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THE STRABO TECHNIQUE

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THE STRABO TECHNIQUE

Edited by

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FORWARD (T. K. Peucker)

Many planning-decisions are made with a complete lack of support data. A survey, even a relatively small sample, seems often too expensive, time-consuming and/or politically explosive. We therefore attempted, over the last years, to develop a technique which could provide information quickly and at low costs.

The idea started in 1975 in Mexico in a discussion between T. K. Peucker and Alejandro Villanueva who was using the Delphi Technique in his study on planning activities in Caracas. Because of the nature of the study, the idea of having respondents reply to questions by identifying areas on maps rather than answering with non-spatial data arose. A short paper was written which outlined the basic questions and pointed at the differences to the Delphi Technique (Peucker, 1975). These differences made it advisable to look for a new name, and the Greek geographer, Strabo, was to the city and the oracle of Delphi as the Technique was to its geographical application.

We were able to use a part of a Canada Council grant to continue our work the following two years. As a result, we produced the basis for the application of the Method to the problem of urban social indicators (Boerner and Peucker, 1976; Peucker, 1976), an overview of the Delphi Technique as it can help the Strabo method (Edelson, 1977) and a first simple programme (Edelson, Little and Fisher, 1977).

We are now at a stage where a first working model of the method is available and several of the basic questions which the method poses have been studied in some detail. The next steps will be:

a) to discuss some fundamental questions as they are outlined by Luscombe (1978).

b) to develop an efficient, user-oriented programme.

c) to apply the method to a variety of problems.

INTRODUCTION (P. W. Luscombe)

The Strabo Technique is a forecasting and planning strategy whose methodology emphasises the determination of a concensus of opinion from a group of experts. It is a logical extension of the Delphi Technique which was developed originally to assist the decision-making processes of the American military (Linstone and Turnoff, 1975, p. 10). Many of the early studies employing Delphi were conducted at the RAND Corporation and were primarily concerned with scientific and technological forecasting. The Delphi Technique has since been used in a variety of studies including the forecasting of many social "indicators" such as human attitudes and values, and the "quality of life". The Technique requires individuals within a group to formulate and assess decisions and opinions and, through this process, establish a convergent group consensus.

The Strabo Technique, presently under development at Simon Fraser university, employs a similar group approach in its methodology, but is differentiated by its emphasis on the spatial component of forecasting and planning. Both, the Delphi and the Strabo Techniques, are characterised by the importance of feedback to the process. Participants in the decision-making process are expected to formulate ideas and opinions, and after comparing their ideas with those of the rest of the group, re-evaluate and reformulate their ideas and opinions. In this manner, it is believed possible to derive a better consensus of opinion and to make a decision more closely reflecting a group "average" with an indication of the variation of opinions.

As a forecasting and planning strategy, Strabo has a wide range of potential applications for situations with spatial components. Geologists, for example, might employ the strategy in making decisions concerning exploration for natural resources. An early attempt by Harris et al. to employ a similar process to the problem of evaluating mineral potential relied upon the spatial mapping of subjective probabilities provided by a group of expert geologists. Climatologists and meteorologists might use the strategy to forecast or predict long or short term changes in weather patterns and systems. Many other applications of the strategy can be foreseen, but, presently, the one showing the most utility and potential is in the field of urban planning. Strabo can be used to identify spatial patterns of highly subjective urban-social phenomena such as social class or neighbourhood livability. It can be used to plan facilities for existing urban social-spatial patterns, or to predict future planning requirements resulting from forecasted changes in social indicators or from forecasted changes in the urban social-spatial patterns.

In order to facilitate the collection and recording of the large amounts of mapped data from each of the individual experts in the group and to prepare a prompt summary analysis of this data, the use of a computer, together with its graphic display capabilities, becomes a necessity. Preferably, the entire Strabo process, including iterations, can be completed at a single session with the expert panel. By providing immediate feedback to the panelists and completing successive iterations at a single convening of the panel maintains the panelists' interest and keeps the problem before them "fresh" in mind.

The computer can assume two very important roles in the Strabo decision-making process. First, with the aid of a digitizer or a scan line converter, the maps produced by the panelists can be rapidly encoded and stored, and, in a sense, the computer can keep a record of all individual and/or group decisions. Secondly, the computer can be used to summarise all the individual maps (or decisions) and derive an "average", or composite map which, by means of appropriate graphic display hardware, can be fed back to the panelists within minutes for successive Strabo iterations.

Although preliminary discussions of the Strabo technique indicate that the strategy may have considerable worth in the field of urban planning, it remains to develop a more comprehensive conceptual framework within which to place the technique. To be a truly practical tool, it must have a sound theoretical basis. Such questions as "Who is an expert?" and "How are within-group clusterings of opinions to be interpreted and analysed?" remain to be investigated.

It is proposed that research be undertaken to answer these underlying concerns of the Strabo Technique and to establish the necessary theorectical foundation for the method. It will be necessary to refine and extend existing computer software to encode, store, and summarise the spatial patterns identified by the expert panelists. The computer-assisted planning and forecasting strategy should be developed so that it is "portable" and can be successfully implemented and completed within one session with the expert panel. The second criteria is not crucial in situations where the panel cannot be convened; however, it is desirable to have all the experts convened at once so that the delay between the initial responses of the panelists and the feedback and then successive iterations is minimal.

To develop the strategy so that it may be applicable to an urban planning environment it is suggested that the methodology be applied and tested on several urban areas of different scales and complexities, for example, a neighbourhood, a small community, and a metropolitan area. A panel of experts would be selected from each of the urban areas and convened at a location with access to computer facilities. They would be individually required to provide spatial information about social and/or economic indicators which would be then input to the computer. Programmes, using a technique of polygon overlays, would produce a composite map indicating areas of agreement and areas of disagreement, or areas of high identification errors. After examining and discussing the composite maps, the panelists would be asked to re-evaluate their decisions of the previous round. Following several successive iterations of this general procedure, a convergence of opinion in a spatial dimension could be analysed.

An application of the Technique to urban areas of different sizes and complexities would demonstrate its general utility as a planning tool. It is not intended that the Strabo method be used in isolation of other planning strategies, but that it be used to complement existing techniques. It can be used when it is necessary to measure or identify highly subjective social indicators that cannot be sufficiently measured by the more conventional methods.

Part 1: CONCEPTS AND PROGRAMMES

1.1 The Conventional Delphi Method (N. Edelson)

The Strabo Technique is a spatial application of a decision-making process called Policy Delphi. Policy Delphi is the result of a set of modifications that have been made on what has been termed the "Conventional Delphi Method". In this section, the paper will discuss some of the main aspects of Conventional Delphi and review part of the history of its development. Subsection 1.1.3 will evaluate some of the criticisms that have been levelled against Conventional Delphi. This will provide a context for understanding Section 1.2 which describes the evolution of Policy Delphi and the way in which the Strabo Technique can function as a spatial component of it.

1.1.1 History of Conventional Delphi

Conventional Delphi was originally developed in the late 1940s by the RAND Corporation as part of a series of classified studies for the American government. Although a few preliminary papers were published describing certain aspects of the Delphi methodology, it was not until the early 1960s that the technique was explicitly discussed in the RAND papers and academic journals. The first was "An Experimental Application of the Delphi Method to the Use of Experts" by Dalkey and Helmer. In 1964, "Report on a Long Range Forecasting Study" by O. Helmer and T. J. Gordon appeared in the RAND paper series. This study generated a great deal of interest and the results were described by Daniel Bell the following year in the more widely read journal named PUBLIC INTEREST (Bell, 1965).

With this increased publicity, three phenomena occurred. First, Conventional Delphi was applied to a wide variety of subjects. These concerned long term predictions by groups of experts in such areas as population growth, scientific breakthroughs, the impact of automation, space exploration, as well as weaponry and war. Secondly, Delphi was extended from a forecasting device to a general method for opinion assimilation and evaluation (see Pill, 1971). Thirdly, a variety of experiments were carried out to test both the accuracy of predictions made as well as the validity and efficiency of consensuses reached by the Delphi Method in comparison to other group decision-making techniques (Dalkey, 1972).

1.1.2 Objectives and Assumptions

Delphi has been characterised as "a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem" (Linstone and Turoff, 1975, p. 3). In its most general sense, Delphi is a set of techniques designed to help in the formulation and assessment of decisions and objectives through an iterative process of information feedback. Most of the early applications of the technique were concerned with improving the accuracy of predictions. The method was designed to help overcome some of the shortcomings inherent in face-to-face committee interaction. These shortcomings include:

1. interpersonal conflicts among committee members;
2. social, emotional, and authority relations among the participants;
3. dominance of certain individuals within the group;
4. lack of creativity by certain individuals in group situations;
5. inadequate consideration of certain alternatives as a result of group discussion dynamics;

6. expenses associated with the length of meetings and the transport of geographically dispersed participants;
7. low feelings of accomplishment;
8. lack of commitment by individuals to the implementation of group decisions (Jung, 1976, p. 1-3).

These kinds of problems tend to reduce rather than enhance the performance of experts in evaluating evidence and coming to policy decisions. Of particular importance are problems associated with the unwillingness of subordinates to risk opinions that might conflict with people having authority over them. One consequence of this and several of the other factors listed above is that the dynamics of group discussion may preclude the serious consideration of acceptable alternatives. In addition, under traditional committee procedures, it is often the case that only the views of the majority and of persistent minorities tend to be recorded. Thus many potentially innovative ideas do not appear in the final reports of committees either because they are not raised or because if raised, they do not represent the view of the majority. A net result of these shortcomings of traditional committee procedures can be a lack of commitment on the part of participants to help support the implementation of agreements reached.

The original applications of the Delphi Method incorporated three invariant elements in attempting to overcome these problems: 1. anonymity of the participants; 2. controlled feedback of responses; 3. statistical group responses (Dalkey, 1972, pp. 20-21). These elements constitute the core of what is now termed "Conventional Delphi". This method follows a series of steps that proceed as follows:

1. test persons are given a set of questions which they have to answer with quantitative estimates of some sort (e.g. the year some event will occur, the level an item will reach, etc.);
2. responses are tallied after being weighted by the amount of confidence the respondent has in his or her answer; a set of descriptive statistics are then determined to summarise their answers;
3. the results are then returned to the test persons along with an indication of where each person stands relative to the group as a whole;
4. the respondents are then asked to re-evaluate their opinions and submit new responses starting the process again.

This process may be repeated any number of times, but is generally not repeated more than two or three. More repetitions are time consuming and tend to promote a false type of consensus among the participants. This will be discussed further in Section 1.1.3 as one of the criticisms of Delphi.

Conventional Delphi is intended to be used by groups of experts or persons with authority to make decisions in specific areas. The technique assumes that all participants have roughly equal knowledge of the matter at hand. Three further assumptions are of importance for statistical reasons:

1. because the participants are similarly knowledgeable, median opinion is more likely to be 'correct' than that of any particular member;
2. if a group of persons expresses value judgements that are divergent, median opinion is most likely to express the correct answer;
3. in general, the larger the group, the more accurate the answer and the greater its reliability.

This does not mean that consensus is the only result recorded by the method. Though their individual identities remain guarded to insure the free exchange of ideas, the opinions of all participants are indicated both in the iterative feedback of information to group participants and in the final report of the committee to those with ultimate authority for decision-making. These divergent opinions are presented along with statistical measures of disagreement within the group. Also included are the degrees of confidence individual members have in their ability to evaluate specific questions. If there are serious disagreements among the participants, these are polarized and explicitly noted. This recording procedure is quite different from traditional committee reports which tend to discard opinions over which there is not a consensus. In this way, decision makers have access to a fuller range of proposals, and minority factions need not feel obliged to abandon their principles in false compromises.

1.1.3 Criticisms and Evolution of Delphi

As a result of the many experiments involving Conventional Delphi, a number of important criticisms have been levelled at the technique. These have led to several important modifications, one of which has been the development of Policy Delphi.

The discussion of the criticisms will focus on questions concerning the validity of Delphi generated consensuses and some of the disadvantages inherent in keeping the opinions of group participants anonymous. This will enable us to better understand Section 1.2 which traces the development of Policy Delphi. One of the strongest criticisms of Conventional Delphi is contained in "DELPHI ASSESSMENT: EXPERT OPINION, FORECASTING, AND GROUP PROCESSES" by H. Sackman (1974). This paper concludes that Conventional Delphi should be dropped "until its principles, methods, and fundamental applications can be experimentally established as scientifically tenable". Since the assessment was published by RAND, the same corporation which was instrumental in developing the technique, it is worthy of some consideration. Sackman raises sixteen basic points of criticism which emerge from an evaluation of the method. This evaluation is based on the American Psychological Association's "Standards for Educational and Psychological Tests and Manuals". These standards relate to sampling, controls, reliability of measures and criteria validity. From his analysis Sackman warns that Conventional Delphi

> "...items are typically broad, amorphous classes of events, not precisely defined empirical occurrences. Delphi forecasts are opinions about such broad classes of events, not systematic documented opinions about such broad classes of events, not systematic documented predictions of such events. These opinions are typically snap judgements frequently based on free association stereotypes. Consensus for such opinion tends to be manipulated consensus to minimize dispersion of opinion. Further, the universe from which items are sampled is typically disregarded and unknown as are the identity and qualification of the expert panelists." (Sackman, 1974, p. 58)

Sackman's criticisms are focused on the reliability of Delphi as a predictive device and several weaknesses inherent in a method which does not allow direct interaction among participants. These weaknesses are interrelated and include the following:

1. Participants may interpret questions differently. The existence of differences in interpretation can often be revealed only through direct discussion and argumentation.
2. Experts may have very different theories with which they are evaluating a particular set of events. They may be basing their estimates on very different assumptions concerning the current situation or the likely future status of key intervening variables. Unless these differences are specified, an averaging of responses may prove to be extremely misleading.
3. Although anonymity of participants was designed to minimise the "bandwagon effect" and authority relations which often appear in regular committee discussions, it does not eliminate them entirely.

The first of these three criticisms can be reduced by individual interviews with each of the Delphi respondents. The second is perhaps the most difficult to overcome. For complicated problems it clearly requires extensive discussion among the various participants in the decision-making process.

The third criticism has been subjected to scientific inquiry. Many psychological tests show that there are tendencies for the opinions of individuals of a group to converge, at least temporarily. This is often true regardless of the techniques used to maintain the "integrity" of the opinions of its members. In 1936, M. Sherif discovered that he could alter the estimates of 'experts' concerning the current size of the Communist Party of the United States of America by approximately ten times by altering the presentation of data concerning its previous size. Other experiments have established the existence of what is termed the "autokinetic effect". For instance, it has been demonstrated that a group of people gathered in a dark room will reach a consensus concerning the 'movement' of an objectively stationary light bulb.

Sackman points out that these experiments are quite relevant to the Delphi Method. If group members have different interpretations of the meaning of a question, or if they believe in fundamentally different theoretical frameworks, then their responses in the first Delphi round will be quite different. Presentation of the average of these disparate estimates can provide a misleading central tendency toward which the participants will "gravitate" in subsequent rounds. Thus, under many circumstances, the advantages of anonymity which were cited above can be outweighed by these kinds of considerations. Conventional Delphi can lead to a temporary and therefore misleading level of agreement among the participants. This apparent consensus is not necessarily authentic. According to Sackman,

> "(a)uthentic consensus refers to group agreement reached as a result of mutual education through increased information and adversary process, which leads to improved understanding and insight into the issues; it does not refer to changes of opinion associated primarily or exclusively with bandwagon statistical feedback" (Sackman, 1974, p. 45).

In effect it can be argued that Delphi is only a tool. Delphi cannot create genuine consensus when the basis of such consensus does not exist as part of the objective interests of those involved in the decision-making process.

It is important to note that despite his severe criticisms of Conventional Delphi, Sackman does not dismiss the validity of the iterative feedback technique as such. He argues that it can be used as a heuristic exercise to help working committees come to a better understanding of the areas in which they agree and disagree.

> "As a heuristic exercise, it would be highly advisable to mix iterative polling with varying forms of quantitative and qualitative feedback, personal confrontation where feasible, cultivated development of adversary positions as opposed to consensus, and controlled variations in the types and level of anonymity." (Sackman, 1974, p. 71)

This kind of process was developed by F. A. Heller (1969) under the title "Group Feedback Analysis". Heller's method involves three steps:

1. completion of individual research implements (questionnaires or interviews);
2. a feedback of some of the results from the individual implements;
3. discussion of the results based on feedback.

Although this ultimately removes the anonymity associated with Conventional Delphi, it still enables all individuals to express their opinions independently at the outset and to receive at least one round of feedback in the form of a statistical analysis of the questionnaires. No one need express his or her view publicly until after the process reaches the face-to-face phase.

1.2 Policy Delphi (N. Edelson)

Turoff (1970) devised a method, similar to Heller's "Group Feedback Analysis", which he calls "Policy Delphi". This decision-making procedure can differ from Conventional Delphi in three important ways. First, whereas Conventional Delphi was designed to gain consensus concerning the likelihood of future events, Policy Delphi is used in areas of political consequence which are less susceptible to precise analytic evaluation. Secondly, whereas Conventional Delphi is generally used to gather the opinions of experts, Policy Delphi can incorporate in the decision-making process the views of ordinary citizens as well as experts. Thirdly, whereas Conventional Delphi stresses the importance of maintaining the anonymity of participants, Policy Delphi can be used as part of an overall planning process which includes general committee work, theoretical and empirical analysis, and face-to-face communication.

According to Turoff, Policy Delphi combines important aspects of Conventional Delphi and face-to-face communication:

> "(It) can be given to anywhere from ten to fifty people as a precursor to a committee activity. ...(It is) an organized method for allowing the respondents representing such views and information the opportunity to react to and assess differing view points. Because the respondents are (initially) anonymous, fears of potential repercussions and embarrassment are removed and no single individual need commit himself publicly until after the alternatives have been put on the table" (Linstone and Turoff, 1975, p. 86).

Thus, this method has several important advantages. It can help to ensure that all possible options have been "put on the table" for consideration. It can be used to estimate the impact and consequences of any particular policy option. Finally, it can aid in the examination and estimation of the public acceptability of any particular option. With such great flexibility, Policy Delphi is suited for dealing with a large number of different types of problems. Linstone and Turoff report on several of the ways in which it has been applied:

1. exploring urban and regional planning options;
2. evaluating possible budget allocations;
3. exposing priorities of personal values, social goals;
4. examining the significance of historical events;
5. planning university campus and curriculum options;
6. putting together the structure of a model;
7. delineating the pros and cons associated with potential policy options;
8. developing causal relationships in complex economic or social phenomena;
9. distinguishing and clarifying real and perceived human motivation;
10. gathering current and historical data not accurately known or available (Linstone and Turoff, 1975, p. 4).

1.3 The Strabo Technique (N. Edelson, F. Fisher, and J. Little)

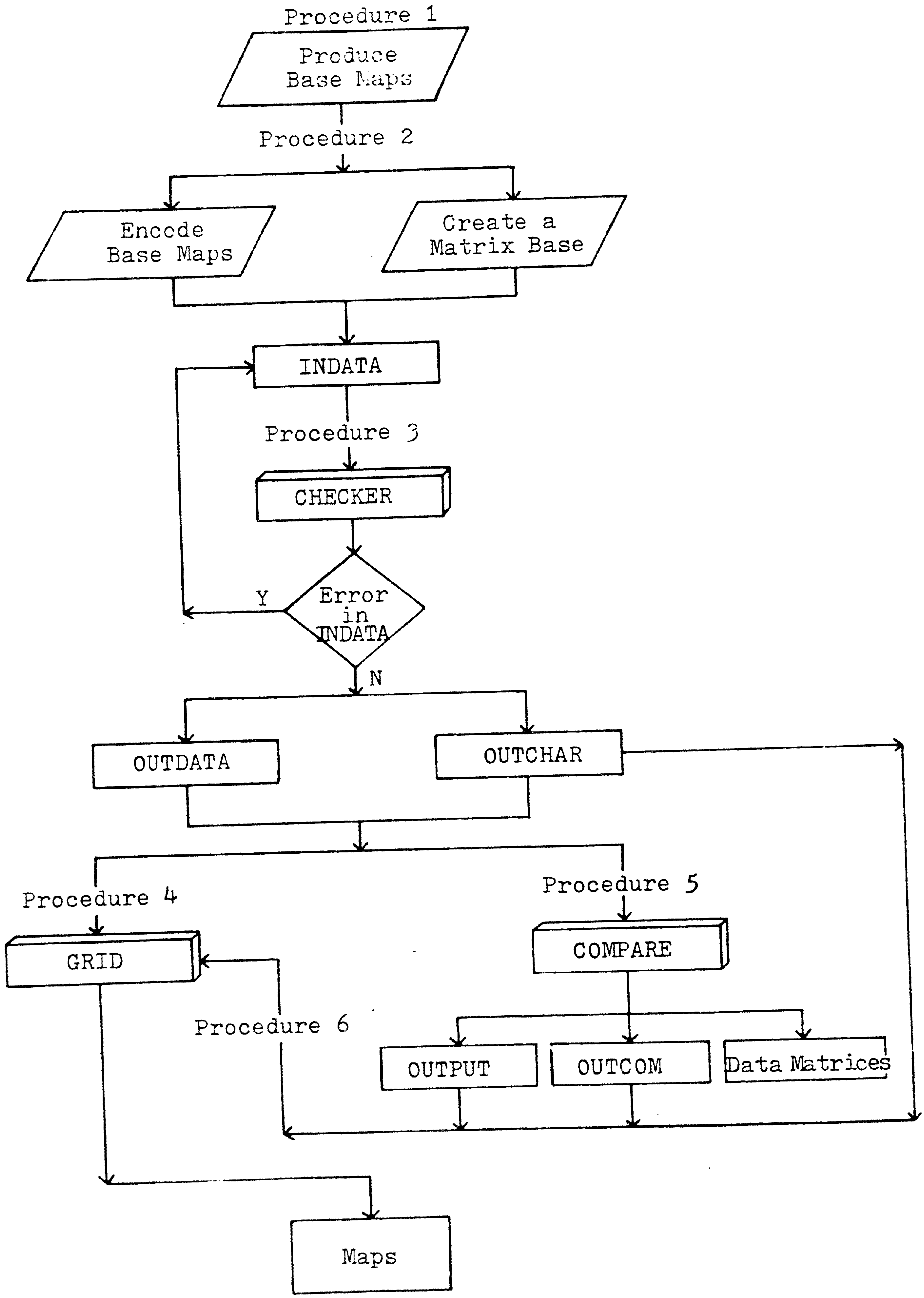
The purpose of this section is to illustrate the use of the Strabo Technique. The Strabo Technique employs a set of computer programmes to produce a series of maps and matrices which help in the analysis of the responses of a group of individuals to questions concerning spatial attributes of an area. The technique can be used, for example, in conjunction with Policy Delphi as a key component of the Strabo Planning Method (footnote 1). It can also be used with other forms of Conventional Delphi, or even in situations not having an iterative feedback procedure, as a general citizen-polling or information-gathering device.

The only necessary condition for the use of the technique is that each participant complete at least one of the two types of maps. The first type is an Attribute Map describing some social indicator, characteristic, or planning policy for past, current or future status of portions of the study area. The second type is a Confidence Map describing the ability of each participant to answer the Attribute question. Information from these maps is transformed into matrices which are subsequently manipulated by the Strabo Technique's programmes. Later they are retranslated into maps reflecting the composite responses of the group of participants. For illustrative purposes, consider the following fictitious example. In this example, the Attribute Maps identify portions of a neighbourhood called Grandview which four local area planning committee members feel should be (1) single family, (2) multiple family dwelling, or (3) non-residential. The Confidence Maps indicate the general familiarity that each member has with portions of the neighbourhood: (1) familiar or (2) not familiar.

The description of the operation of Strabo is divided into a set of 6 procedures (see Figure 1):

1. Participants draw Attribute and Confidence maps;
2. Attribute and Confidence maps are encoded into a grid format;
3. Encoded maps are submitted to the Checker programme where they are checked for logical inconsistencies and transformed into a data matrix (OUTDATA);
4. The matrix from CHECKER (OUTDATA) is used by the GRID programme to reproduce maps to make sure that the matrix corresponds with the original Attribute and Confidence Maps;
5. The Matrix from CHECKER (OUTDATA) is transformed by the COMPARE programme into a set of data map matrices (OUTPUT) and a set of matrices comparing the amount of agreement among pairs of participants;
6. The data map matrix from COMPARE (OUTPUT)is transformed into a set of maps by GRID.

Figure 1: A Flow Chart of the Strabo Data Handling Procedures



Procedure 1:

The purpose of this procedure is to have the Strabo participants fill out appropriate Attribute and Confidence information in pencil on base maps. The base map used for the questionnaire should be drawn so that identification features such as streets, street intersections, rivers, and other obvious boundaries correspond as closely as possible to grid cell boundaries.

Attribute Maps can include a wide variety of phenomena describing, for example, aspects of variations in the quality of life throughout different portions of a neighbourhood, or, for another, spatial variations of the probabilities of locating natural resources. To take the neighbourhood example into more detail, they can describe general characterisitics such as blight areas, areas of air pollution, rich areas, family areas, among others. Attribute Maps can also measure policy preferences--areas which should be zoned for high rise dwellings, areas which should receive neighbourhood improvement grants, among others. Obviously the list of attribute maps is limitless.

The most important consideration is that all individuals participating in the exercise have a common understanding of the meaning of the questions. It is best if the questions arise as a result of the need of a committee to solve fairly specific problems of information gathering or policy resolution. If this need is part of an ongoing planning or forecasting process, the questions will be more clearly defined and clearly understood. In addition, the respondents will be more likely to answer the questions patiently and as accurately as possible.

The Confidence Maps can be used in two ways. Their primary function is to serve as sets of weights for the Attribute Maps. They also reveal important information about variations in the degree to which participants in the planning process are familiar with different portions of the study area as well as the amount of confidence they have for dealing with specific policy or forecasting questions.

There are three kinds of input data that can be used for the Confidence Maps. One is the result of asking all participants to identify the portions of the study area with which they feel generally familiar. A second comes from asking them to weight their own confidence in their responses to specific Attribute questions. A third kind of Confidence Map input data can be derived by testing the level of knowledge participants have about either policy questions or about portions of the study area.

Procedure 2:

The objective of this procedure is to transform the information on the data maps into a data matrix (INDATA). This is begun by dividing the study area into a grid of equal sized cells. The grid format allows comparison and measurement of the original data maps. It is recommended that each cell be 1/8" by 1/10" wide to correspond with the type face of the GRID programme map output which will be discussed in Procedure 4.

Each cell in the grid system corresponding to the Attribute Map must be identified with the appropriate value indicating, for example, (1) single family, (2) multiple family, or (3) non-housing. Each cell in the grid system corresponding to the Confidence Map must be identified with the appropriate value indicating degrees of familiarity: (1) 'familiar', (2) 'somewhat familiar', or (3) 'not familiar'.

In the future it should be possible to transform the original data maps into the grid format very rapidly with the use of a programme such as SYMAP (LCG, 1976). The boundaries drawn on the data maps will simply be traced with a light pen on a cathode ray tube or with a digitizer. This data will automatically be translated into polygons and then into data matrices. These polygon data, collected as polygons, can be transformed into a grid using SYMAP.

Where the technology is unavailable or the maps are simple, the procedure outlined below can be used, and was used for our research. This procedure requires an interactive editor and a cartographic light table. The method of transcribing the data from the penciled maps into a form for input to CHECKER is a type of 'run-length encoding' (Newman and Sproull, 1973). Each row of cells in the base map corresponds to a row in the matrix (INDATA).

Step 1: Tape a piece of paper containing the appropriate grid system on a light table. Tape the data map on the top of it. Identify the coordinates (row, column) of all the intersections of polygons. This should be done in pencil directly on the original data map. Any cell which contains more than one value must be assigned the value which occupies most of its area (see Figure 2).

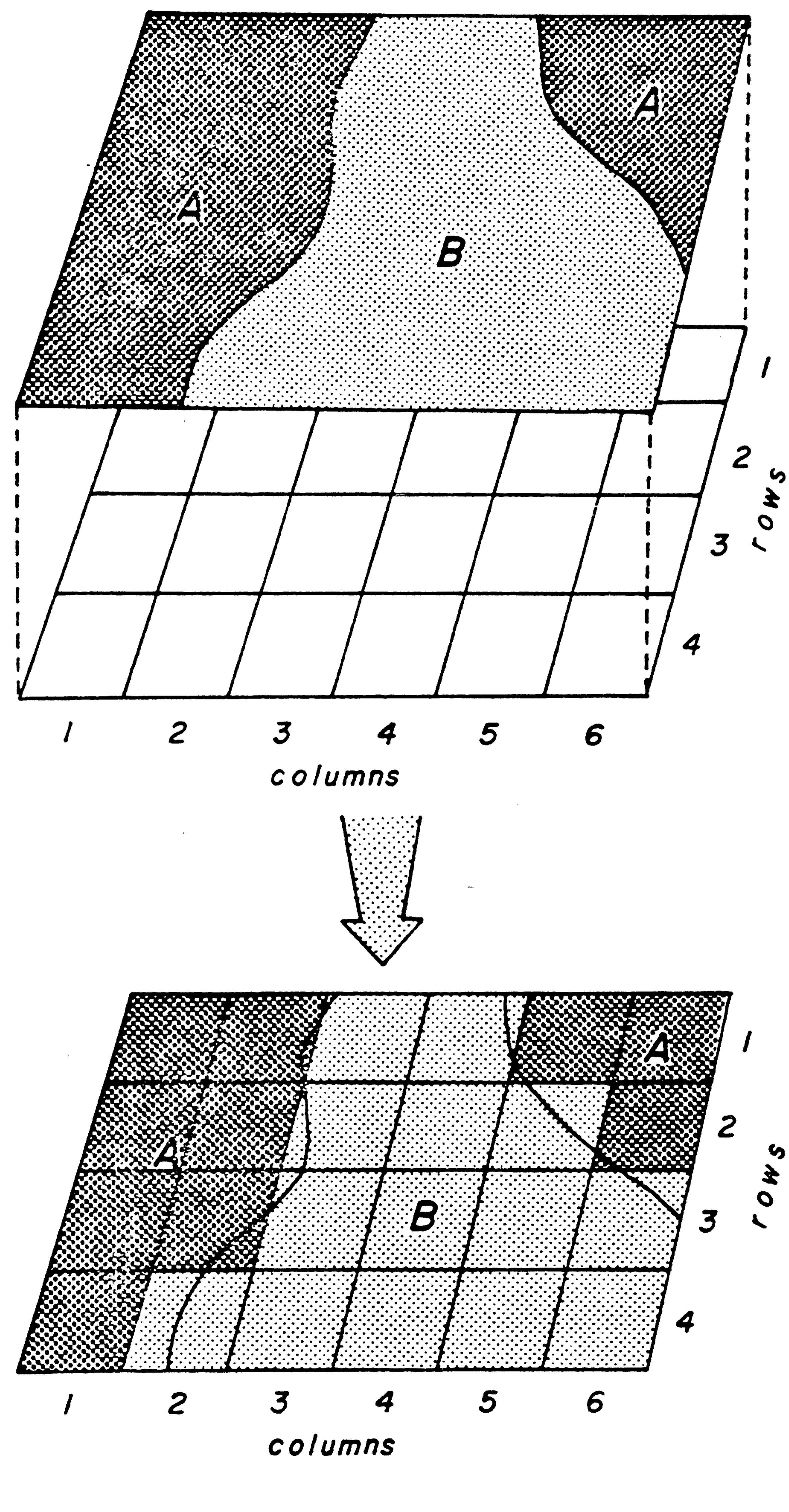
Step 2: For CHECKER, each row must also have four pieces of information: N, M, R, Row

where:

N = the number of the individual participant who completed the map;

M = a number representing the type of the map, e.g. 1 may represent a map of Attribute I, 2 may represent a map of Attribute II, 3 may represent a Confidence map, and so on;

Figure 2: Approximating Polygons by Grid Cells



R = the round number (i.e. the number of times that the participant has drawn map M in the iterative feedback process;

Row = the number of the row.

Create a data matrix base containing one row for each row on the map's grid system. Label columns one through six with the string 'N M R'. Number columns seven through ten with the appropriate row numbers:

N M R 001

N M R 002

...

N M R n

Store this matrix base.

Step 3: For each map, transform the matrix base into the particular map matrix form by replacing 'N M R' with the appropriate string.

Step 4: Identify the data values in each row. Reading from left to right across each row, record those cells, as they are encountered, that represent the right boundaries of the regions. The value of the region is recorded with the cell column number. Thus the string, '1 17 2 40' signifies that the first seventeen cells have value one, and cells eighteen through forty have value two. Likewise, '1 40' signifies a row forty cells long, all the cells of which have the value one. It is important to note that the information can fill several lines following each other. Thus, each row record must be terminated by '-99'. This can be best understood through the coding produced for the following example map which contains 60 rows and 40 columns (Figure 3). The coding of the Confidence Map indicating familiarity for respondent number one was accomplished by:

Changing columns 15-18 to the string '1 40' in row 1.
Changing columns 15-29 to the string '2 9 1 17 2 40' in rows 2 through 16.
Changing columns 15-24 to the string '1 17 2 40' in rows 17 through 30.
Changing columns 15-30 to the string '2 14 1 17 2 40' in rows 31 through 60.

This resulted in the following for Respondent 1, Map 2, Round 1:

```
1 2 1 001     1 40                        -99
1 2 1 002     2 9  1  17  2 40            -99
    ...
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Figure 3: A Map to Illustrate the Digitization Procedure

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*---------------------------------------------*
I 1111111111111111111111111111111111111111111 I
I 2222222221111111122222222222222222222222222 I
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*---------------------------------------------*
```

1 2 1 016	2 9	1 17	2 40	-99
1 2 1 017	1 17	2 40		-99
...				
1 2 1 030	1 17	2 40		-99
1 2 1 031	3 14	1 17	3 40	-99
...				
1 2 1 059	3 14	1 17	3 40	-99
1 2 1 060	3 14	1 17	3 40	-99

Step 5: Repeat steps 3 and 4 for each map.

Step 6: After all the map's matrices have been completed, store them together in a file (INDATA) on card format. The order in which the maps go into INDATA can be arbitrary.

Procedure 3:

The objective of procedure three is to transform INDATA into a matrix called OUTDATA. OUTDATA is the input matrix for the COMPARE programme which is used in Procedure 5. This objective is accomplished with the use of the CHECKER programme. CHECKER performs some tests of consistency in the data as well as writing OUTDATA, which is less expensive to use than INDATA.

Inputs to CHECKER:

1. INDATA file on card format
2. Control Variables:
   a. NROWS = number of rows per map;
   b. NCOLS = number of columns per map;
   c. NRES = number of respondents;
   d. SLOT1, ..., SLOT5 = identifies the order, by type of map (M), in which the input data are to be stored in OUTDATA;
   e. UPDATE = "'0'B" if OUTDATA is being created as a new file; "'1'B" if OUTDATA is already created and is being either completed or revised;

Outputs from CHECKER:

1. OUTDATA = transformation of INDATA data file;
2. OUTCHAR = file containing the description of OUTDATA.

The programme CHECKER creates the data file OUTDATA in an iterative fashion. If CHECKER encounters a mistake in INDATA, it saves the portion of OUTDATA that has been created and records a message indicating the error it has encountered. For example, Figure 4 indicates that CHECKER terminated at row 15 because the column width of a region was larger than NCOLS, the column width of the entire study area. This error must be corrected by changing the column width of the region in row 15 to 7, its appropriate size. It is then necessary to delete lines 1 through 15 in INDATA and to change the control variable UPDATE from '0' to '1'. The control statements for the file handling may also have to be altered to indicate that OUTDATA and OUTCHAR have already been created. After these changes are made, CHECKER can be rerun. This process continues until all of INDATA has been transformed into OUTDATA. Figure 5 shows the message indicating OUTDATA has been successfully completed.

Figure 4: An Example of an Error Message

```
NROWS=      60      NCOLS=      40      NRES=      4      SLOT1=      1
SLOT2=       2      SLOT3=       0      SLOT4=     0      SLOT5=      0
UPDATE=  '0'B;
NO EXCEEDS NCOLS       57 RESPONDENTS       1 MAP      1 ROW      15
     60      40       4       1       2       0       0       0
      7       3  -32000  -32000  -32000
PROGRAM FINISHED
```

Figure 5: An Example of a Message Indicating the Successful Completion of a Run

```
NROWS=      60      NCOLS=      40      NRES=      4      SLOT1=      1
SLOT2=       2      SLOT3=       0      SLOT4=     0      SLOT5=      0
UPDATE=  '1'B;
     60      40       4       1       2       0       0       0
      3       3  -32000  -32000  -32000
PROGRAM FINISHED
```

Procedure 4:

The objective of procedure four is to check OUTDATA to make sure that it accurately reflects the information on the original data maps. This is accomplished with the use of the GRID programme. GRID has been adopted from the GRID Programme developed by the Laboratory for Computer Graphics at Harvard University (see Goodrich, 1972).

Inputs to GRID:

The following is a brief synopsis of GRID commands. For variations of map formats, consult the GRID Manual (Goodrich, 1972).

1. Input files
   a. OUTDATA
   b. OUTCHAR

2. Control Variables
   a. MAP
   b. TITLE (must include three lines for title of map being produced)
   c. Elective Control Variables:

columns 4-5 elective #	6-10 blank	11-20 field I	21-30 field II	31-40 field III	41-50 field IV
1		NROWS	NCOLS	GSD	GSA
2		1	1		
3		NLEV			
4		MIN			
5		MAX			
7					
SYMBOLS			L G B		
OVERPRINTS (3 cards)					

Where:

Elective 1 specifies the parameters for the rectangular grid that is to be mapped
Elective 2 controls the input options for the data
Elective 3 specifies the number of levels into which the total value range is to be divided
Elective 4 specifies the minimum value of the value range
Elective 5 specifies the maximum value of the value range
Elective 7 specifies the grey scale symbolism that will be printed on the map. This elective must be included on the first map of any submission. All five cards (the elective card, the SYMBOLS card, and the three OVERPRINT cards) must be included each time it is used

NROWS = number of rows per map
NCOLS = number of columns per map
GSD = grid cell size down (suggest 1.0)
GSA = grid cell size across (suggest 1.0)
NLEV = number of levels of the value to be printed on the map (up to a maximum of ten levels)
MIN = minimum value
MAX = maximum value
SYMBOLS = one symbol to represent each of the levels of the value being printed on the map; these are placed in columns 1 through 10 (i.e. level one's symbol is in column 1, level two's symbol is in column 2, and so on.)
L = symbol for cells that are less than the minimum level (col. 21)
G = symbol for cells that are greater than the maximum level (col. 23)
B = symbol for background cells (col. 25); this should be ' ' (blank)

OVERPRINT = there can be up to 3 overprints per level; each overprint is placed on a separate card in the column associated with that level's symbol

d. 99999

e. 'a' through 'd' can be repeated as many times as there are maps to be printed. Once an elective has been specified, it will be carried onto successive maps until it is changed.

f. END

3. The following card is input to ROWIN, which is a GRID subroutine on Unit 13:

INPU in columns 1 - 5
This indicates that the input data matrix is being checked.

MXX in columns 8 - 10
M = the SLOT number of the data set to be mapped
XX = the number of the case (e.g. respondent)
Include an INPU card for each map desired.

4. Since these maps are simply reproductions of the original input data, the following control electives should be set accordingly:

Elective 3: set NLEV = the number of possible levels (e.g. in our example, it would equal 3 for the Attribute map and 3 for the Confidence map);

Elective 4: set MIN equal to the minimum value of the data;

Elective 5: set MAX equal to the maximum value of the data;

Elective 7: on the SYMBOLS card, use the numbers representing the input levels as their respective symbols (e.g. single family dwellings = "1", multiple family dwellings = "2", and so on. Set L = "L", G = "M", and B = " ". The three overprint cards should be left blank.

GRID will produce a map corresponding to each of the original input data maps. If there are any mistakes, these must be corrected by revising INDATA and updating OUTDATA through the CHECKER programme.

Procedure 5:

The objective of this procedure is to perform a series of computations on the OUTDATA matrix to analyse various factors indicating the amount of agreement and disagreement contained within the maps produced by the Strabo participants.
This is accomplished through the use of the COMPARE programme.

Inputs to COMPARE:

1. Input files:
   a. OUTDATA file from CHECKER
   b. OUTCHAR file from CHECKER
2. Control Variables:
   a. AA = high agreement threshold (e.g. 80% of NRES)
   b. A = low agreement threshold (e.g. 50% of NRES)
   c. D = high disagreement threshold (e.g. 25% of NRES)
   d. MAP1 = the SLOT number of the Attribute Map
   e. MAP2 = the SLOT number of the Confidence Map
   f. COMPA = '1' to calculate an AGREEMENT/DISAGREEMENT Map
   g. COMPW = '1' to calculate a composite Confidence Map
   h. SCATTER = '1' to calculate a SCATTER Map
   i. MATRIX1 = '1' to calculate a disagreement matrix for the Attribute data
   j. MATRIX2 = '1' to calculate a disagreement matrix for the Confidence data
   k. MATRIX3 = '1' to calculate a disagreement matrix for the Attribute data filtered by the Confidence data

Output from COMPARE:

1. Data Files:

   a. OUTPUT
   b. OUTCOM

2. Data Matrices:

   a. MATRIX1: This is an NRES by NRES matrix indicating the number of cells over which each person disagreed with all the other persons concerning the Attribute Data Map. From the example, Table 1 indicates that person 1 and person 2 disagreed over 334 of a possible 2400 (60 * 40) cells. Persons 2 and 3 disagreed over 514 or 21.4% of the cells. There are three ways in which a great deal of flexibility can be added to MATRIX1. These are discussed in Appendix 1.

   b. MATRIX2: This is an NRES by NRES matrix indicating the number of cells in which each person had a different level of Confidence than each of the other participants. In the example in Table 2 we see that persons 1 and 2 were familiar with similar parts of the study area. They had different levels of familiarity in only 200 of the cells. Person 4 had sharply different levels of familiarity with all three of the other respondents. These disagreements can only be fully understood when they are examined in conjunction with the composite Confidence Maps that will be produced in the next procedure. At this point, it is worth noting that MATRIX2 can be manipulated in the same three ways as MATRIX1. See Appendix 1.

c. MATRIX3: This is also an NRES by NRES matrix. It indicates the number of times participants disagreed over categories in the Attribute Matrix. However, here their disagreement is 'filtered' by the Confidence Matrix. For example, this filtering can be used to eliminate disagreements over cells in which either person being compared states that he is unfamiliar with the cell in question. In a sense, the filtered disagreement matrix measures the amount of 'serious' disagreement among participants (Table 3).

TABLE 1

ATTRIBUTE DISAGREEMENT MATRIX
BY NUMBER OF CELLS

0	334	454	431
334	0	514	403
454	514	0	367
431	403	367	0

TABLE 2

CONFIDENCE DISAGREEMENT MATRIX
BY NUMBER OF CELLS

0	200	813	1057
200	0	811	1073
813	811	0	1105
1057	1073	1106	0

TABLE 3

FILTERED ATTRIBUTE MATRIX
BY NUMBER OF CELLS

0	0	42	82
0	0	42	82
42	42	0	30
82	82	30	0

It is impossible to understand fully the nature of disagreements among members of planning or forecasting committees without examining the set of maps which expresses various aspects of the view of the committee as a whole. These maps are discussed in Procedure 6.

Procedure 6:

The objective of this procedure is to translate the output files of COMPARE into maps showing various aspects of the composite views of the participants. This is accomplished by using the GRID programme discussed in procedure 4.

Inputs to GRID:

1. Input files from COMPARE:
   a. OUTPUT
   b. OUTCOM
2. Input file from CHECKER
   a. OUTCHAR
3. Control Variables are basically the same as discussed in procedure 4. Differences will be specified in the next section discussing Outputs from GRID.

Outputs from GRID:

These output maps are all optional; the label identifying each option occupies the same place as 'INPU' in procedure 4. Examples of these output maps appear in Section 2.1.2.

a. MAPV: produces a composite map for a given variable (e.g. the number of people who identified each cell as single family housing). 'XX' in columns 9-10 identifies the variable to be mapped (e.g. 01 for single family housing, 02 for multiple family housing, and so on).

b. MAPF: produces a composite map similar to MAPV, but filters the given variable of an attribute according to the Confidence Maps. This is done by counting only the responses of those who were familiar with each cell.

c. FILT: produces a filtered Attribute map for respondent 'XX'. The respondent number, 'XX', is indicated in columns 9-10.

d. FAMV: produces a composite map for a given level of Confidence. The Confidence level 'XX' is indicated in columns 9-10 (e.g. 01 for familiar, 02 for somewhat familiar, and so on).

e. AGRV: produces an Attribute Map of cells for which there was agreement in classification amongst at least 'A' respondents. It is suggested that the the symbol for each level (elective 7) reflects the corresponding variable of the attribute. For example, those cells for which at least 'A' respondents felt should be category 1 are identified as "1"; those where at least 'A' respondents indicated category 2 are identified as "2"; and so on. If 'AA' or more respondents (e.g. 80%) agree upon a certain classification, the cell can be doubly shaded with the appropriate symbol. Those cells not obtaining a concensus, i.e. agreement in classification from at least 'A' respondents, are represented by the symbol "D". If a high disagreement threshold is reached for a given cell, it is represented by a doubly shaded "D".

The number of levels (NLEV of option 3) is twice the number of categories, or variables, plus 2. MIN of option 4 is 1 and MAX of option 5 is equal to NLEV.

f. AGRF: produces an agreement map similar to AGRV; however, in this case the responses are filtered by the Confidence Maps.

g. AGFM: produces an agreement map for Confidence levels. The method and the coding is similar to that of the AGRV map.

h. AVGF: produces a map indicating the average level of Confidence for each cell, computed as the arithmetic mean of responses for the cell.

i. SCTV: produces a map indicating the amount of disagreement contained in each cell of the Attribute Maps relative to the maximum amount of disagreement possible. It is a measure of entropy measured by the following formula:

$$E = 1 + \sum_{i=1}^{NVALS} \frac{(R(i) / NVALS) * \log(R(i) / NVALS)}{\log(NVALS)}$$

where: NVALS = maximum number of values for an attribute;
R(i) = number of respondents choosing value i;
E ranges from 1 to 2.

j. SCTF: produces a map indicating the amount of disagreement contained in each cell of the Confidence Map relative to the maximum amount of disagreement possible. It is a measure of entropy based on the same formula as in SCTV.

Part 2: TWO APPLICATIONS OF THE STRABO TECHNIQUE

2.1 THE STRABO PLANNING METHOD (N. Edelson, revised by B. W. Luscombe)

The Strabo Planning Method is being developed to help planning groups deal with the spatial aspects of planning problems. The method cannot be used in isolation because not all of the planning decisions that must be made have important spatial dimensions. The Strabo Planning Method, therefore, must be used in conjunction with other planning procedures.

The Strabo Planning Method should consist of a series of batteries of questions. The specific questions in each battery will evolve depending on the interests of the planning committee and on their levels of concensus as the process progresses. This makes it impossible to outline a complete testing manual; however, it is possible to make some recommendations concerning the types of questions that can be raised and the order in which these types of questions should appear.

It is suggested that three types of question batteries be used. The first battery should concern the familiarity that people have with the area and their assessment of its current status and the changes that are likely to occur given current trends. This kind of information will enable the members of the group to become familiar with each other's awareness of the area, as well as the processes they believe to be affecting it. Once this kind of information is understood by the committee, it will be possible to go on to raise questions concerning what they would like to see occur in different parts of the area. This will help the committee members establish the spatial aspects of their goals and objectives. A third phase of Strabo testing would include questions about policies that might be undertaken to achieve the agreed upon objectives and goals.

The following is an example of a Strabo Planning Method questionnaire and information package that can be used as part of a general local area planning process. It is designed to accomplish two objectives. First, it explains the Strabo Planning Method to individuals involved in local area planning. Second, it elicits data about a study area from the first battery type of questions. These include perceptions of current land use, as well as the degree to which the participants are familiar with portions of the study area. This information will be analysed and returned to the committee in the form of a series of maps that will be used as the basis for discussion. All the individual responses will be treated as strictly confidential. They will be released only to members of the committee to help in the formulation of the neighbourhood plan.

To begin the session there will be a general introduction to the Strabo and Delphi methods and a description of the kinds of testing that will be involved. Each member of the planning committee will be given a packet of material containing examples of the types of maps that will be produced and an explanation of how the analysis of the data will be performed. Then, the members of the committee will be asked to complete several map exercises.

2.1.1 An Application of the Strabo Planning Method to Neighbourhood Planning

A "STRABO PLANNING METHOD" PACKAGE

*** INTRODUCTORY INFORMATION ***

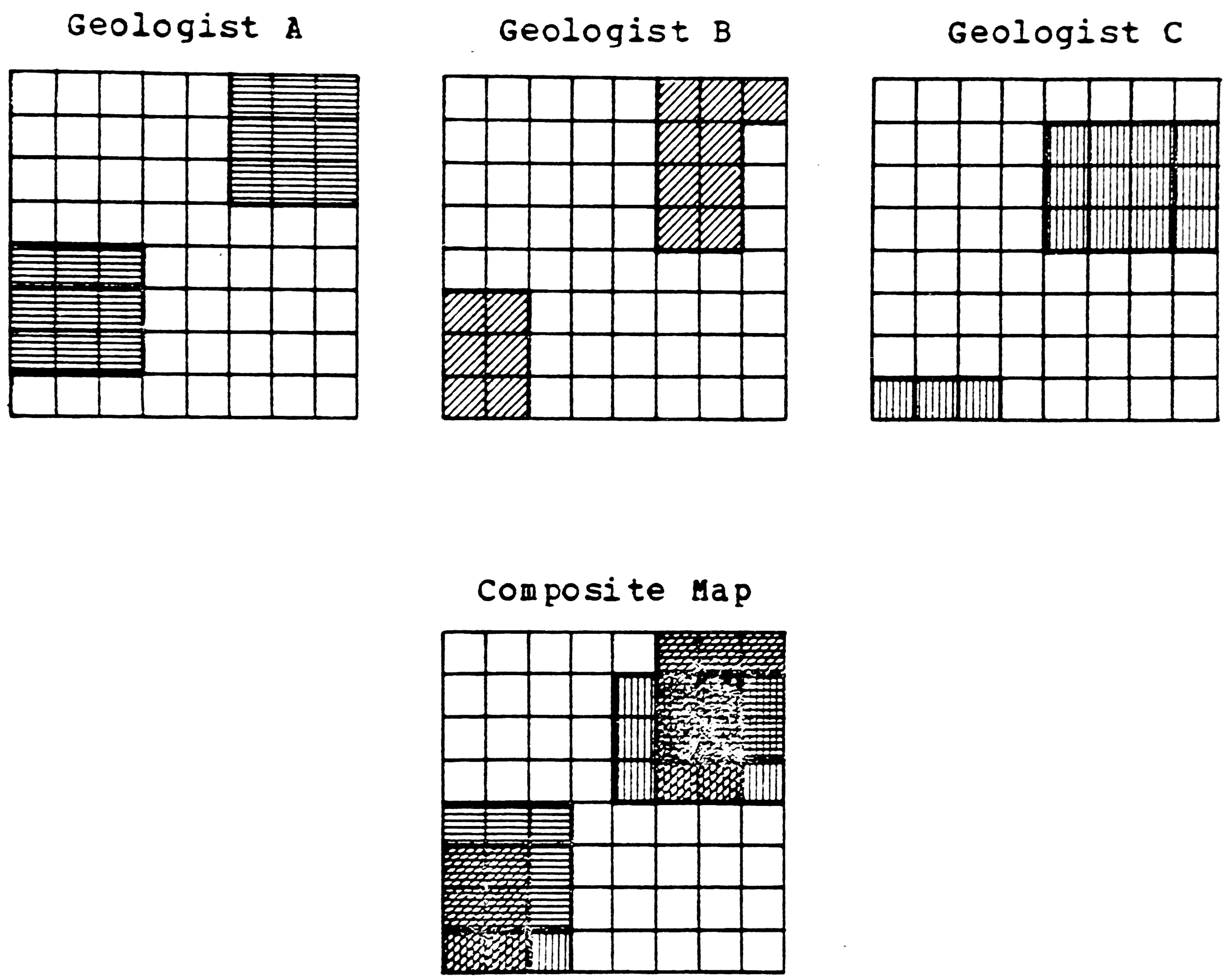
The Strabo Technique is being developed by geographers and computer cartographers at Simon Fraser University. It is named after Strabo, an ancient Greek scientist, who was one of the first cartographic geographers. The method has been adapted from a decision making process called the Delphi Method. The Delphi Method was originally developed by social scientists interested in gathering together the opinions of 'experts' to predict the likelihood of different kinds of new inventions. The method has also been used to help make spatial 'predictions'. We call these kinds of spatial uses of Delphi, the Strabo Technique. The following hypothetical situation illustrates how the technique may be applied. It suggests how geologists in the petroleum industry might use the technique to determine the most likely places in which to drill for oil.

In this example, the technique is carried out according to the following procedures. Several geologists are sent to explore a region where there is reason to expect that oil may be found. They spend several weeks examining any maps or data that they feel are relevant to deciding the best places to locate the drilling equipment. At the end of this information gathering period, each of the geologists is given a base map of the region and asked to identify the best places to find oil. The maps are then analysed and a composite map is drawn showing the average view of the entire group (see Figure 6).

In this example, the maps of three geologists can be analysed. All three generally agreed that oil can be found in the northeastern and southwestern parts of the region, but they disagreed about its exact location. This is evident from the composite map. The composite map shows the places in which they agreed and disagreed. It is formed by counting the number of times each part of the region was thought to have oil. All three geologists agreed that there was no oil in the areas left blank. They were also unanimous in feeling that the area represented by the most darkly shaded cells contain oil. There is disagreement concerning the remaining parts of the region.

The next step in the Strabo Method is to return the composite maps to the geologists and ask them to repeat the exercise. In

Figure 6: Attribute Maps of the Probability of Discovering Oil



this step they are allowed to change their minds in light of the views of the other experts. At this stage they need not feel embarrassed about changing their minds because their individual responses are kept confidential. If there is little disagreement after the second round, then the composite map is given to the corporate executives who decide whether or not to proceed with the drilling.

If there is still a great deal of disagreement amongst the geologists, it may be necessary to hold a face-to-face meeting in order that each might explain why his estimate differed from those of his colleagues. Through this discussion, a geologist may find that important information has been overlcoked or that a miscalculation has been made in his analysis. Some geologists may be convinced by the arguments presented by others; others may wish to maintain their original opinions.

If disagreements remain after the geologists have had an opportunity to view the composite map and discuss it, then they are asked to draw a third map of the best places to find oil. This procedure of drawing individual maps, seeing the composite map, discussing opinions, and then, redrawing individual maps can be carried out several times until either a consensus is finally reached or until it is decided that the disagreements are basically irreconcilable. In either case, the full set of composite maps and statistical measures of the amount of agreement and disagreement among the experts is sent to the corporate executives where a final decision based on the overall interests of the firm can be made.

The Strabo Planning Method is somewhat similar to the example of the oil experts. It is based on the idea that by examining and discussing a series of composite maps made up of everyone's opinions, individuals can come to a clearer understanding of what each other thinks concerning the current status of a study area, the ways in which it is likely to change and the processes that are likely to produce those changes. These understandings are necessary before people can seriously discuss what they would like to do to improve the study area. It should also help to focus discussion on the specific areas of disagreement so that the planning committee can decide whether it is possible to negotiate a compromise plan or whether it is necessary to abandon the attempt to achieve consensus within the committee. If no consensus is possible for the committee as a whole, then subgroups within the committee might attempt to create their own plans and take them to a wider audience to gain support for final approval by City Council.

*** MAPPING EXERCISES ***

MAP A: Residential Land Use Status

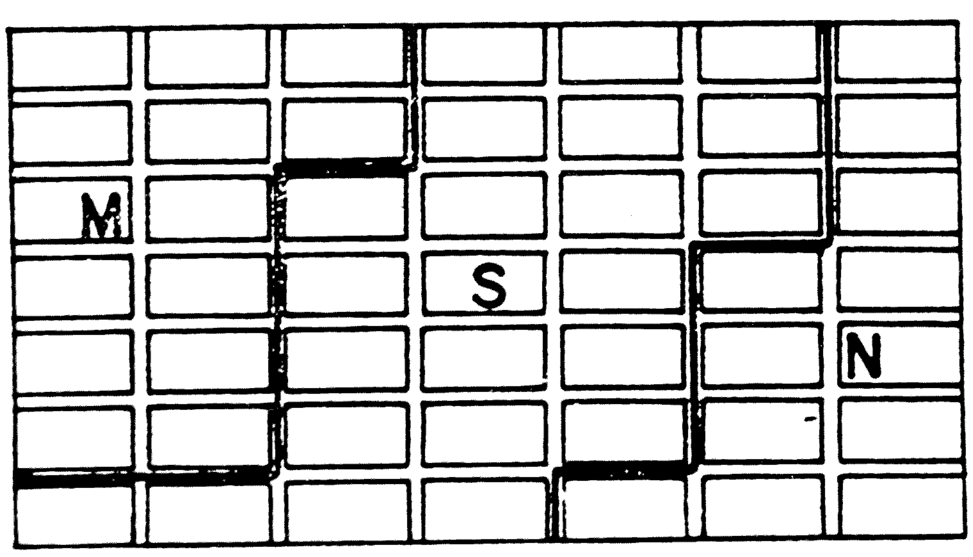
The Grandview area contains many different types of land uses. It is possible, however, to group these into three major categories:

1. S = Single Family
2. M = Multiple Family
3. N = Non-residential

Obviously, many areas contain combinations of these different land uses; but portions of the neighbourhood can be reasonably identified as falling predominantly into one of these categories.

You have received a map of the Grandview area. Identify those areas on the maps that you feel are (S) single family, (M) multiple family, or (N) non-residential. Each area should be identified in a manner similar to that shown in Figure 7.

Figure 7: An Illustration of How to Indicate Land-Use Status on a Map



S = Single Family Area

M = Multiple Family Area

N = Non-residential Area

The person who completed Figure 7 believes that the upper left, or northwest corner, of the map is multiple family status, while the central portion is single family, and the right, or west side of the map is non-residential.

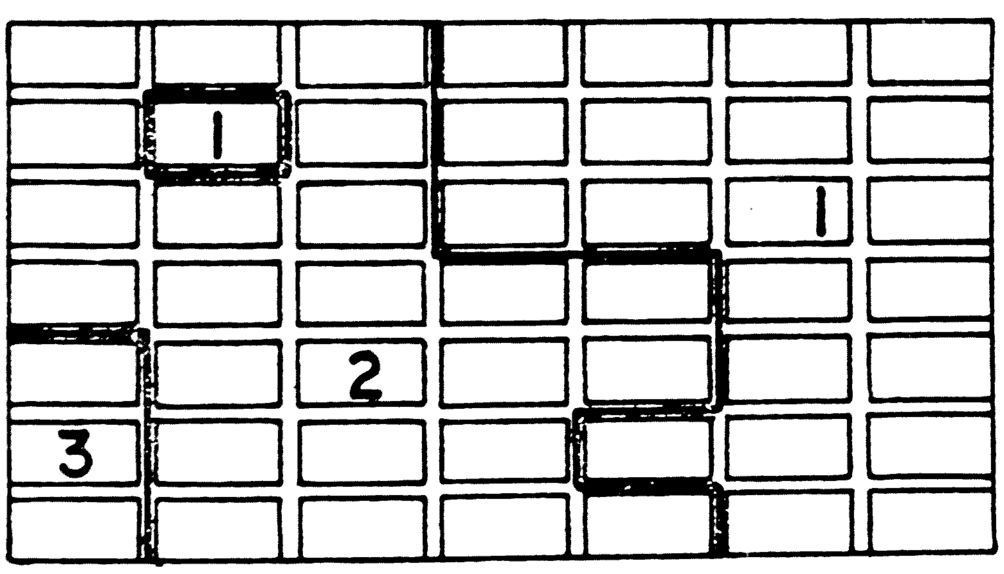
MAP B: Familiarity Map

Attached is another map of the Grandview area with some of the major street names and a few major landmarks on it. Please indicate the parts of Grandview with which you are familiar according to the following categories:

1. Very Familiar
2. Somewhat Familiar
3. Unfamiliar

Be sure that you fill in all parts of the map. Figure 8 illustrates how to indicate the areas of different familiarities.

Figure 8: An Illustration of How to Indicate Familiarity on a Map



1 = Very Familiar Area

2 = Somewhat Familiar Area

3 = Unfamiliar Area

According to Figure 8, the respondent is very familiar with the area in the northeast corner of the map while the southwest corner is largely unfamiliar to him.

2.1.2 Results of a Trial Application

Although this application of the Strabo Planning Method was never actually completed, base maps were fabricated for four imaginary respondents to illustrate the kinds of results which the Method is capable of producing. Once the base map of the attributes have been prepared, they are digitized as in the manner described in section 1.3 (Figures 9-12). Similarly, the base maps indicating the degrees of familiarity with the parts of the area, producing a measure of the respondents' confidence in identifying the spatial distribution of the attributes, are digitized (Figures 13-16). Composite maps can then be prepared by a system of polygon overlays for each of the attributes (Figures 17-19). By a similar procedure, composite maps of "familiarity" can be produced (Figures 20-22). The respondents' attribute maps can be weighted by the degree of familiarity of the respondents with the area (Figures 23-26). New weighted composite attribute maps can then be produced for each of the attributes (Figures 27-29). Figure 30 shows the average familiarity for all the respondents for each of the grid cells.

Figure 31 shows the agreement levels amongst the respondents in classifying the land uses of the area, while Figure 32 shows the agreement levels of classification after filtering or weighting by the respondents' familiarity with the different parts of the region. Similarly, Figure 33 shows the level of agreement in the familiarity amongst the respondents for each of the grid cells.

These composite, or summary, maps can then be returned to the participants for a second iteration of opinion gathering. This application of the Strabo Planning Method has been to illustrate its utility and has, therefore, been very simplistic in design. Much more complex issues, such as environmental quality or expectation of future land uses in a study area, could be examined with the aid of this methodology. Since the purpose of this example has been illustrative, it does not go beyond the first iterative session with the participants.

Figure 9: Input Attribute Map for Respondent Number 1

```
MAP  1,SHEET  1,DATA SET  1
*------------------------------------------*
I 3333333333333333333333333333333333333333 I
I 3333333333333333322222222222222222222222 I
I 3333333333333333322222222222222222222222 I
I 3333333333333333322222222222222222222222 I
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I 3333333333333333322222222222222222222222 I
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I 2222222222222233311111111111111111111111 I
I 2222222222222233311111111111111111111111 I
*------------------------------------------*
```

TEST MAP ATTRIBUTE MAP FOR RESPONDENT ONE

Figure 10: Input Attribute Map for Respondent Number 2

```
MAP   2,SHEET   1,DATA SET   1
*-----------------------------------------*
I 333333333333333333333333333333333333333 I
I 222222222333333332222222222222222222222 I
I 222222222333333332222222222222222222222 I
I 222222222333333332222222222222222222222 I
I 222222222333333332222222222222222222222 I
I 222222222333333332222222222222222222222 I
I 222222222333333332222222222222222222222 I
I 222222222333333332222222222222222222222 I
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I 222222222222223331111111111111111111111 I
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I 222222222222223331111111111111111111111 I
I 222222222222223331111111111111111111111 I
I 222222222222223331111111111111111111111 I
*-----------------------------------------*
```

TEST MAP ATTRIBUTE MAP FOR RESPONDENT NUMBER 2

Figure 11: Input Attribute Map for Respondent Number 3

```
MAP   3,SHEET   1,DATA SET   1
*---------------------------------------------*
I 3333333333333333333333333333333333333333333 I
I 2222222233333333322222222222222222222222222 I
I 2222222233333333322222222222222222222222222 I
I 2222222233333333322222222222222222222222222 I
I 2222222233333333322222222222222222222222222 I
I 2222222233333333322222222222222222222222222 I
I 2222222233333333322222222222222222222222222 I
I 2222222233333333322222222222222222222222222 I
I 2222222233333333322222222222222222222222222 I
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I 2222222233333333322222222222222222222222222 I
I 3333333333333333322222222222222222222222222 I
I 3333333333333333322222222222222222222222222 I
I 3333333333333333311111111111111111111111111 I
I 3333333333333333311111111111111111111111111 I
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I 2222111111111133311111111111111111111111111 I
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I 2222111111111133311111111111111111111111111 I
I 2222111111111133311111111111111111111111111 I
I 2222111111111133311111111111111111111111111 I
I 2222111111111133311111111111111111111111111 I
*---------------------------------------------*
```

TEST MAP ATTRIBUTE MAP FOR RESPONDENT NUMBER 3

Figure 12: Input Attribute Map for Respondent Number 4

```
MAP  4,SHEET  1,DATA SET  1
*------------------------------------------*
I 1111111111111111111111111111111111111111 I
I 2222222233333333322222222222222222222222 I
I 2222222233333333322222222222222222222222 I
I 2222222233333333322222222222222222222222 I
I 2222222233333333322222222222222222222222 I
I 2222222233333333322222222222222222222222 I
I 2222222233333333322222222222222222222222 I
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I 3333333333333333322222222222222222222222 I
I 3333333333333333322222222222222222222222 I
I 3333333333333333322222222222222222222222 I
I 3333333333333333322222222222222222222222 I
I 3333333333333333311111111111111111111111 I
I 3333333333333333311111111111111111111111 I
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I 2222222222222233311111111111111111111111 I
I 2222222222222233311111111111111111111111 I
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I 1111111111111133311111111111111111111111 I
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I 1111111111111133311111111111111111111111 I
I 1111111111111133311111111111111111111111 I
I 1111111111111133311111111111111111111111 I
I 1111111111111133311111111111111111111111 I
I 1111111111111133311111111111111111111111 I
*------------------------------------------*
```

TEST MAP ATTRIBUTE MAP FOR RESPONDENT NUMBER 4

Figure 13: Input Confidence Map for Respondent Number 1

```
MAP  5,SHEET  1,DATA SET  1
*------------------------------------------*
I 1111111111111111111111111111111111111111 I
I 2222222221111111122222222222222222222222 I
I 2222222221111111122222222222222222222222 I
I 2222222221111111122222222222222222222222 I
I 2222222221111111122222222222222222222222 I
I 2222222221111111122222222222222222222222 I
I 2222222221111111122222222222222222222222 I
I 2222222221111111122222222222222222222222 I
I 2222222221111111122222222222222222222222 I
I 2222222221111111122222222222222222222222 I
I 2222222221111111122222222222222222222222 I
I 2222222221111111122222222222222222222222 I
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I 1111111111111111122222222222222222222222 I
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I 1111111111111111122222222222222222222222 I
I 1111111111111111122222222222222222222222 I
I 1111111111111111122222222222222222222222 I
I 1111111111111111122222222222222222222222 I
I 3333333333333311133333333333333333333333 I
I 3333333333333311133333333333333333333333 I
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I 3333333333333311133333333333333333333333 I
I 3333333333333311133333333333333333333333 I
I 3333333333333311133333333333333333333333 I
I 3333333333333311133333333333333333333333 I
I 3333333333333311133333333333333333333333 I
*------------------------------------------*
```

TEST MAP CONFIDENCE MAP FOR RESPONDENT NUMBER 1

Figure 14: Input Confidence Map for Respondent Number 2

```
MAP  6,SHEET  1,DATA SET  1
*-----------------------------------------*
I 1111111111111111111111111111111111111111 I
I 2222222221111111122222222222222222222222 I
I 2222222221111111122222222222222222222222 I
I 2222222221111111122222222222222222222222 I
I 2222222221111111122222222222222222222222 I
I 2222222221111111122222222222222222222222 I
I 2222222221111111122222222222222222222222 I
I 2222222221111111122222222222222222222222 I
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I 2222222221111111122222222222222222222222 I
I 1111111111111111122222222222222222222222 I
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I 1111111111111111122222222222222222222222 I
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I 1111111111111111122222222222222222222222 I
I 1111111111111111122222222222222222222222 I
I 3333333333333322222222222222222222222222 I
I 3333333333333322222222222222222222222222 I
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I 3333333333333322222222222222222222222222 I
I 3333333333333322233333333333333333333333 I
I 3333333333333322233333333333333333333333 I
I 3333333333333322233333333333333333333333 I
I 3333333333333322233333333333333333333333 I
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I 3333333333333322233333333333333333333333 I
I 3333333333333322233333333333333333333333 I
I 3333333333333322233333333333333333333333 I
I 3333333333333322233333333333333333333333 I
*-----------------------------------------*
```

TEST MAP CONFIDENCE MAP FOR RESPONDENT NUMBER 2

Figure 15: Input Confidence Map for Respondent Number 3

```
MAP  7,SHEET  1,DATA SET  1
*------------------------------------------*
I 3333333333333333322222222222222222222222 I
I 3333333333333333322222222222222222222222 I
I 3333333333333333322222222222222222222222 I
I 3333333333333333322222222222222222222222 I
I 3333333333333333322222222222222222222222 I
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I 3333333333333333322222222222222222222222 I
I 1111111111111111122222222222222222222222 I
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I 1111111111111111122222222222222222222222 I
I 3333333333333311133333333333333333333333 I
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I 3333333333333311133333333333333333333333 I
I 3333333333333311133333333333333333333333 I
I 3333333333333311133333333333333333333333 I
I 3333333333333311133333333333333333333333 I
*------------------------------------------*
```

TEST MAP CONFIDENCE MAP FOR RESPONDENT NUMBER 3

Figure 16: Input Confidence Map for Respondent Number 4

```
MAP  8,SHEET  1,DATA SET  1
*------------------------------------------*
I 1111111111111111111111111111111111111111 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
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I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 1111111111111111133333333333333333333333 I
I 1111111111111111133333333333333333333333 I
I 1111111111111111133333333333333333333333 I
I 1111111111111111133333333333333333333333 I
I 1111111111111111133333333333333333333333 I
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I 1111111111111111133333333333333333333333 I
I 1111111111111111133333333333333333333333 I
I 1111111111111111133333333333333333333333 I
I 1111111111111111133333333333333333333333 I
I 1111111111111111122222222222222222222222 I
I 1111111111111111122222222222222222222222 I
I 1111111111111111122222222222222222222222 I
I 3333333333333311122222222222222222222222 I
I 3333333333333311122222222222222222222222 I
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I 3333333333333311122222222222222222222222 I
I 3333333333333311122222222222222222222222 I
I 3333333333333311122222222222222222222222 I
I 3333333333333311122222222222222222222222 I
*------------------------------------------*
```

TEST MAP CONFIDENCE MAP FOR RESPONDENT NUMBER 4

Figure 17: Composite Map for Single Family Housing

```
MAP   1,SHEET   1,DATA SET   1
*------------------------------------------*
I 1111111111111111111111111111111111111111 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000022222222222222222222222 I
I 0000000000000000022222222222222222222222 I
I 0000000000000000022222222222222222222222 I
I 0000000000000000033333333333333333333333 I
I 0000000000000000033333333333333333333333 I
I 0000000000000000033333333333333333333333 I
I 0000000000000000044444444444444444444444 I
I 0000000000000000044444444444444444444444 I
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I 0000000000000000044444444444444444444444 I
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I 0000111111111100044444444444444444444444 I
I 0000111111111100044444444444444444444444 I
I 0000111111111100044444444444444444444444 I
I 1111222222222200044444444444444444444444 I
I 1111222222222200044444444444444444444444 I
I 1111222222222200044444444444444444444444 I
I 1111222222222200044444444444444444444444 I
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I 1111222222222200044444444444444444444444 I
I 1111222222222200044444444444444444444444 I
I 1111222222222200044444444444444444444444 I
I 1111222222222200044444444444444444444444 I
*------------------------------------------*
```

TEST MAP **MAPV** SINGLE FAMILY

Figure 18: Composite Map for Multiple Family Housing

```
MAP   2,SHEET   1,DATA SET   1
*-------------------------------------------*
I 0000000000000000000000000000000000000000 I
I 3333333310000000044444444444444444444444 I
I 3333333310000000044444444444444444444444 I
I 3333333310000000044444444444444444444444 I
I 3333333310000000044444444444444444444444 I
I 3333333310000000044444444444444444444444 I
I 3333333310000000044444444444444444444444 I
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I 3333333310000000044444444444444444444444 I
I 0000000000000000044444444444444444444444 I
I 0000000000000000044444444444444444444444 I
I 0000000000000000022222222222222222222222 I
I 0000000000000000022222222222222222222222 I
I 0000000000000000022222222222222222222222 I
I 0000000000000000011111111111111111111111 I
I 0000000000000000011111111111111111111111 I
I 0000000000000000011111111111111111111111 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 2222111111111000000000000000000000000000 I
I 2222111111111000000000000000000000000000 I
I 2222111111111000000000000000000000000000 I
I 3333222222222000000000000000000000000000 I
I 3333222222222000000000000000000000000000 I
I 3333222222222000000000000000000000000000 I
I 3333222222222000000000000000000000000000 I
I 3333222222222000000000000000000000000000 I
I 4444333333333000000000000000000000000000 I
I 4444333333333000000000000000000000000000 I
I 4444333333333000000000000000000000000000 I
I 4444333333333000000000000000000000000000 I
I 4444333333333000000000000000000000000000 I
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I 4444333333333000000000000000000000000000 I
I 4444333333333000000000000000000000000000 I
I 4444333333333000000000000000000000000000 I
I 4444333333333000000000000000000000000000 I
I 4444333333333000000000000000000000000000 I
I 3333222222222000000000000000000000000000 I
I 3333222222222000000000000000000000000000 I
I 3333222222222000000000000000000000000000 I
I 3333222222222000000000000000000000000000 I
I 3333222222222000000000000000000000000000 I
I 3333222222222000000000000000000000000000 I
I 3333222222222000000000000000000000000000 I
I 3333222222222000000000000000000000000000 I
I 3333222222222000000000000000000000000000 I
I 3333222222222000000000000000000000000000 I
I 3333222222222000000000000000000000000000 I
I 3333222222222000000000000000000000000000 I
*-------------------------------------------*
```

TEST MAP **MAPV** MULTIPLE FAMILY

Figure 19: Composite Map for Non-Residential Areas

```
MAP  3,SHEET  1,DATA SET  1
*-------------------------------------------*
I 33333333333333333333333333333333333333333 I
I 11111111344444444000000000000000000000000 I
I 11111111344444444000000000000000000000000 I
I 11111111344444444000000000000000000000000 I
I 11111111344444444000000000000000000000000 I
I 11111111344444444000000000000000000000000 I
I 11111111344444444000000000000000000000000 I
I 11111111344444444000000000000000000000000 I
I 11111111344444444000000000000000000000000 I
I 11111111344444444000000000000000000000000 I
I 11111111344444444000000000000000000000000 I
I 11111111344444444000000000000000000000000 I
I 11111111344444444000000000000000000000000 I
I 11111111344444444000000000000000000000000 I
I 11111111344444444000000000000000000000000 I
I 44444444444444444000000000000000000000000 I
I 44444444444444444000000000000000000000000 I
I 44444444444444444000000000000000000000000 I
I 44444444444444444000000000000000000000000 I
I 44444444444444444000000000000000000000000 I
I 44444444444444444000000000000000000000000 I
I 44444444444444444000000000000000000000000 I
I 44444444444444444000000000000000000000000 I
I 44444444444444444000000000000000000000000 I
I 44444444444444444000000000000000000000000 I
I 44444444444444444000000000000000000000000 I
I 44444444444444444000000000000000000000000 I
I 22222222222222444000000000000000000000000 I
I 22222222222222444000000000000000000000000 I
I 22222222222222444000000000000000000000000 I
I 11111111111111444000000000000000000000000 I
I 11111111111111444000000000000000000000000 I
I 11111111111111444000000000000000000000000 I
I 11111111111111444000000000000000000000000 I
I 11111111111111444000000000000000000000000 I
I 00000000000000444000000000000000000000000 I
I 00000000000000444000000000000000000000000 I
I 00000000000000444000000000000000000000000 I
I 00000000000000444000000000000000000000000 I
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I 00000000000000444000000000000000000000000 I
I 00000000000000444000000000000000000000000 I
I 00000000000000444000000000000000000000000 I
I 00000000000000444000000000000000000000000 I
I 00000000000000444000000000000000000000000 I
I 00000000000000444000000000000000000000000 I
I 00000000000000444000000000000000000000000 I
I 00000000000000444000000000000000000000000 I
*-------------------------------------------*
```

TEST MAP **MAPV** NON-RESIDENTIAL

Figure 20: Composite Map of Very Familiar Area

```
MAP  1,SHEET  1,DATA SET  1
*--------------------------------------------*
I 333333333333333333333333333333333333333333 I
I 000000000222222222000000000000000000000000 I
I 000000000222222222000000000000000000000000 I
I 000000000222222222000000000000000000000000 I
I 000000000222222222000000000000000000000000 I
I 000000000222222222000000000000000000000000 I
I 000000000222222222000000000000000000000000 I
I 000000000222222222000000000000000000000000 I
I 000000000222222222000000000000000000000000 I
I 000000000222222222000000000000000000000000 I
I 000000000222222222000000000000000000000000 I
I 000000000222222222000000000000000000000000 I
I 000000000222222222000000000000000000000000 I
I 000000000222222222000000000000000000000000 I
I 1111111112222222220000000C0000000000000000 I
I 111111111222222222000000000000000000000000 I
I 333333333333333333000000000000000000000000 I
I 444444444444444444000000000000000000000000 I
I 444444444444444444000000000000000000000000 I
I 444444444444444444000000000000000000000000 I
I 444444444444444444000000000000000000000000 I
I 44444444444444444400C000000000000000000000 I
I 444444444444444444000000000000000000000C0000 I
I 444444444444444444000000000000000000000000 I
I 444444444444444444000000000000000000000000 I
I 444444444444444444000000000000000000000000 I
I 444444444444444444000000000000000000000000 I
I 444444444444444444000000000000000000000000 I
I 444444444444444444000000000000000000000000 I
I 444444444444444444000000000000000000000000 I
I 111111111111111333000000000000000000000000 I
I 111111111111111333000000000000000000000000 I
I 111111111111111333000000000000000000000000 I
I 111111111111111333000000000000000000000000 I
I 111111111111111333000000000000000000000000 I
I 111111111111111333000000000000000000000000 I
I 111111111111111333000000000000000000000000 I
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I 111111111111111333000000000000000000000000 I
I 111111111111111333000000000000000000000000 I
I 111111111111111333000000000000000000000000 I
I 111111111111111333000000000000000000000000 I
I 111111111111111333000000000000000000000000 I
I 111111111111111333000000000000000000000000 I
I 000000000000000333000000000000000000000000 I
I 000000000000000333000000000000000000000000 I
I 000000000000000333000000000000000000000000 I
I 000000000000000333000000000000000000000000 I
I 000000000000000333000000000000000000000000 I
I 00000000000000033300C000000000000000000000 I
I 0000000000000003330000000000C0000000000000 I
I 000000000000000333000000000000000000000000 I
I 000000000000000333000000000000000000000000 I
I 000000000000000333000000000000000000000000 I
I 000000000000000333000000000000000000000000 I
I 000000000000000333000000000000000000000000 I
I 000000000000000333000000000000000000000000 I
I 000000000000000333000000000000000000000000 I
I 000000000000000333000000000000000000000000 I
I 000000000000000333000000000000000000000000 I
*--------------------------------------------*
```

TEST MAP **FAMV** VERY FAMILIAR

Figure 21: Composite Map of Somewhat Familiar Areas

```
MAP  2,SHEET  1,DATA SET  1
*------------------------------------------*
I 0000000000000000011111111111111111111111 I
I 3333333331111111144444444444444444444444 I
I 3333333331111111144444444444444444444444 I
I 3333333331111111144444444444444444444444 I
I 3333333331111111144444444444444444444444 I
I 3333333331111111144444444444444444444444 I
I 3333333331111111144444444444444444444444 I
I 3333333331111111144444444444444444444444 I
I 3333333331111111144444444444444444444444 I
I 3333333331111111144444444444444444444444 I
I 3333333331111111144444444444444444444444 I
I 3333333331111111144444444444444444444444 I
I 3333333331111111144444444444444444444444 I
I 3333333331111111144444444444444444444444 I
I 2222222221111111144444444444444444444444 I
I 2222222221111111144444444444444444444444 I
I 1111111111111111144444444444444444444444 I
I 0000000000000000033333333333333333333333 I
I 0000000000000000033333333333333333333333 I
I 0000000000000000033333333333333333333333 I
I 0000000000000000033333333333333333333333 I
I 0000000000000000033333333333333333333333 I
I 0000000000000000033333333333333333333333 I
I 0000000000000000033333333333333333333333 I
I 0000000000000000033333333333333333333333 I
I 0000000000000000033333333333333333333333 I
I 0000000000000000033333333333333333333333 I
I 0000000000000000044444444444444444444444 I
I 0000000000000000044444444444444444444444 I
I 0000000000000000044444444444444444444444 I
I 0000000000000011133333333333333333333333 I
I 0000000000000011133333333333333333333333 I
I 0000000000000011133333333333333333333333 I
I 0000000000000011133333333333333333333333 I
I 0000000000000011122222222222222222222222 I
I 0000000000000011122222222222222222222222 I
I 0000000000000011122222222222222222222222 I
I 0000000000000011122222222222222222222222 I
I 0000000000000011122222222222222222222222 I
I 0000000000000011122222222222222222222222 I
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I 0000000000000011122222222222222222222222 I
I 0000000000000011122222222222222222222222 I
I 0000000000000011122222222222222222222222 I
I 0000000000000011111111111111111111111111 I
I 0000000000000011111111111111111111111111 I
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I 0000000000000011111111111111111111111111 I
I 0000000000000011111111111111111111111111 I
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I 0000000000000011111111111111111111111111 I
I 0000000000000011111111111111111111111111 I
I 0000000000000011111111111111111111111111 I
I 0000000000000011111111111111111111111111 I
I 0000000000000011111111111111111111111111 I
*------------------------------------------*
```

TEST MAP **FAMV** SOMEWHAT FAMILIAR

Figure 22: Composite Map of Unfamiliar Areas

```
MAP   3,SHEET   1,DATA SET  1
*-----------------------------------------*
I 11111111111111111000000000000000000000000 I
I 11111111111111111000000000000000000000000 I
I 11111111111111111000000000000000000000000 I
I 11111111111111111000000000000000000000000 I
I 11111111111111111000000000000000000000000 I
I 11111111111111111000000000000000000000000 I
I 11111111111111111000000000000000000000000 I
I 11111111111111111000000000000000000000000 I
I 11111111111111111000000000000000000000000 I
I 11111111111111111000000000000000000000000 I
I 11111111111111111000000000000000000000000 I
I 11111111111111111000000000000000000000000 I
I 11111111111111111000000000000000000000000 I
I 11111111111111111000000000000000000000000 I
I 11111111111111111000000000000000000000000 I
I 11111111111111111000000000000000000000000 I
I 000000000000000000000000000000000000000 I
I 000000000000000001111111111111111111111 I
I 000000000000000001111111111111111111111 I
I 000000000000000001111111111111111111111 I
I 000000000000000001111111111111111111111 I
I 000000000000000001111111111111111111111 I
I 000000000000000001111111111111111111111 I
I 000000000000000001111111111111111111111 I
I 000000000000000001111111111111111111111 I
I 000000000000000001111111111111111111111 I
I 000000000000000001111111111111111111111 I
I 000000000000000000000000000000000000000 I
I 000000000000000000000000000000000000000 I
I 000000000000000000000000000000000000000 I
I 333333333333330001111111111111111111111 I
I 333333333333330001111111111111111111111 I
I 333333333333330001111111111111111111111 I
I 333333333333330001111111111111111111111 I
I 333333333333330002222222222222222222222 I
I 333333333333330002222222222222222222222 I
I 333333333333330002222222222222222222222 I
I 333333333333330002222222222222222222222 I
I 333333333333330002222222222222222222222 I
I 333333333333330002222222222222222222222 I
I 333333333333330002222222222222222222222 I
I 333333333333330002222222222222222222222 I
I 333333333333330002222222222222222222222 I
I 333333333333330002222222222222222222222 I
I 444444444444440003333333333333333333333 I
I 444444444444440003333333333333333333333 I
I 444444444444440003333333333333333333333 I
I 444444444444440003333333333333333333333 I
I 444444444444440003333333333333333333333 I
I 444444444444440003333333333333333333333 I
I 444444444444440003333333333333333333333 I
I 444444444444440003333333333333333333333 I
I 444444444444440003333333333333333333333 I
I 444444444444440003333333333333333333333 I
I 444444444444440003333333333333333333333 I
I 444444444444440003333333333333333333333 I
I 444444444444440003333333333333333333333 I
I 444444444444440003333333333333333333333 I
I 444444444444440003333333333333333333333 I
I 444444444444440003333333333333333333333 I
*-----------------------------------------*

TEST MAP   **FAMV**   UNFAMILIAR
```

Figure 23: Filtered Attribute Map for Respcndent Number 1

```
MAP   1,SHEET   1,DATA SET   1
*-------------------------------------------*
I 33333333333333333333333333333333333333333 I
I 00000000033333333000000000000000000000000 I
I 00000000033333333000000000000000000000000 I
I 00000000033333333000000000000000000000000 I
I 00000000033333333000000000000000000000000 I
I 00000000033333333000000000000000000000000 I
I 00000000033333333000000000000000000000000 I
I 00000000033333333000000000000000000000000 I
I 00000000033333333000000000000000000000000 I
I 00000000033333333000000000000000000000000 I
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I 00000000000000333000000000000000000000000 I
I 00000000000000333000000000000000000000000 I
I 00000000000000333000000000000000000000000 I
I 00000000000000333000000000000000000000000 I
*-------------------------------------------*
```

TEST MAP   A FILTERED ATTRIBUTE MAP FOR RESPONDENT ONE

Figure 24: Filtered Attribute Map for Respondent Number 2

```
MAP  2,SHEET  1,DATA SET  1
*------------------------------------------*
I 3333333333333333333333333333333333333333 I
I 0000000003333333300000000000000000000000 I
I 0000000003333333300000000000000000000000 I
I 0000000003333333300000000000000000000000 I
I 0000000003333333300000000000000000000000 I
I 0000000003333333300000000000000000000000 I
I 0000000003333333300000000000000000000000 I
I 0000000003333333300000000000000000000000 I
I 0000000003333333300000000000000000000000 I
I 0000000003333333300000000000000000000000 I
I 0000000003333333300000000000000000000000 I
I 0000000003333333300000000000000000000000 I
I 0000000003333333300000000000000000000000 I
I 0000000003333333300000000000000000000000 I
I 2222222223333333300000000000000000000000 I
I 3333333333333333300000000000000000000000 I
I 3333333333333333300000000000000000000000 I
I 3333333333333333300000000000000000000000 I
I 3333333333333333300000000000000000000000 I
I 3333333333333333300000000000000000000000 I
I 3333333333333333300000000000000000000000 I
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I 0000000000000000000000000000000000000000 I
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I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
*------------------------------------------*
```

TEST MAP   A FILTERED ATTRIBUTE MAP FOR RESPONDENT TWO

Figure 25: Filtered Attribute Map for Respondent Number 3

```
MAP  3,SHEET  1,DATA SET  1
*---------------------------------------------*
I 00000000000000000000000000000000000000000 I
I 00000000000000000000000000000000000000000 I
I 00000000000000000000000000000000000000000 I
I 00000000000000000000000000000000000000000 I
I 00000000000000000000000000000000000000000 I
I 00000000000000000000000000000000000000000 I
I 00000000000000000000000000000000000000000 I
I 00000000000000000000000000000000000000000 I
I 00000000000000000000000000000000000000000 I
I 00000000000000000000000000000000000000000 I
I 00000000000000000000000000000000000000000 I
I 00000000000000000000000000000000000000000 I
I 00000000000000000000000000000000000000000 I
I 00000000000000000000000000000000000000000 I
I 00000000000000000000000000000000000000000 I
I 00000000000000000000000000000000000000000 I
I 33333333333333333300000000000000000000000 I
I 33333333333333333300000000000000000000000 I
I 33333333333333333300000000000000000000000 I
I 33333333333333333300000000000000000000000 I
I 33333333333333333300000000000000000000000 I
I 33333333333333333300000000000000000000000 I
I 33333333333333333300000000000000000000000 I
I 33333333333333333300000000000000000000000 I
I 33333333333333333300000000000000000000000 I
I 33333333333333333300000000000000000000000 I
I 33333333333333333300000000000000000000000 I
I 22221111111111333000000000000000000000000 I
I 22221111111111333000000000000000000000000 I
I 22221111111111333000000000000000000000000 I
I 22221111111111333000000000000000000000000 I
I 22221111111111333000000000000000000000000 I
I 22221111111111333000000000000000000000000 I
I 22221111111111333000000000000000000000000 I
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I 00000000000000333000000000000000000000000 I
I 00000000000000333000000000000000000000000 I
I 00000000000000333000000000000000000000000 I
I 00000000000000333000000000000000000000000 I
I 00000000000000333000000000000000000000000 I
I 00000000000000333000000000000000000000000 I
I 00000000000000333000000000000000000000000 I
*---------------------------------------------*
```

TEST MAP   A FILTERED ATTRIBUTE MAP FOR RESPONDENT THREE

Figure 26: Filtered Attribute Map for Respondent Number 4

```
MAP  4,SHEET  1,DATA SET  1
*------------------------------------------*
I 1111111111111111111111111111111111111111 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 3333333333333333300000000000000000000000 I
I 3333333333333333300000000000000000000000 I
I 3333333333333333300000000000000000000000 I
I 3333333333333333300000000000000000000000 I
I 3333333333333333300000000000000000000000 I
I 3333333333333333300000000000000000000000 I
I 3333333333333333300000000000000000000000 I
I 3333333333333333300000000000000000000000 I
I 3333333333333333300000000000000000000000 I
I 3333333333333333300000000000000000000000 I
I 2222222222222233300000000000000000000000 I
I 2222222222222233300000000000000000000000 I
I 2222222222222233300000000000000000000000 I
I 0000000000000033300000000000000000000000 I
I 0000000000000033300000000000000000000000 I
I 0000000000000033300000000000000000000000 I
I 0000000000000033300000000000000000000000 I
I 0000000000000033300000000000000000000000 I
I 0000000000000033300000000000000000000000 I
I 0000000000000033300000000000000000000000 I
I 0000000000000033300000000000000000000000 I
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I 0000000000000033300000000000000000000000 I
I 0000000000000033300000000000000000000000 I
I 0000000000000033300000000000000000000000 I
I 0000000000000033300000000000000000000000 I
I 0000000000000033300000000000000000000000 I
I 0000000000000033300000000000000000000000 I
I 0000000000000033300000000000000000000000 I
*------------------------------------------*
```

TEST MAP   A FILTERED ATTRIBUTE MAP FOR RESPONDENT FOUR

Figure 27: Composite Attribute Map for Single Family Weighted by Familiarity

```
MAP  4,SHEET  1,DATA SET  1
*--------------------------------------------*
I 1111111111111111111111111111111111111111 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
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I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
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I 0000000000000000000000000000000000000000 I
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I 0000000000000000000000000000000000000000 I
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I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000111111111100000000000000000000000000 I
I 0000111111111100000000000000000000000000 I
I 0000111111111100000000000000000000000000 I
I 0000111111111100000000000000000000000000 I
I 0000111111111100000000000000000000000000 I
I 0000111111111100000000000000000000000000 I
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I 0000111111111100000000000000000000000000 I
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I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
*--------------------------------------------*
```

TEST MAP **MAPF** SINGLE FAMILY (FILTERED)

Figure 28: Composite Attribute Map for Multiple Family Housing Weighted by Familiarity

```
MAP  5,SHEET  1,DATA SET  1
*------------------------------------------*
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 1111111110000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 2222111111111100000000000000000000000000 I
I 2222111111111100000000000000000000000000 I
I 2222111111111100000000000000000000000000 I
I 1111000000000000000000000000000000000000 I
I 1111000000000000000000000000000000000000 I
I 1111000000000000000000000000000000000000 I
I 1111000000000000000000000000000000000000 I
I 1111000000000000000000000000000000000000 I
I 1111000000000000000000000000000000000000 I
I 1111000000000000000000000000000000000000 I
I 1111000000000000000000000000000000000000 I
I 1111000000000000000000000000000000000000 I
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I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
I 0000000000000000000000000000000000000000 I
*------------------------------------------*
```

TEST MAP **MAPF** MULTIPLE FAMILY (FILTERED)

Figure 29: Composite Attribute Map of Non-Residential Areas Weighted by Familiarity

```
MAP  6,SHEET  1,DATA SET  1
*--------------------------------------------*
I 2222222222222222222222222222222222222222 I
I 0000000002222222000000000000000000000000 I
I 0000000002222222000000000000000000000000 I
I 0000000002222222000000000000000000000000 I
I 0000000002222222000000000000000000000000 I
I 0000000002222222000000000000000000000000 I
I 000000000222222200000C000000000000000000 I
I 0000000002222222000000000000000000000000 I
I 0000000002222222000000000000000000000000 I
I 0000000002222222000000000000000000000000 I
I 00000000022222220000000C0000000000000000 I
I 0000000002222222000000000000000000000000 I
I 0000000002222222000000000000000000000000 I
I 0000000002222222000000000000000000000000 I
I 0000000002222222000000000000000000000000 I
I 1111111112222222000000000000000000000000 I
I 3333333333333333000000000000000000000000 I
I 4444444444444444000000000000000000000000 I
I 4444444444444444000000000000000000000000 I
I 4444444444444444000000000000000000000000 I
I 4444444444444444000000000000000000000000 I
I 4444444444444444000000000000000000000000 I
I 4444444444444444000000000000000000000000 I
I 4444444444444444000000000000000000000000 I
I 4444444444444444000000000000000000000000 I
I 4444444444444444000000000000000000000000 I
I 4444444444444444000000000000000000000000 I
I 2222222222222444000000000000000000000000 I
I 2222222222222444000000000000000000000000 I
I 2222222222222444000000000000000000000000 I
I 0000000000000333000000000000000000000000 I
I 0000000000000333000000000000000000000000 I
I 0000000000000333000000000000000000000000 I
I 00000000000003330000C0000000000000000000 I
I 0000000000000333000000000000000000000000 I
I 0000000000000333000000000000000000000000 I
I 0000000000000333000000000000000000000000 I
I 0000000000000333000000000000000000000000 I
I 0000000000000333000000000000000000000000 I
I 0000000000000333000000000000000000000000 I
I 0000000000000333000000000000000000000000 I
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I 0000000000000333000000000000000000000000 I
I 0000000000000333000000000000000000000000 I
I 0000000000000333000000000000000000000000 I
I 0000000000000333000000000000000000000000 I
I 0000000000000333000000000000000000000000 I
I 0000000000000333000000000000000000000000 I
*--------------------------------------------*
```

TEST MAP **MAPF** NON-RESIDENTIAL (FILTERED)

Figure 30: Composite Average Familiarity Map

```
MAP  1,SHEET  1,DATA SET  1
*------------------------------------------*
I 1111111111111111111111111111111111111111 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 2222222222222222222222222222222222222222 I
I 1111111111111111122222222222222222222222 I
I 1111111111111111122222222222222222222222 I
I 1111111111111111122222222222222222222222 I
I 1111111111111111122222222222222222222222 I
I 1111111111111111122222222222222222222222 I
I 1111111111111111122222222222222222222222 I
I 1111111111111111122222222222222222222222 I
I 1111111111111111122222222222222222222222 I
I 1111111111111111122222222222222222222222 I
I 1111111111111111122222222222222222222222 I
I 1111111111111111122222222222222222222222 I
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I 3333333333333311133333333333333333333333 I
*------------------------------------------*
```

TEST MAP **AVGF** (AVERAGE LEVEL OF CONFIDENCE)

Figure 30: Composite Average Familiarity Map

```
MAP  2,SHEET  1,DATA SET  1
*------------------------------------------*
I 2222222222222222211111111111111111111111 I
I 4444444442222222233333333333333333333333 I
I 4444444442222222233333333333333333333333 I
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*------------------------------------------*
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TEST MAP **AVGF** (AVERAGE LEVEL OF CONFIDENCE)

Figure 31: Levels of Agreement in Classifying Land Uses in the Area

```
MAP   1,SHEET   1,DATA SET  1
*------------------------------------------*
I 3333333333333333333333333333333333333333 I
I 2222222233333333322222222222222222222222 I
I 2222222233333333322222222222222222222222 I
I 2222222233333333322222222222222222222222 I
I 2222222233333333322222222222222222222222 I
I 2222222233333333322222222222222222222222 I
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I 3333333333333333311111111111111111111111 I
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*------------------------------------------*
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TEST MAP **AGRV**

Figure 32: Levels of Agreement in Classifying Land Uses in the Area after Weighting by Familiarity

```
MAP  2,SHEET  1,DATA SET  1
*-------------------------------------------*
I 33333333333333333333333333333333333333333 I
I DDDDDDDDD3333333DDDDDDDDDDDDDDDDDDDDDDDDD I
I DDDDDDDDD3333333DDDDDDDDDDDDDDDDDDDDDDDDD I
I DDDDDDDDD3333333DDDDDDDDDDDDDDDDDDDDDDDDD I
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*-------------------------------------------*
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TEST MAP **AGRF** (AGREEMENT MAP FOR ATTRIBUTES, FILTERED)

Figure 33: Levels of Agreement in Familiarity by Grid Cell

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MAP   3,SHEET   1,DATA SET   1
*----------------------------------------------*
I 111111111111111111111111111111111111111111 I
I 222222222111111111222222222222222222222222 I
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*----------------------------------------------*
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TEST MAP **AGFM**   (AGREEMENT MAP FOR CONFIDENCE)

2.2 VANCOUVER LIVABILITY STUDY (C. Boerner and T. K. Peucker)

This report is intended as background material for an investigation into the concept of "livability". The concept as used here applies to a person's subjective images of the environment. Briefly, we describe how the Strabo Technique can be used as a method for mapping livability in an urban area. Some of the advantages and disadvantages of the technique are discussed along with its potential applications.

The need for work in the area of livability studies is the natural outcome of developments in the social sciences (particularly in geography) and computer graphics. Over the last twenty years there has been a growing recognition of the inadequacy of the more commonly used measures of well-being, at the same time, there has been an increasing demand for information on the regional growth and spatial patterns of such information. Thus, there has been a move on the part of researchers away from the practice of using census data without interpretation and towards development of general indices. This can be seen in widespread use of multivariate techniques of analysis, for example. There is, however, no adequate theoretical base for their development or use as yet, while there is universal agreement that it is needed.

At the same time mapping techniques, especially in the area of computer mapping, have advanced to a far greater level of sophistication than in the past. Today it is possible to portray in a simple graphic presentation that which in the past would have been an unmanageable volume of data. While there is much to be done in all areas, we are approaching the point where maps that accurately reflect subjective opinion on a large scale are no longer out of the question.

This study centres on the problem of mapping collective opinion about the livability of an urban area. The subject matter used is undefined and an understanding of which varies from individual to individual. While some attempts, as discussed below, have been made to define concepts like "livability" by those interested in social indicators, we are only just beginning. Our technique is suited for mapping phenomena across an area for which there are no compiled data sources but about which people have knowledge. It may also be used and be particularly valuable for mapping more objective data, such as the established census variables, which are not collected in many parts of the world because of the lack of funding or manpower. Maps produced will show a surface of livability over the city with "peaks" and "depressions" representing high and low values respectively. This report describes the background and methodology involved in the production of these maps. It is divided into four sections as follows:

1. A discussion of the literature on social indicators and related concepts.
2. What is livability and how is it applied?
3. Discussion of the methodology to be used.
4. Some discussion of problems and prospects of the methodology.

2.2.1 Social Indicators: Background and Applications

This study is closely related to much of the work that has been done in the area of social indicators. Over the last two decades a great deal of research has been advanced by government departments and universities, especially in North America, on the development of social indicators. Some research has included mapping social indicators, generally at a large scale; but, for a few cities there have been attempts to map the indicators on a more local scale.

There is a general concensus that research on social indicators has been somewhat lacking in direction. Definitions of "social indicator" have varied from the very general to the fairly specific. There is no real agreement about what a social indicator is. Some writers believe that there is no need to define the term in order to use an indicator meaningfully (Henderson, 1974, p. 50). Among the various definitions that have been proposed is that of the U.S. Department of Health, Education and Welfare (1969) publication, TOWARD A SOCIAL REPORT:

> "a statistic of direct normative interest which facilitates concise, comprehensive and balanced judgements about the condition of major aspects of a society. It is in all cases a direct measure of welfare and is subject to the interpretation that, if it changes in the 'right' direction, while other things remain equal, things have gotten better, or people are 'better off'" (U.S. Dept. of Health, Education and Welfare, 1969, p. 97).

A more concise definition is that of Bixhorn and Mindlin (1973, p. 3): a "quantitative measure of the quality of community life".

Social indicators are generally contrasted with economic indicators in that they deal with normative behaviour, but this does not imply that they can be used to measure behaviour. There is some agreement, however, that the use of social indicators does imply the consideration of other requirements. These are the use of time-series and inter-group comparisons, the interest in monitoring well-being with the objective of somehow helping to better the human condition, and the understanding that a social indicator remains, unlike most measures, a surrogate for some broader phenomenon. Thus, most scholars agree that social indicators are likely to evolve over time, as social phenomena are redefined.

The "social indicators movement" has been criticised from a number of viewpoints. Some have described it as a fad (Dial, 1973,

p. 2); others have denied that we can ever expect to monitor growth and welfare with particular indicators (Sheldon and Freeman, 1970, p. 99). Criticism of vagueness in definition is almost universal.

Applications of social indicators by governments, research institutes and the like abounds despite the criticisms, because the desire for social indicators and their importance as a counter-weight to economic indicators is so great. In Canada, Statistics Canada and the Economic Council of Canada have been the major supporters of research and measurement using social indicators (Henderson, 1974, pp. 60-61). American research has been funded by such divergent agencies as N.A.S.A., The National Science Foundation, and the Census Bureau, among others.

Most uses of social indicators can be placed in three categories: 1) simple compendiums of census-type variables, 2) weighted formula derivations to describe groups of census variables, and 3) multivariate analysis--especially factor analysis--to derive previously undefined "social indicators" from matrices of census variables. The use of other data sources, for example, the derivation of indicators from independent survey, has been minimal.

Relatively little work has been done in the area of urban mapping of social indicators, outside of the application of factor analysis to census data, which has been quite common (Berry, 1972). In general, this has taken the form of mapping, by census tract, three to seven factors with relatively similar results for most North American cities. Interest was originally generated in the early 1960s in connection with sociological and geographical research into urban social patterns. Few of the studies have approached the topic directly from the standpoint of the social indicators movement. Bixhorn and Mindlin (1973) are a notable exception in this regard, with their selection of variables centring around the development of coherent social indicators for a group of areas. Their discussion of the practicalities of social indicator formulation is equally enlightening. Monti's (1971) use of cluster analysis in San Antonio is another case in point.

2.2.2 Livability: What is it, and how is it used?

"Livability" as used in this report is a collective appreciation of the environment, both social and physical. The term, while not as recognised as that of the social indicator, of which it may in a sense be considered a subset, has a history of approximately equal length. It has been applied, almost universally, to an urban setting, and has generally had an association with subjective characteristics of the environment.

Wilson (1962, p. 359) defined the term in a study of North Carolina cities as:

> "the sum total of the qualities of the urban environment which tend to induce in a citizen a state of well-being and satisfaction. Those qualities of the environment which contribute toward a positive valuation of that environment may be called factors of livability."

He applies the term in an interview directed at determining the elements in their environments that persons most associate with a positive feeling. He includes questions dealing with physical conditions such as street repair and parks as well as attitudinal components such as friendship, cleanliness, spaciousness and the like.

Buttimer (1972, p. 279) used the term quite differently, describing it as a "process of becoming". Her approach was related to that of Jane Jacobs (1961) who saw the city as being meaningful only with one's participation in it. Buttimer (Ibid., p. 282) saw the livability in the interaction of the resident, planner and investigator, each contributing to the city as a whole; she describes her view as an existentially-oriented one.

The concept of livability is closely related to that of the quality of life, to which a great deal of attention has been directed lately. Quality of life as a topic of research may be considered as a subset or a group of subsets of social indicators. Research differs from that on social indicators primarily in an emphasis on more tangibly "good" and "bad" categories of existence, such as with pollution, safety, and beauty, all of which are associated with values held by society. Quality of life research also differs in practice from that on social indicators by its lesser use of mathematical functions to define terms, and a far greater use of survey procedures to obtain attitudinal data. In this respect, quality of life studies resemble livability studies. Quality of life studies have also tended to deal with a very broad range of geographical scales, from the street level (Appleyard and Lintell, 1972), to the city level (Saarinen and Cooke, 1970), to the national level (Jones and Flax, 1970). As is the case with social indicator research, no theoretical basis has been developed as yet and topics of interest range widely. In the last decade, there has been an emphasis on pollution studies within quality of life studies.

In Vancouver, the term "livability" has taken on special meaning for those who follow regional politics. This is because of the Livable Region Programme adopted over the last few years by the Greater Vancouver Regional District. This agency is responsible for coordinating long-range planning for a metropolitan area of some 1.2 million persons, and has as a membership city managers from all of the cities, municipalities and districts in an area extending roughly thirty miles to the east of Vancouver. The Livable Region report is described as a set of proposals, "to manage...population growth and still keep the Region a good place to live" (G.V.R.D., 1975, p. 2). It is not called a plan because it has not been formally adopted by any city or municipality. The report (Ibid., p. 3) proposes a five-part programme aimed at:

1. developing residential growth targets for sub-areas of the region;
2. promoting a balance between jobs and population in sub-areas;
3. the creation of regional town centres;
4. providing a public-transit oriented transportation system; and
5. the protection and development of regional open space.

These hopes constitute "livability" for the regional planner in Vancouver. Officials of the G.V.R.D. concede that although the term is somewhat of a "catchword", it is a popular one with politicians.

Three approaches to the concept of "livability" have been discussed in this section. While the term has no formal definition, it has been applied in surveys dealing with the environment, in an existentialist view of the city, and in the political world of the planner. People appear to know what it means and appear to be able to use the term very well. Its vagueness is in fact an advantage. The term is used in this study because it most closely expresses the social indicator that is to be investigated. The term is commonly understood, and it fits the urban context in practice.

2.2.3 Using a Strabo Methodology to Study Livability

This portion of the paper is primary concerned with the special problems encountered in the mapping and feedback stages of the methodology. It also examines some of the literature in environmental psychology and geography that is relevant to the methodology used in this study.

Some mapping problems may be illustrated by presenting an example. We can anticipate, for example, when asking a group of developers to identify those areas of the city which are "livable", that some of the following problems will arise:

1) They will have a very "localised knowledge" of the region. A considerable amount of work has been done by geographers in the area of "information fields" and "action space" to determine how to measure an individual's familiarity with his environment (Marble and Nystuen, 1963; Downs and Stea, 1973). From information about an individual's travel patterns within a city, for example, spatial weightings can be determined for his localised knowledge, rather than having him determine his own familiarity, as is done in the Delphi method. Some further discussion of weightings is found below.
2) Each will have a unique view of what livability is. This is inevitable and is not a problem which can be easily overcome. Some means of determining what the respondent means by

livability will have to be incorporated into the study. A developer will tend to look at "livability" in more economic terms than will others, therefore it might be necessary to limit our definition of livability to account for this, or perhaps broaden our selection of respondents. Related to this matter is the question of what role the person sees himself in when interviewed.

3) They will not know how to draw a map. This problem has been shown not to be a serious one as a variety of simple techniques have been developed to encourage persons to draw (Lynch, 1960; Blaut and Stea, 1970).

4) They will be unable to interpret the summary information or will not react to it by changing their opinions towards the mean. There is no reason to anticipate this any more than with the Delphi method. If responses do not change, Dalkey and Rourke suggest that the distribution of opinions was most likely bi-modal to begin with, or that the subject matter may be "fact" rather than opinion (Dalkey and Rourke, 1971, p. 5).

Mapping problems are considerable with the Strabo method. The respondents will be asked to draw maps of livability by outlining areas on a base map of the Vancouver region that correspond to neighbourhoods of high and low livability. These maps are called individual response maps. From these maps two types of maps are provided the respondent in each feedback cycle. The first is a summary response map, showing regional variation of the degree of correspondence. At the same time reliance maps, giving regional variation of the "predictive accuracy" of the data are presented. After the whole process is completed thematic maps portraying regional variation of the variables are drawn. Each of the last three sets of maps requires techniques for combining individual maps for which we have only limited methodology. The question of determining the statistical confidence of maps is a particularly difficult problem.

Some limited techniques for combining maps of simple single-valued polygons suggest themselves here. These incluude the use of centrographic statistics, (Bachi, 1963; Caprio, 1970). This would require some intermediate step of gridding the map, and would not yield valuable results if there were a great geographical divergence in the respondents' opinions. Another possibility is that of interpolating along outlines for all of the respondents to arrive at a composite mean border. Again, there are problems if respondents all consider different parts of the city to be livable, compounded further by algorithmic details of dealing with doughnut-shaped polygons and outliers. Another possibility is similar to that used by Barry and Freyman in their geological extension of the Delphi method, but more oriented towards spatial statistics. Rather than compiling statistics for data within each cell, one can use a small cell-size and consider all cells to be either within or outside an individual's livability polygon. These may be added up and summary response maps and reliance maps produced from these data. Maps of polygon intersections or unions might also be a possibility as feedback statistics. It is likely that all of these maps would be useful in some ways.

2.2.4 Prospects for the Strabo Technique

We have outlined in brief some of the issues involved in the application of the Strabo technique and in the concept of livability. We will conclude here by suggesting a few of the applications for which the technique might be useful in relation to livability, as well as some that might be useful outside of the area of livability. These include:

1) An investigation of the relationship between socio-economic status and spatial knowledge. While it has been shown that income relates positively to spatial knowledge, no test has been made to relate the two with concepts of livability.

2) A test of the relative speed with which different socio-economic groups evaluate and respond to feedback from others and revise their opinions.

3) The development of a time-series approach to concepts of livability similar to that used in social indicators research.

4) The testing of variation between information fields and livability space for different population groups.

5) A comparison of concepts of livability for different segments of the government and academic world concerned with urban society.

6) The mapping of other undefined concepts like "noisy", "interesting", "dangerous", and the like.

7) An investigation into levels of livability.

FOOTNOTES

1 For the purposes of this paper, the Strabo Technique refers to the general, spatially-oriented, forecasting and planning strategy together with its "implements of application", such as questionnaires and maps, computer programmes, and methodologies of analysis. The Strabo Planning Method, on the other hand, refers to a specific application of the Strabo Technique to a planning situation.

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Appendix 1

Three ways of adding flexibility to Data Matrices:

1. Several categories on one Attribute Map may be reclassified as constituting one category. This can be done by charging several values equal to one value in the INDATA matrix. In our example, we can combine the single and multiple family unit categories into a combined housing category and compare it to the non-residential category. Now we see that although there is considerable disagreement over where to locate single family as opposed to multiple family units, there is a great deal of agreement concerning the location of residential as opposed to non-residential areas.

2. Certain portions of a neighbourhood may be thought to be more 'important' than others. If members of the committee can come to a consensus concerning the relative importance of different locations, the cells can be weighted to reflect their relative importance. This weighting can be accomplished by changing INDATA to count certain cells more than once. For example, if the Grandview planners felt that disagreements over the cells bordering Hastings Street and those bordering First Avenue should be weighted as three times as much as cells in other parts of the neighbourhood, then the rows bordering these streets would simply be recorded three times rather than once. If the cells bordering Commercial Drive between Venables and First Avenue were to be weighted four times as much as other cells, then we could repeat the appropriate columns four times.

3. If the planning committee wanted to see a composite disagreement matrix reflecting their combined disagreements on several different kinds of Attribute Maps, this could be accomplished by giving the relevant rows in portions of the INDATA Matrix the same map identification index. In this way CHECKER and COMPARE would treat the combined maps as if they represented one 'map'. The attributes could also be weighted to reflect their relative importance.