these will then be addressed in the context of the HIND methodology. The HIND study included GIS analysis which sought to compare the perception of neighbourhood change, held by residents and key informants, against secondary spatial data obtained from other sources. Such analysis required public perception to be captured, aggregated and represented spatially within a GIS layer. The nature of the study also opened the possibility of involving community researchers in the process.

Technical details of how the HIND methodology addresses the research objectives will be clearly documented and discussed, include how individual perceptions of neighbourhood change can be captured, aggregated and integrated into a neighbourhood-based GIS; and enabling comparison of the perception of residents and key informants.

The strategy used by the HIND study to involve marginalized West Broadway residents in the HIND project will be described. Methods and issues related to including non-technical community researchers in the data capture process will be addressed.

Chapter 5 will demonstrate the effectiveness of the methodology in addressing the research objectives using the HIND study as an example. The experience of implementing the HIND methodology will be discussed in relation to the research objectives. Following this discussion, it will be argued that the weaknesses of cognitive mapping and PPGIS, as identified in the research objectives, can be addressed and overcome.

Finally, chapter 5 will conclude with a discussion of how well the PPGIS methodology used in the HIND study overcame the weaknesses as identified in the research objectives. Advantages of the methodology and limitations will be discussed, making reference to the review of literature, and suggestions for further research will be offered.

Chapter 2: Perception and Cognitive Mapping

2.1 Introduction

The term *Cognitive Mapping* originated from the work of Tolman (1948), who used it to describe how rats navigate their ways through a maze in order to find food. Tolman used the term to refer to a non-literal, but conceptually spatial mapping process, which according to Stea and Downs (1973) is "composed of a series of psychological transformations by which an individual acquires, codes, stores, recalls and decodes information about the relative locations and attributes of phenomena in his everyday spatial environment" (p 9).

If *Cognitive Mapping* is to be thought of as an internal process, then a *Cognitive Map* is an "understanding of the world" as it exists in a certain place and time (Stea and Downs, 1977, p 6). This image of the world is a uniquely held vision privately conceived by any given individual and "may only faintly resemble the world as reflected in cartographic maps or color photographs" (Stea and Downs, 1977, p 6). When attempting to gauge the perception an individual has of a given environment at a certain moment in time, it is the details of this privately held cognitive map that are solicited.

While it has been argued that long-term memory associated with the hippocampus the human brain perceives of a cognitive map as a map in the truest sense of the word (O'Keefe and Nadel, 1978) it would be misleading to assume that people walk around with maps in their heads (Tuan, 1975, p 213). Regardless, "whether inherently 'map-like' or not, our cognitive maps contain and represent our impressions and understandings of places" (Halseth and Doddridge, 2002, p 568). It would seem that for lack of a better articulation, the idea of a *cognitive map* "becomes a convenient fiction that provides a hook on which to hang interpretive structures but that is tied to no particular representational form" (Golledge and Stimson, 1997, p 238).

Confusing the issue, the term *cognitive map* is used interchangeably throughout the literature of the 1960s and 1970s to refer to both an internalized perception of reality and its external representation. To overcome the confusion of terminology, Liben (1981) coined the term "Spatial Product" to refer to the externalized version of a cognitive map. This convention will be adhered to throughout the remainder of this discussion.

Cognitive researchers of the 1960s and 1970s often assumed that "human spatial behaviour is dependent on the individual's cognitive map of the spatial environment" (Stea and Downs, 1973, p 9). Thus, it followed that human behaviour in a spatial environment could be better understood or even predicted through cognitive mapping analysis. Such analysis was thought to be of use to anyone interested in the analysis of human interaction with the environment, especially designers.

During this same time period, planners were coming under increasing pressure to include the public in the decision making and design process. As stated by Haynes (1981), "if planning is to be sympathetic and responsive to real needs it must recognise the importance of the mental images of ordinary people on the ground" (p 23). The fit between the young and blossoming study of cognitive mapping and the needs of planners to understand public perception of the environment was a natural match. From a planning decision making perspective, the more "aware of people's preferences for, perceptions of, and attitudes toward different environments, then the better matches between planning and policy making can be achieved" (Golledge and Stimson, 1997, p 239). Cognitive mapping quickly became a popular method for both understanding the needs of the population as well as "assessing the impact and effectiveness of designs at both the urban and architectural scales" (Stea and Downs, 1977, p 242). Despite difficulties in demonstrating how the results of cognitive mapping research could be incorporated into the planning decision making process, it was hoped that "eventually, residential planning might incorporate these findings to ensure a better fit between human perception and physical form" (Spencer, 1973, p 4).

Methods used in the 1960s and 1970s to "recover cognitive configurations are as varied as the purposes behind such research" (Golledge and Stimson, 1997, p 241). It is not the intention to discuss Cognitive Mapping methodologies developed for all research goals of the time. The discussion that follows is primarily concerned with methods which could facilitate the capture, synthesis and analysis of public perception of neighbourhood change.

While it was not uncommon for cognitive mapping researchers to include more than one method in their study, for the purposes of our discussion, cognitive mapping methods will be divided into four basic types: **verbal, sketch mapping, completion mapping** and **preference mapping**. Examples from each of the four types will be introduced and the advantages and limitations discussed.

From the discussion it will become evident that cognitive mapping exercises were often limited by the technology of the time. Manual methods of compiling, synthesizing and analyzing responses were often cumbersome and time consuming. In addition, examples of integrating qualitative data related to perception with other quantitative data sets for the purpose of analysis remain largely absent from the literature. Ultimately, the lack of examples in the literature demonstrating the practical application for planning and decision making process would result in the decline of cognitive mapping research in academic journals.

2.2 Verbal Response

Verbal response techniques are most commonly used in wayfinding exercises whereby respondents are asked to describe from memory the route between two locations. The sequence of locations mentioned by the respondent is then analyzed. These types of studies are of little relevance to this project and they will therefore not be detailed in the discussion, although they do raise some points useful for our purposes.

Verbal techniques can be used to elicit responses from individuals regarding their perception of the environment. These techniques rely on a participant's ability to recall or describe aspects of the environment through verbal communication. There is also heavy reliance on the part of the researcher to interpret information conveyed from the respondent. Spatial images of collective public perception are difficult to accurately construct from individual verbal responses.

The reliance on the ability to communicate descriptions of physical space makes this type of technique difficult for some individuals. Social differences in language and perception, rooted in class (Bernstein, 1965) and race (Deutsch, 1960) have long been recognized to limit participation of some groups and individuals. As noted by Spencer (1973), "it is therefore, possible that verbal descriptions of the perceived environment may prove a difficult task for the lower classes and ethnic minority groups, whose images may consequently be under-represented if an unstructured verbal technique was employed" (p 34). The reliance on the respondents' ability to effectively communicate perception of the environment to a researcher will limit the participation of some members of the public.

A significant degree of researcher bias exists in the interpretation and recording of unstructured verbal responses. While the respondent may be giving an accurate assessment of their perception of the environment, this perception must be understood and recorded correctly by the researcher. It will be up to the researcher to decide which information is relevant and how this information should be recorded and represented. As noted by Spencer (1973), "unless descriptions were detailed, considerable subjectivity would enter" (Spencer, 1973, p 33). Overcoming this issue requires a strategy by which respondents record their perceptions themselves, leaving little room for misinterpretation in recording.

Creating an aggregate image of individual responses will be done by breaking down each individual response into a defined set of topics or elements. The frequency by which each element is mentioned in the total sample of responses is then calculated. This frequency value is then used to represent the importance of each specific element. The result can be represented in a table, a chart or spatially, on a map. Creating a spatial representation requires the researcher to determine how best to spatially reference the information. In instances where the information obtained does not relate to a discrete entity, the boundaries will be arbitrarily determined by the researcher. This limits reliable spatial representations to perception of discrete physical elements found within the environment.

Verbal response technique for capturing perception of the environment may be useful for wayfinding exercises. However, these techniques have limited use in studies attempting to gauge public perception of an environment. Issues related to marginalization and researcher bias restrict the ability of these techniques to reliably capture the public perception of a neighbourhood. Even if such issues could be overcome, the results will be of limited use as a spatial product.

2.3 Sketch Mapping

One of the most popular data gathering techniques used in urban behavioural research is sketch mapping. The basic sketch mapping technique involves respondents being asked to draw a map on a blank piece of paper. In most sketch mapping exercises the researcher uses the resulting maps to identify elements or locations found in more than a single map. The more frequently an element or location is identified in the total sample of responses, the more importance it is thought to have in the collective perception of the environment. Conclusions drawn from such studies were thought to benefit planners and designers in decision making.

The first researcher documented to use a sketch mapping technique in the study of perception of urban environments was Kevin Lynch (1960) in *The Image of the City*. Lynch's work in sketch mapping inspired a generation of researchers to develop and employ sketch mapping techniques of their own. Some researchers based their methods on Lynch's (ex. de Jong, 1962; Appleyard et al., 1964), while others developed methods of their own (Ladd, 1970; Appleyard, 1970). Two distinct sketch mapping approaches can be identified from this body of work. The first, *unrestricted sketch mapping*, involves simply instructing a respondent to draw a map on a blank piece of paper. With no restrictions on what to draw or instructions of how to draw it, the variation in responses can lead to difficulty in analysis due to a lack of structure. The second, *structured sketch mapping*, attempts to overcome the ambiguities of the first method by instructing participants in the use of a design language (Lynch, 1960; Beck and Wood 1976). While this method limits variation of responses, it is not without limitations.

The discussion that follows discusses the advantages and limitations of both general approaches. Next, issues related to synthesizing individual responses into a collective image representing the sample population are introduced. This is followed by a brief discussion which compares sketch mapping and verbal techniques. This section concludes with the suggestion that while sketch mapping exercises are useful for gaining an understanding of which physical urban elements of the environment are most often recognized, they are time consuming to administer, yield results that are difficult to interpret and rely on the researcher to define the spatial aspects of the resulting maps. These limitations put the usefulness of these exercises to planners in the decision making process in question.

2.3.1 Unrestricted Sketch Mapping

Unrestricted sketch mapping exercises, which instruct participants to draw a map of a defined area on a blank piece of paper, are easy to administer. According to Kitchen and Blades (2002), this style of sketch mapping is "a simple and comparatively quick method to employ, and one that has some ecological validity, because most adults are familiar with the idea of drawing sketch maps as a way to provide directions for other people" (2002). The simplicity of the method minimizes barriers related to culture and language, as well as allows for the participation of people of a wide range of ages. Anyone able to draw can participate. It is for this reason that researchers involving children in their studies often use this method (ex Ladd, 1970; and more recently, Halseth and Doddridge, 2002). While the method is simple to deliver, the results of such surveys are difficult to analyze.

Analysis of unrestricted sketch mapping products is made difficult due to interpretation issues. This makes unrestricted sketch mapping exercises unreliable. According to Golledge (1976), "when an experimenter asks an individual to compile a sketch or map an area, he or she is asking for an exhibition both of the recall abilities of the individual and of his or her cartographic and graphic representational skills" (p 310). In order for a respondent to communicate their ideas effectively, they need "sufficient motor skills to portray accurately in sketch format what she or he is attempting to complete" (Golledge and Stimson, 1997, p 242). The implication of this is that "the investigator can never be really sure whether the peculiarities of the map are true representatives of the mental picture or whether they are the result of poor drawing skill" (Haynes 1981, p 15). In performing the exercise it is likely that some features will be distorted beyond recognition, while others will be left out completely. In many instances, it is likely that some features will be omitted from the map due to the artist not leaving enough free drawing space to include them. This creates questions regarding what the respondent does not include, and it is up to the researcher to interpret the meaning of blank areas of the map. Analysis of such spatial products could conclude any number of reasons why such features were omitted. While Ladd (1970) suggests that distortions, elaborations and condensations found in drawings considered either pictoral or schematic may have diagnostic significance (p 89), it is "only through interviews with subjects… can we begin to understand the personal meaning of boundaries, landmarks, and other features which are included or omitted" (p 96). Additional information is required from respondents if sketch maps are going to be interpreted correctly.

Studies employing sketch mapping techniques should avoid drawing conclusions based on analysis of spatial products created by individuals. Reliance on such analysis can lead to questionable conclusions: partially due to errors in the original maps and partially due to errors in interpretation. As concluded by Spencer (1973) commenting on this technique, "if more is to be inferred from the mental mapping responses, greater control is necessary so that the variation in the possible meaning of response is reduced. Some form of structuring may be advantageous in this respect" (p 32). Lynch and others felt structure could be incorporated by training respondents in the language of design.

2.3.2 Structured Sketch Mapping

Sketch mapping communication can be improved by using a standardized set of symbols to represent different types of features. Two examples of sketch mapping methods using a structured language for surveying participants are presented. The discussion begins with an introduction to the method made famous by Lynch (1960). This is followed by a brief description of a method developed by Beck and Wood (1976) which attempted to build on the basic ideas promoted by Lynch. This is followed by a discussion of limitations to the structured sketch mapping method.

Lynch Method

Lynch's primary concern, in *The Image of the City*, was to devise a technique to articulate and measure, what he termed, the 'imageability' of urban form. It was thought that understanding which elements of existing urban form held special meaning to the general public would improve the ability of planners to design for the people.

In order to identify which elements of urban form were most 'legible', and therefore held special meaning, Lynch had respondents draw a model of the urban environment on a blank piece of paper. From individual responses, a collective image of the urban environment was created, representing, on the basis of the sample, an often undifferentiated public perception of the urban environment. In the words of Lynch, it is this group image, "exhibiting consensus among significant numbers, that interests city planners who aspire to model an environment that will be used by many people" (Lynch 1960, p 7).

Lynch's methodology began with training respondents to see the urban environment as being comprised of five elements: Paths, Edges, Nodes, Districts and Landmarks. *Paths* are defined as "channels along which the observer customarily, occasionally, or potentially moves" (p 47). *Edges* are linear breaks which divide one area from another. *Districts* are perceived homogeneous areas which an observer can enter into or exit out of. *Nodes* are similar to districts, however they are smaller in size and represented by a point. They are often located at the intersection of two paths. A final set of elements, *Landmarks*, are similar to nodes, except they are focal points which cannot necessarily be entered into. Once trained in this language of elements, respondents were able to articulate and communicate their perceptions.

Respondents were asked to draw a map of an urban area using the five elements to symbolize the urban form. In addition to the map exercise, respondents were given other tasks. First, they were asked a number of open-ended questions related to their perception of the environment. Second, respondents were given a number of photographs of the area under investigation and asked to identify them, group them, and arrange them.

Finally, respondents were asked to lead a researcher through the urban area while describing what they saw along the way using the five elements. These additional exercises helped clarify, understand and support the mapping exercise.

The mapping exercise itself was completed separately from the other tasks. The respondent "mapped the area, indicating the presence, visibility, and the interrelations among the landmarks, nodes, paths, edges, and districts, and noting the image strength and weakness of these elements" (Lynch 1960, p 143). The respondent was then asked to review and verify the resulting map by walking through the area several times. Each element was classified according to its perceived degree of significance. In completing the exercise, Lynch hoped to capture "not physical reality itself but the generalized impressions that real form makes on an observer indoctrinated in a certain way" (Lynch 1960, p 143). Thus, the resulting images were thought to represent the individuals' perception of the environment.

An important shortcoming in Lynch's sketch mapping technique is the reliance on physical elements. Goodey (1971) points out that "while trained observers were able to detail the main elements of city form, they omitted social details, such as subjective evaluations of neighbourhood class…" (p 24). While Lynch admits "this analysis limits itself to the effects of physical, perceptible objects" (Lynch, 1960, p46), he also felt that perception of environment was based largely on physical built form. However, it has also been argued that Lynch did not fully explore the perception that people had of the built form beyond the physical characteristics. Banerjee and Southworth (1990) argue that Lynch's sketch map method "explicitly set aside the other meanings of places to their users" (p 240). His method did not allow for analysis of intensity of like or dislike to be represented. He assumed that urban features most frequently appearing on maps were more 'legible' than those appearing less frequently. There is no analysis of value associated with these objects, only recognition. Lynch did not explore perception of the environment; so much as he did recognition of elements of the built physical environment.

Environmental A

Building on the idea of the design language conceived by Lynch, Wood and Beck (1976) developed a sketch mapping language called "Environmental A" which included symbols for both physical and perceptual elements of an urban environment. For instance, symbols were included to represent value perceptions, such as 'Danger', 'Dirty', 'Litter', 'Sadness' in addition to more physical elements such as 'Home', 'Bank', etc. The technique used in *Environmental A* differed from Lynch's sketch map technique in a number of ways. First, participants were given detailed and careful instructions on how to draw a base map of the area under investigation. Next, participants would overlay the base map with a transparent overlay and record information using the symbol language. Separate overlays were used to record different types of information. According to Kitchin and Blades (2002) "the advantage of Environment A was that the information collected was much more comprehensive than just the layout of places and roads, because the technique also elicited personal meanings and values" (p 140). Despite the advantages of using *Environmental A*, it has rarely been used in data collection, "nor has it inspired the development of similar techniques" (Kitchin and Blades, 2002, p 140).

Limitations

While the sketch mapping technique proved useful for identifying and describing elements of the environment perceived to be important, the technique has limitations. First, the sketch map technique popularized by Lynch required respondents to be trained design language. This required a considerable investment in time and effort. Second, large sample sizes, required in order to accurately represent the public at large, were difficult to obtain.

Sketch mapping assumes that the "subject understands the abstract notion of the model and its relationship to the real world" (Golledge and Stimson, 1997, p 242). In order for respondents to create usable map products, they would first have to be able to effectively communicate their ideas. Lynch recognized that the quality of spatial product produced by an individual was largely a reflection of their ability to articulate and communicate ideas using the five basic urban elements. The quality of image could be improved by educating the public more thoroughly in his design language. Lynch called for the full scale education of the populous whereby "citizens could be taken into the street, classes could be held in the schools and universities, the city could be made an animated museum of our society and its hopes" (Lynch 1960, p 117). Educating large groups in the language of design would add a considerable amount of time to an already lengthy and, in Lynch's words, "elephantine" research method (Lynch 1960, p 152).

Training the lay-public in design concepts prior to participation in a design exercise takes a great deal of time and effort on the part of the researcher as well as the participant. This means that sample populations will only include those with enough free time and active interest in the exercise. Lynch places the onus on the public to learn the language of design. People not trained in Lynch's design language will be unable to participate as fully as those who are. The end result is the exclusion or marginalization of a large portion of the population due in large part to education and social class. This bias toward articulate well-educated respondents is reflected in Lynch's sample being "primarily middle-class, professional and managerial" (Lynch 1960, p 152).

The length of time required to educate respondents, in addition to the time required to participate in the study itself, resulted in very small sample sizes. Even Lynch admits the "samples were inordinately small: 30 people in Boston, 15 in New Jersey and Los Angeles" (Lynch 1960, p 152). Considering the size of the cities under study, a sample population of 30 or less is highly unlikely to be representative of the entire population. Small sample sizes are a common criticism of studies involving sketch mapping exercises. As noted by Spencer (1973), larger samples should be drawn in public image studies where analysis is reliant on shared social and spatial experiences (p 25).

Having a small sample size also limited the ability to investigate the separate images held by various demographic groups. Lynch admits, "probing into group differences would undoubtedly be an interesting inquiry" (p 154). While Lynch recognized that "it is important to understand how the different major groups tend to image their surroundings" (p 157), his study failed to address this. A larger sample size may have allowed for a wider demographic to be captured and differences between groups to be analyzed. Researchers later using Lynch's sketch map method were able to obtain much larger sample sizes and conduct such analysis (See Francescato and Mebane, 1973; Orleans, 1973 in Downs and Stea, 1973).

When individual maps from respondents are synthesized into a composite image, issues related to small mapping errors of an individual map are overcome. The larger the sample size, the more likely the final composite image is to accurately represent the collective public perception of the environment.

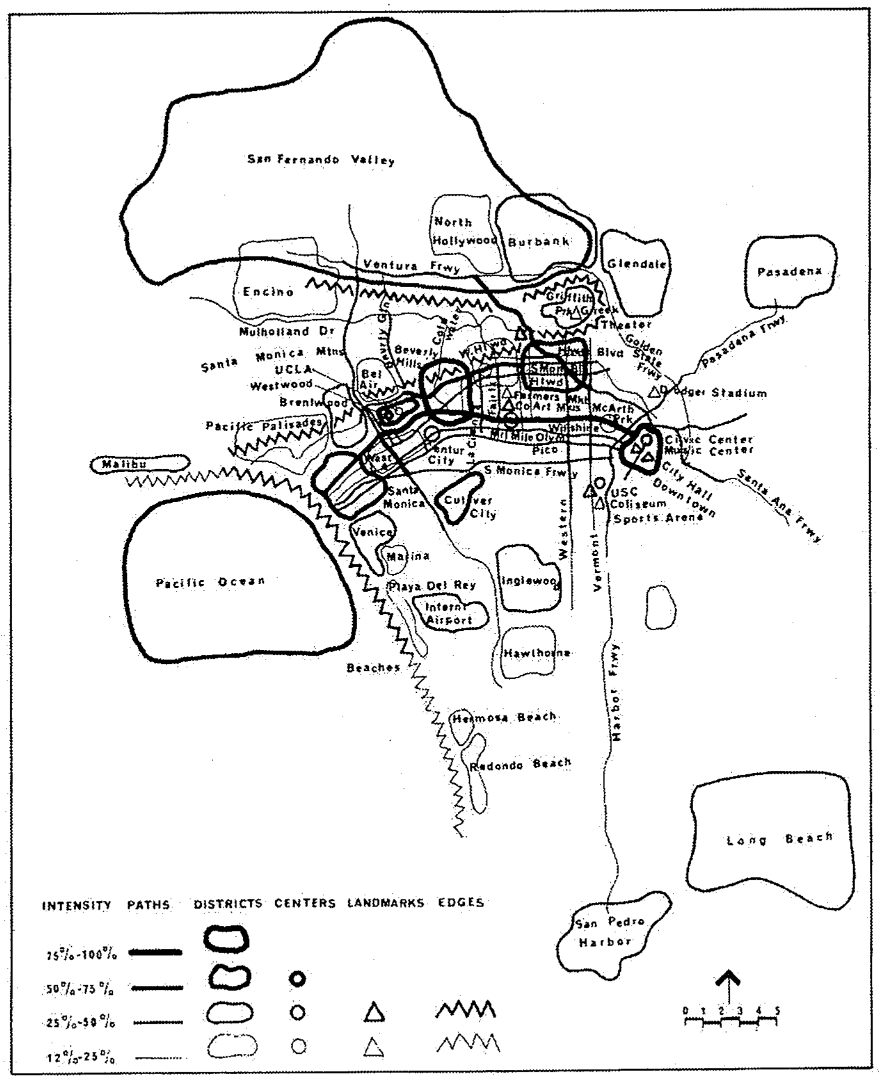
Aggregation

Regardless of the specific sketch map technique used, "one can examine sketch maps and produce frequency distributions of the number of times that certain places are mentioned in the environment or the number of times that certain areas, districts, and so on are produced on the sketch" (Golledge, 1976, p 310). It will, therefore, be up to the researcher to draw the composite map and assign the frequency of appearance to each feature represented on the maps. In effect, this method has little advantage over the verbal method of data collection, other than that it may help to overcome language and cultural barriers. Furthermore, it has the disadvantage of relying on the researcher to interpret which features are represented in the individual maps.

The current discussion continues with an example of aggregating individual responses from a study using a structured language. Next, an example from a study using an unstructured data capture technique is provided.

A good example of a study using Lynch's sketch map technique was documented by Orleans (1973). The study was done by the Los Angeles Department of City Planning in consultation with Kevin Lynch. The goals and conclusions of the study are of little relevance to the current discussion as it is the method of aggregation that is of primary interest. The study surveyed 25 residents of five different neighbourhoods. Once all of the surveys were complete, it was up to the research team to catalogue the number of times each feature was represented in all of the maps. Next, a map of all features was hand drawn by the research team with the frequency of occurrence represented by line thickness. An example of this map can be seen in Figure 2.1

Figure 2.1 - Example of Lynch Aggregation Map



(as found in Orleans 1973, p 122 – reproduced from Los Angeles Department of City Planning, 1971)

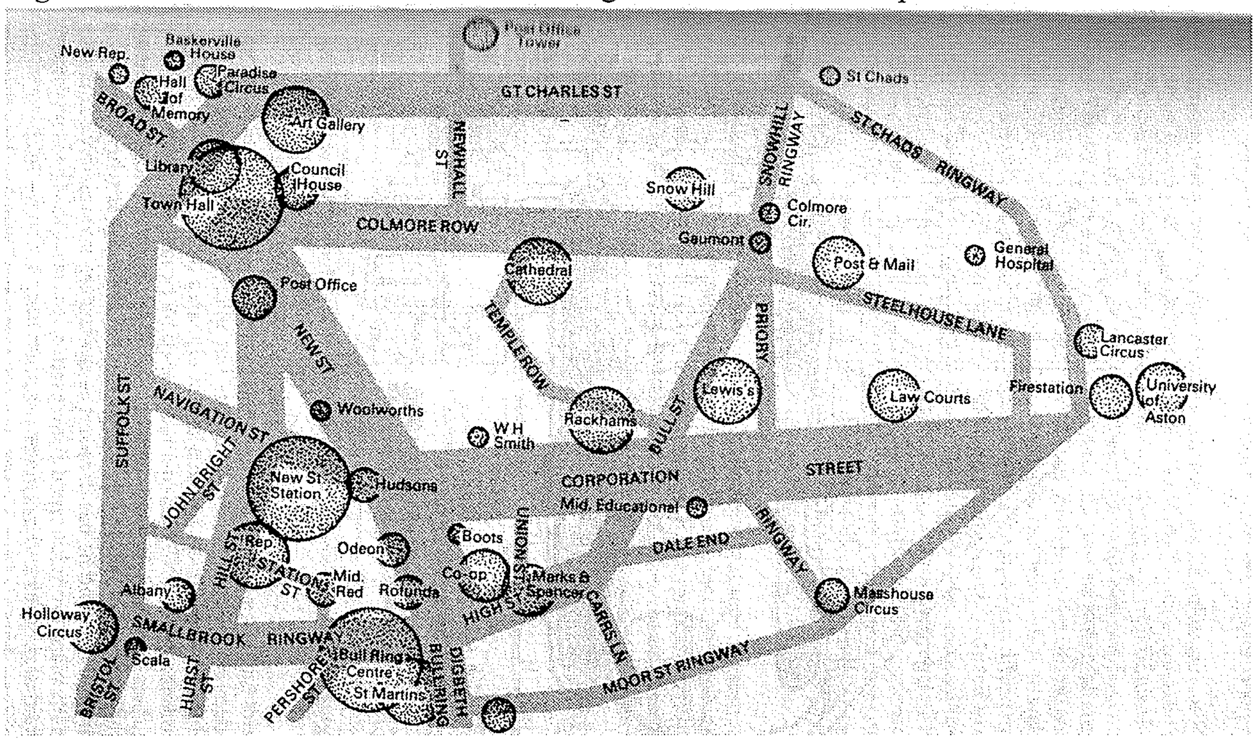
It should be noted that the size and location of each element represented in the map in Figure 2.1 is the work of the researcher, not the respondents. Intensity of perception is based on the percentage of individual maps the feature appears in. It is worth noting that with the exception of neighbourhood boundaries, all of the elements on the map are representations of something physical that can be seen. However, the neighbourhood boundaries represented are the work of the researcher, not the respondents. The spatial extents and arrangements of the elements on the respondents' maps were disregarded in the creation of the composite image. This begs the question: Why not simply have participants respond verbally?

While the final composite map does give an indication of which elements were most often cited by respondents, identifying a practical use for such an image is less obvious. Perhaps, the most useful application of such a map would be the demonstration of differences in familiarity with certain urban features and locations or the exploration of differences in the ways that people value them.

Aggregating individual responses from an unstructured sketch mapping exercise into a composite image can be challenging. As noted by Goodey et al (1971), although the "process of the preparation of composite maps appears simple, it in fact involves many problems, and especially those associated with the abstraction of data from individual image maps" (p 43). The open-ended nature of unstructured sketch mapping exercises gives respondents free reign to decide which symbols to use, which features to capture, and at which scale to represent their perceptions. This makes aggregation of individual responses impossible without interpretation of content and redrawing of spatial elements on the part of the researcher.

In Gould and White's book *Mental Maps* (1974), the authors document the work of Brian Goodey in his investigation of downtown Boston. With the help of a local newspaper they asked readers to send in mapped sketches of the "major impression they had of the area" (p 28). From the many hundreds of responses researchers were able to create a composite map based on the frequency that various locations were represented by the entire sample population. The resulting map is included here as Figure 2.2

Figure 2.2 - Preference for Features in Birmingham's Urban Landscape



(As represented in Gould and White, 1974, p 29)

As with the map of collective responses produced from the Lynch example, the map is once again the sole creation of the research team. By drawing lines on a map, a respondent is merely submitting a 'vote' for the most recognizable urban features.

The map appears to be conceptual and not conforming to any scale or metric. This would limit the ability to combine this map as a layer with other spatial information. Although Gould and White claim the map "proved very valuable to planners trying to think through the future appearance of the city" (p 30), it was not discussed how they used it. Perhaps, it could be inferred that people are most likely to travel down Corporation St. to get to the New St. Station. However, this seems a dubious and roundabout method of arriving at such a conclusion.

Limitations to aggregating individual, blank-page sketch map responses should encourage researchers interested in capturing, synthesizing and analyzing public perception of a neighbourhood to consider alternative techniques of data capture.

Although the use of a design language, such as Environmental A or Lynch's 5 elements, does help to constrain the amount of interpretation required, these methods also face significant challenges. The method of data capture used by Lynch limits the ability to create useful aggregate images of responses. While the aggregate images created may represent public perception of the built environment, without a clear method of how to use such information they are of limited use to planners in the decision making process.

Even when respondents are trained to communicate and record their perceptions in a language of design, there is room for error. The problem is that two individuals may perceive the same location as two different elements, based on their perspective, or the level of knowledge they have. Lynch (1960) recognizes that "an expressway may be a path for the driver, and edge for the pedestrian" (p 48). In addition, the same urban feature may be represented differently by two different respondents due to the scale at which they decided to draw their maps. For instance, a district at a large scale could become a node at a small scale. Different respondents identifying the same feature using different elements can cause confusion in creating the aggregate image; especially if the aggregate is based on the frequency each element is identified. Creating an aggregate image from individual spatial products will therefore require a significant amount of interpretation on the part of the researcher.

Although individual maps produced by respondents of sketch mapping exercises can by synthesized into a collective image, it is up to the researcher to draw and interpret the content of the composite map. In creating the composite image, the number of times a recognizable element is found in the complete sample of individual responses is counted, while the spatial properties of each individual map are disregarded. In light of this, it could be argued that sketch mapping has little advantage over verbal data capture techniques.

Sketch Mapping Vs Verbal Techniques

Many researchers use sketch mapping in combination with other data capture methods. Lynch (1960) supported the sketch mapping exercise with a verbal method interview, which was conducted separately. Because aggregation of individual responses is based on the frequency which features are mentioned, data obtained through either survey technique can be aggregated in the same manner. This allows the results from both surveys to be compared with one another. Examples of the resulting composite images from the verbal survey and sketch maps can be found in Figure 2.3

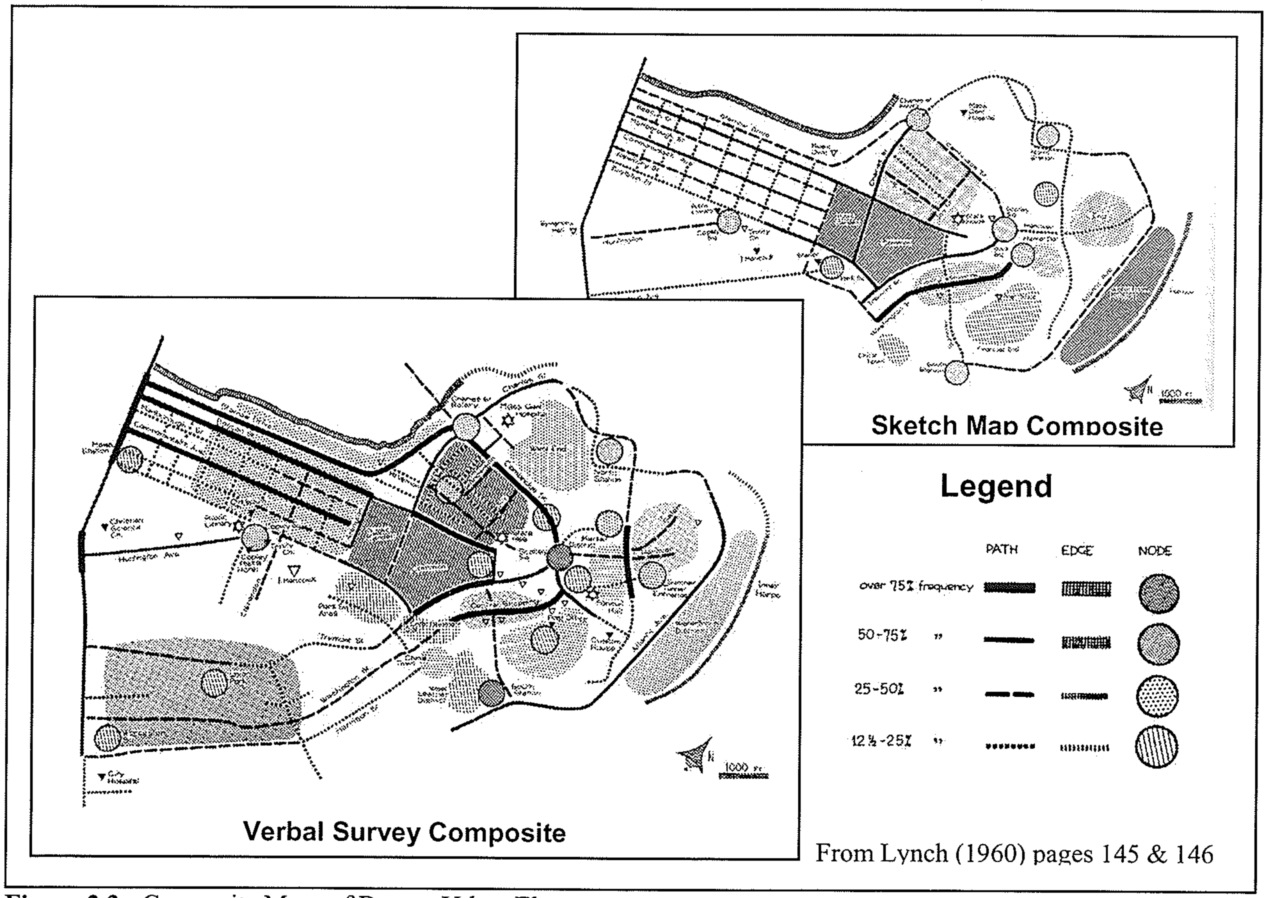


Figure 2.3 - Composite Maps of Boston Urban Elements

It was discovered that the verbal survey method identified many more elements than the sketch map. Lynch suggests that many elements may have been excluded from the sketch map due to the difficult in including them all in a single drawing. He surmised that elements included in the sketch map were only those of major importance. Based on this conclusion, it is possible that verbal techniques are best used for capturing specific details, while sketch mapping is better for capturing and identifying which elements are most important.

While the simple survey interface used by many sketch mapping techniques may be able to overcome language, cultural and educational barriers, they "are considerably more difficult to interpret from a social psychological viewpoint than are the contents of verbal descriptions" (Ladd, 1970, p 75). Survey mapping techniques often require additional information from respondents in order to ensure a correct understanding of elements appearing in the drawing. Difficulties in correctly interpreting the results of individual sketch maps make the reliability of the technique tenuous. However, "sketch mapping is used often in conjunction with other methods for extracting cognitive information about environments" (Golledge and Stimson, 1997, p 242).

Summary of Sketch Mapping

Traditional sketch mapping techniques developed for the purposes of modelling public perception of the environment are of limited use to planners in the decision making process due to difficulties related to interpretation and analysis, time requirements, and lack of spatial integrity found in the resulting map products.

Unstructured responses obtained using unrestricted sketch mapping on a blank piece of paper are extremely difficult to analyze. Poor drawing skills and distortions on the part of respondents, compounded by the lack of a common language between researcher and respondent, allow for errors in interpretation. While some useful information can be obtained using an unrestricted sketch mapping method, "this much seems clear: a blank sheet of paper as a stimulus for obtaining a mapped image of the city is more of a liability than an asset" (Orleans, 1972, p 129). Additional information is often required from respondents if individual sketch maps are to be interpreted correctly. The open-ended nature of the survey makes aggregating individual results difficult. Despite limitations, the method is easily understood by participants and allows for participation from individuals that would otherwise be marginalized using other more complex methods.

Sketch mapping techniques that attempt to structure responses through the use of a design language require a lot of time and resources in the education of respondents. The amount of time required often leads to smaller sample sizes and often excludes participation of certain individuals due to culture, education, language and other factors. While this method does not overcome the need for additional information from respondents, aggregating individual responses into a collective public image is quite simple and straightforward.

Sketch mapping techniques usually capture public recognition of elements of physical form, rather than perception of the environment. While an attempt has been made to improve upon the method devised by Lynch (Environmental A), this method has not found widespread application or acceptance.

Sketch mapping techniques offer little advantage over verbal techniques. Aggregating individual responses into a collective public image is done using the same method. While sketch mapping techniques can overcome language, cultural and educational barriers, they are best used in conjunction with other methods in order to ensure the validity of research conclusions.

While many of the sources cited in the literature suggest that sketch mapping will be of use to planners and designers in the decision making process, it was never made clear how. In order to be of use to planners, the results of a sketch mapping exercise must somehow be integrated into the decision making process. This was never demonstrated in the literature from the 1960s and 1970s. Even today, integration into the planning and decision making process requires data to be included in a common analysis system, such as a GIS. In order to be incorporated into a GIS, the data must have referential integrity and spatial meaning: data obtained from sketch mapping exercises, which use a blank page, contain neither.

As noted by Orleans (1973): "It might well be that a series of partially completed base maps – maps showing, for example, major streets, civil divisions, geologic features, important landmarks, and the like -- would elicit a more detailed, coherent, and consistent imagery" (p 129). In order to obtain information that has spatial meaning, respondents must record their results using a standardized map scale. A standardized map scale would allow for individual results to be compared and aggregated with one another based solely on spatial properties. The aggregate representation of all responses can then be overlain and compared with other spatial data used in the planning decision making process.

2.4 Completion Mapping

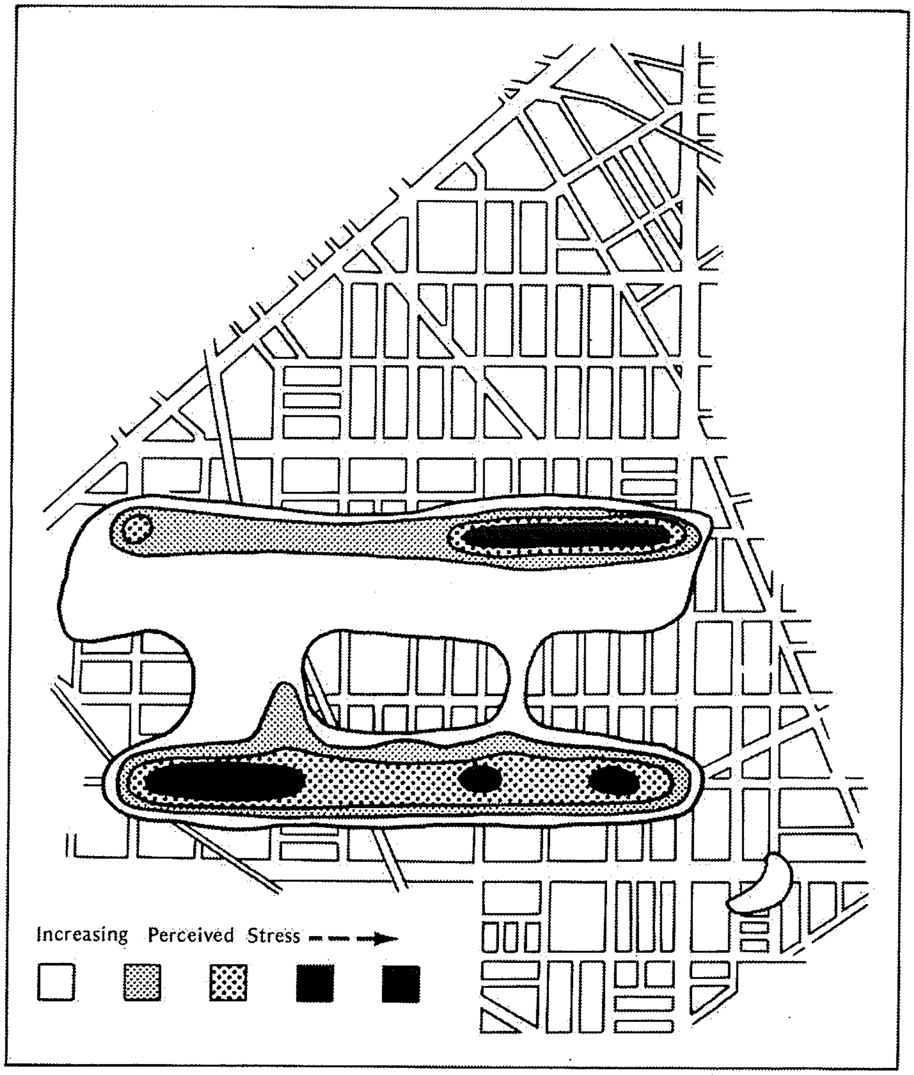
Completion mapping is much like sketch mapping, with the exception that the user is provided with a base map upon which to record their perception of the environment. The use of a base map calls for less reliance on the drawing abilities of participants and gives more control over variations in scale and distortion. Aggregation of individual responses can be done using a spatial overlay method. The resulting collective image of public perception can be correlated and compared with other spatial datasets used in planning decision making. The fact that this method received little attention during the 1960s and 1970s was likely due to the cumbersome task of aggregating responses.

Completion mapping exercises begin with the respondent being given a base map of the study area. The respondent is then instructed to identify areas, places or routes on the map that meet certain criteria. The base map acts as a "frame onto which they 'hang' their knowledge" (Kitchin and Blades, 2002, p 197). This method is very effective for determining public perception of non-visible and or non-physical elements of an urban environment. Examples of this method in the literature are surprisingly rare and often relate to studying perception of neighbourhood extent.

One of the earliest examples of this method can be found in the work of English psychologist Terrence Lee. Lee (1964 and 1968) instructed participants to draw the boundaries of their neighbourhood on a base map. The resulting maps were then superimposed on one another to reveal commonalities and differences held by different respondents of what they considered to be the boundaries of their neighbourhood perceived neighbourhood extent. In both studies, Lee used the results to discredit the parameters by which neighbourhoods were being planned in post-war Britain.

A second often cited example from the literature comes from David Ley (1972), who was interested in examining the perception of danger felt by inner-city residents of Philadelphia. From individual surveys, Ley was able to construct a surface representing the degree of stress felt by the sample population (see Figure 2.4)

Figure 2.4 - Perceived Environmental Stress Surface of a Portion of Philadelphia



(by Ley – as found in Stea and Downs 1977, p 16)

The resulting collective image of individual perceived stress is represented as a continuous surface so every discrete location on the map could have its own stress level value. For mapping purposes, the legend classification scheme used an ordinal scale. From this image areas perceived as most dangerous by the sample population are very clear.

This method has a few advantages over the sketch mapping and verbal techniques discussed. First, the resulting images are based on a single theme and are easy to understand. Second, it is specifically geared towards capturing abstract elements of the environment that are not visible. Third, because respondents record their own answers, there is less opportunity for researcher bias due to misinterpretation. Fourth, this method does not require any training or special language skills as a prerequisite for participation. As a result, the method is simple enough to allow for participants of multiple publics to participate equally. Finally, the collective image of perception, created from individual responses, can be overlaid and compared with other spatial datasets representing an unlimited number of variables.

The resulting image represents a single theme or idea; that of perceived danger. This is due to the fact that responses are based on a single well-worded question, as opposed to one that is open-ended and designed to be exploratory in nature. Ley's instruction to participants was to record their perception of a specific theme or idea; in this case 'danger'. This is an advantage over the sketch mapping and verbal techniques discussed which usually have respondents draw unlimited number of discrete physical entities. The images resulting from sketch mapping and verbal techniques are often confusing and difficult to interpret, while the images resulting from the completion method are much more straightforward to understand.

Completion mapping designed to capture elements or themes that are not physical in nature. As noted by Haynes (1981), "for any inhabitant, the city has hidden meanings quite separate from the location of landmarks and orientation of streets, meanings that a stranger might miss" (p 21). This type of information is not available from sources other than local knowledge. It is also quite unlikely that the planner or researcher will be aware of or fully understand the extent of these hidden meanings without consulting the public. While other methods may be able to capture qualities of non-visible elements of an environment, studies using these methods tend to focus on physical elements.

Such hidden meanings will not be adequately captured with the use of sketch mapping or verbal responses methods, as they rely heavily on the recall of physical features. Verbal descriptions of dangerous places rely on existing physical elements to reference themselves. The spatial uncertainty and lack of scale found in individual sketch maps makes determining the spatial extent of dangerous areas extremely difficult. Capturing hidden meanings or abstract concepts, such as 'perception of danger', is difficult, if not impossible, to capture using other techniques discussed so far.

Having respondents record their own answers on a base map means there is less room for researcher bias through interpretation. Areas identified by each respondent are of the same scale and distortion. This means the locations of boundaries drawn by a respondent do not have to be translated or interpreted by the researcher. In addition, respondents are limited in the manner in which they can respond. The completion mapping method restricts participants to responding drawing points, lines and/or polygons on a map; all of which represent perception of a specific phenomenon. This makes the resulting drawings easy to interpret, and allows less room for error on the part of the researcher.

Having participants enter their responses on a base map does not require any specific training or mastery of an abstract design language. Nor does it require exceptional drawing or cartographic skills for participation. As a result, all respondents have the same level of participation. Respondents that have better language or drawing skills are not able to participate any more or less than others. This method allows for the participation of those otherwise marginalized using other techniques.

Having respondents record their perceptions using a base map of standardized scale and projection allows for individual results to be easily overlain and synthesized into a collective public image of perception. The resulting collective image of perception can then be overlaid and compared with spatial data from other sources. The image could also be used in an exploratory manner with other spatial data sets to determine what other factors contribute to the perception of a given phenomenon. For instance, the stress surface shown in Figure 2.4 could be compared with crime information to determine a spatial correlation between crime and perceived level of stress. In addition, the comparisons could be made with other maps created in the same manner representing different themes or groups within the sample. The collective image of public perception created from individual responses can be correlated with other spatial datasets used by planners in decision making.

Despite the advantages of the completion mapping method there are some limitations. First, the choice of base map must be done carefully so as not to cue or lead respondents. Furthermore, the base map should allow for information to be easily extracted. Second, the manner in which the question is asked must allow for a non-response. Overcoming these limitations is simply a matter of taking care when creating the survey tool. A third limitation is related to the ability to aggregate individual maps using a spatial overlay method.

It should be noted that some bias may be introduced through spatial and location cueing found on the base maps (Kitchin and Blades, 2002). Researchers must be careful only to include as much detail and information on the base map as necessary to allow for an adequate frame of reference. O'Connell and Keller (2002) found the use of a topographic map in capturing perception of a rural environment to be good due to their detail, rigorous spatial integrity, and inexpensive cost. However, referencing Harley (1990), they admit "topographic maps are social constructions which contain considerable cultural bias and silences, and therefore are not value-neutral generalisations of reality" (O'Connell and Keller, 2002, p 610). Speaking from a similar experience related to British Ordnance Survey Maps, Spencer (1973) suggests using a base map comprised of selected landmarks and routes (p 31). This appears to be a reasonable and effective solution to cuing issues.

Anderson and Tindall (1972) espouse the use air photos as base maps in completion mapping exercises. While it could be argued that air photos provide a complete, unbiased view of the environment, they can be difficult to read without the aid of labelling. In addition, information recorded on a paper base map may be difficult to read and extrapolate. For this reason, air photos should not be used completion mapping exercises done on paper.

A second caveat is to ensure participants do not enter information they know not to be true. It has been found that some respondents provide answers questions to which they don't know the answer in order to avoid appearing ignorant in the eyes of the researcher. Related to this, as articulated by Goodey (1971), "there is a nagging suspicion that if one asks people to identify a neighbourhood, they will find one, regardless as to whether it is a meaningful framework for their social, spatial or political activities" (p 7). It is important to frame instructions in such a manner so as to not force participants to enter information when they have limited knowledge of the area or topic under investigation.

Aggregating individual responses is done using a spatial overlay technique. Theoretically, all individual maps are overlain with one another and the number of polygons coinciding with any given location on the map is recorded. While this method is simple to do with two map images, it becomes increasingly difficult and cumbersome with increase in the number of overlays. During the 1960s and 1970s this process would have had to be done manually by recording the coincidence of overlays on a separate piece of paper or mylar. The introduction and acceptance of GIS after 1980 would have made this cumbersome and tedious task very easy. However, the introduction of GIS came after the decline of popularity of cognitive mapping.

Completion mapping overcomes the limitations of sketch mapping and verbal responses methods. The use of a base map ensures that responses are recorded by the participant using a standard scale and projection. Individual responses to specific questions about perception of the environment are then recorded spatially onto the base map. The resulting responses are then aggregated using spatial overlay method. The final collective image of perception has the necessary spatial integrity to be spatial correlated with other datasets used in policy and planning decision making. Despite its strengths, the cumbersome task of compiling and analyzing responses gave this method limited appeal to cognitive mapping researchers of the 1960s and 1970s who did not yet have access to GIS technology.

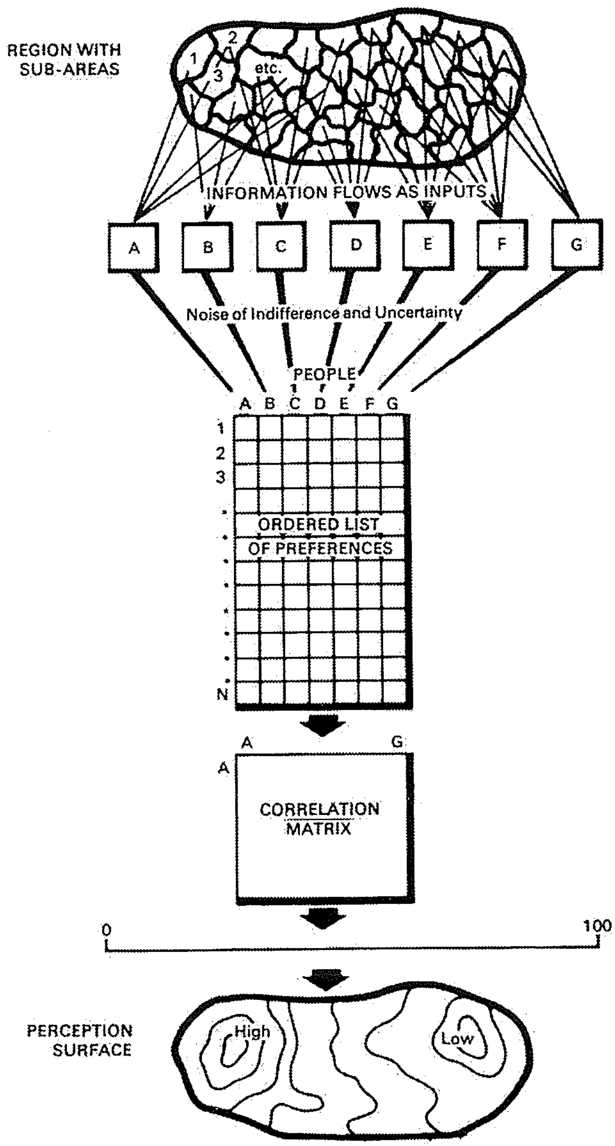
2.5 Preference Mapping

A final method used by cognitive mapping researchers of the 1960s and 1970s that is of interest and relevance to the discussion is preference mapping. In this method, respondents indicate their preference from a discrete set of alternatives. Tabulation of results for any given location is based on either the number of people that vote for it or the preference ranking they assign to it. Unlike the completion mapping method, voting is constrained to a discretely defined set of items pre-determined by the researcher. A continuous surface covering the study area is often interpolated a from the resulting point values. While the images of public perception created using this method appear to be much the same as those created using in completion mapping, there is an important difference in the manner in which data is collected and values assigned.

Many examples of this method can be found in the literature, most authored by the geographer Peter Gould (1966, 1973a, 1973b; and Gould and White, 1974). Gould's method was relatively simple. He would present participants with a list of places and instruct respondents to rank order them in terms of preference. A good example of this method is his 1966 study in which he had U.S. College students indicate preference for locations according to where they would most like to live.

In Gould's words "The basic data consisted of a matrix whose rows represented areas (states in the U.S.A., countries in Europe, and administrative districts in Africa), while the columns represented people" (Gould, 1973a, p186). The cells of the matrix would contain the rank order preference for each person by location. Next, correlation coefficients were calculated between all possible pairs of respondents. These correlation coefficients where then used as weights, which were multiplied by the original rank values for each location / respondent pair. Finally, the resulting values for each location were added together to produce a final score ranging from 0 to 100. These final scores were then plotted on a map and an image of continuous preference was interpolated using the locations as interpolation points. A graphical representation of this process is provided in Figure 2.5

Figure 2.5 - Construction of a Preference Surface



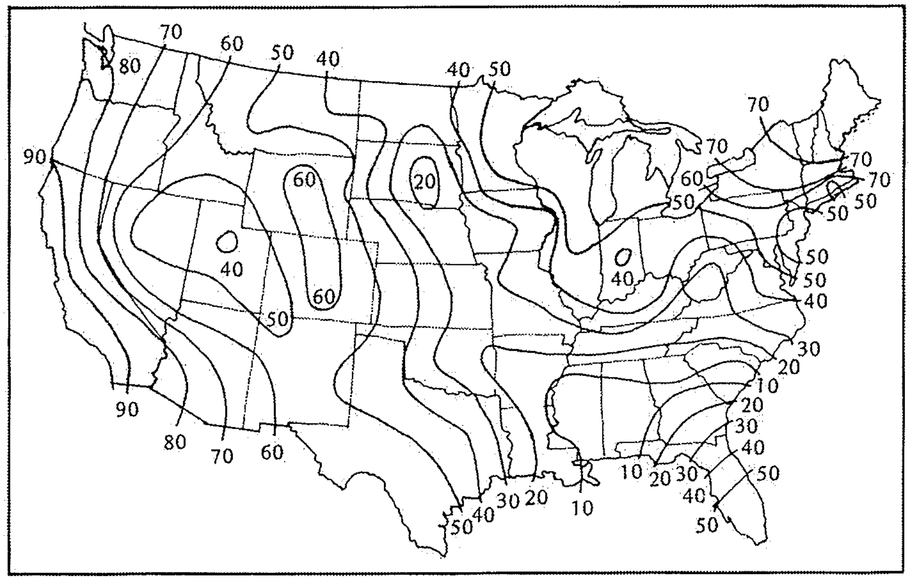
(Gould and White, 1974, p 66)

One of the advantages to this technique is that it is very easy to administer and complete. Of particular interest to this discussion is that Gould had respondents demonstrate preference by rank ordering items in a list. When demonstrating preference of location, “many people find it rather difficult to assign interval measures, but feel it is relatively easy to rank places in order” (Gould and White, 1974, p 57). A large enough sample size will effectively draw the same conclusion regardless of the method whether information is rank ordered or assigned a value on an interval scale. According to Gould, “for any group of reasonable size, say over twenty, the mental maps constructed from interval and ordinal measurements are virtually indistinguishable” (Gould and White, 1974, p 57). Garnering large sample sizes is not a problem with this technique.

The disadvantage to rank ordering many items is that respondents may be forced to comment on places they likely know little or nothing about. Such places are likely to be ranked somewhere in the middle as most respondents will be reasonably sure of their most and least preferred items. Therefore, it may be better to instruct respondents to perform two separate tasks: one to order their top few preferences, and another to rank order their lowest few preferences. This will reduce the potential for respondents to assign preference to items they are not familiar with.

Gould’s method is easy to administer and because the researcher has control over the total domain of potential responses, the results are easy to tabulate. There is absolutely no drawing on the part of the respondent. As a result, the collective perception surface may not represent the spatial perception of the population as accurately as one may assume. For instance, consider Figure 2.6

Figure 2.6 - Residential Distribution of U.S. College Students: the view from California



(from Gould, 1973a, p 188)

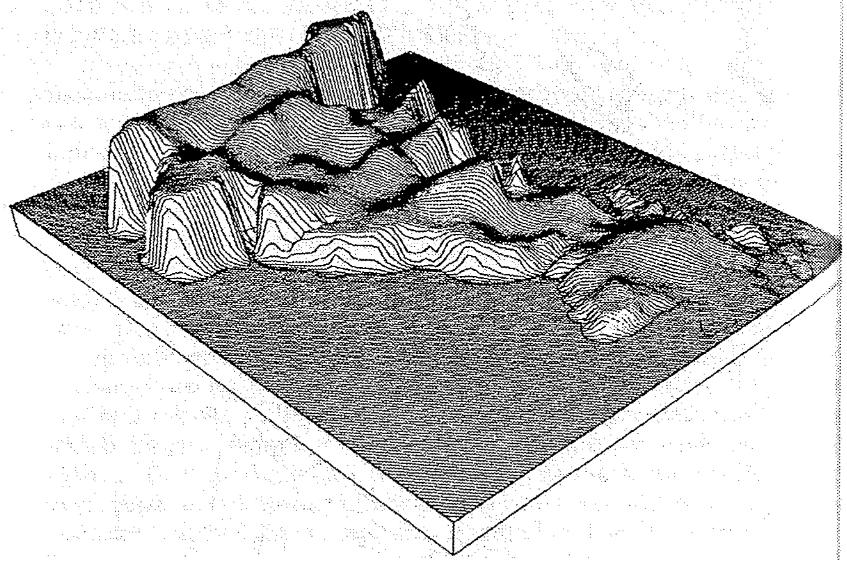
Because the domain of potential locations is controlled by the researcher, the researcher will have the power to influence the outcome. Clusters of locations could serve to accentuate the valleys and peaks throughout the map. For instance, if respondents have the ability to indicate the top three preferences as "Los Angeles", "Huntington Beach" and "Hollywood", California, preference to this single larger metro area will carry significant influence on the result. In order for this method to be free of such influence, locations would have to be evenly distributed throughout the study area.

Another issue is that the resulting image assigns a preference for every location on the map, regardless of whether or not it appeared in the matrix. Areas in between identified locations are assigned values according to some form of interpolation. While the exact interpolation method used is not mentioned in any of the literature reviewed, it is clear that the resulting collective image must be interpreted with caution. For instance, it is unlikely that anyone would prefer to live in the Nevada desert over living in the mid-west as the map would suggest.

Critics of Gould's technique point out that the graphics, which are a large part of the analysis, are a product of the investigator and not the subjects (Stea and Downs, 1973, p 180). As Stea and Downs (1973) suggest "the composites compiled by Lynch from subject-produced cognitive maps (which indicate the frequency of mention of features in each element-class) and the preference surfaces statistically derived by Gould from subjects' rankings of places are both investigator-produced" (p 180). The spatial representation is not a direct product of individual respondents. Perhaps the harshest criticism of Gould's technique comes from Tuan (1974): "So far as I can tell, the mental maps of this book [Gould and White's *Mental Maps*] are opinion and information surveys represented in cartographic form" (p 591). Readers of Gould's preference surfaces should be aware that the image is a result of the researcher's interpretation and analysis of the results.

A final matter related to preference mapping that deserves some attention is Gould and White's three-dimensional image of a national perception surface for the south of England. Gould's penchant for creating fancy graphics reached a pinnacle when he produced the image in Figure 2.7

Figure 2.7 - Map of Living Preferences in Southern England



(Gould and White, 1974, p 83)

The graphic presented in Figure 2.7 was created by entering an interpolated preference surface into a computer and having it render the values as elevations. The result is a three dimensional image that is very appealing to look at, but is of very little use. From this image it is extremely difficult to draw comparisons between any two locations on the map. It is also very difficult to exactly associate particular cities or other locations with specific peaks or valleys. In short, although Gould should be commended incorporating technology into his work, three-dimensional graphics serve little purpose when it comes to presenting perception surfaces. No additional information is gained when displaying a single variable in three dimensions in isolation of other variables or data sets.

Gould's description of the practical application of his mapping technique deserves some attention. Gould and White (1974) suggest that the collective image of perception can be used by planners and policy makers to understand preference levels of various themes. Policy can then be directed toward finding ways to "smooth out the hills and valleys of the perception surfaces to make them perceptual plateaus..." (Gould and White, 1974, p 171). Obviously, additional information would be required before policies were created to smooth out the peaks and valleys in the perception surface. However, the perception surface does provide a good source of public knowledge which can be overlaid and correlated with other spatial information used in the planning and policy decision making initiatives.

It is interesting to note that while Gould presented the differing perception of the multiple publics participating in the study, this was never recognized as a characteristic that a planner would be interested in. For instance, Gould would report his results in multiple maps; one for each cluster of respondents. Clusters were based entirely on the location in which a respondent participated in the study. The result was the ability to compare results from California and New York. In this respect, his method was ahead of his time. Unfortunately, planners of the time were still making decisions for an undifferentiated public.

2.6 Conclusion

While many researchers claimed that the results of cognitive mapping exercises will be of use to planners in the decision making process, this was rarely demonstrated. Even Lynch himself "bemoaned the fact that studies of urban cognition have had few demonstrated applications (and quite a few misapplications), and that his own pioneering studies have been adopted by social scientists rather than planners" (Stea and Downs, 1977, p 241). By the late 1970s critics began to formally recognize the lack of practical application and questioned whether or not the results of such research could be incorporated into the planning decision making process, or was even based on valid assumptions to begin with.

Critics of cognitive mapping techniques have been particularly hard on Lynch. Banerjee and Southworth (1990) reported that although his ideas were adopted by planners, they "would simply skip the citizen interviews as a nuisance, and use the bright new terminology (nodes, edges, landmarks) to describe their own image of the city, thus giving a show of respectability to the particular pattern they were bent on imposing" (p 240). To Lynch's dismay, his method became a language for planners to use in communicating their ideas, rather than a language for listening to the public. As a device for public participation, Lynch's method had failed by no fault of his own.

Perhaps the most devastating blow to the cognitive mapping field as a whole came from Bunting and Guelke (1979). In their article, *Behavioral and Perception Geography: a critical appraisal,* they questioned the most basic assumptions of cognitive mapping research: "On grounds of both empirical evidence and theoretical reasoning we would contend that there is no simple or straightforward link between cognitive and overt behaviour" (p 456). In light of this failing, the Bunting and Guelke suggest more emphasis be placed on behavioural observation which would at least "provide us with an understanding of man's [sic] environmental behaviour" (p 461). Bunting and Guelke's critique and suggestion are reasonable. However, it should be kept in mind that this attack was directed at studies which attempted to predict behaviour based on ability to rank or recall elements of the environment. It does not apply to studies which attempt to simply assess publicly held values of an environment.

The main reason for the decline of cognitive mapping research in the late 1970s was likely due to a lack of clear practical application in the planning field. Spencer (1973) expressed his pessimism of the cognitive research movement when he admitted that "cognitive mapping techniques employed in some studies have proved only limited value to the design professions and public policy-orientated research" (p 24). Although many studies before 1980 claim to be of value to planners, studies in the literature which clearly demonstrate how the results of cognitive mapping can be used in the planning decision making process are rare to non-existent.

In order to be of use to planners, it must be demonstrated that cognitive mapping studies can produce results, within a reasonable time frame, that will improve decision making. Banerjee and Southworth (1990) conclude that cognitive mapping "research techniques were found to be too time-consuming, the data too difficult to analyze, and the results either too remote from the pressing issues that confronted them" (p 240) to be of practical use in the planning field. As previously discussed, methods used cognitive researchers proved to be too time consuming or yielded data that was difficult to analyze. Further, it was never made clear how to incorporate the results of cognitive mapping exercises into planning decision making. The acceptance of GIS, beginning in the mid-1980s, would help to overcome such issues. However, the use of GIS in cognitive mapping exercises was not immediately apparent; nor was it immediately obvious that GIS would be the vehicle that would allow for cognitive mapping exercises to be incorporated into the planning decision making process.

GIS would benefit cognitive mapping studies in a number of ways. First, it would provide an excellent set of tools for the capture of perception of the environment.

Second, it would provide the tools necessary to quickly and easily aggregate individual results of completion mapping exercises into a collective image of perception. Third, it would facilitate the spatial analysis of the collective image of perception. And finally, it would allow for the collective image of perception to be incorporated into a GIS as a layer of equal weight and value as other layers used in the decision making process. However, the use of GIS in the planning decision making process has yet to capitalize on cognitive mapping methodologies of the 1960s and 1970s. The use of GIS in the capture, aggregation and analysis of public perception for use in the planning decision making process will be the topic of discussion in Chapter 3.

Chapter 3: Capturing Perception with GIS

3.1 Introduction

The term, 'Public Participation GIS' (PPGIS), is a product of the planning literature. According to Barndt (1998) PPGIS "is a term that has been coined to represent the vision of those interested in the socio-political contribution of GIS to communities" (p 105). Scholarly PPGIS material and related applications can be found in the planning literature since the early 1990s. The goal of PPGIS is to empower communities by creating spatial analysis tools that are easy to use and widely accessible. Many PPGIS are web-based in an attempt to make the tools more available to a wide audience. Others are created on a limited budget and focus on data collection and analysis to support the investigation of a specific issue. Although well represented in cognitive mapping literature of the 1960s and 1970s, methods for capturing and representing spatial information related to local public perception remains sparse and inadequately addressed in the PPGIS literature.

It should also be noted at this point that the rise of communicative action planning ideals in the 1990s influenced the goals of PPGIS. First, there was a shift away from modelling and analyzing the needs of a singular public. Most mapping exercises of the 1960s and 1970s aimed to model and understand the perception of an undifferentiated public. PPGIS initiatives of the 1990s began to be more sensitive to understanding the needs of multiple publics contained within the larger, more general public. In order to facilitate this shift in thinking, attributes of respondents needed to be incorporated into the data capture and modelling process. Second, communicative action ideals sought to "make sure all the major points of view are heard, and not only those of the most articulate or powerful" (Sandercock, 1998, p 65). Meeting this ideal meant obtaining participation from a broad audience with diverse participation needs.

The importance of capturing and including a spatial representation of local knowledge in analysis has been recognized in the PPGIS literature. According to Carver et al., (2000), "existing community and individual ideas and/or perspectives on the decision problem should be presented where known" (Carver et al., 2000, p 162). As noted by Harris et al (1995), "a central component of such a system is the incorporation of local knowledge as a thematic coverage" (Harris et al., in Pickles, 1995, p 214). Even as a layer not incorporated into analysis, spatial representations of local knowledge "could aid in the communication process simply by exposing underlying perceptions otherwise obscured by a lack of appropriate communicative format" (Talen, 2000, p 291). However, despite a few scarce examples, methods of successfully capturing and representing spatial information related to local public perception remain sparse and inadequately addressed in the PPGIS literature. According to Talen (1999): of the major issues related to neighbourhood PPGIS "the attempt to translate environmental cognition and/or resident perception of the neighbourhood and its associated meaning into a form suitable for GIS is the most underdeveloped and has received the least attention" (p 534). The literature has yet to adequately address this issue in the years since this statement was published. The willingness of PPGIS advocates to include local knowledge and perception in decision making analysis has yet to be matched with an effective means to do so.

3.2 Participation

As the name suggests, the main objective of PPGIS is to include public participation through the use of a GIS. Active participation requires genuine communication between planners and citizens. The suitability of using GIS for public participation is outlined by Barndt (1998), who puts forth a list of requirements for public participation. According to Barnt, public participation requires:

- access to comprehensive information
- tools that recognize the inter-relationships among data
- current information
- relevant information
- that information be organized in relevant formats

(Barndt, 1998, p 106)

In addition, Barndt claims that the public participation process can contribute to the creation of more useful data systems. GIS is often regarded as an appropriate tool capable of delivering these requirements and more. It is useful to note that the last point Barndt makes includes the capture and inclusion of local group knowledge and perception.

Peng (2001) states: "Internet GIS can support and facilitate public participation in the planning or decision making process at any point where public discourse and participation enter in" (p 891). Specifically, such a system should contain the following functions: exploration, evaluation, scenario building and discussion forum (p 893). Talen (2000) suggests that PPGIS should focus on the collection, integration and expression of public views. As represented in Figure 3.1, PPGIS methodologies integrate easily into a planning process as they can support a variety of public participation goals.

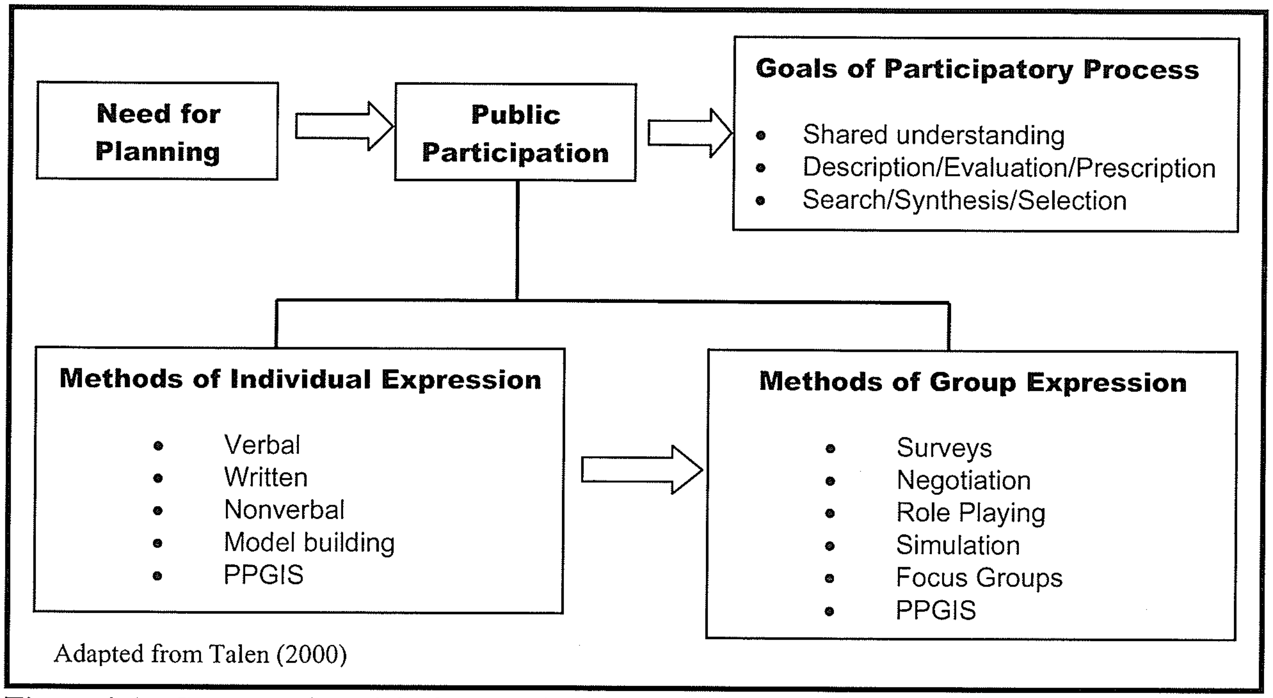


Figure 3.1 - Conceptual model of PPGIS in the Planning Process

PPGIS can foster communication between planners and citizens at the description, evaluation or prescription phase of a planning process. Participation begins with capturing individual expression which is then aggregated into some form of group expression. Representations of group expressions are used as a tool for consensus building. While Talen (2000) points out that not all PPGIS are set as consensus building techniques, they "can be used to support a more multidimensional expression of views" (p 283). PPGIS "aids the dialogue, ultimately expressing whatever representation is most meaningful to a particular group" (p 283). Related to this, Harris and Weiner (1998) speak of *community-integrated GIS* whereby GIS is used by a community to enable discussion, analysis of alternatives and group-decision making.

Before the discussion of PPGIS can continue, it is necessary to provide a definition of what constitutes a GIS.

3.3 What is GIS?

The term GIS is an acronym for "Geographic Information System". As noted by Pickles (1995), "Defining GIS is not a straightforward matter" (p 1). GIS means different things to different people and "is likely to change rapidly as digital spatial data and computer graphics spread rapidly into engineering, medical, earth science, design, planning and other fields" (Pickles, 1995, p 1). With this in mind, a generic and widely accepted definition is provided by Burrough: a GIS is a "set of tools for collecting, storing, retrieving at will, transforming, and displaying spatial data from the real world for a particular set of purposes" (Burrough, 1986, p 6). Although often confused with other graphics programs, GIS differ in that they include tools for spatial analysis.

3.4 Types of GIS

It is important to understand that GIS is a system of components, not all of which are necessarily found on a computer. Burroughs hints at this in his discussion by stating: "data in a GIS, whether they are coded on the surface of a piece of paper or as invisible marks on the surface of a magnetic tape, should be thought of as representing a model of the real world" (Burrough, 1986, p 7). This implies that paper maps could be considered part of a GIS. This concept is more clearly articulated by Star and Estes (1990) when they differentiate between two types of GIS: "a geographic information system can, of course, be either **manual** (sometimes called analog) or **automated** (that is, based on a digital computer)" (bolding from source) (Star and Estes, 1990, p 3). The information and processes provided by either type of system are the same (Calkins and Tomlinson, 1977), although processing and analysis are often more tedious, cumbersome and time consuming in a manual system. In essence, cognitive mapping projects could be considered analog GIS projects.

Clark (1998) presents a dichotomous typology of GIS in order to help position his discussion on the social implications of GIS. He distinguishes between Project GIS and Enterprise GIS. Characteristics of each are found in Table 3.1:

Table 3.1 - Project GIS vs. Enterprise GIS

Project GIS	**Enterprise GIS**
Uses many different processes to manipulate or transform or analyse the data. The system is process intensive	Applies a limited range of routine data-handling processes to a large data set. The system is data intensive
Develops processes to apply to a particular project, and then discards or modifies them	Develops a sometimes complex data-handling routine, and then applies it widely without further modification
Often developed and used on a stand-alone workstation. There is unlikely to be centralized system management	Often implemented on a network, or mounted on many separate terminals. There may be centralised system management
The user is often the developer, or interacts with the developer. The user often 'understands' the system and takes responsibility for it	The user is often introduced and trained after implementation. The user does not need either to 'understand' the system or to take responsibility for it
The database may well be an integral part of the GIS, under the user's management	The database is likely to exist and (at least in part) be managed separately from the GIS and its user
The data are likely to be individual to the project and to the system	The data are likely to be corporate, and to require complex data-sharing and management protocols
Many academic GIS projects and some government projects fall into this category	Many commercial GIS projects and some government projects will fall into this category

From Clark, 1998; p307

It should be noted that Enterprise systems normally contain some form of user administration function, whereby different users are given different levels of access to various portions of the system. Enterprise systems in the planning field are designed specifically to support planning decision making. The term "Planning Support Systems" (PSS) has been adopted to refer to geographical information and communication technology used in support of planning decision making (Geertman, 2002). These systems take the form of electronic conference rooms, "GIS-supported collaborative decision making tools and WWW-based mediation systems for cooperative spatial planning" (p 23). These systems will manage the entire planning decision making process, including public participation and collaboration with planners. PSS are often theoretical and implemented as prototypes. Much of the current PPGIS literature is focused PSS.

From the brief discussion that follows it will become evident that PSS are large multi-dimensional systems that often incorporate GIS to fulfill various roles. These systems are most often aim at automating all or a portion of the planning decision making process. Providing an in depth review of PSS throughout the literature would not reveal insight into our current investigation of methods for capturing public perception. Regardless, it is quite possible for methods of capturing, modelling and analyzing differentiated public perception to be incorporated into a PSS, and thus, the planning decision making process.

Typically, GIS will be incorporated into a PSS for a number of purposes. First, GIS can be used to store and disseminate information to participants. Participants will use the GIS as an exploratory tool to educate themselves with issues and trends occurring in the neighbourhood. Second, GIS can be used to run 'what if' scenarios. In this role, the GIS tools would allow for scenarios to be run based on a defined set of modifiable parameters. Third, GIS can be used to capture individual preferences based on locations on the map. Often, users will apply a rank order to a set of alternatives, similar to preference mapping exercises of the 1960s and 1970s. Fourth, GIS can be used to tabulate and report the results of a preference mapping exercise. Having the results reflected back to the group allows participants to understand how their perception relates to the rest of the group. Seeing the results of a vote can have the effect of quieting outspoken radicals within the group. It provides evidence that everyone's opinion is represented equally, provided, of course, that the system embraces the range of basic assumptions held by group members. And finally, a GIS can be used to analyze (and correlate) differentiated public preference against other parameters stored as spatial layers.

While Harris and Weiner (1998) and others (for example: Jankowski and Nyerges, 2001; Peng 2001) argue for the creation of community integrated GIS that involves multiple stakeholder groups in a system that manages every stage of the planning decision making process, there are limitations. First, such systems are extremely costly and require a good deal of technical resources to establish within a community. Neighbourhood organizations are not likely to have the time, money or expertise to establish and maintain such a system. Second, maintaining interest in ongoing participating in such a system is difficult. Obtaining a respectable number of participants in public participation exercises at the neighbourhood level is difficult to begin with. Expecting ongoing group participation seems unreasonable. Third, defining a single process or PSS tool that will be of equal relevance to all planning decision making situations is unlikely. No one single PSS would be "flexible enough to respond to the needs of the participants in the diverse participatory planning process" (Geertman, 2002, p 24). A system that is useful in one situation may be irrelevant in another.

While PSS often include methods for capturing individual and group preferences, they rarely seek to capture and include perception. As alluded to previously, these systems often capture preference by having respondents rank order place preferences from a list of alternatives. Individual responses are then synthesized and the results represented spatially. The methodology used is reminiscent of preference mapping exercises of the 1960s and 1970s.

PSS provide an excellent framework and opportunity to capture and include perception of multiple publics in the planning process. However, it appears that authors of these systems have been slow to recognize the advantages to be gained by capturing and including perception into their work flow and analysis. One notable exception to this is O'Connell and Keller (2002), whose work will be discussed in more detail later on.

3.5 Computerized Capture of Local Knowledge

Public perception is a specific form of local knowledge. Issues related to using PPGIS for the capture of local knowledge will be directly relevant to the capture of public perception. In addition, vehicles and interfaces employed in the capture of local knowledge can also be used to capture public perception. While the following discussion focuses on issues surrounding the capture of local knowledge, the advantages and limitations discussed apply to the capture of public perception.

Capturing local knowledge first requires a data collection technique capable of generating a high rate of participation from the public. The technique should allow for the participation of citizens marginalized by traditional PPGIS methodologies of the past. It also requires that the bias of the planner be minimized in the data capture process. This will ensure that individual perceptions captured more accurately reflect those of the participant, and not that of the planner.

Discussion will begin with general issues related to data collection and participation using computers. First, advantages and limitations of using web-enabled PPGIS to solicit public participation will be presented. Next, a discussion of facilitator-led PPGIS techniques will follow. From this discussion, issues related to marginalization of certain sections of the population will be addressed. This discussion concludes that many of the limitations to capturing public perception and local knowledge are related to the Internet and computer. The enthusiasm of researchers to adopt and apply new technologies to old problems has blinded them to considering more simple and traditional interfaces that are not computerized.

3.5.1 Web-enabled PPGIS

Capturing local knowledge for representation as a spatial layer in a GIS requires public interaction and involvement. Traditional public participation techniques include survey questionnaires, mark up maps, design charrettes and Likert scale exercises (Talen, 2000), often in a facilitated public forum. Internet PPGIS offers advantages over traditional public participation techniques related to capturing public input.

Advantages

Town hall meetings are a typical venue for public participation and the capture of local knowledge. One of the shortcomings of town hall meetings is the fact that they are held at a specific time and place. Scheduling conflicts and logistical constraints will often arise for people wanting to participate. As noted by Jankowski and Nyerges (2001), "Being able to attend a meeting due to scheduling (distance and timing) constraints is a fundamental concern in participation" (p 33). Jankowski and Nyerges go on to include that hosting additional meetings does not always overcome this barrier "since more time away from some other (perhaps work) activity is not always as convenient" (p 33). Widespread access to the Internet allows for web-based PPGIS to improve opportunities for participation in public forums.

Peng (2001) notes "Internet-based PPGIS allows the public to participate in the issues being discussed anywhere with web access at anytime" (p 890). Such systems are not constrained by time or place and participants can access the forum any time during the day.

A second shortcoming of public town hall events is related to the social environment of such events. "The physical (or virtual setting) of a place has a significant impact on whether people attend a discussion" (Jankowski and Nyerges, 2001, p 33). As a result of this intimidation, their participation is limited to that of observation.

Many people are often intimidated by both the facilitator and other participants. Oftentimes, "decision-makers are positioned on a platform with the general public down below in a less favourable physical and psychological position" (Carver et al., 2000, p 161). In addition, the vocal more aggressive participants can 'shout down' views of the more passive participants (Healey et al., 1988). This can also serve to intimidate others from participating in discussions.

An advantage of Internet based PPGIS is that people may participate anonymously and avoid potential confrontation (Howard, 1998). Participants are free to make as many comments as they feel necessary to express their opinion, without fear of backlash from other participants. Even with systems that allow for dialog between participants, comments are often made anonymously.

Public town hall events have also been criticized for being highly structured and technical. Much of the structure present in such events is necessary to maintain order and ensure some form of due process. According to Kingston et al (2000), one must "learn the language" of the meeting in order to fully participate. This includes being confident and familiar with bureaucratic procedures (Carver et al., 2001, p 907 with reference to Parry et al., 1992). Web-enabled PPGIS are not bound by the constraints of bureaucratic process during interaction with the public.

Participants using a web-enabled PPGIS do not have to follow a set procedure within a given amount of time. Well designed PPGIS can walk users through the more difficult portions of the process (such as voting and ranking exercises). In addition, participants are free to take as much time as they feel necessary to explore and understand the issues related to any particular portion of the issue being presented. Participants are in control of how much time they spend participating.

Map products created for public events are often difficult for the layperson to completely understand. Depending on the type of presentation given, the map may only be displayed for a short period of time, and often at a distance. According to Howard (1998), "citizens who attend these meetings often experience difficulty understanding the spatial relationships portrayed on maps and plans" (page number not available). As noted by Shiffer (1996), "information is only powerful when it is effectively comprehended by those who use it" (as quoted in Howard, 1998). The use of a web-enabled GIS allows for participants to view the maps for longer periods of time.

Interactive web-enabled PPGIS can allow participants to query and alter information on the maps in order to help them better understand the spatial relationships.

Shiffer (1998) suggests that interactive GIS tools can allow for maps that are "easy to understand and manipulate as well as appealing, so that information that would normally be meaningless and intimidating is accessible even to the lay person" (p 90). This assumes, of course, a basic level of technical ability on the part of the participant.

Disadvantages

Despite the ability of PPGIS to expand participation of the public through overcoming many of the issues related to public forums, Internet-based PPGIS has some limitations. First, implementing a PPGIS through the Internet can be expensive. Second, lack of access to the technology, both Internet and computers, can exclude some from participating. Third, Internet PPGIS does not appear to engage the more apathetic members of the population. And finally, Internet PPGIS do not easily allow for open-ended dialog to take place between the planner and the participant.

The dollar cost of computer technology and data continues to decline as time passes. This decreasing cost makes GIS and Internet technology more widely available for use by planners and neighbourhood groups. However, Internet based PPGIS products are not available off-the-shelf and require some development on the part of the host organization. The creation of an Internet PPGIS, along with all of the relevant datasets and GIS tools, is an expensive process. As noted by Carver (2001) "the R&D costs associated with developing web-based PPGIS seem so expensive compared with more traditional approaches to public consultation based on meetings and surveys" (p 804). It is likely that most community groups will have a difficult time justifying the cost of an Internet PPGIS over more traditional methods. Such groups should not abandon the idea of using PPGIS; they should instead consider alternative PPGIS approaches.

Although it is argued that placing a PPGIS on the Internet improves public access, the opposite could also be true. It is reasonable to suggest that any gains made in participation, could be offset by the lack of Internet access (Carver et al. 2000, p 159). Some have argued that the increase in Internet access points in recent years makes PPGIS more accessible than ever to the general public (Carver et al., 2001; Waters, 2002). However, the issue of access has more to do with the ability to know how to take advantage of available Internet connections, than it does with opportunity.

Widespread access to technology does not necessarily mean universal expertise or adoption. As Carver et al (2001) admit: "although the Internet may seem second nature to most readers…, there are still many people to whom it (and computers in general) remains a mystery" (p 803). This makes the Internet an unfriendly and unattractive medium for many people (Carver et al 2000, p 169).

Carver (2001) suggests "…perhaps the biggest boost will come not from the Internet but from digital television" (p 804). It is interesting that Carver seeks unproven high-tech solutions in overcoming barriers to technology, when viable less complex solutions exist. It would not be unreasonable to allow for the public to interact with a PPGIS through multiple, alternative mediums, such as a combination of Internet *and* paper surveys.

Regardless of how accessible or usable an Internet based PPGIS is, "efforts need to be made to encourage the public to use the system" (Peng 2001, p 903). The advantages of employing an Internet PPGIS will only be realized "if the public can be bothered to use them" (Carver et al. 2000, p 160). In fact, "antipathy and apathy are possibly the worst enemies of any democratic process relying on the Internet and active public involvement" (Carver et al. 2000, p 160). Encouraging the public to participate takes more than creating usable PPGIS tools or generating awareness of a PPGIS installation.

Just because Internet PPGIS is extremely accessible does not mean that people have the time to participate. Spending time on the Internet surfing should not necessarily be considered as time available to participate in public discourse related to development initiatives. People use the Internet to relax; often as an alternative to television. Participation in public decision making activities is likely to increase with decreasing demands of time and effort on the part of the participant.

Participation in Internet PPGIS requires initiative from the participant, rather than the planner. Perhaps, better dialog could be achieved if the planner were to be more active in soliciting participation, rather than simply waiting for responses to an advertisement. This could involve more time and effort on the part of the researcher in seeking out respondents through less formal means. This could include meeting people on the street and bringing technology to them via some form of portable interface.

Collaboration between planners and the public requires good open-ended dialog. While Internet PPGIS can allow for participation at any time of day, participation is done in the absence of the planner. This separation between the citizen and the planner limits the amount of discourse that can take place. Regardless of the advantages of Internet PPGIS, traditional face-to-face meetings still hold value due to their ability to facilitate dialog between researchers and participants.

While it has been suggested that capturing public input in decision making and planning exercises can be improved using web-based PPGIS, "possible increases in participation are contradicted by the inequalities of public access to the Internet" (Carver et al., 2001, p 908). The major drawback to web-based PPGIS is that it excludes participation of those without access to Internet, or the technical ability to use computers. Peng (2001) suggests, "in the absence of universal access to the Internet, other methods, such as the traditional town-hall meeting, should also be used" (p 892). However, alternative approaches to Internet PPGIS are available.

3.5.2 Facilitator-Led PPGIS

Not all PPGIS that allow for collaboration in decision making are necessarily web-enabled. Many PPGIS created for capturing collective public perception and/or collaborative decision making are set up in a single room, using computers that are networked together. Participants explore ideas and collaborate with one another with the aid of a PSS. A facilitator often supports and/or leads participants through a series of tasks which often include expressing opinions or voting exercises.

Facilitator led PPGIS are very effective in enabling collaborative decision making. Some enable participants to query, manipulate and edit GIS layers, or even perform basic spatial processing. In addition to being a very effective method for enabling collaboration between planner and participant, these types of PPGIS initiatives have the ability to capture spatial patterns of preference and perception.

Facilitator led PPGIS allow for close collaboration between planners and participants. The "war room" setting of some of facilitator led PPGIS creates an environment that optimizes intuitive interaction with users (Nyerges et al. 1996). Barndt (1998) describes such a "war room" setting:

> *Imagine a large video "board" in a conference room. Selections of data are quickly organized for display. Software "wizards" guide the creation of complex displays and limit misuse. Map displays are augmented to include sketches, photographs, verbal comments, and other kinks of information. Trends can be evaluated by creating a series of maps simulating a time sequence. Images may be captured and moved to a clipboard area near the edges of the display*
>
> (Barndt, 1998, p 105)

While facilitator led PPGIS overcomes the Internet issue of access and technical ability of participants, it does not address the issue of time and place. Participants are still required to attend a session at a certain time and location.

Advantages

Advocates of Internet based PPGIS often suggest that community organizations can be empowered to use the PPGIS tools independently of planners or facilitators (Barndt, 1998). However, as Barndt (1998) points out, "It seems inappropriate to assume that a layperson can do the work of a professional" (p 110). Participants using PPGIS without the aid of a facilitator may not be using the tools to their potential. Facilitators can help participants make more effective use of the tools and suggest more sophisticated options for analysis. It can also "intensify collaboration between professionals and laypersons" (p 110). In turn, the collaborative environment created using PPGIS initiatives allow for planners and participants to create an accurate picture of a community (p 110).

PPGIS can be a powerful tool in assisting in visualization and communication. Most commonly PPGIS are used to foster communication and present a point of view (Barndt, 1998, p 110). In the past, paper maps have filled this role during community meetings. However, "users cannot derive any further attribute information pertaining to the mapped data nor can they change the content or the display style of the map" (Shah, 2002; page n/a). PPGIS tools allow for flexibility of map content, scale and display.

The visualization abilities of PPGIS also allow the planner to present ideas much more effectively. Reflecting on a frustrating experience with using static slide images during a public meeting, Al-Kodmany (2002) recalls being limited in ability to express ideas as the discussion developed. Participants became overwhelmed in trying to synthesize representations from various slides. This led to the realization that a more flexible visualization tool was required. More sophisticated PPGIS now contain multimedia support for media beyond simply mapping.

Disadvantages

Regardless of the advantages of facilitator led PPGIS over Internet PPGIS, some issues persist. First, issues related to marginalization remain regardless of the approach used. Second, interactions using PPGIS technology are very time consuming. Third, interaction requires a pre-established time and location for the meeting to occur. And finally, the skills necessary for employing PPGIS represent a significant barrier for many community based organizations. Overcoming all of these issues requires rethinking PPGIS methodologies currently being employed in planning processes.

Perhaps, the most important criticism of PPGIS in the past 10 years is that it is 'elitist' technology which empowers those with access and marginalizes those with out access (Harris and Weiner, 1998). In 1995, John Pickles compiled a collection of essays related to the social implications of GIS and released them in a book called *Ground Truth*. *Ground Truth* had a huge impact on the PPGIS literature which, for the decade leading up to its release, was characterized by "boosterism" (Flowerdew, 1998; 289).

This impact of the book is best characterized in the words of Clark (1998): "the attack on the complacency and flawed thinking of GIS launched by Pickles (1995) in *Ground Truth* is an academic Blitzkrieg of unusual power and ferocity" (p 304). The release of the book saw the beginning of a movement which sought to consider the social implications of GIS.

A special issue of *Cartography and GIS (CAGIS)* was released in 1998 which contained papers dealing with issues raised in *Ground Truth*. Later, in that same year, the Varenius project of the US National Center for Geographic Information and Analysis (NCGIA) sponsored a workshop calling for papers "which better reflect community interests and involve and empower its members" (Craig et al., 1998, p 5). It was clearly stated that the specialist meeting would be concerned with "ways in which PPGIS can have unintended consequences by marginalizing people and communities" (Craig et al., 1998, p 5). The workshop resulted in a collection of papers still very much relevant today. Many of these papers are included in Craig, Harris and Weiner's book, *Community Participation and Geographic Information Systems* (2002).

GIS marginalizes people and communities in a number of ways. First, if users of the technology are empowered with access to information, then it follows that non-users are disenfranchised. In effect, "Polarization of users and non-users results" (Pickles, 1991, p 84). Harris and Weiner (1998) suggest that "empowering groups through GIS technology can also simultaneously disempower historic leaders of that community who are uncomfortable with computer technology" (p 71). Those who do not adopt the technology are marginalized due to their lack of participation and access to the GIS tools.

It also follows that those considered the most marginalized of the population before the adoption of GIS, will certainly be further marginalized once GIS is adopted.

A second way GIS can marginalize people and communities is through access to data. If knowledge is power, and access to data leads to knowledge, then the individuals and organizations with access to the best data have the most power. This power is over and above that of the organizations and individuals without the same access to the data. It follows that institutions and individuals responsible for creating the data have the most power. GIS data is aggregated and generalized in order for it to be displayed in choropleth zones. The data provider controls the level of generalization and the size of the zones in which data are reported. In having limited access to GIS data, "small users, local governments, non-profit community agencies, and non-mainstream groups are significantly disadvantaged in their capacity to engage in the decision-making process" (Harris et al., 1995, p 203 – with reference to Edney, 1991).

Some authors have suggested that maintaining differential access to data is in the best interests of those in control of it. Data and information being withheld by those in power may have little to do with preserving the anonymity of the individual and more to do with preserving the power of the authority. As noted by Clark (1998) "where information spreads, so too does the ability to question decisions which previously had to be accepted unchallenged" (p 313). There are suspicions that the HIND project encountered this issue when attempting to obtain public information from Residential Tenancies Branch.

A third way GIS can marginalize people and communities is through digital representations. In order for data to be used in a GIS it must conform to certain standards. For instance, it must have a spatial extent and attributes. While data related to the physical environment are easily represented GIS data set, other types are more difficult to represent. "It is clear that the physical environment has been given greater emphasis within GIS because of the ease of capturing physical objects relative to more complex forms of cultural or societal phenomenon" (Harris et al., 1998, p 70). Cultural and societal phenomena, such as perception of environment, are "crucial to understanding issues related to place" (p 70), however their inability to be easily captured and represented leaves them out of most neighbourhood GIS. The result is that relevant data sets, such as perception residents have of aspects of their neighbourhood, are not included in neighbourhood GIS. This often leaves analysis relying on data acquired from other sources.

Issues related to marginalization remain largely unresolved in the PPGIS literature. Overcoming them requires universal access to GIS tools, universal access to datasets, and the inclusion of local knowledge. Overcoming these issues will allow for more complete participation of residents in decision making processes. According to Ghose (2001) "the inclusion of residents in information gathering, policy study and policy formation hardly requires argument – it benefits agencies just as much as residents by making them partners rather than adversaries" (as referenced in Waters, 2002, p 4).

Many researchers have attempted to overcome marginalization issues related to technology by developing innovative GIS tools and techniques (To name two: Al-Kodmany, 2002; Shiffer, 2002). All of the cases reviewed to date attempt to use technology to overcome difficulty with using GIS tools. Whiteboards, projections, multi-media, facilitated computer labs and hypermedia components have all been proposed as solutions to expanding participation to those marginalized by GIS. The solution always appears to be adding more technology to overcome difficulties with technology. Interestingly, the use of a paper map in capturing local perception has rarely been found in the literature since the 1970s.

Universal access to data has more to do with politics and power than it does with technology. As noted by Clark (1998) "GIS has unprecedented power to disseminate access to usable information" (p 303). Dangermond (2002) provides an introduction to the 'geography network' which allows for open access to geographic data from around the world. As the geography network demonstrates, the ability to give access to data is unprecedented. However, gaining access to useful local data is often difficult and expensive.

The issue of data dissemination often has much to do with confidentiality issues. Barndt (1998) talks of the benefit of establishing local 'data clearinghouses' which are independently run organizations responsible for maintaining and distributing local data from various sources. Such establishments "can integrate information from different sources by working with individual records under agreements that allow the organization to work with confidential data" (p 108). Such organizations require political will from those in power positions; this is not likely to occur in Winnipeg. If a community wants good local data, they often have to create it themselves.

As noted by Talen (2000), "conventional use of GIS is largely *top-down* in the sense that GIS data is provided, manipulated, and presented by technical experts" (p 280). Some researchers have attempted to limit marginalization by focusing on changing the top-down focus of GIS by including local residents in the data capture process and creating spatial representations of local knowledge (Harris and Weiner, 1998; Rundstrom, 1995). By including local residents in the data capture process and creating spatial representations of local knowledge the focus becomes 'bottom-up'. Talen calls this "BUGIS" (Talen, 2000).

Overcoming the many issues related to marginalization in PPGIS requires a bottom-up approach. The more successful a PPGIS is in overcoming these issues, the more successful the PPGIS will be in serving the needs of the community and supporting planning decisions. Success will depend on a number of things. First, the GIS database must include and incorporate datasets spatially representing information collected locally. Second, local residents should be involved in the data collection of local knowledge. Third, the interface between the GIS and the resident must be extremely simple and easy to use.

A second general limitation of PPGIS is the time demanded of participants. Some PSS projects put great time demands on participants. This is especially true of neighbourhood GIS installations that aim to continually involve participation at every stage of the planning process. Such systems have been coined "community-integrated GIS" (Harris and Wiener, 1998), and "can become a forum around which community-based issues, information, alternative perspectives, and decisions evolve" (Peng, 2001, p 891). Participation in such systems is on-going and can be never ending.

Even regular facilitator led PPGIS can be time consuming. Jankowski and Nyerges (2001) document a facilitator led PSS exercise that attracted 109 volunteer participants. Engaging such a large sample size required dividing participants into 22 separate groups which met for 5 sessions each. This represents a tremendous investment in time on the part of the researchers and participants alike.

While these types of GIS enable close collaboration between planners and citizens, the amount of time and attention required from participants can be enormous and unreasonable.

A third issue that persists with facilitator led GIS is that of time and location of sessions. Pulling PPGIS off the Internet and into a 'war room' has many of the same limitations of a traditional public meeting.

Of particular interest to this study, is the poor rate of participation that is often experienced when using facilitator led PPGIS session. For example, Talen's (2000) "Cadillac Heights Community Mapping Project", which is discussed in more detail later on, attracted only 10 participants. Such a small sample size does not allow for the collective perception of a community to be reliably captured and represented.

A fourth persistent issue related to PPGIS is the technical skills required to implement and manage a PPGIS initiative. "Building and managing a GIS database requires specialized skills" (Shah, 2002, p N/A). Since GIS skills are specialized, adopting GIS technology requires training existing staff, hiring new staff with the necessary skills, or contracting GIS and computer professionals. Training staff requires a significant investment of time and money. Hiring new staff with the necessary skills is not always a viable option for community development organizations with limited budgets. Contracting out to professionals can be even more expensive. Regardless of how an organization obtains the skills, any capacity created through the use of PPGIS is soon lost when those with the expertise move on.

In order for a PPGIS to be persist through time the capacity to administer the system must be maintained. In the absence of such capacity, access to GIS data from previous local PPGIS initiatives and projects must be possible. In addition, methodologies used for capturing local knowledge must be reproducible by future initiatives. The ability to reproduce such data layers will be improved with good documentation and simple methods. The less technical the method, the less technical are the skills required to reproduce it.

3.5.3 Summary

Whether PPGIS is delivered through the Internet or facilitator led sessions, issues related to data collection and participation remain. The approaches most often used to overcome the limitations of these issues usually involve increasing accessibility through the advancing technology. However, many of the limitations to PPGIS are due to the limitations of Internet and computer technology upon which they are delivered. Perhaps, the real limitation to these methodologies is not PPGIS, but the delivery system. While Carver et al (2000) suggest digital television as delivery system alternative (p 159), it is likely that overcoming participation issues related to technology, time and place requires a non-digital interface that can be easily distributed by non-technical staff.

3.6 Case Studies

While PPGIS has grown in popularity, there are very few instances of the technology being used for the capture, synthesis and analysis of differentiated public perception. The discussion now turns to a review of promising GIS based methodologies for the capture, synthesis and analysis of public perception.

Some researchers have demonstrated how GIS and/or Internet technology can be used to replicate sketch mapping exercises of the 1960s and 1970s. Talen (2000) uses an unstructured response technique in which respondents record their perceptions of an urban environment in a GIS using any manner they choose. Al-Kodmany (2001) and Carver et al. (2000) attempt to apply structure to responses using Lynch's five elements. However, such research rarely involves the creation of a collective image nor do they demonstrate how to integrate a collective cognitive image with other data layers for analysis. These examples are bound by the same limitations of Sketch Mapping studies of the 1960s and 1970s.

Two examples were found in the literature in which researchers employed the use of GIS to support completion mapping exercises. Methods used by both Waters (2002) and O'Connell and Keller (2002) provide insight into how best to capture and synthesize individual perception of an environment into a collective image of public perception. The resulting collective image of public perception can then be incorporated into a GIS supporting planning decisions.

3.6.1 Sketch Mapping

Talen

Talen (2000) presents a case study, "Cadillac Heights Community Mapping Project", in which a PPGIS was used to "solicit information from local residents about what was liked, disliked, or desired for their community" (p 283). Participation was limited to 10 residents who were to attend two three hour weekend sessions. Participants would use an off-the-shelf GIS program to map out their issues and preferences. All base map data was provided by the researchers. A GIS facilitator was available to train participants on use of the GIS tools. Participants were free to use any GIS tools available in the GIS (in this case Arcview 3.x) to identify locations on the map. Participants were trained in how to apply ranking scores to the features they created in the GIS.

The academic goal of Talen's GIS was to demonstrate how individual views can be expressed in a spatial medium. Synthesizing the expression of many individuals was secondary, although addressed in her article. Her reluctance to aggregate the perception of individuals was based on her fear "that such synthesis might compromise individual viewpoints" (p 291). However, a critic may suggest the manner in which data was recorded by participants did not lend itself to aggregation.

With regard to marginalization issues, the method used is questionable. First, the datasets made available to participants could influence their decisions on what is important. For instance, if only crime statistics and traffic violations data are available it is likely that a respondents' perception map will be a reflection of the spatial patterns of such data. In effect, giving access to such data serves to educate and therefore influence the respondents' spatial perception of issues under investigation. However, were a respondent to comment on crime or safety issues without having seen the related datasets, the resulting map would be a more accurate reflection of his/her perceptions (Cinderby, 1999). Such a technique would serve to limit the influence of traditional top-down focussed data sets. It would also allow for more reliable conclusions to be drawn in studies focussing on the correlation between neighbourhood interventions and their perceived outcomes.

Second, the use of a GIS facilitator in a computer room setting is likely to influence people in some way. The facilitator may inject personal influence in the things he/she says or does, without even being conscious of it. For instance, the facilitator may perform all of the demonstrations using a crime layer. This would have the affect of making people more aware of a particular dataset or issue.

Third, those with good computer and/or GIS skills would be at an advantage and would be able to put more meaningful content into their maps. Those with poor technical skills would not be able to participate to the same level, in that they would not be able to create the same amount of work in the amount of time given.

Fourth, having participants attend two workshops for three hours each is very demanding. Not only is there the potential to marginalize people who are not available at the required times, it also limits access to those who are not as mobile.

And finally, a sample size of 10 people is very poor by any standard. The amount of time (6 hours) and effort required for such a poor sample size is hardly worthwhile. In addition, it is extremely unlikely that an aggregate of views from a sample of 10 people going is to reflect the any of the perceptions held by a differentiated public.

The method of data capture used by Talen is very complex and difficult. Reducing the complexity of the exercise is likely to result in more accurate and reliable feedback. According to Jankowski and Nyerges (2001), "Reducing cognitive workload will hopefully lead to a more thorough treatment of information, by exposing initial assumptions more clearly, facilitating critiques of the accuracy of information, and subsequently resulting in more effective and equitable participatory decisions" (p 4). Talen (2001) justifies the complexity of her approach by suggesting her methodology allows for "a more complex spatial vocabulary than a simple paper map" (p 282). While it is understandable that individual expression could be limited on a paper map, the high level of complexity has other repercussions. More specifically, the ability to aggregate responses becomes increasingly difficult with increase in complexity of the responses.

The complexity and range of map products produced by the respondents leaves Talen with very few options for aggregating responses into a single representation for any given issue. For instance, some respondents may include areas perceived as 'unsafe', while others may not. Of those including 'unsafe' areas, some may include a ranking scheme to communicate levels of perceived safety, while others may not. Lack of continuity in map content from respondents makes aggregating responses difficult. The open ended nature of the data capture methodology is reminiscent of unstructured sketch mapping techniques of the 1960s and 1970s.

Lynch

Building on the work of Lynch (1960), Al-Kodmany (2001) employed the use of an Internet-based application to assist in capturing the 'Imagability' of a neighbourhood. According to Al-Kodmany, the web provides an "effective medium to visualize a community in an interactive, associative, realistic and accessible way that is not available with traditional media" (p 805). While Lynch's surveys used text, sketches and photographs to describe the five rudimentary elements of an urban environment, computer technology allowed for Al-Kodmany to incorporate panoramic photographs, video and 3D virtual reality models into his methodology. By placing his work on the web, he sought to reach a wider audience than was possible with traditional techniques, as well as "provide a more realistic visualization of the places" (p 809).

Al-Kodmany began by surveying respondents in order to reveal imageable places throughout the urban environment under investigation. Paper maps were used to record individual responses which were elicited using questions geared towards Lynch's five traditional elements. Locations mentioned most often during the survey were then included in map. Electronic visualizations were then constructed for each location represented on the map. Social, economic and ecological information was then associated with each of the locations.

The completed model was placed onto the Internet "for informational purposes, to assist residents and planners in visualizing these selected areas of the community" (p 824). As with traditional sketch mapping techniques, there is no clear explanation as to how this information will be of use to planners in the decision making process. However, Al-Kodmany does suggest that the system could be improved to solicit responses regarding the amount of personal like or dislike of each element documented on the map.

Al-Kodmany recommends the system present a predefined checklist of items related to the location clicked by the user. The user would then place a checkmark next to items in the list they like and dislike. Capturing data in this manner would allow for the statistical analysis of responses. However, as Al-Kodmany admits: "The obvious disadvantage is that the format limits participants to the predefined list of comments and so the data may not adequately reflect participants' views" (p 826). Another obvious limitation is the evaluation provided comments exclusively on physical form. This method holds little value for the capture of individual perception of the environment beyond physical form.

Another option discussed by Al-Kodmany was to solicit open-ended textual feedback from the user. Carver, et al (2000) allowed open-ended feedback from users of their Internet-based 'Virtual Slaithewaite' GIS. Like Al-Kodmany's system, Virtual

Slaithwaite consists of a map of an urban area represented using Lynch's five elements. When an element is clicked, a text window appears and the user is prompted to enter their open-ended opinion. Responses are then analyzed based on the number of times various comments are recorded. The open-ended feedback method suggested here suffers from the same limitations of the Verbal Response technique used by cognitive mapping researchers in the 1960s and 1970s.

Limitations to many Sketch Mapping techniques can be partially overcome through the use of technology. The ability to document and represent an urban environment is greatly enhanced through the use of video and 3D virtual reality. It has also been suggested that placing the project on the Internet allows for wider access. This should translate into larger sample sizes.

Despite these advantages over traditional sketch mapping techniques, these systems have severe limitations related to capturing, synthesizing and analyzing individual perception of the environment. First, these systems do little to capture of perception of non-physical elements of the environment. Second, as with traditional techniques, the spatial representation of the resulting aggregate map of individual responses is created by the researcher. Respondents are merely voting for elements they consider 'imageable'. As discussed in the previous chapter, this limits the validity of the resulting map as a reliable spatial representation of perception.

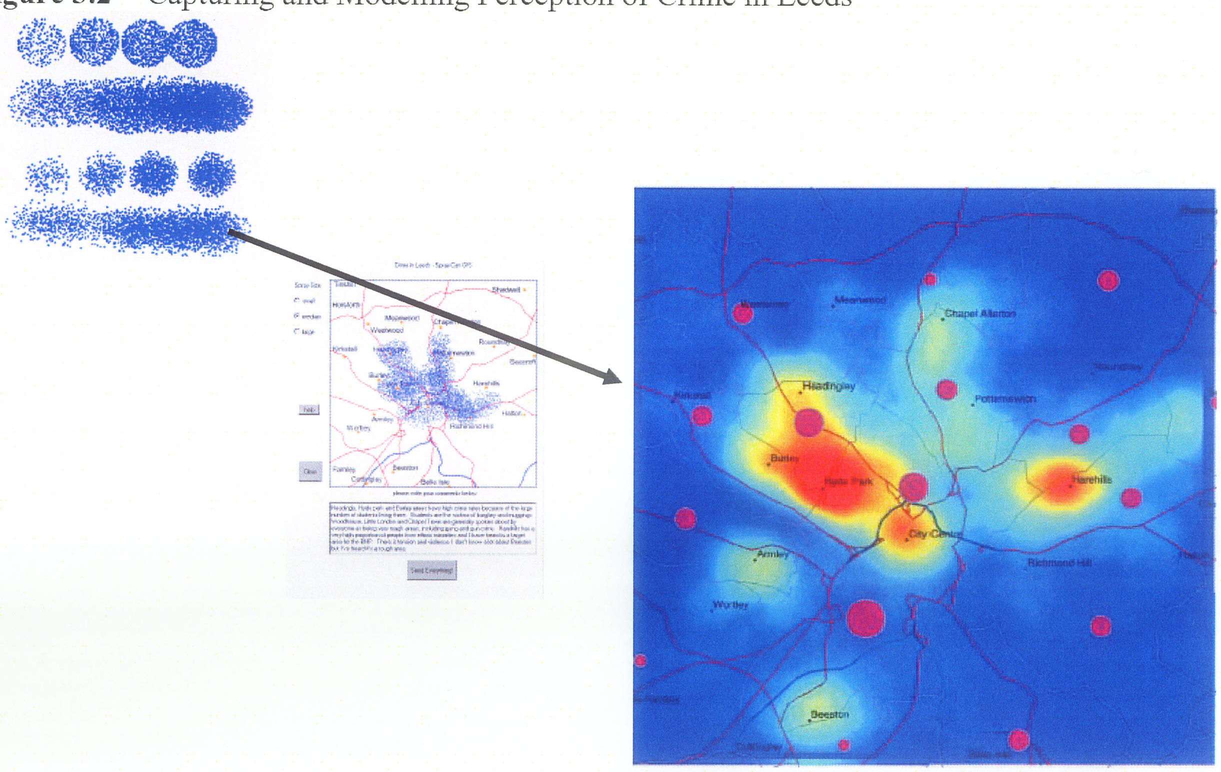
And finally, It is not clear how these systems can be of practical use to planners in the decision making process. While these systems appear to be useful to informing the public of physical elements that exist at various locations throughout an urban area, it is not clear how these systems can be used by planners. It appears that these systems are merely an expensive and complicated way to inventory the physical environment.

3.6.2 Completion Mapping

Waters

A promising PPGIS example of a collective aggregation technique for the analysis of perception comes from a GIS Masters Thesis by Timothy Waters (2002). Waters attempts to aggregate perception of crime in Leeds using an Internet-based PPGIS. Participants visiting the web-site are shown a map of Leeds. Using a tool resembling a spray-can, users 'spray' areas of the map they perceive as having the most crime. The resulting individual layers are then aggregated together by the GIS expert. The resulting collective image, seen in Figure 3.2, could then be used in a traditional McHargian GIS overlay analysis.

Figure 3.2 - Capturing and Modelling Perception of Crime in Leeds



(Waters, 2002)

The base map provided to residents contained very little information; just lines, representing streets, and points with labels, representing neighbourhoods. While the influence of the map content was minimized, "it was noted that the concentrations of sprayings were centered around the points on the map, labelling the neighbourhoods" (p 85). Had labels on the map been shifted slightly or represented differently, the resulting responses may have been different. This suggests that despite the use of a very simple base map, some influence remained.

Waters' tool allows users to determine for themselves the distance between ranks by using intensity of spray. In effect, he was trying to measure the intensity of 'like' or 'dislike' for certain areas on the map. The problem is two-fold: first, a single respondent would have the ability to wield considerable influence by placing 100% of their allotted resources on a single spot. The result would be a huge intensity for a single area. Second, users defining more than a single zone or area of 'like' or 'dislike' would have the ability to assign the width of the gap between the two zones they identify. For instance, the interface asks users to enter in data by "making darker/lighter any differences within the area." There are no rules or constraints to guide how dark is dark or how light is light. What is dark to one user may be light to another. In other instances, the differences between dark and light areas may be very small for one user, and large for another. This freedom of expression is difficult to control for and makes the individual layers difficult to aggregate.

According to Waters: "the creation of a composite map proved to be one of the toughest challenges in the design phase" (p 44). However, he cites the difficulty was due to the size of each input image and not with classification issues. It is likely the ranking issue previously discussed was overlooked.

By placing his tool on the Internet Waters was able to overcome some of the marginalization issues related to access of venue. However, one of the drawbacks, of course, is that the tool was not accessible to those without computer access. In fact, most of the 50 participants in Waters' study were students or academics from his university. He does recognize this flaw as a limitation to his study.

One of the strengths of Waters' GIS is it allowed for additional comments and information to be collected and referenced to each of the images created. This allows for the work of different groups of respondents to be aggregated and compared with one another. Although, Waters did not fully explore the perceptions of a differentiated public in his study, he captured enough information about respondents to allow the ability to do so.

O'Connell and Keller

Perhaps, the most promising example of a methodology that could be used to capture, aggregate and analyze individual public perception of an environment comes from O'Connell and Keller (2002). O'Connell and Keller developed a methodology for including individual stakeholder groups in First Nations land-claim settlements in the valuation of land that resembles completion mapping exercises of the 1960s and 1970s. The methodology used demonstrates that "computer technology has advanced sufficiently to make it reasonably straightforward to collect information about individual stakeholders' land valuations, and that the resultant information can be packaged effectively in a collaborative spatial decision support system to facilitate consensus building" (p 607). Using a methodology similar to completion mapping exercises of the 1960s and 1970s, a collective image of land value is created from individual responses and then included as a thematic layer in a GIS.

O'Connell and Keller explain "that there are attributes to land that defy easy quantification" (p 608). Examples of these include "aesthetics and ambiance", which are clearly products of perception. In order to capture perception of land suitability for recreation (for instance), participants were given a topographic map sheet and were asked to identify areas based on a Likert scale. Values ranged from 1 to 4 with 1 being 'low value' and 4 being 'exceptional value'. Answers were recorded using coloured pencils on a transparent mylar which was overlaid on the topographic map.

By having respondents record answers using pencil crayons on mylar, O'Connell and Keller by-passed limitations associated with Internet and computer usage. This extends participation to a much wider audience than would be possible through a more technical interface. People who are intimidated by computers or do not have access to the Internet can participate equally. In addition, cultural and language barriers would be easily dealt with through the use of a researcher from the community; in this case an aboriginal. A community researcher would be able to explain the exercise clearly and easily in the language of the participant. This method is accessible to almost everyone in a given community regardless of age, language or skills.

The method leaves little room for bias through interpretation. By having each pencil colour represent a certain land value there is little room for misinterpretation on the part of the researcher. Interpretation of individual responses is also made easier due to the fact that responses are restricted to a domain of four values and relate to a single question. Responses to each question were recorded on separate mylars. This overcomes issues associated with responses from open-ended questions which have to be interpreted by a researcher.

The simplicity of this method of data capture means respondents need very little training beyond a brief introduction. As a result, the researchers were able to yield a respectable sample size of 71 participants. Although it should be noted that as a demonstration project almost all participants were students. Regardless, the simplicity of the method overcomes the long and arduous training requirements of many Structured Sketch Mapping techniques of the 1960s and 1970s.

Once participants had been briefed, they were given the survey materials to take away with them. Participants were given two weeks to complete the task and return the completed surveys. This technique shares many advantages with Internet-based PPGIS techniques for data capture. First, respondents could complete the survey at any time or place within the two week period. Second, they could spend as little or as much time as required to complete the survey to their satisfaction. Third, the opportunity for researcher bias during the completion of the exercise is minimized.

Having respondents record their answers spatially with the aid of a topographic map meant individual responses were of the same scale and distortion. Once again, this limits researcher bias as researchers would not have to interpret the spatial extents of each polygon; merely transcribe them. An example of a digitized individual response is presented in Figure 3.3.

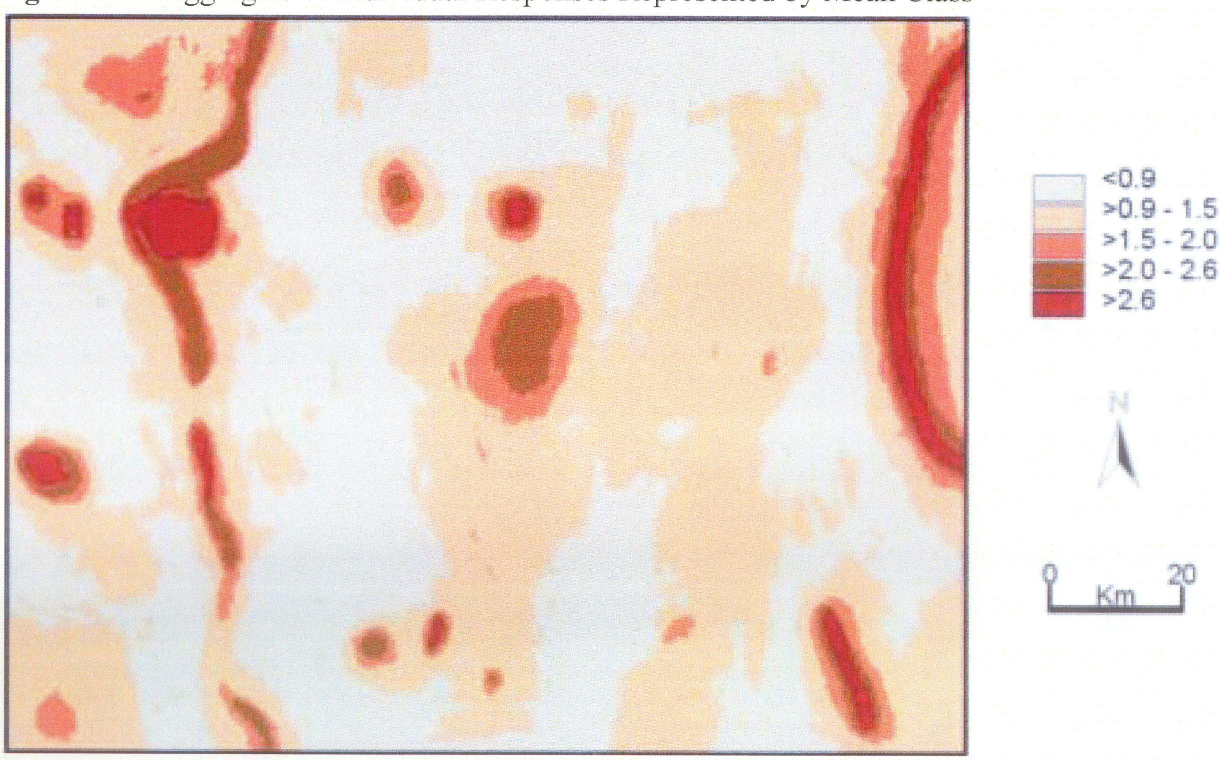
Figure 3.3 - Individual Preference Response

(O'Connell and Keller, 2002, p 612)

Despite the advantages to having data recorded by individuals using the same spatial reference, O'Connell and Keller did experience unforeseen problems. First, there were instances of overlapping regions being recorded on individual responses. Second, they did not anticipate areas being left 'blank'. Both issues were easily overcome. Overlapping regions were dealt with by bisecting them into two equal portions during the digitizing process. This created two adjacent polygons rather than two overlapping ones. Blank areas were dealt with by assuming 'no value'. By allowing blank areas to be recorded as 'no value' O'Connell and Keller overcame the issue of respondents commenting on areas they knew little or nothing about; a failing of Gould's methodology from the 1960s and 1970s. In overcoming an issue, O'Connell and Keller turned a limitation into an advantage.

Once all of the individual responses had been digitized, they were easily overlain with one another using a GIS to produce a map layer representing collective valuation of land. A process which would have been cumbersome and tedious in the 1960s and 1970s is now easily and accurately performed using a standard GIS overlay operation. The ease with which data can be manipulated within a GIS allows some interesting opportunities. First, different aggregation approaches can be performed and compared with one another. O'Connell and Keller aggregated the individual responses using a few different approaches. For instance, they aggregated based on rank to produce 'modal images'. They also computed based on the average land class value assigned by the total sample population (see Figure 3.4). A similar map was produced using standard deviations from the mean value. The results clearly represent public perception of land value for a particular use; in this case recreational potential.

Figure 3.4 - Aggregate of Individual Responses Represented by Mean Class



(O'Connell and Keller, 2002, p 616)

A second interesting opportunity afforded through the use of GIS is the ability to compare collective results of different stakeholder groups. O'Connell and Keller did not explore this approach in their study, likely because of a homogeneous sample population of students. However, the approach used to aggregate individual responses certainly lends itself to the possibility of comparing the perception of different groups of respondents.

Perhaps the most valuable aspect of O'Connell and Keller's methodology is that the results of the survey can be easily incorporated as a layer of information into a GIS used by planners in the decision making process. Planning decisions are supported by GIS which contain a collection of data layers representing the both the physical environment and socio-economic variables, such as those obtained from Census. For some decision problems, a GIS will include information collected specifically related to the issue being planned around. For instance, data collected on noise can be collected and used in support of planning decision making related to residential development in close proximity to airports or highways. The datasets included in a GIS are analyzed against one another in the support of the planning decision. In this way, many datasets from various sources are included in the holistic analysis of an environment.

In order for something to be represented in a GIS, it must be measured and modelled spatially. Traditionally, this has meant that only quantifiable and/or scientific information could be incorporated as a layer in a GIS. However, the ability to capture and model public perception of an environment spatially allows for public perception to be included and analyzed in the GIS along with quantifiable scientific data. "Such a combination will allow the scientific and objective evidence brought to the table by the quantitative/reductionist techniques to be complemented and enhanced by evidence submitted in the form of perceived value judgements… and vice versa" (p 609). This finally addresses the longstanding issue of how to include public perception data into the planning decision making process.

3.7 Conclusion

Scholarly Public Participation GIS material and related applications can be found in the planning literature since the early 1990s. While this body of work recognizes the importance of including local knowledge and public perception in the planning decision making process, few successful practical examples exist.

Planning Support Systems (PSS) provide an excellent framework to support the capture, aggregation and analysis of public perception of the environment. These systems often incorporate GIS functionality throughout the planning decision making process they automate. As part of the decision making process, these systems often use GIS overlay methods to correlate and analyze many spatial map layers. This analysis helps planners gain an understanding of the environment and assists in the decision making process. Capturing and modelling differentiated public perception of an environment would allow for local knowledge to be included as layers in the GIS. However, a vast majority of these systems fail to capture information in a manner that facilitates spatial modelling of public perception of an environment.

Communicative action planning ideals promote a large and diverse sample population. Advocates of PPGIS claim public participation in planning decision making can be enhanced through the use of Internet and computer interfaces. However, these systems require a good deal of resources on the part of decision makers, and time and effort on the part of participants. In addition, internet access and computer usage is not evenly distributed throughout the population. This excludes participation from many key marginalized groups, many of whom are known to cluster in stressed neighbourhoods. While Internet and computer interfaces promise to improve participation in planning decision making, they create barriers and marginalize much of the population whose input is crucial for the modelling of public perception of an environment.

PPGIS methodologies that build on Sketch Mapping ideas from the 1960s and 1970s share the same limitations as their predecessors. Unstructured PPGIS methods that allow participants the freedom to comment on anything they like and in any manner they like yield data that is difficult, if not impossible to aggregate into a collective image of public perception. Structured PPGIS methods, which build on Lynch's approach, yield a collective image of preference for physical elements of the environment. The spatial representation created through this method is a product of the researcher and not the participants; limiting the usefulness of the resulting spatial data layer for analysis within a GIS. It remains to be clearly demonstrated in the literature how data collected from such systems can be of use to planners in the decision making process.

PPGIS methodologies based on Completion Mapping exercises of the 1960s and 1970s show a good deal of promise for the capture, aggregation and analysis of public perception of an environment. Waters (2002) presents an Internet based methodology that is able to capture, aggregate and analyze spatial patterns of perception of crime in an environment. The resulting aggregated image of public perception could easily be incorporated into a GIS used for planning decision making. An additional strength of this method is that it captures information about each respondent. While Waters did not use this information to perform analysis within the data collected, the data would allow for such analysis to take place. The major limitation of this method is that it contains an Internet interface. This limits participation to those with internet access.

Limitations related to Internet and computer use were overcome by O'Connell and Keller (2002) who used a non-computer interface to survey participants. Respondents recorded answers to specific land-perception related questions by drawing polygons on a registered map, much like completion mapping exercises of the 1960s and 1970s. Once digitized, a GIS was used to perform the aggregation of individual responses into a collective image of perception. The resulting layer could then be added as a layer in a GIS supporting the planning decision making process.

Lessons learned from the work of Waters (2002) and O'Connell and Keller (2002) inform the development a method for capturing perception of change in the neighbourhood of West Broadway.

Chapter 4: Methodology

4.1 Introduction

The methodology presented in this chapter describes how to effectively capture and model differentiated public perception of neighbourhood change. It is suggested that public participation in planning decision making could be enhanced with the development of a methodology that meets the four objectives of this study. Once again, these objectives are to develop a methodology which allows for:

1) individual perceptions of neighbourhood change to be captured, aggregated and integrated within a neighbourhood based GIS
2) participation from as broad of range of participants as possible
3) the collective perception of residents to be compared with that of key informants
4) non-technical community researchers to be included in the data capture process.

First, measurement of neighbourhood improvement is often done through the use of indicators such as increase in property value, income, and homeownership. These indicators fail to capture the impact neighbourhood interventions have had on neighbourhood residents. Capturing, aggregating and integrating differentiated public perception of the environment into a GIS used in the support of planning decision making would allow for local knowledge to be included in both evaluation of past interventions, in addition to the planning of future interventions. Public perception of changes that have occurred throughout the neighbourhood as a result of the interventions represents qualitative local knowledge that can be analyzed in conjunction with more traditional indicators of neighbourhood improvement.

Second, residents most affected as a result of interventions leading to neighbourhood improvement are the marginalized residents, often characterized as uneducated, unemployed, aboriginal, or renters. These people are at most risk of further marginalization, or even displacement, due to changing neighbourhood conditions. Ironically, these are the people most often excluded from participation in the planning decision making process. Ideally, the interface of the survey instrument will allow for full participation from marginalized residents, regardless of language, technical skills, or education.

Third, the ability to compare the perception of neighbourhood change held by neighbourhood residents with that of key informants, or decision makers, will allow for the differing views to be better understood. This will allow planners to understand how their perception of issues in the neighbourhood differs from those who are the benefactors of planning decisions. Understanding this difference will allow planners better insight into where their perception of the success of past interventions may be inaccurate. Armed with this information, planners will be better able to target future interventions.

Finally, effectively capturing public perception of neighbourhood change requires the use of local residents to conduct the survey interviews. This is important for a number of reasons. First, it is hoped that the use of neighbourhood researchers will encourage participation from local residents that would otherwise feel threatened or intimidated by planning professionals. Residents are more likely to take the time to participate in the survey if they are familiar with the interviewer. This is could be particularly valuable in instances where residents have participated in many similar studies in the recent past and would otherwise not be interested in taking part in another. Second, it overcomes barriers that often exist between planners and public. For instance, language and cultural barriers can often be overcome when the interviewer and respondent are of same cultural background or speak the same language. And finally, it is hoped that the neighbourhood researchers see the benefit of capturing public perception of neighbourhood change, and encourage the collection of similar data in the future. This will ensure that local knowledge continues to be included in future planning decisions.

The methodology discussed in this chapter can be broken down into three stages: Data Capture, Data Processing and Data Analysis. The steps in the basic methodology are represented in Figure 4.1.

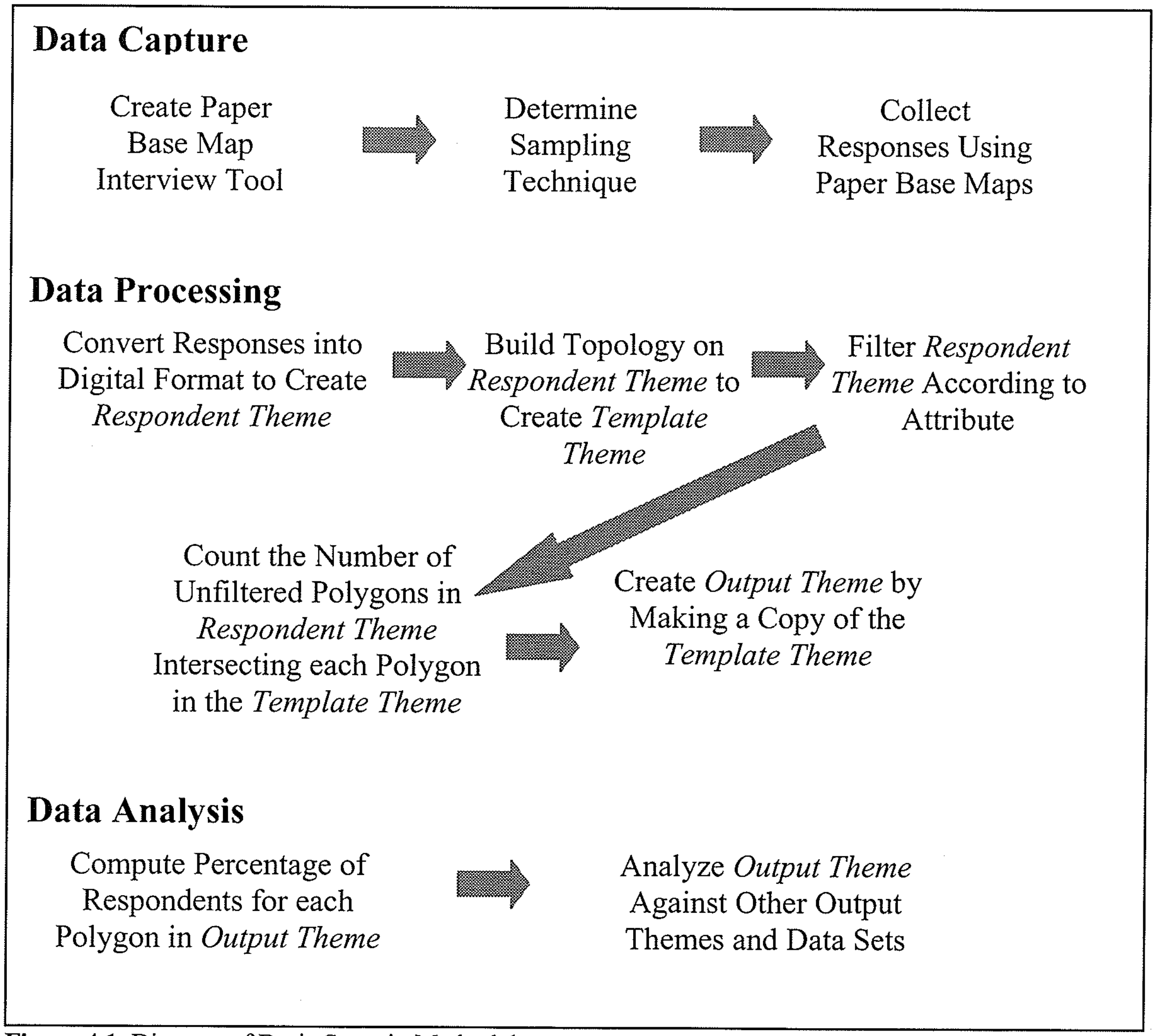


Figure 4.1 Diagram of Basic Steps in Methodology

The discussion that follows describes the steps represented in Figure 4.1 in more detail.

4.2 Data Capture

4.2.1 Survey Instrument

Obtaining differentiated public perception of changes that have occurred within a neighbourhood requires participation from a broad range of residents. From the review of literature, it was discovered that most PPGIS initiatives failed to attract participation from marginalized constituencies within a neighbourhood. Computer skills and Internet access normally confine participation to educated, employed, white professionals or students. Expanding participation to marginalized residents requires a less technical interface.

Many cognitive mapping studies of the 1960s and 1970s have been largely characterized by participation that is "unbalanced as to class and occupation" (Lynch, 1960, p 152) with participants "being primarily middle-class, professional and managerial" (p 152). Studies that have been successful at including a marginalized population are those which specifically seek their exclusive participation (To recognize a few: Halseth and Doddridge (2002) – children; Ladd (1970) – black youth; Orleans (1973) – working class poor). These studies rarely include participation outside of the population targeted. In identifying an appropriate survey instrument for capturing participation from a wide range of participants, it is only logical to adopt an interface that has proved successful when targeting a marginalized population and then administer it to a wider audience. Such an interface for data capture should also allow for equal participation from participants of multiple publics.

Overcoming this limitation requires a methodology which does not limit participation based on technical skills, language, culture or ability to learn complicated design languages. Many survey techniques used in cognitive mapping exercises require respondents first to be trained in an observation (Lynch, 1960) or communication technique (i.e. 'Environment A' used by Beck and Wood, 1976) specific to the study. Learning the language necessary for full participation can take a significant amount of time and often results in an uneven level of participation from respondents. In addition, it excludes participation from those unable to understand the complexities of the design language and concepts. For these reasons, the interface should be simple and require a minimum amount of training.

Completion mapping exercises of the 1960s and 1970s provide an ideal interface for capturing the perception of a marginalized population. This method is accessible to anyone capable of reading a simple map and allows for equal participation among participants. Level of participation is not dependent on ability to draw, articulate or use a computer interface. One of the advantages to employing a completion mapping technique in the data capture phase is the resulting responses need only be transcribed, and not interpreted by the researcher. Many traditional cognitive mapping exercises require respondents to record their responses on a blank piece of paper in an attempt to minimize bias and foster the capture of true uninfluenced perception. In these cases where users draw on a blank piece of paper, it is up to the researcher to interpret what has been drawn by the respondent. It may be incorrectly assumed that a line drawn by a respondent represents a certain street or that a polygon represents an area or district. In addition, the actual extent of these elements is difficult, if not impossible to translate onto a standardized map. Without reference points on the drawing it will be up to the researcher doing the transcribing to determine the exact extent of a district drawn by a respondent. The actual extent of these elements is difficult to interpret and translate into a uniform scale and distortion.

As discussed in Chapter 3, O'Connell and Keller's (2002) use of a paper map for data capture overcame marginalization issues related computer and Internet interfaces. Despite yielding responses on sheets of mylar, they were able to convert the responses into digital format to allow for aggregation and analysis to be done using GIS software. For these reasons, adopting a completion mapping methodology for the capture of public perception of an environment appears to be advantageous.

The use of a paper base map to record responses provides a medium familiar to people of any language, social class, or culture. As noted in Chapter 2, issues related to bias and cuing can be controlled if the base map includes only enough information to orient the participant. The paper base map should include roads, street names and study area boundaries. Landmarks inside the study area should be identified using generic labels. For instance, the label should include the type of establishment rather than the actual name. Reducing the bias attached to establishment names controls the likelihood of influencing responses.

The instructions for performing the mapping exercise in the HIND study were designed to be clear and specific. The instructions were clear and concise in their description of what was to be drawn on the map by the respondent. This task was made more straightforward by limiting the amount of information to be captured by each drawing task. A separate map was used to capture each idea solicited from respondents.

This allowed for responses to each instruction to be clearly represented and later interpreted.

In order to ensure respondents were not providing feedback for areas they know little or nothing about, the survey did not ask for a specific number of items to be identified. This limitation was discussed in Chapter 2 with regard to Gould's work in the 1960s and 1970s. With this in mind, instructions used in the HIND study mapping exercise directed respondents to "identify up to three areas" having a certain perceived attribute. In this way, respondents had the opportunity to identify only two areas containing a certain attribute if they not know of a third.

After respondents completed each drawing, the researcher asked the respondent to rank order each item drawn based on intensity of perceived value. The researcher recorded the response on a separate sheet of paper. This allowed for additional descriptions of each item to be captured. This information was useful during interpretation and analysis of the results.

The survey tool also captured additional attributes about the respondent; such as age, income, etc. This allowed for responses to be grouped into various classifications. These groupings allowed for further analysis of responses and the identification of the perception of specific groups. In this way, the perceptions of a differentiated public could be explored.

4.2.2 Survey Sampling

Soliciting perception of neighbourhood change from a neighbourhood containing a large marginalized population is best done using face-to-face interviews. While mail-out surveys can be effective for generating large sample sizes (see Brian Goodey's study of Birmingham as documented in Gould and White, 1974 – discussed in Chapter 2), apathetic residents are not likely to participate. This limitation is shared with methods using an Internet interface, such as the one used by Waters (2002). Face-to-face interviews are often obtained by visiting people where they live and asking for their participation. It is much easier for potential respondents to discard a mail-out survey, or disregard a request to visit a particular website than it is to refuse a face-to-face interview. Effort must be made on the part of the potential respondent to refuse an interview.

One option of survey delivery available to the HIND study was be to have respondents travel to a predefined venue location to participate. While this would maximize efficiency on the part of the research team, it would still require a good deal of initiative on the part of respondents. The most appropriate method was, therefore, to have interviewers take the survey directly to the respondents.

Community and student researchers delivered the survey in person throughout the neighbourhood. In situations where it is unfeasible to survey every residence, such as in West Broadway, a random sample should be used; for example, surveying every third house on either side of the street. This generates a controlled random sample of responses that is evenly distributed throughout the study area.

In neighbourhoods considered 'unsafe', survey work should be done in pairs. During the HIND study, pairs of survey personnel were assigned specific areas within the neighbourhood to survey. It was up to the research workers to decide at which time of day to deliver the survey. However, it was expected that research workers would solicit participation at various times throughout the day and week. Varying the schedule of survey solicitation allowed for a wider range of participation as residents are likely to have varying schedules.

4.2.3 Interviews

Soliciting participation through neighbourhood excursions allows for survey personnel to meet people as they go about their daily activities. It is anticipated that people not normally interested in participating in a survey would be more inclined to participate after having a short conversation with survey personnel, which may include a short pitch regarding the purpose of the study. This is especially true after understanding the brief time commitment required for participation. Residents that do not have the time to participate at initial contact, can be re-contacted at a more appropriate and agreed upon time.

As previously discussed, many techniques require survey personnel to undergo a significant amount of education and training to be able to conduct successful interviews. Completion mapping exercises have the advantage of being very easy to administer. Research personnel simply read the instructions to the participant and give them a map to record their response. In some cases, the interviewer may be required to re-explain the exercise in more culturally specific words. For example, the original wording of the instructions may have used terms which the respondent is not familiar with due to language barriers. It is expected that survey delivery personnel will be better able to deal with respondents questions when they are of the same cultural background.

Despite the simplicity of survey design, HIND survey personnel underwent a small amount of training. First, community researchers were informed of the objectives of the study. As part of this explanation, the value of the research instrument was made clear so that community researchers aware of the important role they were fulfilling. Second, community researchers were trained on how to approach and address potential participants throughout the neighbourhood. This included how to represent the study in a professional manner and how to address questions from respondents regarding the study itself. Third, community researchers were trained in how to record responses. This included assigning ID numbers to surveys.

Prior to delivering a survey, Mock Interviews should be conducted for the benefit of community and expert researchers alike. Mock interviews can be of benefit to both the planner and the community researchers. These exercises can help to identify problems community researchers may have with certain aspects of the interview process. For instance, some community researchers may inadvertently be leading answers by improperly re-phrasing instructions. Or, there may be concerns with recording certain responses. The mock interview allows for such issues to be addressed and dealt with properly.

Mock interviews also allow for feedback from community researchers related to the survey. Feedback from community researchers can be valuable for ensuring meaningful feedback from respondents. During the mock interviews community researchers may express concern over the wording of some of the instructions. For instance, it may come to light that the wording of some instructions is too formal and community researchers would feel more comfortable using different phrasing. The necessary alterations can be made to the survey prior to it being administered throughout the neighbourhood. Feedback from community researchers can influence the success of the survey in meeting its intended objectives.

Once the interview personnel have been trained and are comfortable with the interview procedure, the survey work may begin. It is advisable that survey personnel work in pairs for reasons of safety and study representation. Working in pairs will make research personnel less likely targets of resident aggression or crime. Partnering community researchers with planner creates an interview team reflecting the partnership between expert and community groups involved in the project. Partnering community researchers with a more experienced researcher can provide a strong interview team able to deal with most situations.

4.3 Data Processing

4.3.1 Conversion to Digital

The data capture method described allows for individual responses to be transcribed into digital format with a minimum amount of interpretation. Having participants draw on a base map containing the basic locational information allows for improved uniformity in scale and distortion from individual responses.

It is true that error is introduced in any data conversion exercise. It could be argued that the method used to transcribe information from the original paper maps into digital format invites error through digitizing and even experimenter bias. More specifically, it would be close to impossible to transcribe the results recorded on a paper map into a digital representation without some error in accuracy. For instance, a researcher may slightly extend a digitized boundary to include a location of interest to the researcher. Errors in digitizing could be attributed to both operator input, as well as some level of researcher bias. It is assumed that these errors can be mitigated through a large enough sample size.

The following discussion presents the process for performing this task using a commercially available GIS software package called ArcView 3.x, which stores spatial data layers in a file format known as a 'Shapefile'. When a Shapefile is loaded into the program it appears as a layer of spatial data known as a 'Theme'. For the purposes of our discussion, the Theme containing all of the responses recorded for a specific mapping exercise will be referred to as the 'Respondent Theme'.

Individual responses are digitized into a single data file (the Respondent Theme). The process for digitizing responses into Arcview 3.x can be done found in Appendix B.

4.3.2 Building Topology

As noted by O'Connell and Keller (2002) "Producing such maps requires extensive manipulation of the original vector maps, including complex multiple overlay operations" (p 616). For this reason, O'Connell and Keller (2002) decided to use Raster based GIS to perform their overlay and analysis operations. However, Raster based data layers are not able to store attributes in a manner necessary to facilitate analysis within the data set itself. In addition, the accuracy of Raster based GIS are limited by cell resolution. In light of these drawbacks, a Vector based GIS was used to perform the data capture as well as the analysis.

A 'Topological Clean and Build' is run on the 'Respondent Theme'. A 'Topological Clean and Build' operation creates a new polygon from each polygon intersection. As an example, if one considers two polygons overlapping one another, the result would be three polygons. Consider Figure 4.2.

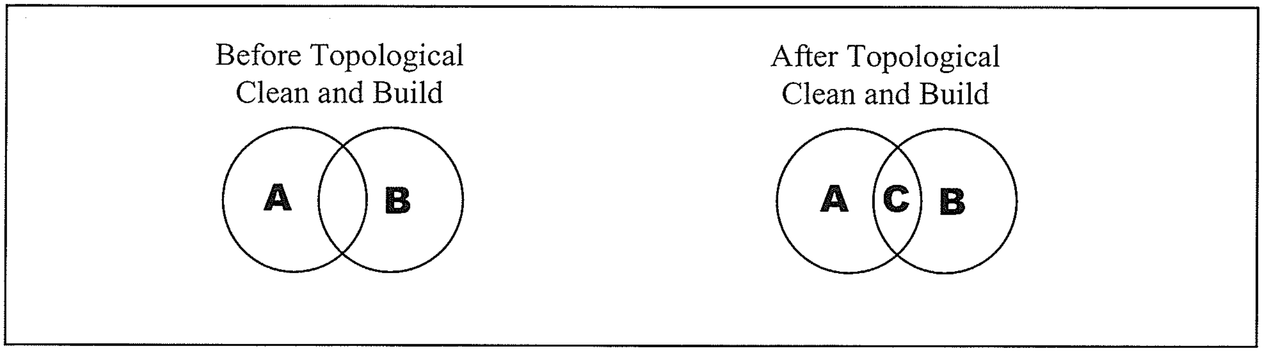


Figure 4.2 - Basic Topological Clean and Build

Prior to the Topological Clean and Build operation two polygons ('A' and 'B') overlap one another and share space. After the Topological Clean and Build operation a third polygon ('C') is created to represent the overlap of polygons 'A' and 'B'. Polygons 'A' and 'B' no longer overlap one another; rather, both polygons now share a boundary with polygon 'C'.

Arcview 3.x does not have the ability to perform a 'Topological Clean and Build' function. This function can be performed by either:

- Using ArcGIS,
- writing a script in Arcview's development language: Avenue, or
- downloading third party software.

Regardless of which option is chosen, the Topological Clean and Build should be performed on a copy of the Respondent Theme. The original Respondent Theme is still required in its original form.

The new polygon theme created from the 'Topological Clean and Build' operation will be referred to as the 'Template Theme'. The number of polygons in the Respondent Theme that share space with each polygon in the Template Theme will be stored as an attribute for each polygon in the Template Theme. The number of intersecting selected polygons from the Respondent Theme will be stored in 'TheCount' field found in the attribute table of the Template Theme. Detail specifications of this field can be found in Appendix C.

4.3.3 Assigning Values

Each polygon of the Template Theme is assigned a value based on the number of polygons from the Response Theme that share space with it. This requires the creation of an Avenue script. This script can be found in Appendix D and will be referred to as the 'Roll-up Script'

The Avenue script counts the number of unfiltered polygons found in the Response Theme that intersect with each polygon of the Template Theme. The resulting value is then stored in the TheCount field of the Template Theme's attribute table. Having the count based on the number of unfiltered polygons in the Response Theme allows for different groups within the data set to be modelled. For instance, to model all of the items ranked number 1, simply apply a filter to display only those records with a rank of one using the Response Theme 'Theme Filter' and run the Rollup Script. The number of unfiltered Respondent Theme polygons ranked number 1 will be counted for each polygon in the Template Theme and stored in TheCount field.

Once the Roll up script has been run, the Template Theme will contain the count of the number of intersecting polygons selected in the Response Theme Filter. A new theme can be created by simply making a copy of the Template Theme. The resulting Output Theme represents public perception of the environment of the group selected in the Response Theme. This Output Theme can then be compared to other Output Themes representing other groups selected from the Respondent Theme.

4.4 Data Analysis

In order to facilitate analysis between Output Themes, it is necessary to have data represented as a percentage of the total sample of responses. It is therefore, necessary to add a new field to each Output Theme to store this percentage value. Details of this field can be found in Appendix C.

The Prop field is populated by dividing the value found in TheCount field by the number of respondents in the group. This yields a proportion value. A legend can then be created using values from the Prop field. The use of a standardized legend, common to all Output Themes, allows for visual analysis to be performed between themes.

The resulting GIS data layers, or themes, can now be analyzed to reveal patterns of public perception of the environment. The aggregation method described, allows for groups from within the sample population to be modelled individually and compared with one another. At this point, all datasets can be converted to Raster format to take advantage of the many Raster GIS tools. Raster GIS, such as ArcView's Spatial Analysis extension, allow for overlay analysis operations, such as cross tabulations, to be performed across Output Themes. In addition, the resulting themes representing public perception of the environment have the qualities necessary to be incorporated and analyzed in conjunction with other datasets in a GIS used in the planning decision making process.

4.5 Conclusion

The methodology presented in this chapter describes how differentiated public perception of neighbourhood change can be captured, aggregated and integrated into a GIS for decision making in planning. Many marginalization issues which limit participation, as discussed in Chapter 3, are overcome during the data capture process through the use of a paper map. This simple interface allows for community researchers to be involved in the data capture process. Problems with aggregating individual responses into a collective image of public perception, as discussed in Chapter 2, are overcome using a computerized GIS. Capturing and storing information about respondents allows for groups within the dataset to be analyzed against one another. The resulting data layers contain the spatial integrity necessary for inclusion into a GIS used in the planning decision making process.

The use of a paper base map to capture individual perception of an environment provides a non-technical interface which does not limit participation from those marginalized by technology, language, social class or culture. The content of the base map should be simple, generic, and contain only the information necessary to provide a spatial frame of reference for respondents. Instructing respondents to identify and rank between zero and three locations that meet a certain criteria controls the problem of having respondents comment on areas for which they have limited knowledge.

The simplicity of the survey instrument interface allows for community researchers to be actively involved data capture process. This could help generate responses from those who would otherwise not be willing to participate. In addition, community researchers can help fine tune the research instrument to be more sensitive to local conditions.

Individual responses are easily converted into digital format using commercially available GIS software. Once all polygons have been digitized into a single GIS layer, a Template layer is created by running a 'Topological Clean and Build' operation. A collective layer of individual responses is then created by a counting the number of polygons drawn by respondents which intersect each polygon in the Template layer. Groups of polygons in the original digitized layer can be selected based on any captured attribute and then aggregated into the Template layer. In this way, the perception of multiple publics can be modelled. Once the intersecting polygon count has been calculated and stored in the Template layer, copies can be made. These copies represent a public perception of the environment. The copies can then be used for to perform analysis between groups within the data set, or with other spatial data used in the planning decision making process.

This chapter has presented a methodology for capturing, aggregating and modelling perception of neighbourhood change. The next chapter will demonstrate how this methodology was used for capturing and modelling perception of change in the Winnipeg inner-city neighbourhood of West Broadway.

Chapter 5: Demonstration

This chapter demonstrates how the methodology presented in Chapter 4 was used to capture, aggregate and analyze differentiated public perception of neighbourhood change in the neighbourhood of West Broadway. The discussion begins with an introduction to the neighbourhood. From this, the challenges facing researchers with respect to the marginalized population of West Broadway will become evident. Next, details of the data capture process will be discussed. This is followed by a demonstration of how data was converted to digital format and then aggregated for multiple publics. Finally, a demonstration of the analysis facilitated by the resulting datasets will then be provided. This chapter will conclude that the method described in Chapter 4 was successful at meeting the objectives of the study.

5.1 HIND Project

The Winnipeg inner-city neighbourhood of West Broadway is a neighbourhood in transition. Interventions starting in the mid-1990s have rescued the neighbourhood from further decline. This reversal of fortune has brought new prosperity to the neighbourhood along with new residents. While anecdotal evidence suggests that improvements have occurred as a result of the many neighbourhood interventions, it is not clear how or where these interventions have made the most impact. Capturing and analyzing the perception of residents and key informants of neighbourhood change provides insight into the impact past interventions have had throughout the neighbourhood. In addition, such insight can inform the development and adoption of future interventions.

Obtaining participation from marginalized residents of West Broadway was extremely important to the Housing Intervention and Neighbourhood Development

(HIND) project. Many of the people of interest to the study of neighbourhood change are marginalized long-term residents which many of the interventions were aimed to support. Successfully improving the neighbourhood would include enhancing the living situation of this marginalized group of residents. Obtaining their participation in future planning and decision making exercises presents a significant challenge.

As demonstrated in Table 5.1, a sizable portion of the 2001 population could be characterized as *marginalized.*

Table 5.1 - Indicators of Marginalized Population in West Broadway, 2001

	West Broadway	**City of Winnipeg**
Aboriginal Identity	27.5%	8.6%
Black	4.7%	1.8%
Rented Accommodation	93.8%	36.4%
Total Collective Income from Government Transfers	27.2%	12.1%
Unemployment Rate (25 years and older)	12.6%	4.6%
Incidence of Low Income (Private Households)	64.6%	20.3%
Average Employment Income	$16,590	$29,145

(Source: Statistics Canada, 2001)

5.2 Data Capture

The nature of the study required participation from a wide variety of respondents, including those from various cultures and little education. In addition, as it became apparent during the course of the fieldwork, many of the potential respondents most valuable to the study were heavy substance abusers. The paper base map proved successful in overcoming issues of marginalization during the data capture process.

5.2.1 Survey Instrument

The purpose of the survey was to understand perception of changes that had taken place in the West Broadway neighbourhood over a five year period. After answering questions related to changes that had occurred respondents were given a map of the area (seen in Figure 5.1). Respondents were instructed to do the following:

Now, looking at this map of the neighbourhood, I have a few more questions. Once again, imagine walking around the neighbourhood. Using this map as a guide, familiarize yourself with where things are. Think about the changes that have taken place in the past 5 years.

Circle the top three areas/places of improvements in the neighbourhood over the past five years. Label each of these areas 1-3 with '1' being area of highest improvement.

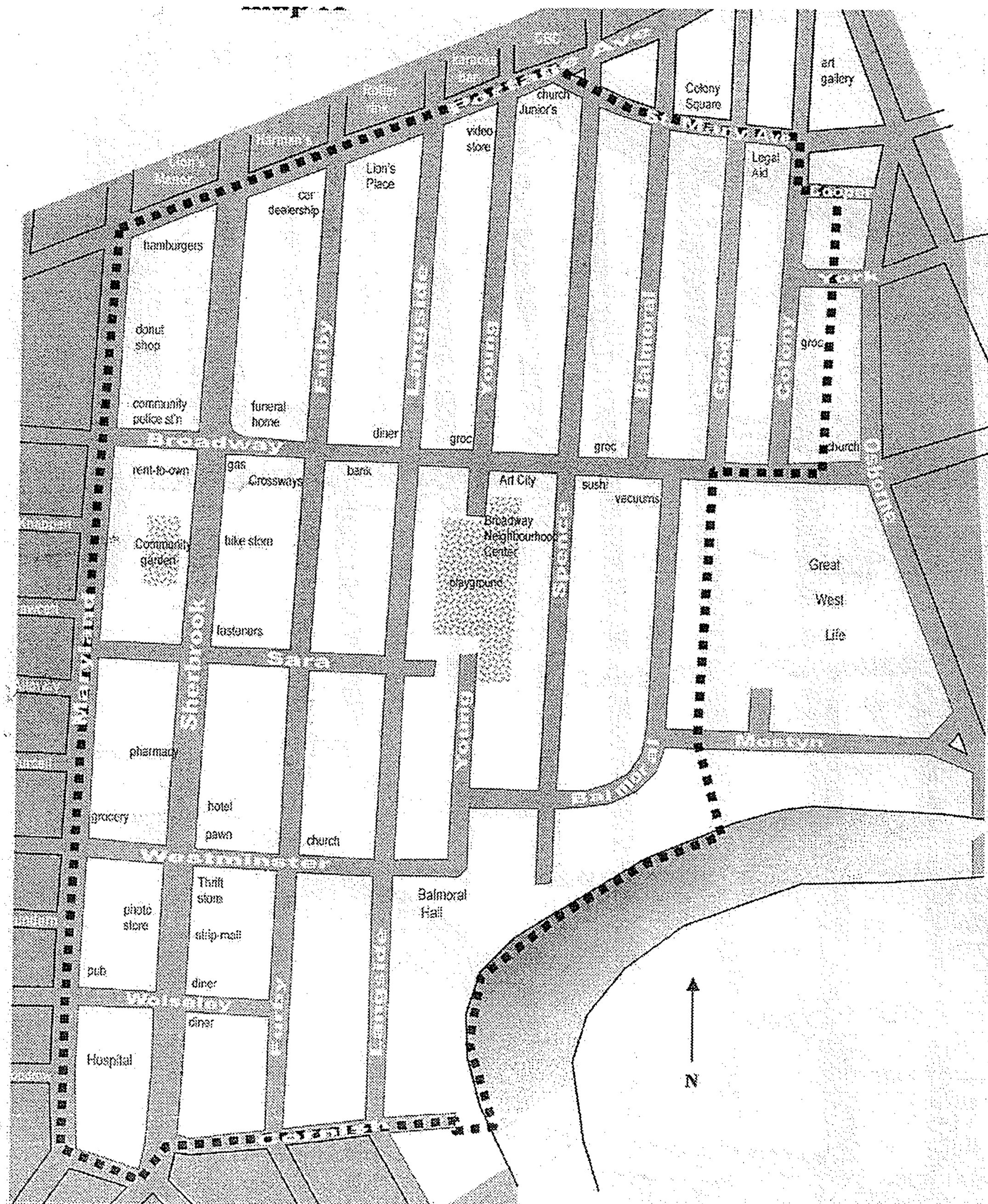


Figure 5.1 - Survey Questionnaire Base Map

Respondents used a pencil or pen to draw polygons on the map and indicate the rank of each. The interviewer would then look at what the respondent had drawn and ask:

What improvements have occurred in each of the areas you identified?

The interviewer recorded the answers on the survey questionnaire sheet. Respondents were then given a second identical map and asked to identify the top three areas/places experiencing a *lack of improvement* over the past 5 years.

Respondents from all demographic groups had little trouble understanding the paper maps or the exercise required of them, as was clear from their active involvement in this part of the interviews. There was no training or detailed explanation required to have respondents draw areas of improvement and lack of improvement on the map. In some rare cases, a respondent was given a little guidance or clarification by the community researcher; however this did not result in a lower level of participation as it would with other techniques.

The usefulness of the paper base map in overcoming issues of marginalization was confirmed during an interview with a neighbourhood resident with limited motor skills, apparently due to substance abuse. Although significantly hampered by limited motor skills, the respondent was able to manipulate the pencil enough to draw polygons on the base map; albeit very slowly. Thus, despite a limited ability to articulate responses to open-ended questions presented during the interview, the respondent was able to successfully understand and respond to the mapping exercise. This experience demonstrated the value of the paper base mapping tool in obtaining participation from individuals who might otherwise be excluded using other methods of data capture.

The survey method used provided advantages over those currently used in PPGIS projects or during the cognitive mapping boom of the 1970s. The simplicity of the survey tool addressed issues of marginalization due to technology, while allowing for meaningful input to be obtained using non-technical researchers from the community. The method proved successful in obtaining meaningful responses from a wide demographic, including those that would normally be excluded using other popular techniques.

5.2.2 Survey Sample

The HIND study sought to solicit opinions from both key informants and neighbourhood residents. Both groups of respondents participated in the mapping exercise.

The key informant sample was drawn from a list of people with known interest or expertise of the West Broadway neighbourhood that ideally extended back at least five years. The sampling strategy aimed to obtain a random sample of respondents with attention to ensuring a wide range of opinion without too much expertise in a single area. Key informants were not necessarily residents of the neighbourhood and included professionals (doctors, lawyers), activists, politicians, business owners and real estate professionals. 39 key informants participated in the study.

A spatially controlled random sample of neighbourhood residents was obtained from key zones of transition identified within the neighbourhood in another stage of the project. Community researchers were given maps of the area that showed property boundaries. Attempts were made to survey every third property on each side of the streets shown to be within a transition area. Attempts were made to solicit participation at various times of day throughout the week. This helped obtain a sample that included students, unemployed people, shift workers, professionals, rooming house tenants, homeowners, of all adult demographics. Fifty five neighbourhood residents were interviewed during the course of the study.

5.2.3 Interviews

The lack of computers, complicated terminology, or abstract constructs (as per Lynch, 1960) allowed community researchers to successfully conduct surveys with a minimal amount of training. Responses returned from the community researchers were easy to understand and were very rarely discarded due to coding errors or unclear recording of responses. Actively involving community researchers had other tangible advantages.

Despite the simplicity of the data collection tool, a small amount of training was still required for community researchers. First, community researchers required training on procedural and ethical matters. This included the importance of obtaining the participant's signature on a permission form, the requirement for participants to be over 18 years of age, and how to appropriately introduce and represent the study. Next, community researchers were trained in how to deliver the survey. This included instruction on how to delivery the interview tool without leading responses. Community researchers were also reminded that respondents were not required to answer any question they did not feel comfortable answering. Training was also given on how to record answers.

It should also be noted that community researchers played a large role in the creation of the survey tool itself. The final survey tool represented a collaborative effort between community and university researchers. The paper base map used was actually created by a community researcher with the advice of all researchers involved.

Prior to conducting interviews in the field, practice interviews were conducted on graduate students from the University of Manitoba. Feedback from them allowed for the interview skills of the researchers, as well as the research tool itself, to be fine tuned.

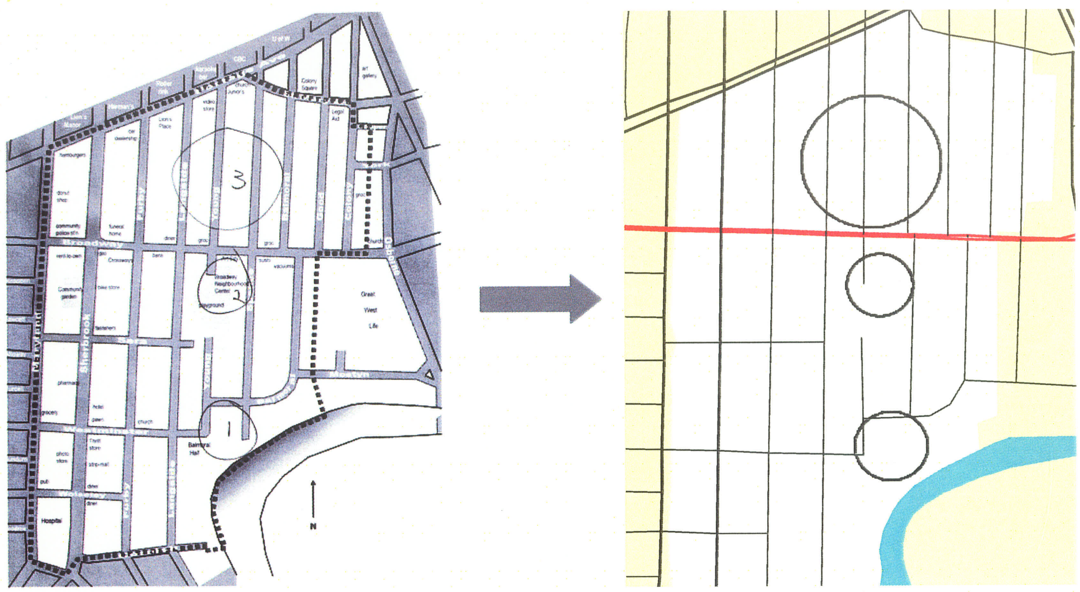
It is suspected that the use of researchers from the community increased both participation and legitimacy of responses. Neighbourhood residents were often approached at their residence by one of the community researchers. Oftentimes, the community researcher would be familiar to the respondent. Other times, cultural differences would be minimized when the respondent identified directly with the cultural background of the community researcher. The involvement of community researchers helped to reduce the appearance of the study being top-down or elitist.

5.3 Data Processing

5.3.1 Conversion to Digital

The completed survey maps were then collected and converted into digital format. Two separate 'Respondent Themes' were created using the procedure described in Chapter 4; one for perception of *improvements* and one for perception of *lack of improvements*. Digital representations were captured using a Universal Transverse Mercator (UTM) projection in North American Datum 1983 (NAD83). Attributes captured for each polygon during the interview, such as rank, survey ID and description, were recorded in the attribute table of each Respondent Theme. The conversion process went relatively smoothly despite a few issues.

Accurately digitizing the boundaries of each polygon with the tools available in ArcView 3.x proved to be challenging. ArcView has tools for drawing rectangles, polygons and perfect circles. In addition, an oval can be created by 'stretching' the height or width of an existing perfect circle. Responses drawn by hand are rarely, if ever, perfect rectangles, circles or ovals. Therefore, digital representations are limited to being close approximations of the original responses (See Figure 5.2)



Example of Individual Participant Response

Response Transcribed into Digital

Figure 5.2 Conversion to Digital

According to Heywood, et al (1998), "manual digitizing is recognized by researchers as one of the main sources of error in GIS" (p 197). During the digitizing process "human operators can compound errors present in an original map and add their own distinctive error signature" (p 197). Such errors are referred to as "operational errors" and are extremely difficult to eliminate from manual digitizing exercises.

An alternative method of translating individual responses into digital format would employ the use of a digital scanning device. Once scanned, individual responses could then be translated into vector format using automated imaging and GIS tools. Digital scanning would allow for responses to be captured in digital format exactly as they were drawn by respondents, without introducing the opportunity for operator induced operational errors. Researchers conducting similar research in the future should consider using digital scanning of responses.

Errors in distortion due to digitizing were controlled by having all responses digitized by a single researcher. The assumption is that while operational errors in digitizing are inevitable, those generated by a particular operator will be uniform; that is, distorted in the same manner. Since all responses in the current study were digitized by the same operator, operational errors are likely to be uniform and therefore, not likely to have a significant adverse impact on the results.

Obtaining responses in unanticipated formats appears to be a common issue. Recall from the discussion in Chapter 3 that O'Connell and Keller (2002) were forced to deal with responses outside of the expected format. Instead of removing such items from the sample population, O'Connell and Keller adopted a strategy of making rules for altering individual responses during the digitizing process to deal with deviant responses. As explained below, this was not considered necessary for the current study under investigation.

In the HIND study, overlapping polygons drawn by an individual respondent were considered valid. It is possible that two polygons representing slightly different improvements could overlap. For instance, one area could be considered improved based on physical improvements to housing, while a second experienced improvements due to a decrease in crime. These two areas may overlap, but not share the same extents. The same logic applies to overlapping areas of perceived improvement and lack of improvement.

Despite clear instructions to record only 3 areas of perceived improvement or lack of improvement in the neighbourhood, eleven respondents insisted on identifying four or more areas. Three of these respondents identified six areas and assigned ranks between '1' and '3', yielding more than one polygon with a single ranking. The remaining eight respondents identified five areas and ranked them between '1' and '5'.

Responses identifying more than a single area for any given rank were considered valid. It is not unreasonable to assume that a respondent may perceive two or more areas as having a common attribute or shared value. Identifying more than a single contiguous area as having a certain rank does not represent over-participation any more than would a respondent drawing zero polygons represent under-participation.

Cases where respondents assigned items a ranking of '4' and '5' provided a different problem. Respondents assigning more than three rankings could be considered over-participating. Regardless, these items were digitized into the dataset and assigned the rankings assigned by the participant. Recoding rank values in the Respondent Theme allowed for these items to be screened out during the aggregation and analysis phase of the study.

The resulting Respondent Theme representing *perception of improvements* contains polygons that cover almost the entire area of the neighbourhood (see Figure 5.3). As one would expect, when the individual responses are represented collectively some areas of the neighbourhood are represented more than others.

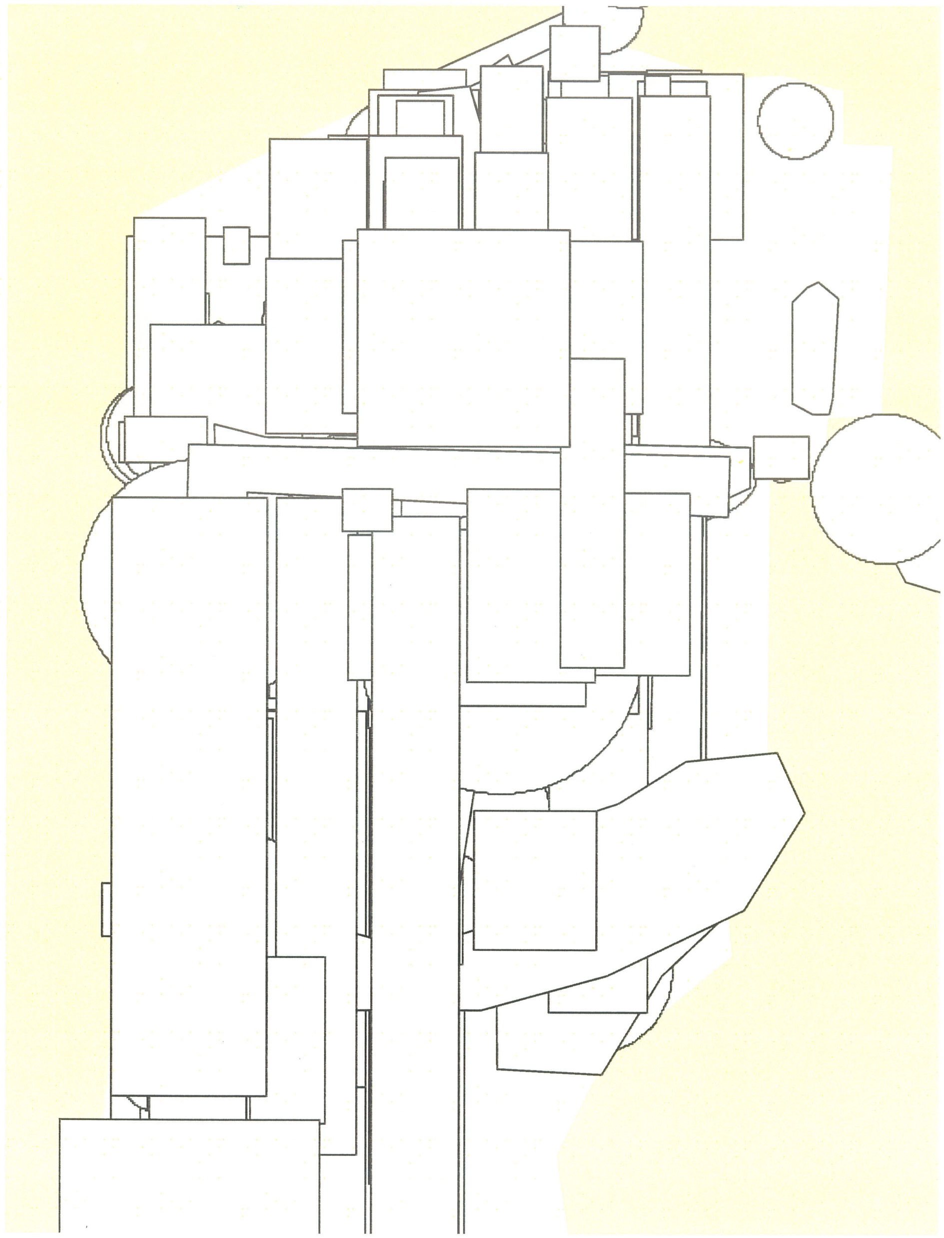


Figure 5.3 - Respondent Theme: Improvements as Perceived by All Respondents

However, it is difficult, if not impossible, to identify which areas are most often identified and by how much. In order to be able to identify and analyze spatial patterns, the Respondent Theme must first be processed using a GIS ‘Topological Clean and Build’ operation to create a Template Theme. Next, the number of polygons in the Respondent Theme that intersect with each polygon in the Template Theme must be computed.

5.3.2 Building Topology

ArcView 3.x does not come packaged with a 'Topological Clean and Build' operation. As mentioned in Chapter 4, this function can be performed using ArcGIS, creating a script using Avenue, or by using third party software.

The Department of Geography at the University of Manitoba maintains an installed version of ArcGIS. While this installation can be made accessible to students from other departments, this could still take a reasonable amount of time and effort. For the HIND study, the use of ArcGIS was viewed as a last resort.

The complexity of writing a 'clean and build' operation in ArcView's development language, Avenue, would prove to be difficult and time intensive. There is no sense in spending time creating an operation that is available through other means. Therefore, the Internet was searched for a third party ArcView 3.x Clean and Build operation. A company called "Spatial Online"[1] was found to offer a free trial version of the required operation. Since the operation need only be run once in the creation of a Template Theme, the free trial version of 'SSIArcPolyTopo' was downloaded.

The creation of a separate Template Theme for both Respondent Themes seemed redundant. In light of this, The Respondent Theme containing all polygons related to perception of improvements was merged with the Respondent Theme containing polygons representing lack of improvements. The SSIArcPolyTopo operation was then performed on the theme representing all responses. The result is presented in Figure 5.4

[1] http://www.spatial-online.com/

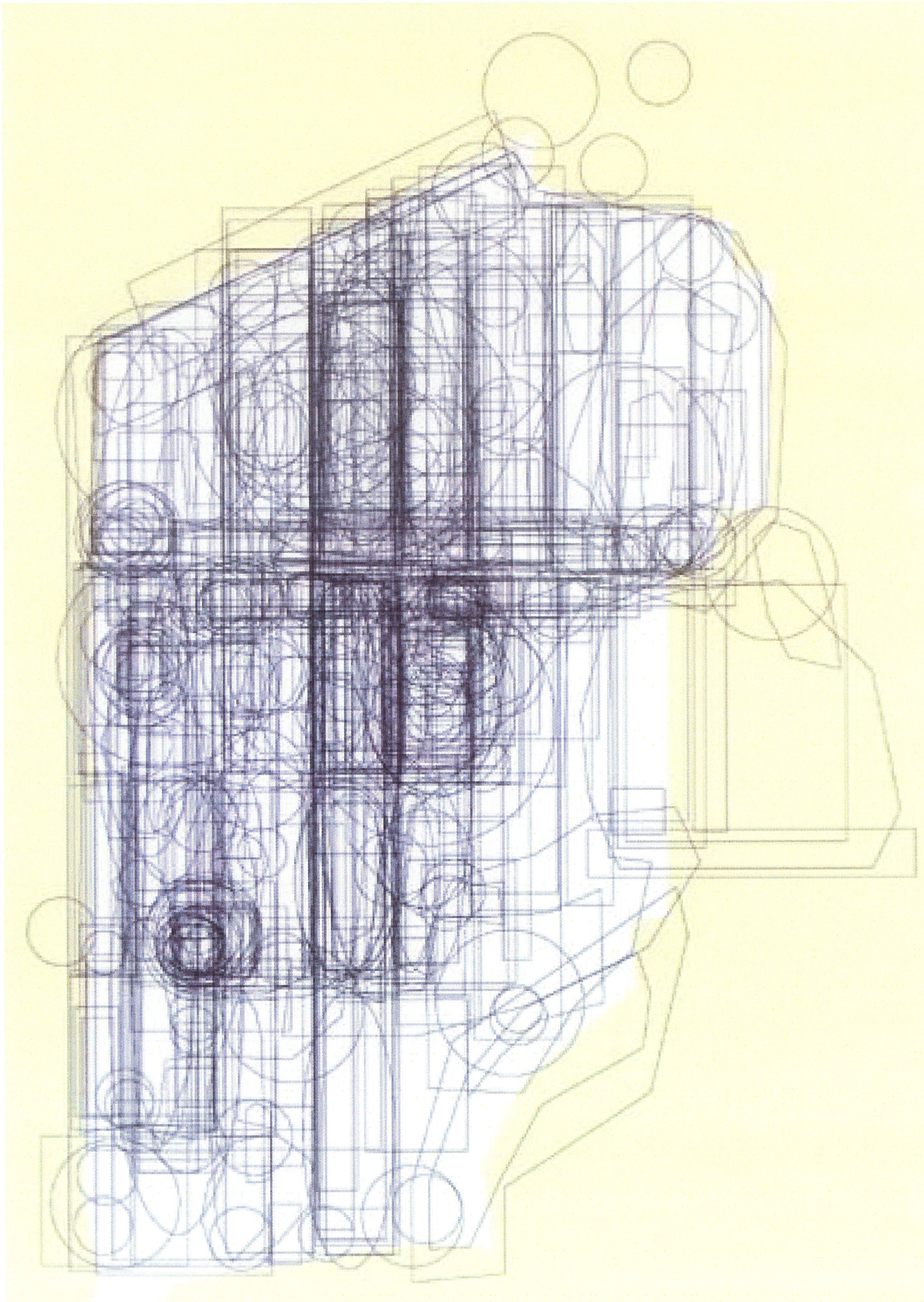


Figure 5.4 - Template Theme: All Polygons Recorded By Respondents

5.3.3 Assigning Values

The number of selected polygons contained in either of the two Respondent Themes intersecting each polygon of the Template Theme could then be computed using the Roll-up script (Appendix D). As described in Chapter 4, the number of original polygons intersecting with each of the resulting polygons was then stored as an attribute. This allowed for each of the polygons to be represented according to their original polygon intersection count using a colour ramped legend (see Figure 5.5)

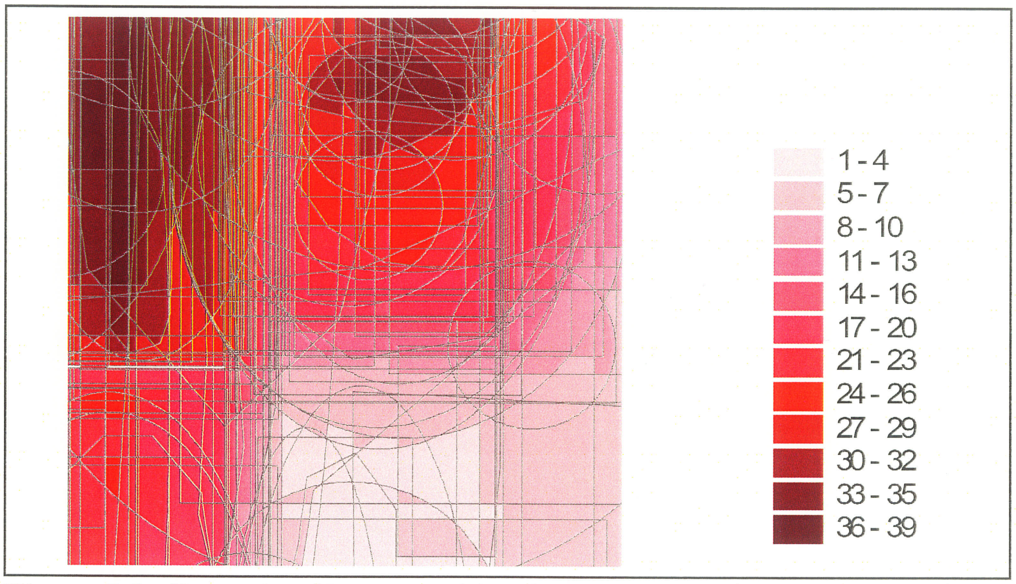


Figure 5.5 - Example of Data Resulting from Roll-up Script

The Template Theme was then copied to create a new theme: the Output Theme. In order to facilitate analysis against other Output Themes, the number of original polygon intersections for each built polygon was divided by the number of respondents represented in the layer. This yielded a percentage value for each polygon, instead of a straight number count. The resulting layer was represented using a standardized colour ramped legend. The standardized colour ramped legend allowed for analysis to be performed between layers (Figure 5.6)

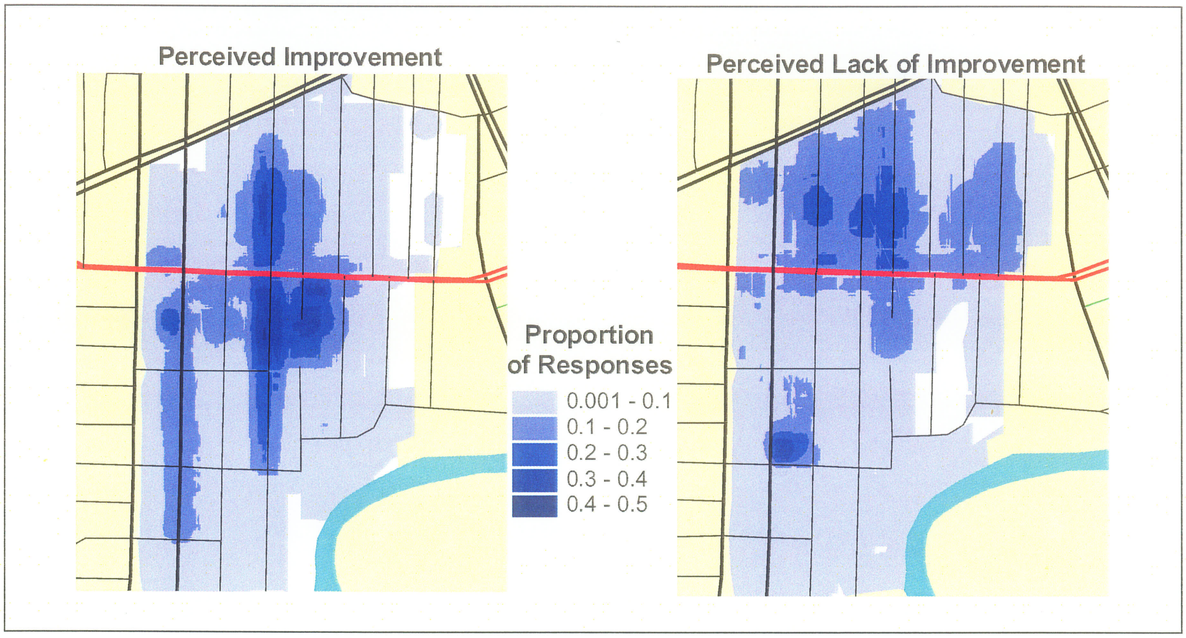


Figure 5.6 - Comparison of Perceived Neighbourhood Improvements vs Lack of Improvements for All Responses

It was discovered that comparing groups of responses with one another was somewhat difficult when the data was displayed in 2 dimensions. Consider Figure 5.6 which displays a representation of perceived neighbourhood improvement next to a representation of lack of neighbourhood improvement. Even with the standardized legend categories it is difficult to discern exactly where perceived improvements outweigh a perceived lack of improvements. In order to facilitate such analysis, the resulting datasets were analyzed in 3-dimensions.

In order to display the Output Themes in 3-Dimensions, they were first converted into Raster format using the ArcView Spatial Analyst extension. Next, the 3-D Analyst extension was loaded into ArcView. The rasterized Output Themes were then loaded into a new 3D Scene. The elevation of each cell was then assigned according to the proportion value stored for each cell in the raster data set. A vertical exaggeration was then applied.

5.4 *Analysis of Perceptions*

5.4.1 Improvements vs. Lack of Improvements

In comparing differences found within the survey sample, it was useful to have layers represented in the 3rd dimension. The resulting 3D images allowed for the visual analysis of two variables to be performed quickly and easily. The first analysis done using this technique compared the collective images of all respondents based on perception of Improvements and Lack of Improvements (see Figure 5.7)

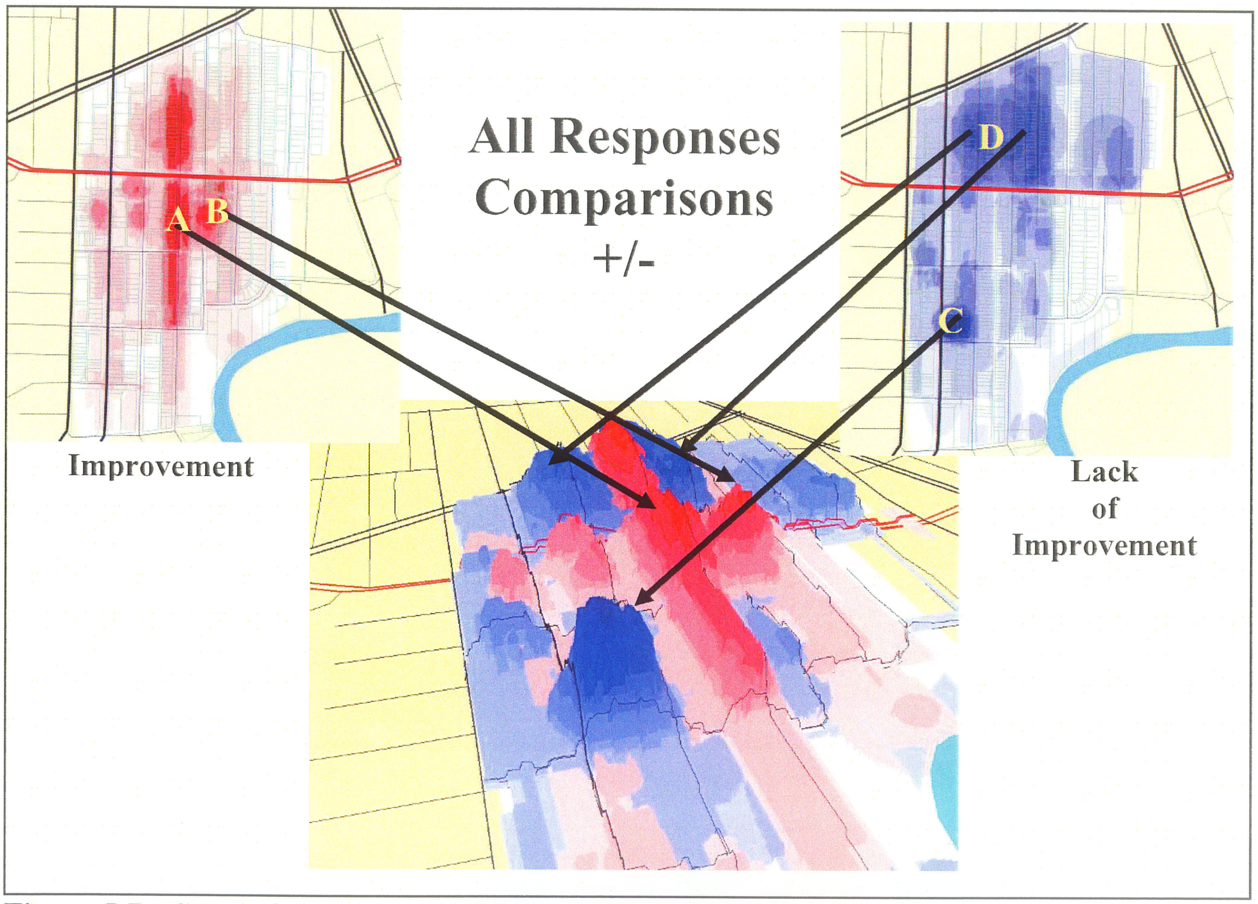


Figure 5.7 - Comparison of All Responses: Improvements vs. Lack of Improvements

This analysis suggests the area associated with the original housing interventions is perceived as having experienced the most improvement in the neighbourhood over the five year period under investigation (see 'A' in Figure 5.6). From the descriptions provided by respondents it is evident that this improvement was largely physical. Another area of significant improvement is the area associated with the West Broadway Neighbourhood Centre (see 'B' in Figure 5.7). Again, interventions included in this area occurred were some of the first to be implemented in the neighbourhood (See Appendix A). Descriptions provided by respondents suggest that improvements perceived in this area were less physical and more program oriented.

Areas in the neighbourhood perceived as experiencing a lack of improvement over the five year period focused on the area around a commercial area on Sherbrook Street (see 'C' in Figure 5.7) or the residential area north of Broadway Avenue (see 'D' in Figure 5.7). It is interesting to note the confusion surrounding area 'D'. In the 2D images, it is difficult to interpret which areas north of Broadway Avenue are perceived as having improved or not improved. When shown in 3D, it becomes evident that an area of perceived improvement runs through an area of perceived lack of improvement.

5.4.2 Key Informants vs. Neighbourhood Residents

The second analysis performed was to compare areas of perceived improvement between key informants and neighbourhood residents (see Figure 5.8)

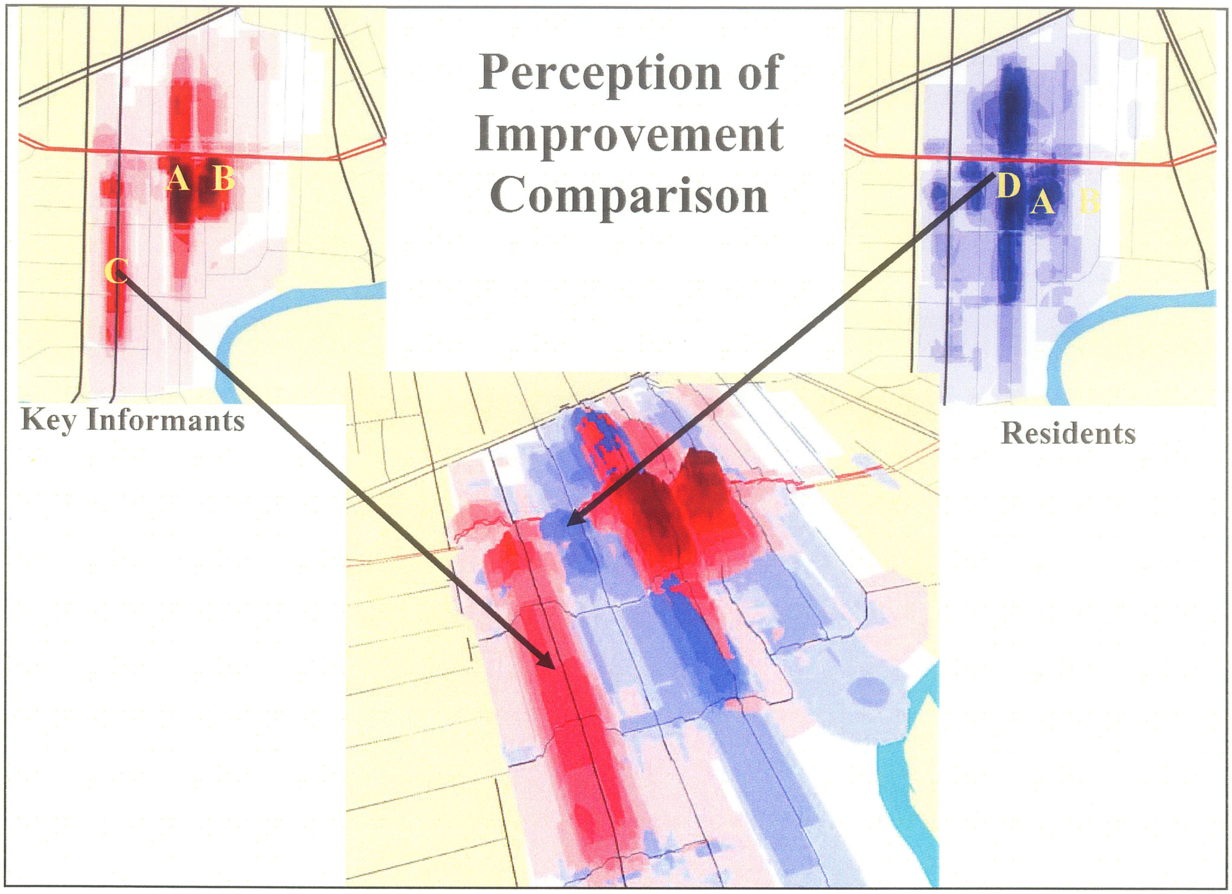


Figure 5.8 - Perception of Improvement: Comparison of Key Informants and Neighbourhood Residents

Both groups perceived improvements as having occurred in areas marked 'A' and 'B'. As with Figure 5.8 these areas are associated with the original housing and social interventions implemented in the neighbourhood (See Appendix A). It is interesting to note that respondents of key informant group perceived the commercial area along Sherbrook Street has having improved (see 'C' in Figure 5.8) while neighbourhood residents did not. One possible explanation for this could be that respondents considered as key informants did not necessarily live in the neighbourhood, and would only see the neighbourhood from their cars as they drove down Sherbrook Street. The portion of Sherbrook Street perceived as improved has been subject to beautification and commercial improvement efforts of the Sherbrook BIZ. In this case, perception of improvement appears to be based largely on physical improvements.

Neighbourhood residents, on the other hand, perceived the area focussed around the church at Furby Street and Broadway Avenue (see 'C' in Figure 5.8) as having improved. This is likely due to residents noticing the decrease in visible gang related activities during the evening, along with an increase in social programs during the day. Based on this assumption, it could be said that residents based much of their perception of improvement on social aspects rather than physical attributes of built form. The information represented is based solely on local knowledge.

The third analysis performed was to compare areas of perceived lack of improvement between key informants and neighbourhood residents (see Figure 5.9)

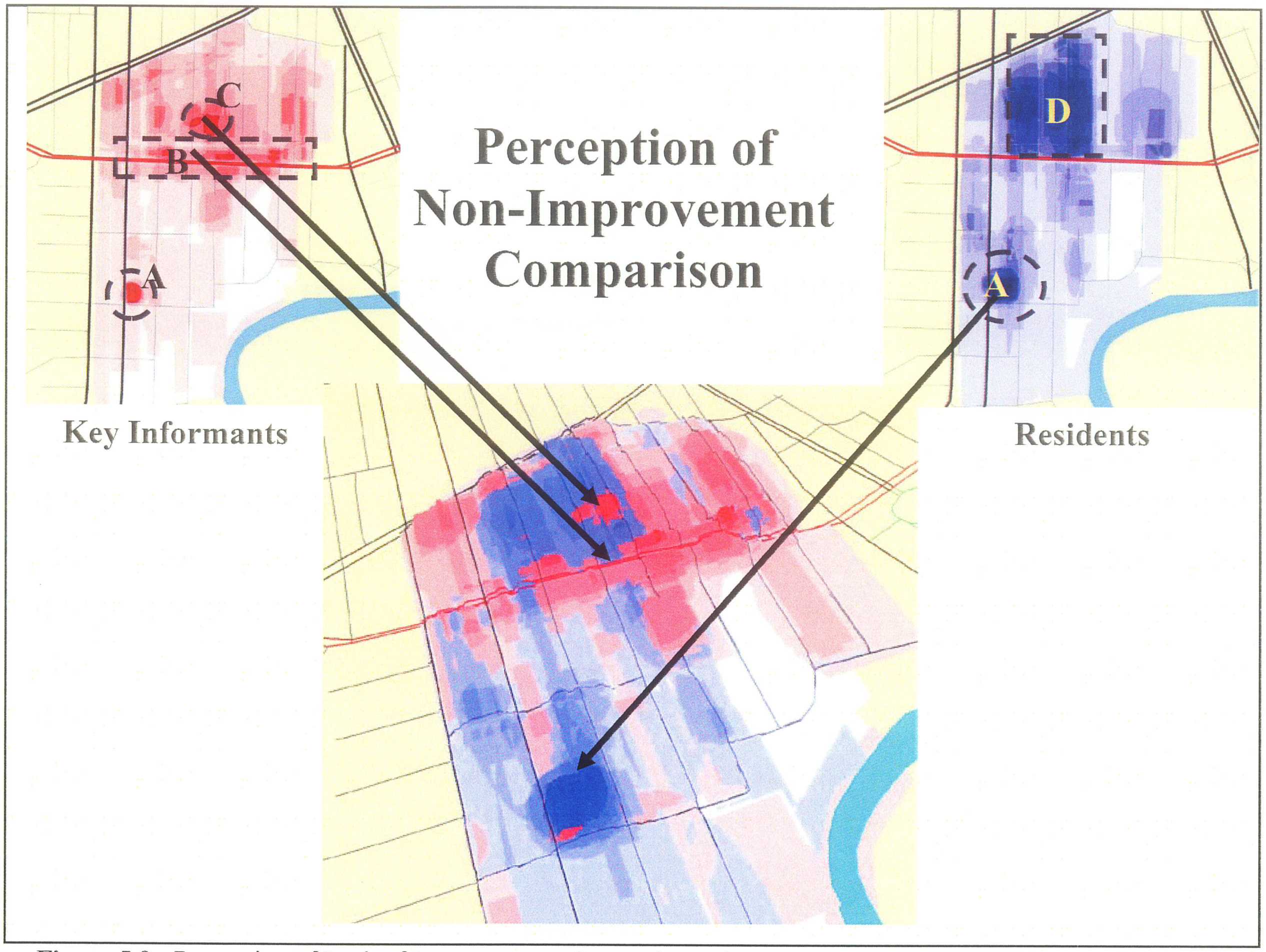


Figure 5.9 - Perception of Lack of Improvement: Comparison of Key Informants and Neighbourhood Residents

Key informants and neighbourhood residents appear to agree that area 'A' has experienced a lack of improvements during the five year period under investigation. However, it is interesting to note that a higher percentage of residents felt area 'A' had not improved than did key informants. A potential explanation is based on the fact that this area was probably perceived as exhibiting physical as well as social maladies. Key informants likely based their perception on the physical appearance of the area they get when they travelled past. The local residents likely base their perception on the activities that occur there during the evening in addition to the physical appearance.

The fact that key informants perceived Broadway Avenue (area 'B' in Figure 5.9) has having lack of improvement is likely once again a reflection of their impression of the neighbourhood being based on what they see as they travel through. This impression was not shared by the neighbourhood residents.

Both neighbourhood residents and key informants perceived portions of the residential area north of Broadway Avenue as exhibiting a lack of improvement (areas 'C' and 'D' Figure 5.9). However, neighbourhood residents perceived the lack of improvement covering a much wider area than did key informants. It could be that a particularly tall unattractive building was visible to key informants as they travel through the neighbourhood down Broadway Avenue. Many of the neighbourhood residents interviewed lived on Spence Street (to the right of area 'D') and likely based their perception on night time activity that occurs somewhere in the area identified as 'D'.

5.5 Aggregated Layer of Public Perception

A final challenge was to represent perception of neighbourhood improvements and lack of improvements together in a single data layer, that could be incorporated into a GIS used in the decision making process.

A single layer representing both improvements and lack of improvements was created by converting both datasets to Raster formant and simply overlaying them using a subtraction function. The result is a raster data layer containing the values representing the amount of difference between the two input data layers (see Figure 5.10). This spatial information product has the advantage of clearly displaying areas of improvement over areas of lack of improvement. It also provides a means to balance areas of perceived improvement with areas as perceived has having a lack of improvement. As a result, areas represented as having the highest value will be those that have a high percentage of respondents perceiving the area as having improved against and a low percentage indicating the area has noticeable lack of improvement. This method is useful for the creation of a layer to be used in the integration of a GIS concerned with analysis with other spatial data sets (such as those found in Appendix A). It also provides an indication of areas perceived to have experienced the most improvement and lack of improvement over the five year period.

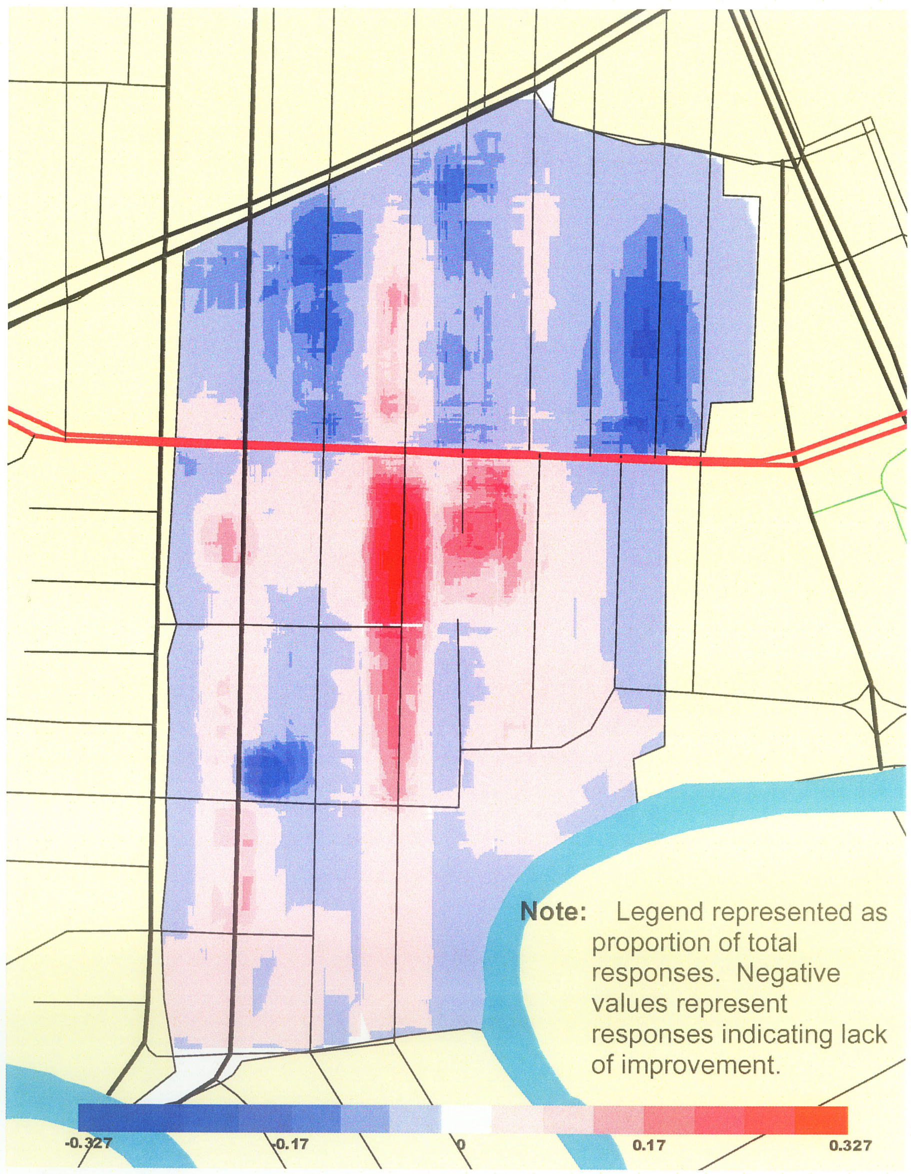


Figure 5.10 - All Responses Represented as a Single Data Layer

Although many people identified particular properties as 'problems', the method used does not allow for individual addresses or locations to be singled out. While the area surrounding a property may be collectively identified as being undesirable, the individual business or housing unit is not specifically identified. This allows for all interested parties to come to the discussion without the survey results being considered a personal attack.

Local knowledge, such as the spatial distribution of social improvements in the neighbourhood, can only be obtained from neighbourhood residents themselves. This type of spatial information is not available from any other datasets currently available to neighbourhood groups in the City of Winnipeg. Local knowledge, such as this, could be a valuable component of any decision making process. Capturing and representing the collective knowledge or perception of neighbourhood residents allows for such information to be included in traditional McHargian overlay or GIS analysis of neighbourhoods which support decision making.

5.6 Limitations & Lessons Learned

While the method was successful in meeting the overall objectives of the study, there are a few limitations which deserve mention. First, despite the reasonable sample size obtained (+/-100 in all), the mapping exercise could have been improved with a larger sample size. Second, technical expertise is still required for some portions of the methodology. Third, the method of converting responses to digital format introduced operational errors that could have been better controlled by other methods.

A larger sample size would have allowed for more and better analysis to be performed on the resulting data. Although it was possible to derive some interesting and useful results in comparing perceptions held by key informants with neighbourhood residents, it would have been useful to compare differences within each of these groups. Unfortunately, a much larger sample of neighbourhood residents would be required to begin differentiating perceptions held by the multiple publics within the neighbourhood (for instance, Marginalized & Renting vs. Home-owning Gentrifier).

The sample size was limited due to the data capture method used. The data capture method was still rather time consuming and required a significant amount of effort on the part of the researchers. Although the mapping exercise itself took very little time for respondents to complete, it represented only a small portion of a larger survey questionnaire. Each survey took between 20 and 30 minutes to complete; of which, only a couple minutes were spent on the mapping exercise. In addition, survey personnel spent a good deal of time going door-to-door in search of willing participants. As a result, survey personnel could only collect a few responses each day.

If the mapping exercise were administered alone, a larger sample of neighbourhood residents may have been possible. The sample could have also been improved by triangulating data capture methods. For instance, a mail-out survey could have been used in conjunction with an Internet survey. As it is likely that these methods would only capture participation from non-marginalized residents, the methodology described in this Thesis could then be used to capture the perception of the marginalized public.

A second limitation to the methodology under investigation is that some level of GIS expertise is still required. While the data capture process can be carried out by semi-technical survey personnel, aggregating and analysing responses requires GIS software along with technical personnel to operate it. It is unlikely that neighbourhood development groups are going to have the software and expertise to conduct this work in-house. Ideally, the more technical aspects of this methodology would be carried out by a larger organization supporting multiple neighbourhoods that could perform the work as a service bureau.

A third limitation to this methodology relates to the digitizing process. As discussed, the digitizing process used for converting paper responses to digital introduced operational errors. There are a couple of reasons for this. First, the GIS software used in the digitizing process did not provide the tools necessary to replicate shapes drawn by respondents. Second, data is always lost during a conversion process. Human error in the digitizing process cannot be overlooked. As a result of these operational errors, the polygons captured during the digitizing process could be considered an approximation of the original shapes drawn by users. However, were responses converted into digital format error-free, the results of the analysis are not expected to have been any different.

5.7 Conclusions

This chapter has demonstrated how an abstract concept, such as perception of neighbourhood change, can be spatially captured, synthesized and analyzed using widely available GIS tools. The method is in line with communicative action planning ideals of representing a differentiated public as well as ensuring participation from all major points of view.

By using a survey technique, similar to those of the cognitive mapping exercises of the 1970s, perception of neighbourhood change was captured from a wide demographic throughout the neighbourhood. The simple data capture technique used also allowed for non-technical community researchers to be able to deliver the survey effectively and efficiently. Using a paper map to record individual responses, provided a means of data capture that maximized the participation, without marginalizing based on language, culture, education, training, technical ability, or internet access. It also allowed for individual responses to be easily converted into digital format with a minimum amount of interpretation on the part of the researcher.

The method of synthesizing individual responses allowed for analysis to be carried out between groups of individuals. The analysis resulting from the synthesized data was able to uncover differences between key informants and neighbourhood residents, that otherwise may not have been discovered.

The resulting images of perception of change provides a means for local neighbourhood revitalization authorities to gain a better understanding of the spatial impact past interventions have on the residents affected. This information will aid in the strategic placement of future interventions.

And finally, the method used results in a dataset, representing collective perception, which can be incorporated into a traditional GIS overlay process. Typically, data incorporated into such analysis is visible, has a physical presence, can be quantified, and is usually obtained from other sources. Data acquired through the method discussed represents non-visible local knowledge, which, although considered valuable by many accounts (Lynch, 1960; Talen, 1999 and 2000; Harris et al, 1995), was previously excluded from contemporary Gestalt-style spatial analysis. In addition, it addresses one of the major criticisms of the cognitive mapping movement of the 1960s and 1970s: a clearly defined method of integrating spatially represented public perception into analysis used in the decision making process.

5.8 Future Research

This Thesis lays the foundation for further research in a number of areas. A First recommendation for future research relates to the improvements in a couple aspects of the methodology itself. Second, the results of this study can serve as a benchmark of comparison for future studies of perception in the neighbourhood of West Broadway. Third, the feasibility of incorporating this methodology more universally into other neighbourhood analysis exercises requires examination. Both avenues of further research could lend support to the formal inclusion of perception of environment into the planning process.

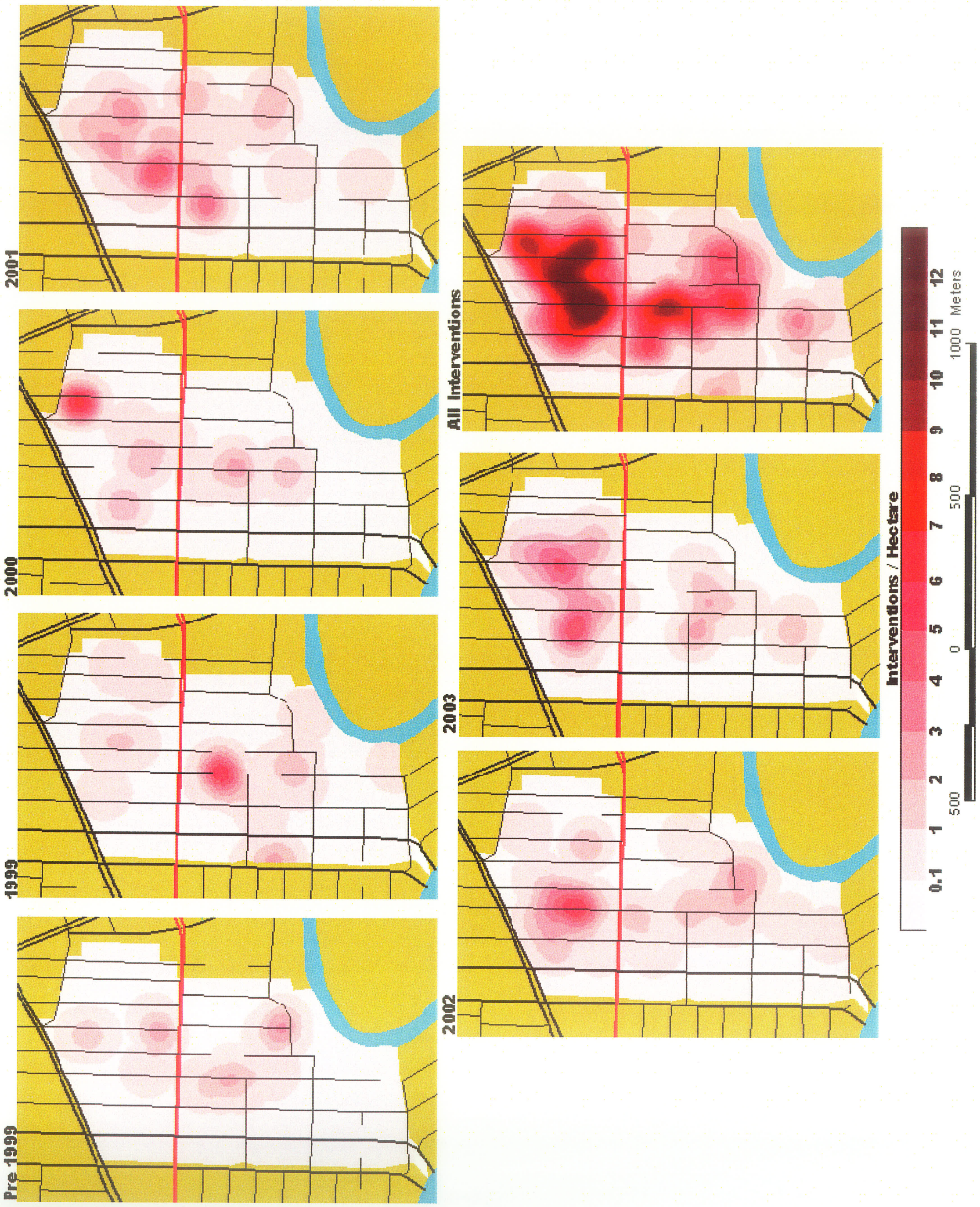
The first recommendation for future for future research relates to data conversion and aggregation of responses. Any future work based on the ideas of this study should consider converting responses to digital format using digital scanning technology. The use of a digital scanner could allow user drawn shapes to be better represented in their digital format. In addition, the method of aggregation could be improved through the use of geo-statistical operations available in many modern GIS. Such operations could lend an additional validity to the results.

Second, replicating this mapping exercise in the neighbourhood of West Broadway will allow for analysis of perception of changes over time. Comparing perception of changes, both positive and negative, between different years would allow for an understanding of the direction certain areas of the neighbourhood are taking. Such analysis could aid in evaluating the success of neighbourhood revitalization interventions, and help inform strategic placement of future interventions.

Indicators of community improvements hold a bias toward quantitative information. The methodology presented provides an alternative source of local knowledge that could be incorporated into the evaluation of changing neighbourhood conditions. Further research is required to evaluate the feasibility of incorporating this methodology into community planning initiatives in distressed neighbourhoods within the City of Winnipeg. Such research should include the establishment of a service bureau for technical GIS data, skills, and analysis at the neighbourhood level.

Future research would give the field of Planning a precedent for successfully including perception of environment into planning decision making processes. Such a precedent would give new relevance to the cognitive mapping researchers of the 1960s and 1970s.

APPENDIX A – Density of Interventions in West Broadway



From Skelton, et al (2005)

APPENDIX B – Digitizing Process

Process for Digitizing Responses into Digital Format Using Arcview 3.x:

1. A polygon shapefile is created and loaded into Arcview as a data layer or 'Theme'
2. The following fields are added to the new shapefile (now loaded as a Theme):

Field Name	Data Type	Length	Description
Code	String	12	ID value for individual survey response
Rank	Numeric	2	Rank assigned to polygon
Desc	String	45	Respondent description of polygon attributes
Zone	String	2	Predefined zone in which response was collected

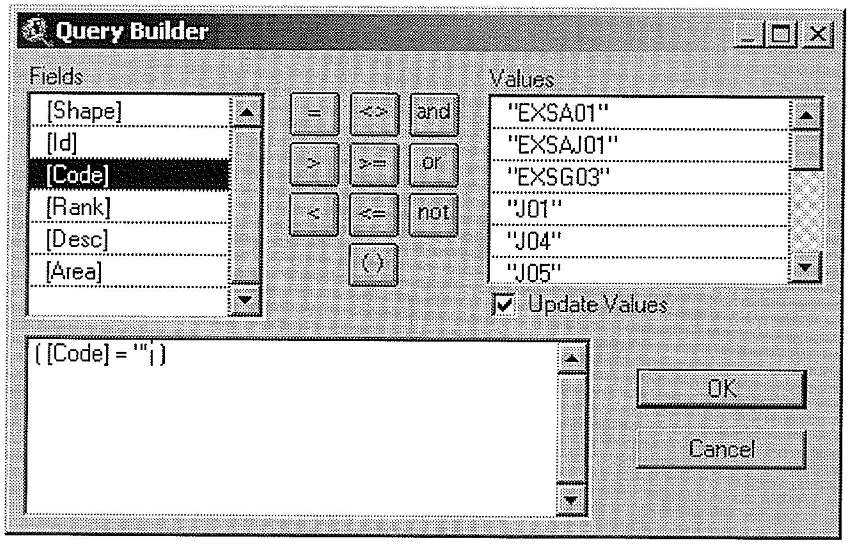
3. Appropriate reference datasets are loaded into the GIS. These datasets include streets, neighbourhood boundaries, rivers, etc. These layers should contain the same information that was represented on the base map used to record individual responses.
4. The polygon shapefile is made editable
5. The GIS operator digitizes the areas drawn from the first survey as close as possible.
6. Attributes of each polygon are entered.
7. Stop editing the theme.

Steps 5 and 6 are repeated for each response in the sample.

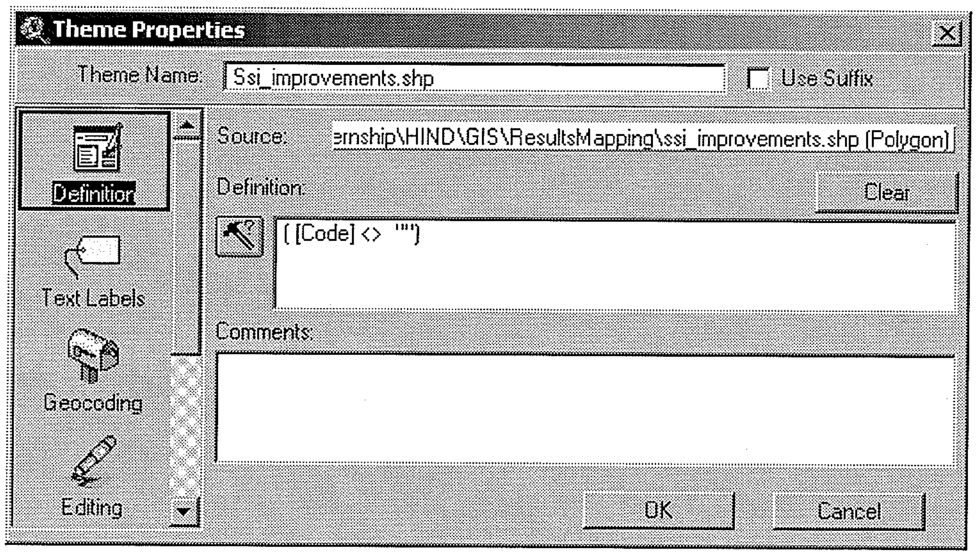
It is recommended that responses for each map contained in the survey be captured in different files. This will help keep the data organized.

It is also recommended that a filter be applied to the Respondent Theme during the digitizing process. This filter will make polygons already captured invisible. In ArcView 3.x, a filter is applied using the Theme Properties dialog box as follows:

- Open the Theme Properties dialog from the Theme menu.
- Click the Query Builder tool button and the following dialog appears:



- Create a query that will return only records that have not been assigned with a value for a specific field.
- Click the OK button of the Query Builder window.
- Click the OK of the Theme Properties window to apply the filter



With the filter applied, only the polygons of the response currently being digitized will be visible. Once the attributes have been assigned, in step 6, the polygons will become invisible. This will allow the operator a clear map to enter in new data.

Once all of the polygons have been digitized and the appropriate attribute information as been recorded, remove the Theme Filter. This is done by opening the

Theme Properties dialog window and clicking the 'Clear' button. Clicking the 'OK' button in the Theme Properties dialog window will remove the Theme Filter and return control to the View document.

APPENDIX C – Field Specifications

Respondent Theme Fields:

Field Name	Data Type	Length	Description
TheCount	Number	4	Number of polygons from the Respondent Theme that share space with the Template Theme polygon associated with this record in the attribute table

Output Theme Fields:

Field Name	Data Type	Length	Decimal Places	Description
Prop	Number	5	3	Proportion of the total sample

APPENDIX D – Roll-up Script

```
'jdp.Roll-Up
'
' This AVENUE script counts and stores the number of intersecting polygons in the Response
Theme for
' each' polygon in the Template Theme.  Subsets within the Response Theme by applying a
theme filter
' prior to execution of the script.
'

theView = av.GetActiveDoc

theTemplateTheme = theView.GetActiveThemes.Get(0)

' Prompt user for Response Theme
theResponseTheme = msgbox.listAsString(theView.GetThemes, "Select Theme to roll up", "")
if (theResponseTheme = nil) then
  Return NIL
end

' Get the Ftabs for each theme
theTemplateFtab = theTemplateTheme.GetFtab
theResponseFtab = theResponseTheme.GetFtab

' Get the necessary fields
theTemplateShape_fld = theTemplateFtab.FindField("SHAPE")
theTemplateVal_fld   = theTemplateFtab.FindField("theCount")

theCount = 0

theTemplateFtab.SetEditable(TRUE)

for each rec in theTemplateFtab
  theCount = 0
  theShape = theTemplateFtab.ReturnValue(theTemplateShape_fld, rec)

  ' Overlaps will be evaluated using polygon centres.
  theCentroid = theShape.ReturnCenter

  ' Count the number of selected polygons in the Response Theme that
  ' intersect the centroid of the polygon from the Template Theme.
  theResponseTheme.SelectByShapes({theCentroid}, #VTAB_SELTYPE_NEW)
  theResponseFtab.UpdateSelection
  theCount = theResponseFtab.GetSelection.Count

  theTemplateFtab.SetValue(theTemplateVal_fld, rec, theCount)
end

theTemplateFtab.SetEditable(FALSE)

Return NIL
```

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